5. Circuit Description

5-1 Logic Part

5-1-1 Power Supply

Press "PWR "key to turn on the phone and then the V_BAT and ON_SW signals will be connected. This turn on inner regulator (V_PD,V_PA,) of U201(MIC2214)and release them from the shut down state to output regulated 2.85V (V_PD), 2.6V (V_PA).

The V_BAT applied to ON_SW will change ON_SW_SENSE signal from HIGH to LOW.This will allow MSM(U100) to send out PS_HOLD (logical HIGH)to turn on inner regulator (V_PD,V_PA,V_TCXO)even after the PWR key is released. The others regulators will be controlled the ON/OFF state by GPIO interface and IDLE_N signal.

The regulated voltage V_MSMD from V_PD (U201) is used in the digital part of MSM. The regulated voltage V_MSMA fromV_PA (U201) is used in the analog part of MSM. The regulated voltage V_TX (U410) is used in the RF TX part. The regulated voltage from V_RX from V_IF (U301) is used in the RF RX part. The regulated Voltage V_IF from U301 is used in the PLL circuit. The regulated voltage V_TCXO from V_PD is used in the TCXO.

5-1-2 Logic

The logic consists of internal CPU of MSM, SRAM, FROM and EEPROM. The MSM receives TCXO clock signals and controls the phone during the PCS,CDMA and the FM mode. The major components are as follows:

-CPU :ARM`7 CPU core
-FROM /SRAM :U110(AM50DL128BG)
128Mbit Flash ROM & 32Mbit SRAM
-EEPROM :U104 (AT24C256)

CPU(U100:MSM5100-208FBGA)

ARM 7 CMOS type 32/16-bit microprocessor is used for the main processing. The CPU controls all the circuitry. The MSM5100 derives all of its internal clock sources from three clock input TCXO (19.2MHz),SLEEP_XTAL(32.768KHz,in Sleep Mode),48XTAL(48MHz,for USB). 32.768 kHz is used for sleep. This is equipped with the ARM 7 CPU core,CDMA and DFM block,vocoder,general purpose interface and other interfaces and is one of the most important components of the CDMA cellular phone.

FROM AND SRAM (U110:AM50DL128BG)

Memories are consist of 128Mbit FROM and 32Mbit SRAM.128Mbit Flash ROM is used to store the FONT data and terminal's program. Using the down-loading program, the program can be changed even after the terminal is fully assembled. 32Mbit SRAM is used to store the internal flag information,call processing data,and timer data.

EEPROM(U104:AT24C256)

A serial 256Kbit EEPROM is used to store ESN, NAM,power level,volume level,and telephone number.

KEYPAD

For key recognition, key matrix is setup using SCAN(1:6) and KEYSENSE(0:3) signals of MSM. 14 back light LEDs and back light circuitry are included in the keypad for easy operation in the dark.

LCD MODULE

The Subscriber Units should have a 65k color TFT LCD of 128 x 160 pixels and a 65k color STN LCD of 128 x 96 pixels. These display shall be capable of presenting animation.

5-1-3 Baseband

MOBILE SYSTEM MODEM (MSM)

The MCU equipped with the ARM 7 CPU core is an important component of the CDMA cellular phone. The MSM comes in a 208-Ball FBGA Package.

MICROPROCESSOR INTERFACE

The interface circuitry consists of reset circuit, address bus(A0-A21),data bus(D0-D15),and memory controls (LWR_N, ROM_CS1_N, ROM_CS2_N, RAM_CS1_N)

CODEC

The MSM5100 (U100) integrates an audio voice band CODEC into the Mobile Station Modem. The integrated CODEC contains all of the required conversion and amplification stages for the audio front end.

GPADC

The MSM5100 (U100) has an on-chip 8bit AD Converter (GPADC) which is intended to digitalize DC signal corresponding to analog parameters such as Battery voltage,Temperature,and Battery type.

Clock

-CPU clock :19.2MHz.This clock signal from the TCXO

-Sleep clock :32.768KHz.This clock signal is used for sleep.

-TCXO/N :This 19.2MHz clock source is used by various blocks of the MSM5100 device,such as the ARM7TDMI ringer, UARTs, general-purpose PDMs, and the Digital FM circuits.TCXO can be used as a vocoder clock source for EVRC support. TCXO is also used by the MSM5100 device to produce CHIPX8.

-CHIPX8 :9.8304 MHz clock source in CDMA mode. 360 kHz clock source in digital FM mode.

-USB clock :48MHz.This clock signal is used to drive the USB interface on the MSM5100.

S1M8662, SIM8680 AND MSM INTERFACE

A.CDMA Data Interface

-I_OUT,I_OUT_N and Q_OUT,Q_OUT_N(U400 pins 3,4 /1,2):Differential analog output for I and Q component used during CDMA and FM mode.

-RX_IDATA0-3 (U303 pins 29-32)and RX_QDATA0-3(U303 pins 24-27):RX data bus used during CDMA.

B.Clock

-CHIPX8 :ADC reference clock(9.8304MHz)used in CDMA RX mode.

C.RF Interface

-TX :TX_AGC_ADJ(U100 pin A12)port is used to control the TX power,PA_ON_PCS(U100 pin C11) signal used to control the PCS power amplifier and PA_ON_CELL(U100 pin D6)signal used to control CDMA power amplifier.

-RX :RX_AGC_ADJ(U100 pin A11)port is used to control the RX gain and TRK_LO_ADJ(U100 pin B11) is used to compensate the TCXO clock.

5-1-4 Audio Part

The MSM5100 integrates an audio voiceband Codec into Mobile Station Modem. The integrated Codec contains all of the required conversion and amplification stages for the audio front end. The Codec operates as a 13bit linear Codec with the transmit(TX)and receive(RX) filters designed to meet ITU-TG.712 requirement. The CODEC contains the software controller amplifier for both the receiving and transmitting sections. Also,the vocoding schemes used will be 13kbps QCELP and 8Kbps EVRC.The QCELP vocoder is based in the MSM internally.

TX AUDIO PATH

The voice signal from the microphone is inputted to the internal CODEC.The voice signal is then amplified by the internal amplifier and is converted to PCM data to be outputted to the MSM as 13bit data. This data is then processed by the MSM (U100)'s internal.

RX AUDIO PATH

The PCM data from the MSM (U100)'s internal is inputted to the internal CODEC and the data will be decoded by the internal DAC and audio levels are adjusted by the amplifier. The final audio is then sent to the audio receiver.

ALERT TONE AND MELODY DRIVING CIRCUITRY

A speaker generates alert tone and melody. When the MSM(U100)receives the data, it generates alert tone and melody. Ringer signal generated in MSM5100 is intended to drive a speaker.

KEY TONE GENERATOR

The CODEC data out from the MSM5100 is converted to DTMF signal by TONE generator of internal CODEC, is then amplified by the internal audio amplifier to be sent to the speaker unit.

5-2 RF Part

5-2-1 Transmitter (For CDMA PCS(1900MHz))

ANTENNA

Antenna sends signal to the base station and receives the signal from the base station.It is a tri-band Antenna and covers PCS band, CDMA band and GPS band.

RF SWITCH

It(U460:UPG2031TQ)is used to switch the triple RF path. The cell band is closed when CELL_BAND is high(the last control signals are low). The others(PCS & GPS) is same as cell band.
These logical signal come from MSM5100 GPIO.

DUPLEXER

Duplexer(F400)allows to transmit only the signals within acceptable Tx frequency range 1880 ±30MHz through the antenna.

POWER AMP

Power amplifier module(U430) amplifiers signal to be sent to the base station through the antenna.

DRIVER AMP

The driver amp(U400 ;included in SIM8680X) allows the signal to be inputted to the power amp(U430)as a specified level.

UP-CONVERTER(MIXER)

The up-converter(U400 ;also included in SIM8680X) receives the first local signal 2143.6 ±30MHz and the 263.6MHz IF signal controlled by TX AGC amp(in SIM8680X)to generate Tx RF signal 1880 ±30MHz which signal comes out from the mixer output by adding 263.6MHz IF signal to 2143.6 ±30MHz first local signal.

IF AUTOMATIC GAIN CONTROL

The TX IF AGC amp (in SIM8680X)controls gain of AGC to deliver power level needed at driver amp. Dynamic range is 85dB,and its control voltage varies from 0.2V to 2.5V.

5-2-2 Transmitter (For CDMA(800MHz))

ANTENNA

Antenna sends signal to the base station and receives the signal from the base station.It is a tri-band Antenna and covers PCS band, CDMA band and GPS band.

RF SWITCH

It(U460:UPG2031TQ)is used to switch the triple RF path. The cell band is closed when CELL_BAND is high(the last control signals are low). The others(PCS & GPS) is same as cell band.
These logical signal come from MSM5100 GPIO.

DUPLEXER

Duplexer(F440)allows Rx frequency range(881.49±12.5 MHz)and Tx frequency range (836.49 ±12.5MHz)from the antenna to pass through LNA. It also matches LNA input in receiving part and PA(U450)output in transmitter part with the antenna.

POWER AMP

Power amplifier module(U450) amplifiers signal to be sent to the base station through the antenna.

DRIVER AMP

The driver amp(U400 ;It is included in SIM8680X) allows the signal to be inputted to the power amp(U450)as a specified level.

UP-CONVERTER(MIXER)

The up-converter(U400 ;It is also included in SIM8680X)receives the first local signal 836.49 ±12.5MHz and the signal controlled by TX AGC amp(in SIM8680X).836.49 ±12.5MHz signal comes out from the mixer output by substracting 228.6MHz IF signal to 1065.09 ±12.5 MHz first local signal.

IF AUTOMATIC GAIN CONTROL

The TX IF AGC amp in SIM8680X controls gain of AGC to deliver power level to be needed at Driver amp.Dynamic range is 90dB,and its control voltage varies from 0.2V to 2.5V.

5-2-3 Receiver (For CDMA PCS(1900MHz))

LOW NOISE AMPLIFIER(LNA)

The low noise amplifier(It is included in MAX2538 : U302)amplifies a weak signal received from the base station to obtain the optimum signal level.

RF BAND PASS FILTER(RX RF SAW FILTER)

The RF BPF(F303)passes only a specific frequency(1960 ±30 MHz)from the signal received from the mobile station.The bandwidth is 60 MHz.

DOWN CONVERTER(MIXER)

The first local signal is applied to the down converter in MAX2538 :U302. This component converts the RF signal from the LNA to IF signal(183.6MHz).The IF signal is made by subtracting first local signal(2143.6 ±30 MHz) from RF signal(1960 ±30MHz).

IF BAND PASS FILTER(RX IF SAW FILTER)

This filter(F306)eliminates the image products generated by the mixer.The bandwidth is 1.25MHz.

IF AUTOMATIC GAIN CONTROLLER(AGC) AMP

IF signal(183.6MHz)is applied to IF AGC amplifier(in SIM8662X01).The AGC amp(in SIM8662X01)keeps the signal at a constant level by controlling the gain.Dynamic range is 90 dB with control voltage range from 0.5 to 2.5 voltage.

5-2-4 Receiver (For CDMA(800MHz) and AMPS)

LOW NOISE AMPLIFIER(LNA)

The low noise amplifier(It is included in MAX2538 U302)amplifies a weak signal received from the base station to obtain the optimum signal level.

RF BAND PASS FILTER(RX RF SAW FILTER)

The RF BPF in F304 passes only a specific frequency(881.49 ±12.5 MHz)from the signal received from the mobile station.The bandwidth is 25 MHz.

DOWN CONVERTER(MIXER)

The first local signal is applied to this down converter in MAX2538 :U302.The down converter converts the signal from LNA into 183.6MHz IF signal.183.6MHz IF signal is made by subtracting 881.49 ±12.5 MHz from first local signal 1065.09 ±12.5 MHz RF signal.

IF BAND PASS FILTER(RX IF SAW FILTER)

This filter(CDMA:F306)eliminates the image products generated by the mixer.

IF AUTOMATIC GAIN CONTROLLER(AGC)

IF signal(183.6MHz)is applied to IF AGC amplifier in SIM8662X01.The AGC amp in SIM8662X01 keeps the signal at a constant level by controlling the gain. Dynamic range is 90 dB,up gain 45dB,and down gain -45dB.

5-2-5 GPS(1575.42MHz)

ANTENNA

Antenna receives signal from GPS satellites.
It is a tri-band Antenna and covers PCS band, CDMA band,AMPS band and GPS band.

RF SWITCH

It(U460:UPG2031TQ)is used to switch the triple RF path. The cell band is closed when CELL_BAND is high(the last control signals are low). The others(PCS & GPS) is same as cell band.
These logical signal come from MSM5100 GPIO.

PRE-FILTER

The RF Pre-filter(F301 :B9000)passes only a specific frequency(1575.42 ±2MHz)from the signal received from the satellite.The bandwidth is 2 MHz.

LOW NOISE AMPLIFIER(LNA)

The low noise amplifier(It is included in MAX2538 : U302)amplifies a weak signal received from the base station to obtain the optimum signal level.

RF BAND PASS FILTER(RX RF SAW FILTER)

The RF BPF (F302:B9000)passes only a specific frequency(1575.42 ±2 MHz)from the signal received from the satellite.The bandwidth is 2 MHz.

DOWN CONVERTER(MIXER)

The first local signal is applied to this down converter in MAX2538(U302).The down converter converts the signal from LNA into 183.6MHz IF signal.183.6MHz IF signal is made by subtracting first local signal (1391.82 MHz)from the RF signal(1575.42MHz).

IF BAND PASS FILTER(RX IF SAW FILTER)

The IF BPF (F305) passes only a specific frequency from the signal received from the Mixer. This is composed of discrete capacitor and inductor (L301,L302,L304,C309,C317,C310, C312). It allows only an IF frequency (183.6 MHz)to pass to the detection circuitry(SIM8660A01)

F AUTOMATIC GAIN CONTROLLER(AGC) AMP

IF signal(183.6MHz)is applied to IF AGC amplifier in S1M8662.The AGC amp in S1M8662 keeps the signal at a constant level by controlling the gain. Dynamic range is 90 dB,up gain 45dB,and down gain -45dB.

5-2-6 PLL Block

FREQUENCY SYNTHESIZER CIRCUIT

The PLL(Phased Locked Loop)block consists of VC-TCXO(OSC301), PLL IC(U304)and VCO(OSC302). Input reference frequency is generated at VC-TCXO(OSC301)and the RF local signal is generated at VCO. PLL compares the two signals and generates the desired signal with a preprogrammed counter which controls voltage.

VC-TCXO

The VC-TCXO (OSC301)is a reference source of the frequency synthesizer. It provides 19.2MHz reference frequency to PLL-IC. It is a voltage controlled temperature compensated crystal oscillator having 19.2MHz ±2.5ppm frequency stability over all useful temperature range. A correct frequency tuning is made by the control voltage.

VOLTAGE CONTROLLED OSCILLATOR (DUAL VCO)

The VCO(OSC302)generates the signal having center frequency 2130 ±44MHz by voltage control. The PLL IC(U304)controls this signal.

TEMPERATURE TO VOLTAGE CONVERTER

The temperature to voltage converter(TH100)detects temperature.
It is used to compensate active component characteristics due to the temperature difference.

5-3 Test Command Table

To change the phone from normal mode to test mode, you should enter the following keys. :

Press [4 7 * 6 8 # 1 3 5 8 0]

Command No	Command SW Name	Description
01	T_SUSPEND_I	/* enter to test menu */
02	T_RESTART_I	/* escape from test menu */
03	T_SAVE_VAL_I	/* Save values in e2prom only in auto test */
04	T_GET_MODE_I	/* Get mode CDMA/FM AUTO TEST */
05	T_SET_MODE_I	/* Set mode CDMA/FM AUTO TEST */
06	T_WRITE_NV_I	/* Write the EEPROM item */
07	T_CARRIERON_I	/* turn on the carrier */
08	T_CARRIEROFF_I	/* turn off the carrier */
09	T_LOADSYN_I	/* load the synthesizer for locking */
10	T_PWRLEVEL_I	/* change RF power level */
11	T_RXMUTE_I	/* mute rx audio */
12	T_RXUNMUTE_I	/* unmute rx audio */
13	T_TXMUTE_I	/* mute tx audio */
14	T_TXUNMUTE_I	/* unmute tx audio */
15	T_VOC_ESEC_I	/* Echo Canceller */
19	T_CDMA_IMD_I	/* lna range control */
20	T_LNA_GAIN_WR_I	
21	T_TEST_SYS_I	/* Set TEST_SYS */
22	T_SNDNAM_I	/* Send NAM Information */
23	T_SNDVERSION_I	/* Send Software Version */
24	T_SNDESN_I	/* Send ESN */
25	T_BACKLIGHT_ON_I	/* Backlight on */
26	T_BACKLIGHT_DIMM_I	/* Backlight Dimm */
27	T_BACKLIGHT_OFF_I	/* Backlight off */
28	T_7_LED_COLOR_I	/* LED test */
29	T_REBUILD_I	/* Rebuilding EEPROM */
30	T_PLINE_I	/* Product life information */
31	T_MRU2_TABLE_I	/* MRU reset */
34	T_CDATA_I	/* continuously send TX Control data */
35	T_VOLUME_UP_I	/* Electric Volume Up */
36	T_VOLUME_DOWN_I	/* Electric Volume Down */

37	T_CLR_LIFETIME_I	/* Clear Life Time */
38	T_DATASVC_ON_I	/* Data Service ON for Manufacturing Test JOJ_010809 */
39	T_DATASVC_OFF_I	/* Data Service OFF for Manufacturing Test JOJ_010809 */
40	T_VOC_CDMA_UNITY_GAIN_I	/* Vocoder CDMA unity gain */
41	T_VOC_FM_HFRX_UPGAIN_I	/* Vocoder fm hfrx upgain */
42	T_DTMFON_I	/* Turn on DTMF */
43	T_DTMFOFF_I	/* turn off DTMF */
48	T_VIBRATOR_ON_I	/* activate a vibrator */
49	T_VIBRATOR_OFF_I	/* inactivate a vibrator */
50	T_BATT_TYPE_I	/* Battery Type */
52	T_CDMA_TEMPCOMP_I	/* CDMA Temp Compensation */
53	T_PCS_TEMPCOMP_I	/* PCS Temp Compensation */
54	T_CARRIER_ID	/* Carrier selection */
55	T_SET_EXT_AUDIO_I	/* External Audio Path On/Off */
56	T_LOOPBACK_I	
57	T_PA_R0_ON_I	/* PA_RO ON */
58	T_PA_R0_OFF_I	/* PA_RO OFF */
59	T_ALLPATH_I	/* tune on the all audio path */
67	T_READ_BATT_I	/* Saved Low battery value read */
68	T_VBATT1_I	/* set the low battery position in the standby */
69	T_VBATT2_I	/* set the low battery position in the talking */
70	T_WRITE_BATT_I	/* write a BATT */
71	T_CDMA_TXADJ_I	/* sets tx_agc_adj for cdma mode */
72	T_FM_TXADJ_I	/* sets tx_agc_adj for fm mode */
73	T_CLEAR_ALL_I	
74	T_SNDPINFO_I	/* Send Product information 8 character */
75	T_READ_RSSI_I	/* read a RSSI */
76	T_PCS_RSSI_I	/* adj RXRAS in PCS */
77	T_THERM_READ_I	/* read a Thermistor */
78	T_RXRAS_AUTO_I	/* adj RXRAS from 8924C */
79	T_BACKUP_CAL_DATA_I	
80	T_RESTORE_CAL_DATA_I	
81	T_VOC_PCMLPON_I	/* turn on to play a PCM LOOP BACK */
82	T_VOC_PCMLPOFF_I	/* turn off to play a PCM LOOP BACK */
83	T_CDMA_PWR_LIMIT_I	/* CDMA Tx pwr limit */

84	T_PCS_PWR_LIMIT_I	/* PCS Tx pwr limit */
85	T_YMN_DUTY_I	
86	T_YMN_MCNT_I	
87	T_YMN_NCNT_I	
88	T_TRK_ADJ_I	/* TRK LOCAL ADJUST */
89	T_CDTRK_ADJ_I	/* CDMA TRK LOCAL ADJUST */
90	T_PCS_TXRAS_ADJ_I	/* PCS TX RAS adj = TXRAS offset array */
91	T_PCS_RXRAS_ADJ_I	/* PCS RX RAS adj = RXRAS offset array */
92	T_TXRAS_ADJ_I	/* TX RAS adj = TXRAS offset array */
93	T_RXRAS_ADJ_I	/* RX RAS adj = RXRAS offset array */
94	T_LNARAS_ADJ_I	/* LNA RAS adj= LNARAS offset array */
95	T_PCS_CH_FLATNESS_I	
96	T_CH_FLATNESS_I	/* Tx Pwr : 23dBm */
97	T_FM_TX_PWR_I	/* setting the volume for Power Level 2 - 7 */
98	T_SND_MODEL_ID_I	
99	T_SND_VOC_CAL_I	
100	T_SIO_TO_DM_I	/* Write NV_SIO_I */
121	T_LNA1_ON_I	
122	T_LNA2_ON_I	
123	T_LNA12_OFF_I	
124	T_CDMA_IMD_CODE_I	/* lna range control */
129	T_BREW_PLATFORM_ID_I	/* Brew Platform ID */
130	T_FS_ERASE_I	/* FS ERASE */
131	T_PTX_RAS_AUTO_I	/*Tx ras auto calibration offset value */
132	T_CTX_RAS_AUTO_I	/*Tx ras auto calibration offset value */
134	T_PA_RISE_FALL_I	
140	T_MAX_I	

1) The AB (Input Argument Byte Number) values of these commands are used only in the manual test. In automatic test mode, the AB is regarded as 0.

2) You can assign the value for these commands. If the AB value is assigned without argument, the test is achieved with the value stored in EEPROM.

3) After you get a desired test value by performing these commands, if you want to save the value into EEPROM, use T-SAVE-VAL-I command to store the test value into the corresponding position.

*OP: Operation Command Number / AB: Input Argument Byte Number / RB: Return Byte Number

*SAT 32, 33 are not operating in MSM2 CHIP test

*46 command is required in Rx, and Tx path test at AMPS mode.