

# Circuit Description

## 1 RF circuit

### 1.1 Main functions of RF circuit:

The baseband modulate the uplink signal, and then transmit it on RF carrier by the antenna; Demodulate the received wireless signal transmitted by the base station by the receiving circuit then get the forward signal; at the same time, provide the steady en-control 26MHz frequency source.

### 1.2 Structure of RF circuit:

We can divide it to 4 units according to the functions: Antenna unit, frequency synthesized unit, receiving unit, transmitting unit.

#### 1.2.1 Antenna unit

Antenna unit is composed by antenna groupware, antenna switch and FEM SKY77568. This antenna groupware is the transceiver of the wireless signal that is composed by inside antenna, and could fetch up the disadvantages such as the low efficiency and the poor radiance direction by the high performance match. This phone has the antenna switch and diplexer. The antenna switch is used as the auto-test mechanical switch, which is located at the RF channel and parallel connected to the antenna. When producing and testing, it is connected to the test cable. Diplexer is used to isolate the received and transmitted signals, which can reduce the interference.

#### 1.2.2 Frequency-synthesized unit

The MT6250A has a single fast-locking fractional synthesizer used for VCO control in both receive and transmit mode. The entire system including VCO, tank, fractional N dividers, sigma delta compensation, charge pump and loop filters are fully integrated. The only external

component is the frequency reference. The synthesizer is controlled via the serial interface. The VCO is fed into the respective dividers to generate the appropriate LO frequencies for the RX and TX bands.

### Fractional N Dividers

The fractional N divider allows the PLL system to have a smaller step size than the comparison frequency which is set by the external reference to 26 MHz. This feature allows all the GSM frequency band raster to be achieved, with fast lock times and good phase noise characteristics.

The divider section consists of a dual modulus 8/9 prescaler, integer M & A dividers, and fractional N system based on sigma-delta modulation to generate the required fractional divide ratio. The Denominator of the fractional divider can be set to 3 different values, (1040, 1170, 1235), depending on the mode of operation. For example a denominator of 1040 with an input fraction F maintains an average value of  $F/1040$  allowing 25 kHz steps when operated at a reference of 26 MHz.

### Phase Frequency Detector/Charge Pump

A Phase Frequency Detector (PFD) is used for the PLL phase detector. The charge pump is designed such that good matching of up and down currents is achieved over a wide output operating range. The charge pump output is internally routed to the integrated synthesizer loop filter.

### Synthesizer Loop filter

To minimize complexity of the external PCB layout the Main Synthesizer loop filter is also fully integrated into the IC. No external components or adjustments are required.

### Voltage Controlled Oscillator

The integrated voltage controlled oscillator (VCO) is a complete self-calibrating subsystem. This employs a fully auto-mated digital self-calibration function to ensure optimum phase noise performance over the entire frequency range. The VCO generates frequencies between 2520MHz and 2985MHz as required to operate in the four GSM bands for RX and TX.

### Reference Oscillator

The MT6250A requires only an external low cost crystal as the

frequency reference. The circuitry to oscillate the crystal and tune its frequency is fully integrated. For good noise immunity the oscillator is a balanced implementation requiring the crystal to be connected across 2 pins. There is a programmable capacitor array included for coarse tuning of fixed offsets (e.g. crystal manufacturing tolerance), and an integrated varactor for dynamic control. The oscillator is designed for use with a 26MHz crystal.

### 1.3. Transmitting unit

The transmit section of the MT6250A radio implements a translation loop modulator. This consists of a quadrature modulator, high speed phase-frequency detector (PFD) with charge pump output, loop filter, TX VCO and a feedback down converting mixer. The VCO output (divided by 2 for low band) is fed to the power amplifier with a portion internally fed back into the down-converting feedback mixer to close the feedback loop.

The Quadrature modulator takes the baseband I & Q signals and translates these into a GMSK signal at the Transmit Inter-mediate Frequency (TX IF). After bandpass filtering and limiting the TX IF signal is used as the reference input to the Phase Frequency Detector (PFD) of the transmit PLL.

#### Phase Frequency Detector (PFD)

The PFD ensures that the transmitted signal contains the required modulation and is accurately locked to the desired GSM channel. The downconverted feedback signal from the TX VCO and the Quadrature Modulator output are phase compared by the PFD. The PFD charge pump generates a current pulse proportional to the difference in phase which is applied to the loop filter.

#### Loop filter

To minimize complexity of the external PCB layout the TX loop filter is fully integrated into the IC. At power up the filter is automatically calibrated as part of the baseband filter cal, eliminating process tolerances. The calibration is fully integrated and requires no extra programming.

#### TX VCO

The Transmit Voltage Controlled Oscillator (TX VCO) and tank components are a fully integrated subsystem. The subsystem includes

PA drivers so the outputs are used to directly drive the external PAs. The low noise oscillator design and internal filtering mean that external TX SAW filters are not required. In Low band operation the TX VCO output is divided by two and filtered. The TX VCO is automatically calibrated to ensure optimum performance over its operating frequency of 1648 to 1910 MHz.

### Feedback Down-Converting Mixer

The feedback down converting mixer is used to translate the TX VCO output frequency to the TX IF. An integrated band pass filter exists between the mixer and the PFD to filter the mixers unwanted side band and higher order mixing products.

### Transmit Frequency Plan

Unlike many other translation loop modulators the MT6250A uses only a single VCO source to derive the local oscillator signal for both the Feedback Down-Converting Mixer and the Quadrature modulator.

This ratio was chosen to minimize VCO tuning range, TX IF frequency variation and ensure excellent transmit spectral mask performance.

The Feedback-Down Converting Mixer operates low side injection for the high bands and high side injection for the low bands. The final relationship between the transmitted TX frequency and the LO VCO frequency is different between the two bands.

These relationships are taken account of in the synthesizer architecture and programming.

### 1.4. Receiving unit

The MT6250A receiver section fully integrates all the RF and baseband signal processing. Each major block is described in the following sections.

### Low Noise Amplifiers

The MT6250A includes four fully integrated Low Noise Amplifiers (LNAs), to support quad band applications without further external active components. The LNAs have differential inputs which minimize the effect of unwanted interferers. The inputs are easily matched to industry standard Front End Modules (FEMs) or discrete Rx SAW filters. The outputs of the LNAs are directly coupled to the down-converting mixers. The gain of the LNAs are typically 24 dB. Each LNA can be switch to a low gain mode when receiving large input signals as part of the AGC system.

## Down-Converting Mixers

Two quadrature mixers are used to mix down the signals from the LNAs, one for the high bands (1800 and 1900 MHz) and one for the low bands (850 and 900 MHz). The outputs of the mixers are connected to the baseband section through an integrated single pole filter with nominal cut-off frequency of 800kHz. This acts as a “roofing filter” for the largest blocking signals (i.e. those  $\geq 3\text{MHz}$ ) and prevents the baseband amplifiers from being overloaded.

## Baseband Amplifiers / Low Pass Filters

The baseband amplifiers provide the majority of the analog receiver gain. The filtering is provided by an integrated 5th order Chebyshev filter giving the necessary adjacent channel and blocking filtering, it is also acting as an anti-alias filtering for Baseband IC's converters. A final low pass pole is possibly each of the baseband outputs via internal series resistor along with an external shunt capacitor. The external capacitor is not normally required with ADI baseband ICs. The on chip filter has an auto calibration feature ensuring that the filters are tuned for optimum performance.

The baseband amplifiers have programmable gain for system AGC. A total of 57 dB of gain control is provided in 3dB steps programmable over the serial interface. This together with the LNA gain control gives a total of 77dB of gain control range.

The receive baseband outputs are routed to the common Rx/Tx I/Q ports for connection with the baseband converters.

## Baseband Output D.C. Offset Correction

In order to minimize D.C. offsets inherent in the receiver and maximize dynamic range a D.C offset correction circuit is integrated. This correction is triggered over the serial bus and then an offset tracking loop is enabled to minimize residual offsets under all conditions. The tracking loop is fully hardware integrated, requiring no software intervention.

## Receiver Local Oscillator (LO) Generator

The Rx LO generator is used to avoid DC offset problems associated with LO leakage into the receiver RF path. By operating the VCO at a frequency other than the desired receive frequencies, any leakage of the VCO will fall out of band. The LO generator is used to convert the

offset synthesized VCO output to the on-frequency quadrature LO required by the chipset. The LO generator is implemented as a regenerative frequency divider, performing a  $2/3$  multiplication of the VCO output for the high band (DCS1800/PCS1900) and a  $1/3$  multiplication for low band (E-GSM 900/GSM850).

## **2. Digital base band circuit principle**

### **2.1. General**

MT6250 is a feature-rich and extremely powerful single-chip solution for high-end GSM/GPRS capability .based on the 32-bit ARM7EJ-Stm RISC processor.MT6250,s superb processing power, along with high bandwidth architecture and dedicated hardware support, provides a platform for high-performance GPRS CLASS 12 Modem application . MT6250 also features

A highly integrated Bluetooth transceiver which is fully compliant with Bluetooth specification V3.0

A FM receiver supporting both audio broadcast de-modulation and RDS/RBDS data decoding.

### **2.2. The circuit and principle of each unit**

#### **2.2.1. Central control and data processing unit**

Platform

MT6250 is capable of running the ARM7EJ-STM RISC processor at up to 260Mhz, which provides the best trade-off between system performance and power consumption.

For large amounts of data transfer, high-performance DMA with hardware flow control is implemented, which greatly enhances the data movement speed while reducing the mcu processing load.

Targeted as a media-rich platform for mobile applications, MT6250 also provides hardware security digital rights management for copyright protection. For further safeguard and to protect the manufacture's development investment, hardware flash content protection of the software load.

## Memory

MT6250 supports serial flash interface with various operating frequencies.

## Multimedia

The MT6250 multimedia subsystem provides conventional parallel interface and 2-bit serial interface for CMOS sensors, the camera resolution is up to 2M pixels. The built-in Hybrid Motion JPEG Encoder hardware enables real-time capture of high-resolution images and recorder of video format such as MPEG-4 or Motion JPEG with smooth quality. The software-based codec can also be used to process various video types. Besides, MT6250 provides fancy UI capabilities through its hardware 2D accelerator. The 2D accelerator performs high-speed linear transformations with filtering. To take advantage of the high MCU performance, GIF and PNG decoders are implemented by the software.

## Connectivity and storage

MT6250 supports UART, USB 1.1FS/LS, SDIO, HIF interface and MMC/SD storage systems. These interfaces provide MT6250 users with the highest level of flexibility in implementing high-end solutions.

## Audio

Using a highly integrated mixed-signal audio front-end, the MT650 architecture provides easy audio interfacing with direct connection to the audio transducers. The audio interface integrates A/D converters for voice band, as well as high-resolution stereo D/A converters for both audio and voice band.

MT6250 supports AMR codec to adaptively optimize the quality of speech and audio. Moreover, HE-AAC codec is implemented to deliver CD-quality audio at low bit rates.

In addition, a 850mw CLASS-AB amplifier is also embedded to save the BOM cost of adopting external amplifiers.

## GSM/GPRS radio

MT6250 integrates a mixed-signal baseband front-end in order to provide a well-organized radio interface with flexibility for efficient customization. The front-end contains gain and offset calibration mechanisms and filters with programmable coefficients for comprehensive compatibility control on RF modules. MT6250 achieves outstanding modem performance by utilizing a highly dynamic range ADC in the RF downlink path.

MT6250 embeds a high-performance and completely integrated saw-less RF transceiver for multi-band GSM cellular system. In this RF transceiver, a quad-band receiving feature with high sensitivity is supported utilizing two RF differential receivers and a fully integrated channel filter. With ultra-high dynamic range, the saw filters on the receiving path can be removed for BOM cost reduction. In addition, the minimum component count is guaranteed by realizing a highly integrated transmitter, low-spur frequency synthesizer and a digitally-controlled crystal oscillator.

## FM radio

The FM radio subsystem provides a completely integrated FM Rx receiver supporting 87.5~108MHz FM bands with 50kHz tuning step.

## Bluetooth radio

MT6250 offers a highly integrated Bluetooth radio and baseband processor. Only a minimum of external components are required. MT6250 provides superior sensitivity and class 1 output power and thus ensures the quality of the connection with a wide range of Bluetooth devices.

MT6250 is fully compliant with Bluetooth v3.0 and offers provides the coexistence protocol with 802.11 system.

MT6250 supports rich Bluetooth profiles, enabling diversified applications that are widely used on the handset with excellent interoperability.

## Power management

A power management is embedded in MT6250 to provide rich features a high-end feature phone supports, including Li-ion battery charger, high performance and low quiescent current LDOs, and drivers for LED and backlight.

MT6250 offers various low-power features to help reduce the system power consumption. MT6250 is also fabricated in an advanced low-



power CMOS process, hence providing an overall ultra-low leakage solution.

#### 2.2.2. External Memory

128M Serial flash 1.8v 6X8mm WSON

#### 2.2.3. DISPLAY

We use a 176\*220 dot matrix 262k color TFT LCD module.

#### 2.2.4. WIFI

MT5931 is Wi-Fi device which includes

802.11 b/g/n

PA

LNA

TR-Switch

MT5931 provides the best and most convenient connectivity functions. MT5931 implements advanced and sophisticated radio coexistence algorithms and hardware mechanisms. Enhanced overall quality for simultaneous voice, data and audio/video transmission on mobile phone and tablet PC can be achieved. The small package size with low power consumption reduces PCB layout area.