Service Manual

Z400

GPRS 900/1800

Revision History

Version	Date	Author	Status	Remarks
0.1	Oct30, 2003	Robert Kim	Draft	Initial Draft
1.0	Mar31, 2004	Robert Kim	Official	1st Release
1.1	July 14, 2004	Sylvester Lee	Official	New function added

Table of Contents

1. Introduction

This document titled "Service Manual" is intended to serve as a technical guideline for repairing the GSM cellular phone (Model: Z400) when in trouble. In order to troubleshoot a phone, service engineers or technicians should know about basic knowledge on how the cellular phone is working and how it was designed. According to symptoms of a problem, they should judge how to troubleshoot by taking proper procedure. This service manual with other separate documents will provide such information. In this document, the subject on system design, which is unique with Z400, will be discussed, and some instructions for troubleshooting will be covered by "HW troubleshooting guide". Of course, it's impossible to cover all kinds of problems and its solution in a document, but tried to introduce basic and proper procedure for troubleshooting that can serve as a reference. Experienced service engineers or technicians maybe have their own tricks or know-how regarding some specific problems, which are not discussed in this material or other documents, and maybe theirs are more efficient and practical. Unless violate recommended warnings or cautions, they can use theirs at their own risks but it's highly recommended to follow the guidelines suggested in this material if possible.

2. Product Description

Z400 is a "Dual-band Dual-mode GSM phone" that supports both E-GSM and DCS 1800 bands, and their channel numbers (AFRCN) and operating frequencies are tabled at the end of this manual.
Z400 has many other features except basic phone operation, and can use some accessories with which C614 is used more conveniently and efficiently, and they will be discussed briefly hereafter since they are also part of candidates that service engineers or technicians need to troubleshoot.

2-1. Features Set

. 65K Color TFT display for Main LCD (Pixel Size: xxx)
. 65k Color OLED display for Sub LCD (Pixel Size: xxx)
. 64-poly melody play through Stereo speaker
. Vibrator for etiquette mode
. Li-ion Battery (Capacity: 650 mAh) with protection circuit
. Headset for hands free (4-pole with SEND/END Key & Mic) *
. Blue LED Keypad backlight
. Travel Charger (TC)
. Internal Ant.
. SIM Card Interface that support 3V SIM cards (5V SIM is not supported)
. CMOS Camera Module (300K pixel resolution)

*** Note: Other SW features are not included in the list, and you can refer to "User Manual" for detailed features of Z400 regarding their usage.*

2-2. Minimum Radio Performance

The following table shows summarized electrical performance of Z400, which are required for phone operation and also specified in GSM standards. Actual performance of Z400 surpasses minimum required performance.

Parameters	Standard Requirement		Remarks
	E-GSM	DCS 1800	
Static Sensitivity @ RBER < 2.4 %	< - 107 dBm	< - 105 dBm	Typical
Tx Output Power	+ 33 dBm ± 2 dB	+ 30 dBm ± 2 dB	
Tx Frequency Range	890.2 ~ 914.8 MHz	1710.2 ~ 1784.8 MHz	
Rx Frequency Range	935.2 ~ 959.2 MHz	1805.2 ~ 1879.8 MHz	
Power Class	4	1	
No. of RF Channels	124	374	
Duplex Frequency Offset	45 MHz	95 MHz	
Duplex Time Offset	3 Time Slot	3 Time Slot	
Channel Spacing	200 KHz	200 KHz	
Modulation Type	0.3 GMSK	0.3 GMSK	
Frequency Error	< ± 90 Hz	< ± 180 Hz	
Phase Error	Peak < 20 degrees RMS < 5 degrees	Peak < 20 degrees RMS < 5 degrees	

2-4. General Description of Each Functional Block

In this section, each functional block shown in the "System block diagram" will be discussed one by one briefly. When faced problems, understanding hardware design will be helpful for troubleshooting effectively.

2-4-1. Antenna (or briefly ANT)

ANT is a device that receives and transmits radio signals to communicate with base station nearby. Its type is classified by its structure and implementation methods. Z400 is employing monopole type internal ANT and fixed on top of the PCB. A phone user can't see the ANT outside of phone. Its electrical performance is determined by careful adjustment and optimization with ANT matching circuit on PCB board.

2-4-2. Antenna Switch Module (or simply ASM module; U104)

Since Z400 supports dual band operation (both E-GSM and DCS 1800) and each system is operating at different frequency band, this device acts like a switch that controls the RF signal flow, that of in-band signal received by ANT into two different LNAs and transmitting signals from dual band PA, so that it prevents any out-of-band interference signals from interrupting proper operation at the selected band. Its switching action is controlled by 2 control signals from "Analog Base band IC", and named as " CTL1 and CTL2".

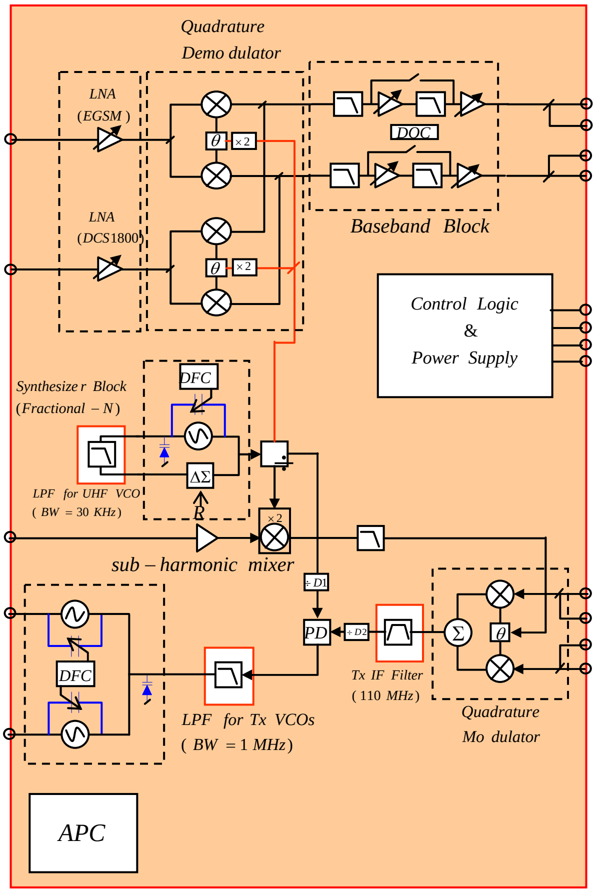
2-4-3. SAW Band pass Filter (or, SAW BPF; F101, F102)

In order to select desired signals (in-band signals) and reject undesired signals received by ANT, Z400 is employing two SAW BPFs, with which each operating frequency band is covered, between ASM and Transceiver IC. ASM has some amount of rejection for undesired signals but not sufficient for the phone to meet the requirement specified in the standard, thus they were employed for better selection and rejection performance.

2-4-4. Transceiver IC (CX74063; U101)

This IC provides a lot of functions required for the signal processing in RF band and base band related to both modulation of received signal and demodulation for transmitting signal, such as "low noise amplification by LNA block", " up/down conversion", " base band processing", and " frequency synthesis for LO and Tx frequency generation" etc… All functional blocks are controlled by software with sophisticated algorithms via multiple control signals grouped by and called "interfaces" (you can see many interface group in the schematic). As both receiver and transmitter architecture, CX74063 is employing "Direct Conversion" scheme, where IF stages are not required.

CX 74063 Transceiver IC



* APC = Analog Power Control

Fig 2 – Transceiver IC

CX74063 IC has 7 basic functional blocks required for transceiver operation, which are as the following,

1. Three Low Noise Amplifiers (LNA)
2. Quadrature Demodulator
3. Base band signal processing block
4. Control logic circuitry governing whole transceiver operation
5. Synthesizer block for local signal generation (Fractional-N + Tx Translation Loop)
6. Quadrature Modulator
7. Two Tx VCOs

2-4-4-1. LNA Block

LNA block amplifies incoming signal from ANT so that the signal level should be sufficiently high for demodulation process. Though CX74063 is supporting "Tri-band" and having 3 LNAs for each band, Z400 is only employing 2 of them, LNA for E-GSM and LNA for DCS1800, in its design.

2-4-4-2. Quadrature Demodulator

(or, simply "quad-modulator")

Since GSM is adapting "digital modulation" scheme called "GMSK", quadrature modulator is required for demodulation of received signal, where both "In-phase signal" and "Quadrature phase signal" (or, shortly called I/Q signals) is split for digital signal processing at base band processor (CX805-32) to extract information. Local signal from synthesizer block is fed into the "quad-modulator" for down conversion of received RF signal to analog I/Q signals. (Later, this analog I/Q signals is converted into digital signals at Analog BB IC, CX20524-13)

2-4-4-3. Base band signal processing block (or, "base band block" in short)

The down converted I/Q signals are filtered and amplified according to the signal strength at the ANT for optimum signal level to be fed into successive functional blocks, and the amplifier gain is adjusted to optimize the receiver performance so that the receiver has sufficient immunity in terms of interference rejection performance.

2-4-4-4. Control circuit

GSM system is using Time Division Duplex (or simply TDD) schemes to separate receiver and transmitter operation, thus it requires that whole circuitry should operate precisely in terms of timing, and control block is taking charge of this function by providing complex control signals both internally and externally.

This block is also involved in proper parameter setting of internal block such as receiver I/Q filters, gain stages, and synthesizer programming according to input signal level and operating channel for optimum performance in various environment, and plays a linkage role between Analog BB IC through control lines called "interface".

2-4-4-5. Synthesizer block;

To generate the required local signal(LO) to receiver block and to make Tx signal GMSK modulated, a little complicated process is undertaken as shown below

Fig 3 shows how transmitter frequency is generated, where 2 synthesizer loops are involved in, one is "fractional-N PLL" for receiver LO signal generation from UHF VCO and the other is "Translation Loop" for direct modulation of Tx VCOs. Depending on operation band, appropriate divider (or multiplier) is selected to make accurate frequency generation. Fractional-N PLL with UHF VCO provides low phase noise and fast lock time, which is required for multi-slot operation in GSM/GPRS System. The Tx VCOs are directly modulated by translation loop in which both UHF VCO and I/Q signals from base-band are involved to generate GMSK modulated RF signal. The demodulated base-band signal is fed into Analog Base-band IC for further signal processing.

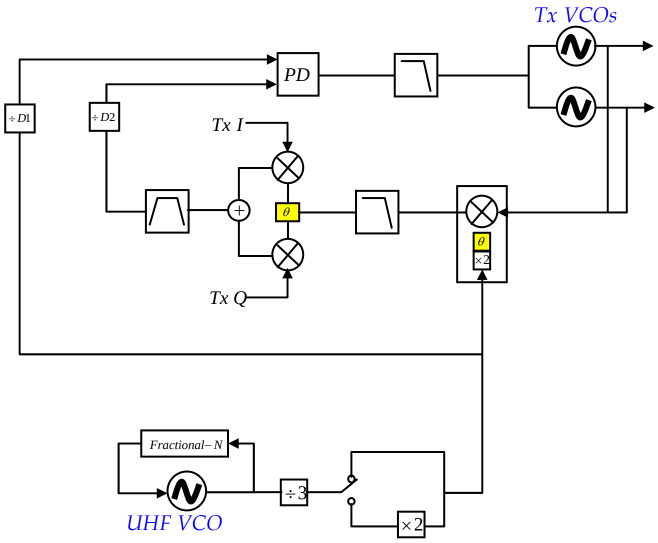


Fig 3 – Transmitter Frequency Generation

In Fig.3, the "translation loop" is composed of a couple of sub blocks as the following;

Tx VCO -> Harmonic Mixer -> LPF -> Quadrature Modulator -> BPF -> Divider (D1 or D2) -> Phase Detector -> Loop Filter -> Tx VCO,

And the signal directly from UHF VCO acts like a reference signal in a normal PLL loop.

Tx I/Q signals from base-band is quadrature modulated with mixing product between UHF VCO and Tx VCO, which is 100.267 MHz in GSM band and 102.812 MHz in DCS1800 band, and compared with reference signal to generate modulating signal for Tx VCOs. For receiver LO signal generation, only UHF VCO is used as shown in Fig.4., where

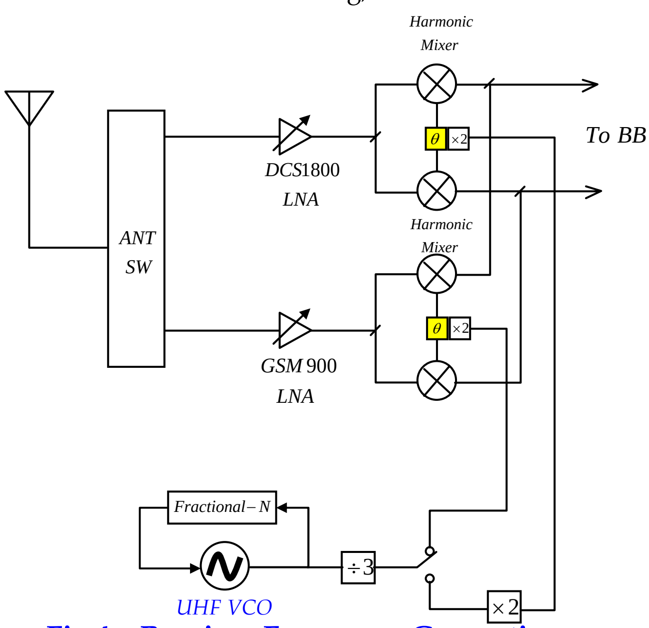


Fig 4 – Receiver Frequency Generation

UHF VCO is divided by 3 in GSM900 band operation, and multiplied by 2 after division by 3 for DCS 1800 band operation. The quadrature demodulator is realized by sub-harmonic mixer that requires 1/2 the received RF frequency from ANT, this helps preventing LO leakage to ANT port that is well known problem in a receiver employing direct conversion architecture.

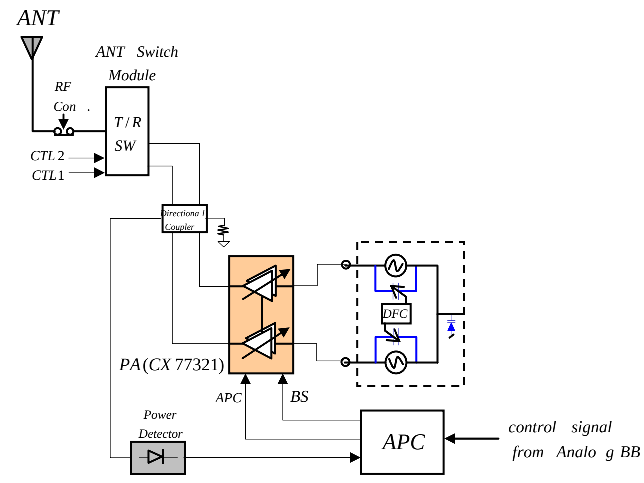


Fig.5 – Power Amplifier Block

2-4-4-6. Power Amplifier (simply, PA; U102) ;

In Fig.5, there are 2 power amplifiers were employed in Z400 design to support both GSM and DCS band operation. GMSK modulated Tx VCOs are input to each PA according to the operating band of interest, and APC(Analog Power Control) circuit inside CX74063 Transceiver IC controls PA operation in terms of band selection and ramp control in burst mode. In order to control the PA properly, part of output signal from each PA is coupled by directional coupler and is regulated to the corresponding DC voltage through "power detector" as shown in the Fig. 5, and properly controlled transmitting signals (both power level and burst timing) are fed into ANT via ASM module.

2-4-5. Analog Base-band IC + PMIC (SKY20524; U201);

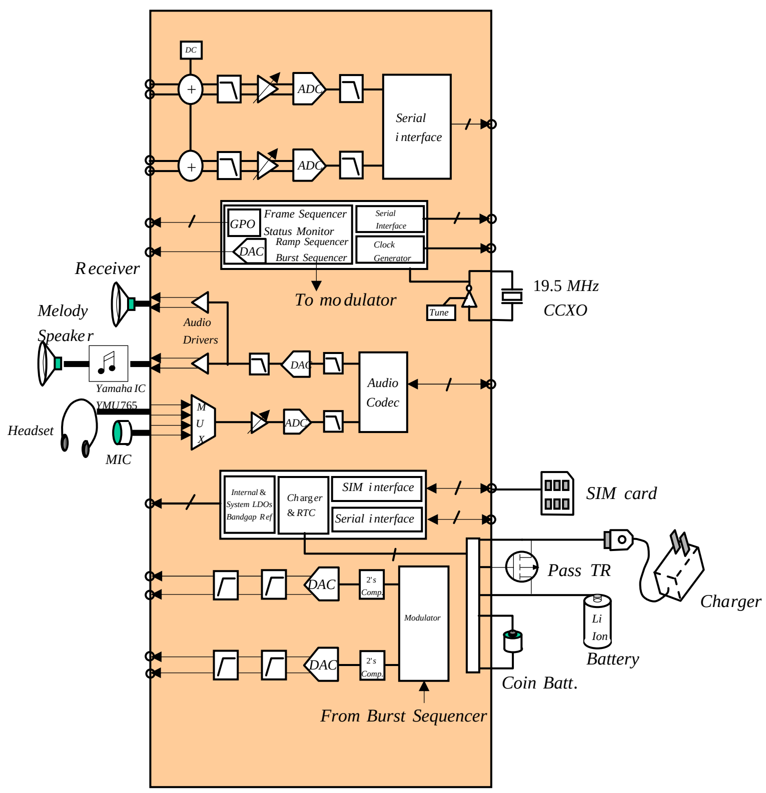


Fig.6 – Analog Baseband + PMIC

Analog Base band IC includes required signal processing blocks for both receiver and transmitter in base band domain, such as digitizing received analog I/Q signal from receiver block in transceiver IC and making analog I/Q signal from digital I/Q data from base band processor for transmitter, and except basic signal processing blocks, power management function is integrated onto the same IC, which provides DC voltage supplies for various functional blocks.

In addition, there's a couple of interface circuitries for peripheral devices such as earpiece (or receiver speaker), melody speaker, headset, MIC, SIM card interface, internal charging circuit, and coin battery for "real time clock (simply, RTC) as shown in Fig.6.

2-4-5-1. Earpiece/Melody Speaker/ Headset Interface;

Earpiece, or receiver speaker, is providing voice signal that a phone user wants to hear during a call, while melody speaker is used only for melody sound playing (64 poly phonic sound). The reason why employed separate speaker is that a phone user usually listens voice signal in normal phone operating position, making the phone close to the listener's ear after flip open, while melody playing is performed under flip closed condition to show off to a friend or other people. Headset is recently used as a means of hands free device, or for privacy during a call, and Z400 is providing required interface for dedicated headset device that has 4-pole plug design (for detailed operation, refer to HW troubleshooting guide, where you also can see a photo of headset)

2-4-5-2. Power Management IC (or, simply PMIC; U201) ;

Though this block is not clearly seen in the Fig.6, PMIC takes charge of very important role, which is generating various DC voltages for each functional block. Some of them may need to be turned ON/OFF according to the predetermined timing sequence (please note that GSM is TDD system in its operation).

Z400 is utilizing 6 different DC supplies from PMIC block, and refer to "power distribution chart" for detailed information. You will probably understand later that the knowledge on these supply lines will be very helpful for troubleshooting purposes because many cases of problems are closely related to DC supply failure.

2-4-5-3. Internal Charger;

Analog BB IC has a circuitry for charging a battery, which is called "internal charger", with the help of travel charger (or, simply TC). Actually, TC is not a charger but a constant DC voltage supplier and internal charger circuitry is playing a role of charging a battery. This circuit is composed of "pass Transistor" (p-channel MOSFET), and current sensing resistor, and control block that is integrated onto the IC internally.

It controls the gate bias voltage of the pass TR with the help of SW, and adjusts charging voltage and current according to different battery type. Detailed structure of the charging circuitry will be covered in "HW troubleshooting guide" later.

2-4-5-4. Real Time Clock (or, simply RTC);

RTC is a functional block that manages time and date information as is with a time watch or time clock to a phone user, and it operates independently from other blocks with independent DC supply called "coin battery", and can operate even without battery for a given time. The 32.769 KHz crystal(X301) at base band processor IC (U301) is mainly employed as reference signal source to count time. For detailed information, refer to "HW troubleshooting guide".

2-4-6. Base and Processor IC (CX805-32; U301);

Base band processor IC acts as brain for a human, it commands, controls, monitors, and performs signal processing whole radio and it's beyond the scope of this manual to cover detailed operation of the processor but brief structure is as shown in Fig. 7, where the main body is divided by two cores called "ARM core" and "DSP core". ARM core takes charge of controls and commands while DSP core does mainly signal processing required for sophisticated phone operation specified in GSM standards. In addition, there's a couple of interfaces such as "keypad interface", where Key pressing or operation is scanned and monitored, "back light interface", which is related to keypad back lighting, "ringer and alert interface", which is for providing audio signals to a phone user during a call, " memory interface", which is for communication with flash memory where SW and other useful data are stored, and "system connector interface", which is for communication with external devices such as data cable to a computer, and other functions.

32.769 KHz crystal is connected to this IC to provide reference signal source for RTC block.

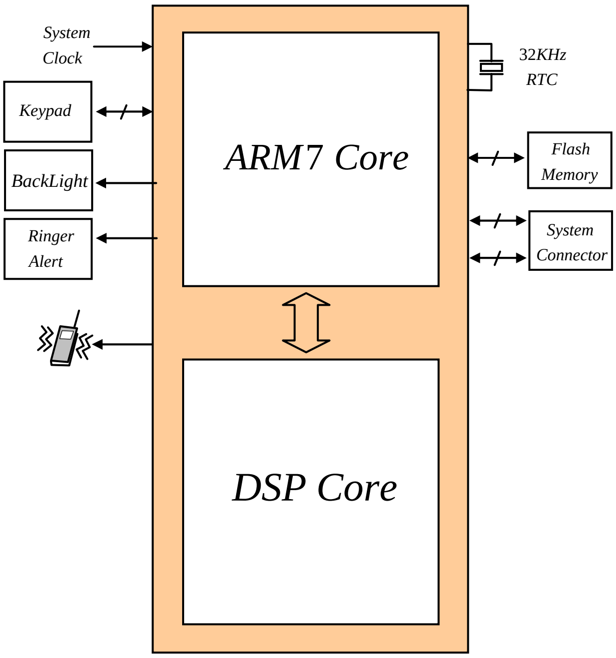


Fig.7 – Base band Processor (CX805-32)

