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Technical Description

SX5 GSM 850/1900 RADIO

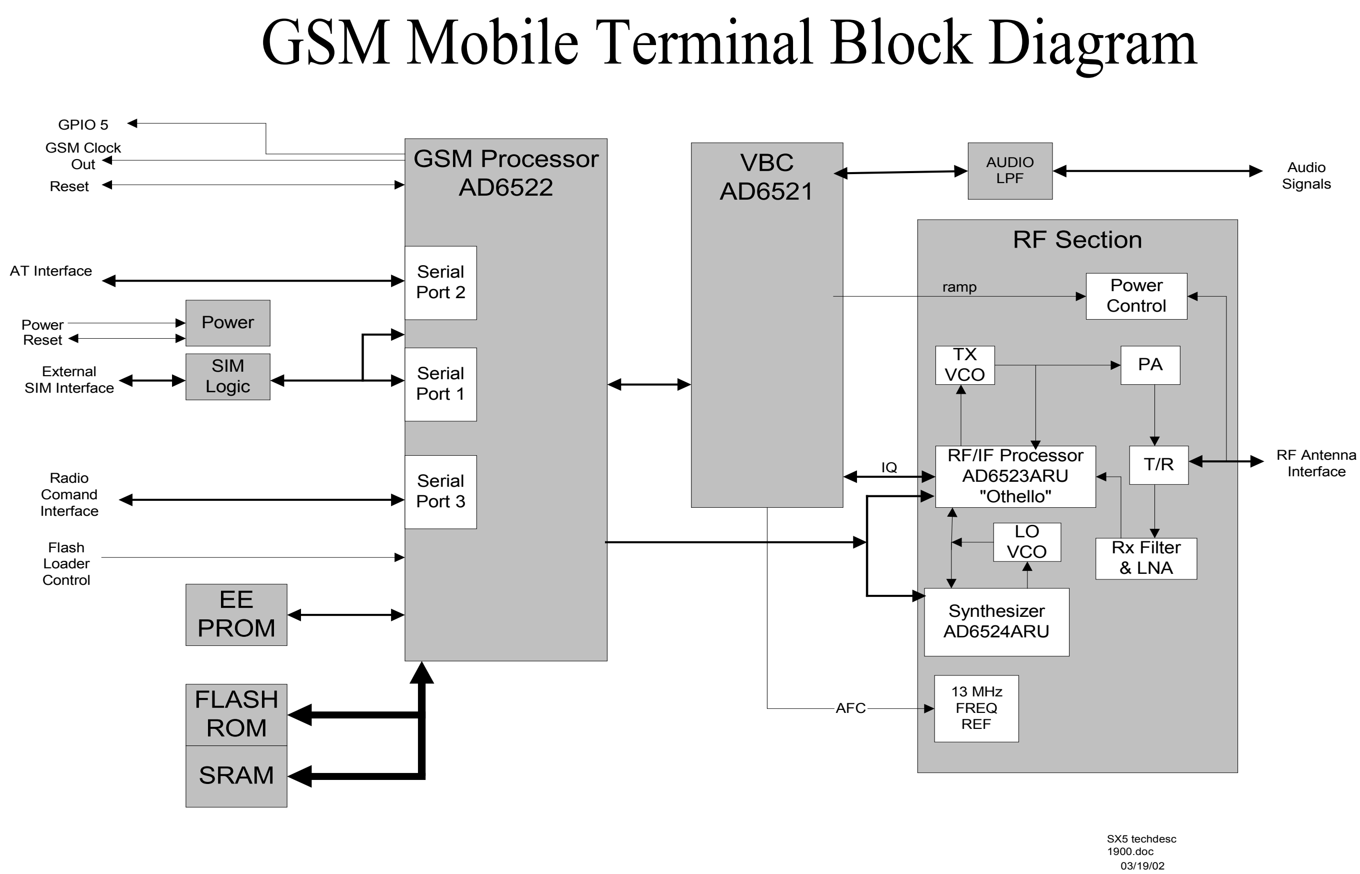
This document details the functional description of the GSM 850/1900 Mobile Stations (MS). This assembly consists of two major sub-systems:

The RF/IF processor
The GSM processor and Baseband codec

The RF/IF processor is based on the Analog Devices “Othello” radio and the baseband platform is comprised of the Analog Devices “430” chip set . The chip set contains four ICs, The AD6523 Transceiver, the AD 6524 Frequency Synthesizer, the AD6522 GSM processor and the AD6521 baseband codec. A functional block diagram of the Radio is depicted in figure 1.

This is a GSM Phase 2 compliant MS, that provides voice and data/fax capability. The RF part of the assembly operates in the GSM 850 frequency band (uplink 824 - 849 MHz, downlink 869 - 894 MHz) and forms a Class 1 MS, capable of delivering 2 Watts at the RF connector. It also operates in the GSM1900 frequency band (uplink 1850-1910 MHz, downlink 1930-1990 MHz) and forms a Class 1 MS, capable of delivering 1 Watts at the RF connector.

Figure 1. **GSM Radio architecture**



1. Local Oscillator

The entire radio module uses a single frequency reference of 13.000 MHz. A Voltage Controlled Variable Crystal Oscillator (TCVCXO) with AFC capability is employed to utilize the frequency stability of the GSM link. The baseband processor chip supplies the AFC control voltage. All frequency sources are derived coherently from this crystal reference.

Common to the transmitter and receiver is a Phase Locked Loop (PLL) controlled Local Oscillator that operates at exactly 3/4ths of the current transmit or receive channel center frequency in the 1900 band. The channel frequency is set by programming counters within the Synthesizer IC via a digital word from the baseband processor.

2. Transmitter

The transmit path of the system consists of a burst store, a GMSK modulator and two high-speed DACs with output spectrum shaping FIR filters. These filters provide the 0.3 GMSK waveform required for the GSM system.

The RF chip contains a vector modulator, a phase detector, down-converter mixer and two dividers. The Vector Modulator is used as a reverse-modulator in a translation loop, which in turn modulates the transmit VCO.

This architecture is illustrated in figures 2a and 2b.

Figure 2a. **RF Transmitter architecture – GSM 1900**

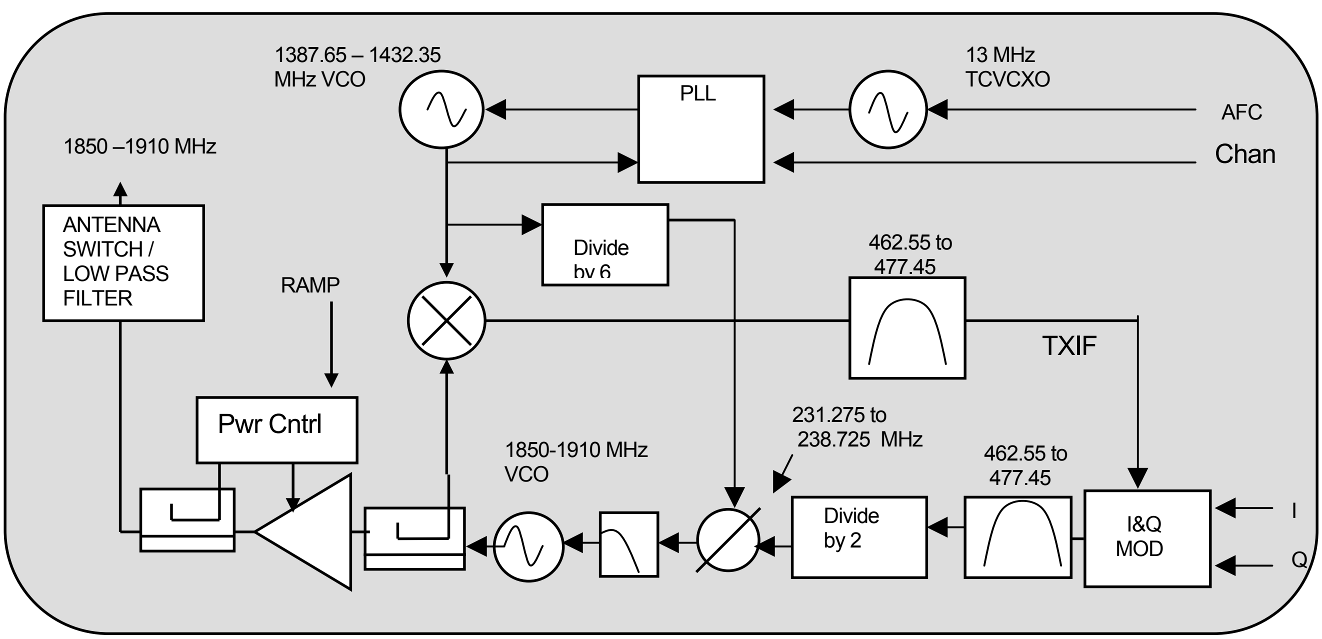
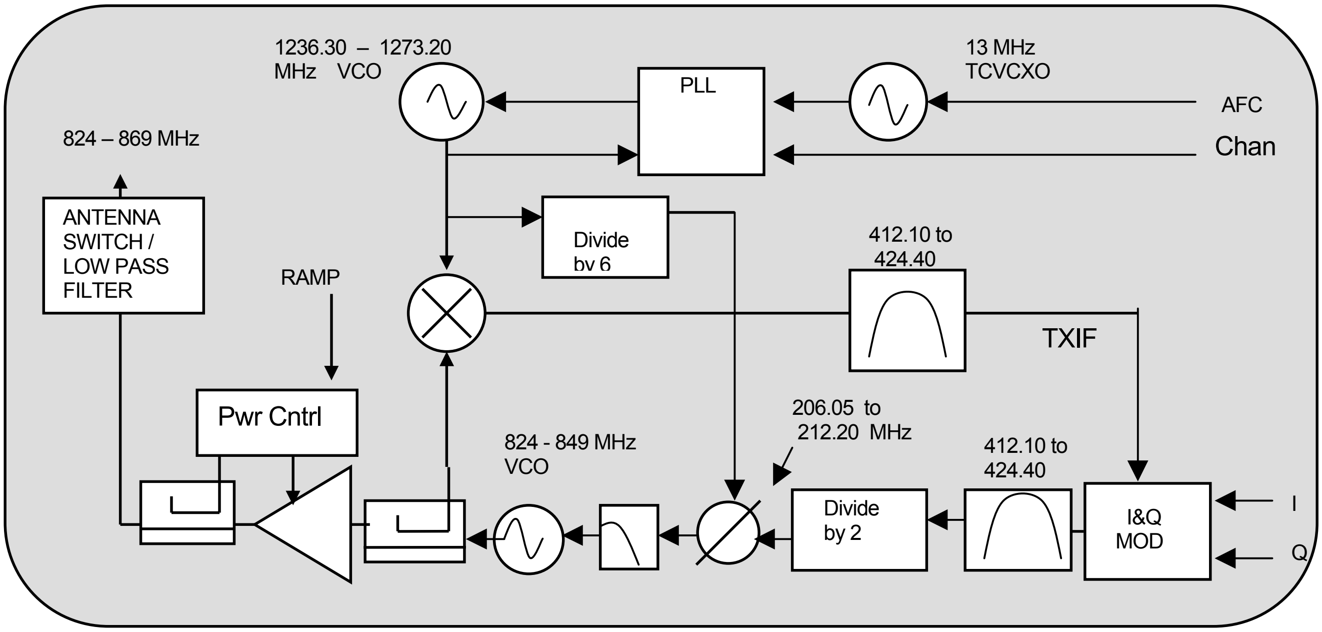


Figure 2b. **RF Transmitter architecture – GSM 850**



The Vector Modulators Carrier input is fed with a down converted version of the transmitter output (called the TXIF) containing the full GMSK modulation index. The I and Q baseband GMSK transmit modulation signals from the D/A converter are applied to the Vector Modulator. The resulting output from the Vector Modulator is a carrier at exactly 1/4th the AFRCN carrier frequency, with some residual error signal.

(The loop drives the output from the Vector Modulator to as pure a carrier signal as possible, in the process impresses an exact copy of the I-Q transmit waveform onto the main Transmit VCO.)

This resulting carrier plus residual error signal is divided by two and then applied to a phase/frequency detector which uses a pure carrier signal counted down from the Local Oscillator as it's reference.

The Phase Frequency Detector drives a Charge Pump and Loop Filter. The error voltage is then used to tune the transmit VCO to the exact ARFCN channel frequency.

(It should be noted that the TXIF is always exactly one fourth the transmit frequency.)

The output of the transmit VCO carries the original GMSK information and is fed to RF power amplifier.

The peak output power and the profile of the transmitted burst are controlled by means of a closed feedback loop, which is directed by the baseband processor.

The final RF output passes to the antenna connector through an integrated TX/RX switch and lowpass filter to attenuate the harmonics generated by the power amplifier.

3. Receiver

The receiver subsystem is a direct conversion receiver to baseband. The pictorial presentation is illustrated in figures 3a and 3b below.

The RF signal enters the receiver through the TX/RX switch. This is followed by a 881.5 MHz or 1960 MHz SAW bandpass filter and a low–noise amplifier. The signal passes via a BALUN transformer to the receive down-converter.

The receiver Local Oscillator, operating at exactly 3/2 (or 3/4th for PCS Band) of the channel frequency is converted to 0 and –90 degree oscillator signals needed by the Down-Converter, exactly on channel via a regenerative divider internal to the Receiver IC. Use of this internal regenerative divider solves the problems of local oscillator leakage paths upsetting the balance of the following mixers.

The mixer multiplies the RF frequency with the 1st LO, and produces I & Q baseband signals. DC offsets within the mixer are calibrated out.

The Baseband outputs are then filtered and pass to the dual AGC amplifiers. A succession of L/C and digital filters internal to the receiver IC limit the bandwidth of the baseband signal as it is amplified by the AGC amplifier.

Gain of the AGC amplifier is set by a digital word supplied by the baseband processor chip. The usable control range is in excess of 80 dB.

The I and Q information is then applied to the A/D converters. The FIR filters internal to the baseband chip perform the remaining channel filtering. The information is then converted into voice by the baseband codec and applied to the audio interface circuitry.

Figure 3a. **RF Receiver architecture – GSM 1900**

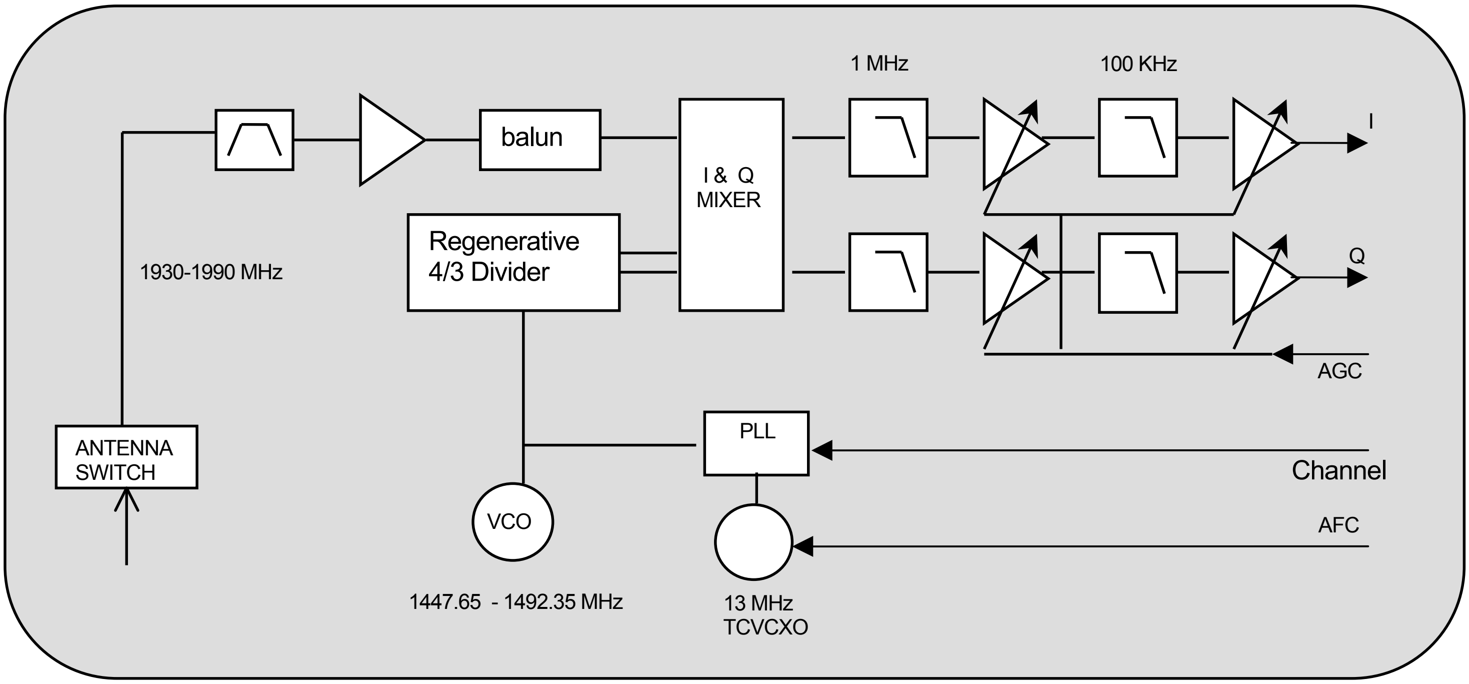


Figure 3b. **RF Receiver architecture – GSM 850**