Circuit Description

Note: The description related to the SPK is applicable to X1e only.

1. RF Section

1.1 TX Circuit

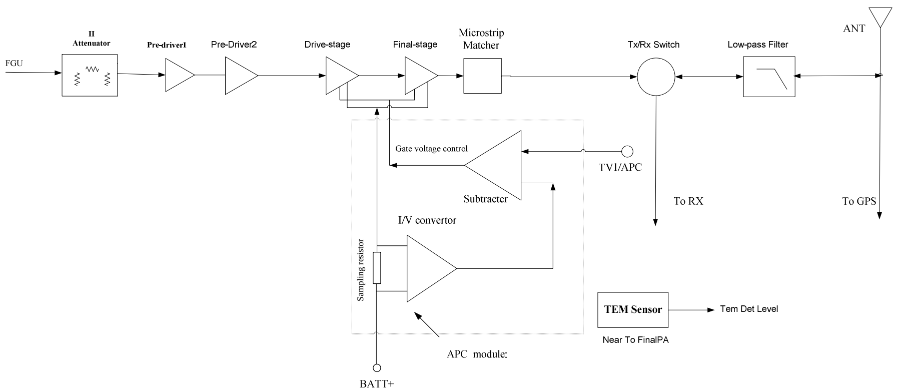

Figure 1 Diagram of TX Circuit

The TX circuit is mainly composed of:

① RF power amplifier circuit

② Low-pass filter circuit (for suppressing harmonics)

③ Auto power control circuit (APC) (including temperature detection circuit)

The carrier signal generated by TX VCO is modulated and amplified, and then feeds to the TX circuit. In this circuit, the signal passes through a II-type attenuator first, allowing certain isolation between the RF power amplifier circuit and TX VCO. Then it goes to a pre-driver amplifier (2SC3356) for pre-amplification, also providing certain isolation. After that, the signal goes to another pre-driver amplifier (2SC4988) and a driver amplifier (RD01) for further power amplification, to provide appropriate signal to the final-stage amplifier (RD07) for final power amplification. After processed by multiple amplifiers, the signal is processed by a microstrip matcher to complete output impedance matching, so as to reduce output power loss due to impedance mismatch. Then the signal passes through the TX/RX switch and goes to the low-pass filter.

The low-pass filter is a high-order Chebyshev filter composed of lumped-parameter inductors and capacitors. Via this filter, the spurious signal within the stop band can be attenuated as much as possible while the in-band ripple is within the required range.

In the auto power control and temperature detection circuit, the drain current from the driver amplifier and final-stage amplifier is converted to voltage via the sampling resistor and subtraction circuit (composed of the first operational amplifier). This voltage is compared with the APC control voltage (output by DAC) at the second operational amplifier. Then the error voltage, which is output by the second operational amplifier, controls TX power by controlling the bias voltage at the gates of the amplifiers (including the driver amplifier and the final-stage amplifier). The temperature sensor detects the surface temperature of the final-stage amplifier, and converts it to DC voltage. Then the DC voltage is compared with the voltage corresponding to the protection temperature (generally 90% of the extreme temperature) of the amplifier. If the surface temperature is too high, the bias voltage of the amplifier will be reduced, so as to reduce output power. The bias voltage will not be increased until the surface temperature restores to normal level. This process will be repeated while the radio operates.

1.2 RX Circuit

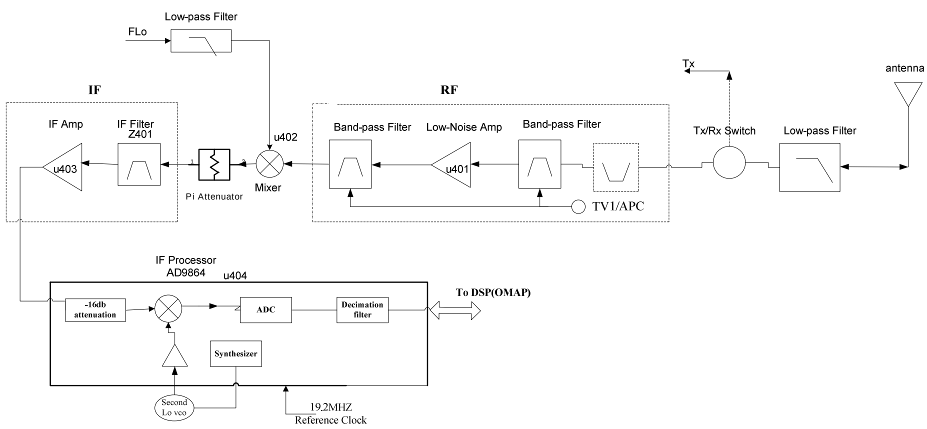

Figure 2 Diagram of RX Circuit

The RX circuit mainly comprises the RF band-pass filter, low-noise amplifier, mixer, IF filter, IF amplifier and IF processor.

1) Front-end Circuit

The HF signal from the low-pass filter passes through the electrically tunable band-pass filter controlled via APC/TV1 level, to remove out-of-band interference signal and to send wanted band-pass signal to the low-noise amplifier (Q9001). The amplified signal goes to a band-pass filter controlled via APC/TV1 level, to remove out-of-band interference signal generated during amplification, and to send wanted HF signal to the mixer.

The wanted signal passes through the RF band-pass filter and low-noise amplifier and goes to the mixer (D9017). Meanwhile, the first local oscillator (LO) signal generated by VCO passes through the low-pass filter and also goes to the mixer (D9017). In the mixer, the wanted signal and the first LO signal are mixed to generate the first IF signal (44.85MHz). Then the signal passes through a II-type attenuator (2dB) and the LC, to suppress carrier other than the first IF signal, and to increase the isolation between the mixer and the IF filter. After that, the first IF signal is processed by the crystal filter (Z9001), and is sent to the two-stage IF amplifier circuit (composed of 2SC3356) for amplification. Then the amplified signal goes to the IF processor AD9864(U401) for processing.

2) Rear-end Circuit

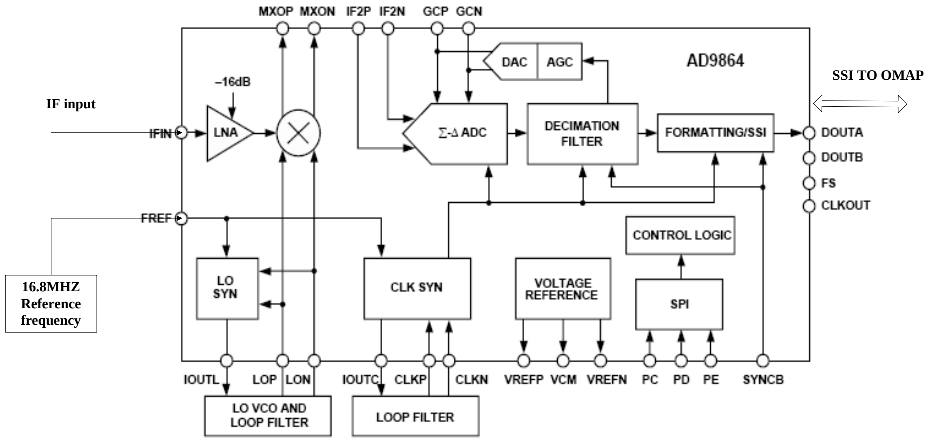

Figure 3 Diagram of IF Processor

The first IF signal (44.85MHz) output by the IF amplifier goes into AD9864 (U401) via Pin 47, where the signal is converted to the second IF signal (2.25MHz). Then the signal is converted to digital signal via ADC sampling, and output via the SSI interface. Finally, the digital signal is sent to DSP (OMAP5912) for demodulation.

AD9864 employs reference frequency of 19.2MHz and shares the crystal with OMAP. The second LO VCO comprises an oscillator, a varactor and some other components, to provide the 47.1MHz LO signal. The 18MHz clock frequency is generated by the LC resonance loop.

1.3 Frequency Generation Unit (FGU)

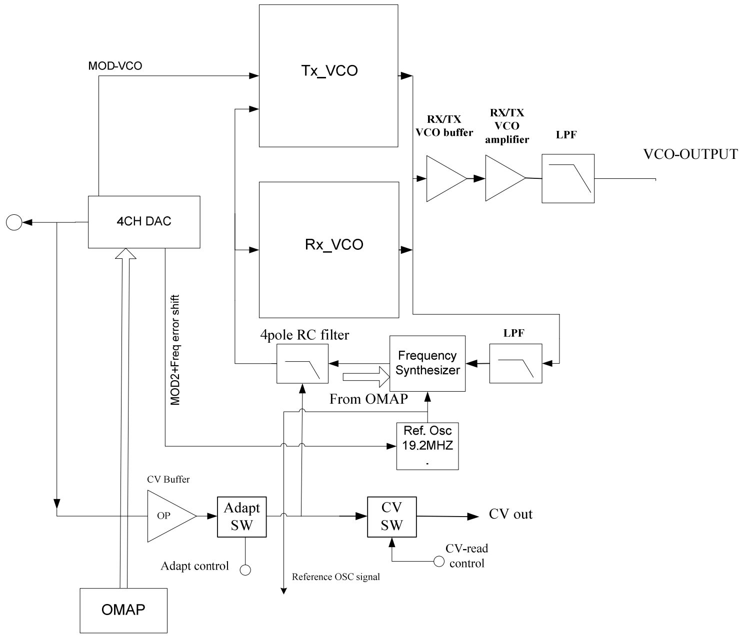

Figure 4 Diagram of FGU

The FGU is composed of VCO and PLL. It is the core module of the whole TX-RX system. This circuit provides accurate carrier frequency during transmission, and stable LO signal during reception. It has a direct influence on the performance of the system.

1) Working Principle of PLL

The 19.2MHz frequency generated by the reference crystal oscillator goes to PLL for division, generating the reference frequency (i.e. step frequency f1). Meanwhile, the frequency generated by VCO generates another frequency (f2) through the frequency divider in PLL. Then frequencies f1 and f2 are compared in the phase detector (PD), to generate continuous pulse current. The current goes to the loop filter for RC integration, and is then converted to CV voltage. Then the CV voltage is sent to the varactor of VCO. It adjusts the output frequency of VCO directly until the CV voltage becomes constant. Then PLL is locked, and the stable frequency output by VCO goes to the TX-RX channel after passing through two buffer amplifiers.

2) Working Principle of VCO

VCO employs Colpitts oscillator circuit (the RX oscillator circuit is composed of D102, D103, D106, D107 and L112; the TX oscillator circuit is composed of D108, D109, D110, D101 and L117). It obtains different output frequencies by changing the varactor's control voltage (i.e. CV voltage).

There are two types of VCO: TX VCO and RX VCO. Both types control EMD22 to switch operating status via OMAP. RX VCO is composed of the oscillator loop and Q104, to provide LO signal. TX VCO is composed of the oscillator loop and Q108, to provide carrier for TX signal.

3) Two-point Modulation

In TX mode, the two-point modulation technology is employed, to obtain higher modulation accuracy and lower 4FSK bit error rate. MOD-VCO and MOD-XO send the modulation signal to the modulation end of VCO and the reference crystal oscillator of PLL respectively to modulate TX VCO and the reference crystal oscillator.

1.4 GPS Circuit

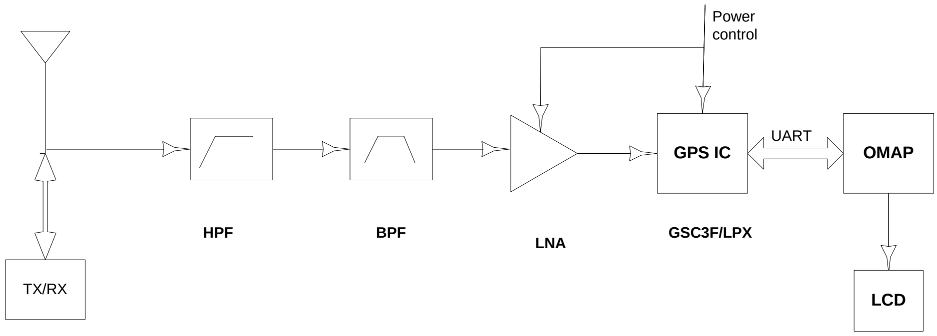

Figure 5 Diagram of GPS Circuit

The GPS function is realized via GSC3F/LPX. The GPS circuit integrates a baseband processor, a LNA and a SAW. The 1575.42MHz GPS signal is received by the antenna, and then goes to HPF to remove the in-band signals used for transmission and reception. After that, the signal goes to BPF to further remove in-band signals, as well as harmonic and spurious signals. Then the weak GPS signal goes to a low-noise amplifier (LNA) for amplification. After amplified, the signal goes to the GPS module for further amplification and filtering, and is then sent to the baseband section for calculation. Then the calculated GPS positioning information is sent to OMAP via the UART interface. Meanwhile, OMPA can send appropriate command information to the GPS module via the UART interface. Finally, OMAP sends the processed data information to LCD.

1.5 BT circuit

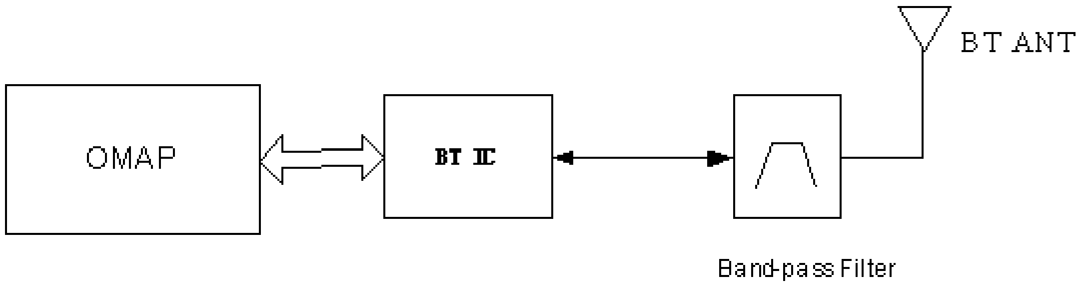

Figure 6 Diagram of BT Circuit

The BT function is realized via the BT module. The BT module integrates a BT IC, a Band-pass Filter and a BT ANT. The 2.4-2.4835GHz BT signal is transmitted or received by the antenna, and then goes to Band-pass Filter to remove the spurious signals. After that, the signal goes to the BT module for further amplification and filtering, and is sent to demodulation. Then the demodulation information (data and voice) is sent to OMAP via the UART port. Meanwhile, OMPA can send appropriate command information to the BT module via the UART port.