CDMA/GSM Mobile Phone

EG59

Technical Manual

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1. Introduction

EG59 mobile phone is designed and developed for CDMA/GSM network. Its main features are:

- The QUALCOMM single chip QSC6085 and MediaTek MT6223D chipset are used, which feature Zero-IF and CMOS technology, resulting high integration and great RF performance
- Memory chips are 256MByte NAND/128MByte DDR and 64M bit NOR/32M bit PSram MCP
- 65k colors, 320*240 TFT color LCD display
- MIDI,MMF,AAC,MP3 ringtone
- Camera
- T-Flash memory card
- Bluetooth
- Touch panel
- USB storage

2. Key Design Technology

2.1. Hardware:

CDMA/GSM/Bluetooth antenna design
technology Transmit link design technology
Receive link design technology
Frequency synthesize technology
RF control software compensation technology
Integrated system control technology
LCD implementation technology Interface
circuit design technology
Low power consumption design technology
High intensity PCB design technology
Ringtone quality improve technology
Components cost control
EMC/EMI design technology

Reliability design technology

2.2. Software:

Reliable control of Flash & RAM

User-friendly UI design

Localized system capture optimization technology

Power consumption reducing software optimization technology

Systematic reliability design

3. Technical Specifications and Performance Parameters

3.1. General specifications

Item	Content
Mode	CDMA/GSM
Frequency Band	CDMA 800MHz Tx: 824 ~ 849MHz Rx: 869 ~ 894MHz GSM 900 MHz: (Used in European only) Tx: 880 ~ 915MHz Rx: 925 ~ 960MHz DCS 1800 MHz: (Used in European only) Tx: 1710-1785MHz Rx: 1805-1880MHz BLUETOOTH: 2402MHz to 2480MHz
Dimensions (L*W*D)	116mm×51mm×13.5mm
Working temperature	-20 ~ +55℃
Storage temperature	-30 ~ +60℃
Relative humidity	5% ~ 95%
Tx Output Power	23±2dBm Max (CDMA) 33±2dBm Max(GSM) 29±2dBm Max(DCS) -6~+4dBm(BT)

Channel bandwidth	1.23MHz(CDMA) 200kHz(GSM)
Battery capacity	1100mAh

3.2. Electronic specifications

Tx unit
GSM:

Item	Description	Marks
Frequency band	GSM: 880~ 915MHz DCS: 1710-1785MHz	
Output power	GSM: 33±2dBm DCS: 29±2dBm	
Channel bandwidth	200kHz	
Modulation	GMSK/QPSK	

CDMA:

Item	Description	Marks
Frequency band	Tx:824 ~ 849MHz	
Output power	23±2dBm Max	
Channel bandwidth	1.23MHz	
Modulation	OQPSK	

Rx unit
GSM:

Item	Description	Marks
Frequency band	GSM: 925~ 960MHz DCS: 1805-1880MHz	
Receiver sensitivity	–102dBm (Class II FER<2.44%)	
Phase Error Peak	-20° -- +20°	
Phase Error RMS	≤5°	
Frequency Error	GSM: ±90Hz DCS: ±180Hz	

CDMA:

Item	Content	Comment
Frequency band	CELL：869~ 894MHz	
Channel bandwidth	1.23MHz	
Receiver sensitivity	< –104dBm (FER:0.5%)	
Single Frequency Interference Resist	< –101dBm (FER: 1.0%)	Frequency offset: 900KHz Power: -30dBm
Inter-modulation spurious response attenuation	①Frequency offset: ±0.9MHz/±1.7MHz, Power: -43dBm	
	②Frequency offset: ±0.9MHz/±1.7MHz, Power: -32dBm	
	③Frequency offset: ±0.9MHz/±1.7MHz, Power: -21dBm	
Conductibility spurious emission	①<–81dBm	
	②<–61dBm	

3.3. Other Electronic Specifications

SIM / UIM interface, Support either 3V or 1.8V

4. Phone Work Principles

4.1 RF circuit

4.1.1 RF circuit of CDMA

4.1.1.1Main functions of RF circuit:

The baseband CDMA signal is modulated by transmitting circuit, and then is transmitted by antenna on the bandwidth: 824MHz~849MHz; When the receiver circuit receives the signal on 869MHz~894MHz, it is demodulated and becomes to the forward channel baseband CDMA signal; and at the same time, provides the constant controllable 19.2MHz frequency source.

4.1.1.2 Structure of RF circuit:

We could divide it to 4 units according to the functions: Antenna unit,

frequency synthesized unit, receiving unit, transmitting unit.

4.1.1.2.1 Antenna unit

This unit is composed by antenna groupware, antenna switch, diplexer and duplexer.
This antenna groupware is the transceiver of the wireless signal that is composed by intside antenna, and could fetch up the disadvantages such as the low efficiency and the poor radiancy direction by the high performance match. This phone has the antenna switch, diplexer and duplexer. The antenna switch is used as the auto-test mechanical switch, which is located at the RF channel and parallel connected to the antenna to reduce the 0.47dB loss during using. When producing and testing, it is connected to the test cable. Duplexer is used to isolate the received and transmitted signals, which can reduce the interference.

4.1.1.2.2 Frequency-synthesized unit

QSC6085 platform has a high integration on the frequency-synthesizing and a flexible design project, which is composed of the following circuits: crystal oscillator (XO) 19.2MHz, Loop filter and QSC6085 power management. Crystal oscillator (XO) is provided to TX and RX as the fiducially source, and also is provided to QSC6085 as the clock source buffered and filtered by inside power management.

4.1.1.2.3 Transmitting unit

Mainly the following circuits compose this unit: Tx SAW filter, Power amplifier, burst mode/PA-ON control circuit and high power detect circuit. CDMA 1X signal is output from QSC6085. For transmitting the power control correctly, QSC6085 outputs TX_AGC_ADJ PDM signal to control the output power. PDM pulse wave can realize the plus control beyond 85dB by RC filter circuit. The frequency of the output signal is conversed up from analog base band signal to 824MHz-849MHz mixed by UHF_LO. Output signal go through TX SAW filter (836.5MHz+/-12.5MHz) to power amplifier, and then output to duplexer. The duplexer has 55dB isolation to the receiver unit.

4.1.1.2.4Receiving unit

The duplexer gets the 869MHz-894MHz signals received from the antenna. To the transmitting loop, the duplexer has 56dB isolation, and the insertion loss of the duplexer is 2.2dB. After entering the integrated low noise amplifier embedded in QSC6085 chip, the low noise amplifier has gain switch function, when there are stronger interfering signals coming in the received band, the gain will be reduced, which will

weaken distortion generated by inferior processes. When the received signal is lower than -85dBm, LNA processes the high gain control, at the same time, QSC6085 controls LNA current offset and gain compensation of QSC chip. LNA outputs to RX SAW filter and restrains the 40dB transmitted signal and out-of-band signal. The bandwidth of the filter is 25MHz, and the frequency range is 881.5+/-12.5MHz, then output to QSC6085. QSC6085 supports zero intermediate frequency technology, which can converse the frequency down to base band signal directly, and then generates two analog signals (I and Q) to enter QSC6085 chip for advanced demodulation.

4.1.2 RF circuit of GSM

4.1.2.1 Main functions of RF circuit:

The baseband modulate the uplink baseband GSM signal, and then transmit it on 885MHz--915MHz carrier by the antenna; Demodulate the received wireless signal transmitted by the base station on 925MHz-925MHz carriers by the receiving circuit and get the forward channel GSM signal; at the same time, provide the steady en-control 13MHz frequency source.

4.1.2.2 Structure of RF circuit:

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

4.1.2.2.1 Antenna unit

Composed by antenna groupware, antenna switch and diplexer. 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.

4.1.2.2.2 Frequency-synthesized unit

EG59 uses MT6139 as RF transceiver. MT6139 is a highly-integrated RF transceiver IC for GSM850/GSM900/DCS1800 bands. It includes 4 LNAs, 2 RF quadrature mixers, a channel filter, a programmable-gain amplifier for the receiver, a high-precision I/Q modulator for the transmitter, a 26MHz VCXO reference, a fractional-N frequency synthesizer with a fully-integrated LC-tank VCO and 3 built-in LDO regulators for VCO, VCXO and SDM. Its functional block diagram is shown as below.

The MT6139 includes a Phase-Locked Loop (PLL)-based fractional-N frequency synthesizer with a fully-integrated LC-tank VCO. It provides the Local Oscillator (LO) signals for both receiver and transmitter. In order to reduce the inherent spurs caused by the fractional-N synthesizer, a 3rd-order sigma-delta modulator with a dithering function is used to generate the division number N for the prescaler. The prescaler is composed of a high-frequency divided-by-2 circuit and a multi-modulus frequency divider with the programmable division number ranging from 32 to 127. A conventional digital-type Phase-Frequency Detector (PFD) with a charge pump is used for phase comparison.

4.1.2.2.3. Transmitting unit

MT6139 transmitter adopts the direct-conversion architecture with higher integration level and simpler frequency plan. It consists of BaseBand (BB) I/Q filters, I/Q modulators, frequency dividers, output buffers and a bias-core circuit. BB I/Q differential signals from the BB chip are fed into the one-pole RC low-pass filter first for better out-of-the-band noise performance. The 3-dB frequency corner is allocated at 700kHz. Two double balanced mixers (modulators), one for I+/I- and another for Q+/A- signals, are responsible for translating the filtered BB I/Q signals to the transmitting frequencies. LO signals are provided by the divided-by-2 (DCS1800) and divided-by-4 (GSM850/GSM900) dividers. The output buffers amplify the modulator output signals to an adequate level to fulfill P-in requirement of Power Amplifier (PA). At last, the on-chip balun is used to convert the differential signals to single-ended output signal.

4.1.2.2.4. Receiving unit

The receiver section includes Quad-Band Low-Noise Amplifiers (LNAs), RF quadrature mixers, channel filters, Programmable-Gain Amplifiers (PGAs), and on-chip automatic DC-offset correction loops. The differential inputs are matched to SAW filters using LC networks and the H/L gain step is 36dB. Following the LNAs are two quadrature RF mixers that down-convert the RF signal to IF I/Q signals. The LO signals

for mixers are generated by VCO divided-by-2 (DCS1800) and divided-by-4 (GSM850/GSM900). The IF I/Q signals are then filtered and amplified through a low-pass filter and a PGA. The overall channenl response composes of an anti-blocking low-pass filter with f3dB = 1.5MHz at mixer differential load and a 5th-order Butterworth low-pass filter with f3dB = 135kHz. The multi-stage PGA is implemented between filtering staged to control the gain of the receiver. With a 2dB gain step, a 60dB dynamic range of the PGA ensures a proper signal level for baseband setting requirement. Two DC-Offset Corretion (DCOC) loops ensure that the residual static DC-offset voltage held digitally is less than 200mV at maxium gain case. DC-offset correction is performed every time the receiver gain is programmed even in the multislot mode.

4.2. Digital base band circuit principle

4.2.1 General

The digital base band circuit is composed by central control and data processing unit, power management unit, voice processing unit, display unit and outside interface unit.

4.2.2 The circuit and principle of each unit

4.2.2.1 Central control and data processing unit

QSC6085 is a single chip integrated multiple processors on-chip. The baseband circuits and system software incorporates a low-power, high-performance reduced instruction set chip (RISC) microprocessor core featuring the ARM926EJ-S™ CPU and Jazelle™ accelerator circuit from ARM® Limited. There are two low-power, high-performance QDSP4000™ digital signal processor (DSP) cores, one for the modem and one for applications.

The QSC6085 is High tier device (153.6kbps data, dual memory bus) within the family of QUALCOMM single chips. It support all the usual digital signal processing and software functions, eg : processors, memory support, video, audio, BREW, security, JTAG. At the same time, The keypad (and its backlighting), USB, UARTs, RUIM, speakers, microphones, LCD (and its backlighting), vibration motor are also supported.

The baseband function reduces part costs by using two external bus interfaces to support next-generation memory architectures, such as NAND FLASH, SRAM and pseudo SRAM (PSRAM), page and burst mode NOR or MLC NOR FLASH, and low-power SDRAM (LP-SDRAM). The EBI2 also serves as an enhanced LCD interface.

Audio support supplements the analog/RF function's CODEC, including MP3 decoding,AAC and AAC+ devices, a Compact Media Extension™ (CMX™)/MIDI synthesizer, and QCELP®.

The CDMA air interfaces are implemented on the baseband CDMA processor. All necessary interfaces to the RF functions are provided, some using a portion of the 57 GPIOs. Many of the AMSS-configurable GPIOs are available for alternate uses as desired by the wireless product designers.

Support circuitry and baseband internal functions include security, clock generation and distribution, JTAG/embedded trace macrocell (ETM) test interfaces, mode and reset controls, and the Q-fuse.

QCT provides a complete software suite — Advanced Mobile Subscriber Software™(AMSS™) — for building handsets around the QSC6085 device.

The GSM platform is MT6223D.It performed as the Modem.QSC6085 communicate with MT6223D by UART.

4.2.2.2 External Memory

CDMA: 256M Byte NAND FLASH + 128M Byte DDR
GSM: 64M bit NOR FLASH + 32M bit pSRAM

4.2.2.3 Power circuit

The input power management portion of its block accepts power from common sources —the main battery or an external charger — and generates all the regulated voltages needed to power the appropriate handset electronics. It monitors and controls the power sources detecting which sources are applied, verifying that they are within acceptable operational limits, and coordinates battery and coin cell recharging while maintaining the handset electronics supply voltages.

On-chip voltage regulators generate ten programmable output voltages using one switched-mode power supply and nine low dropout voltage regulators, all derived from a common trimmed voltage reference.

The PM general housekeeping functions include an analog multiplexer that has several internal and external connections. The internal connections are used to monitor on-chip functions, such as the temperature sensor and reference voltage. Six external connections are hardwired to access input power nodes, such as VCHG, VBAT, etc. And finally, two multipurpose pins can be configured as analog inputs and routed to the multiplexer through a switch matrix. These are available to monitor system parameters such as temperatures, battery ID, or transmit power level. The multiplexer output signal's offset and gain is adjusted, then buffered and routed to the analog/RF circuits for analog-to-digital conversion.

Various oscillator, clock, and counter circuits are provided to initialize and maintain valid pulse waveforms and measure time intervals for higher-level handset functions. A dedicated controller manages the TCXO warm-up and signal buffering, and key parameters are monitored to protect against detrimental conditions. A new and improved search and acquisition algorithm eliminates the need for a VCTCXO (typically ±2.5 ppm) allowing a less expensive 19.2 MHz crystal (typically ±12 ppm, max load capacitance, 7 pF) to be used.

Handset-level user interfaces are also supported. The PM block includes two backlight or LED drivers with brightness (current) control that are intended for keypad and LCD lighting. A vibration motor driver alerts handset users of incoming calls, and a speaker driver with volume control can be used for audio alerts or speakerphone and melody ringer applications.

PM circuit interfaces include a bus used by the baseband circuits to control and status the PM functions. This bus is supplemented by an interrupt manager for time-critical information. Another dedicated interface circuit monitors multiple trigger events and controls the powe on/poweroff sequences. A universal serial bus (USB) transceiver is included for interfacing the baseband circuits to computers as a USB 1.1 peripheral.

4.2.2.4 LCD

We use 320*240 dot matrix 262k color TFT LCD display module, with touch panel support.

4.2.2.5 Camera Module

We use 2.0 mega camera module with OV CMOS sensor.

4.2.2.6 Bluetooth

We use Qualcomm BTS4025 as main Bluetooth transceiver IC which supporting voice and data communication function. Its working mode or state is controlled by QSC6085 via UART inferface. The PCM voice siganal interfacing with BTS4025 is processed by QSC6085 directly.The MT6223D analogy signal was transferred via the CODEC of QSC6085 .

And BTS4025 needs a external 32MHz crystal as clock source and use the QSC6085'S LDO as power source.