CDMA PORTABLE CELLULAR PHONE
LGC-500W

SERVICE MANUAL

LGIC
LG Information & Communications, Ltd.

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General Introduction

The LGC-500W cellular phone functions as both analog cellular phone worked in AMPS (Advanced Mobile Phone Service) mode and digital cellular phone worked in CDMA (Code Division Multiple Access) mode.

CDMA mode applies the DSSS (Direct Sequence Spread Spectrum) technique that has been used in military. This technique enable to share one frequency channel with many users in the same specific area. As a result, that it increases the capacity 10 times more compared with that in the analog mode (AMPS) currently used.

Soft/Softer Handoff, Hard Handoff, and Dynamic RF power Control technologies are combined into this phone to reduce the call being interrupted in a middle of talking over phone.

CDMA digital cellular network consists of MSC (Mobile Switching Office), BSC (Base Station Controller), BTS (Base station Transmission System), and MS (Mobile Station). Communication between MS and BTS is designed to meet the specification of IS-95A (Common Air Interface). MS meets the specifications of the below :

- IS-95A (Common Air Interface) : Protocol between MS and BTS
- IS-96A (Vocoder) : Voice signal coding
- IS-98 : Basic MS functions
- IS-126 : Voice loopback
- IS-99 : Short Message Service, Asynchronous Data Service, and G3 Fax Service

LGC-500W is composed of a transceiver, a desktop charger, two Li-Ion Batteries (1650mAh), a hands-free kit, a travel charger. In digital mode, the hands-free kit is designed to operate in full duplex.

CHAPTER 1. System Introduction

1. Introduction to the Cellular System

1.1 Basic Concept for the Cellular System

The design objective of early mobile radio systems was to achieve a large coverage area by using a single, very high powered transmitter with antenna mounted on the tall tower. While this approach achieved very good coverage, it also meant that it was impossible to reuse those same frequency throughout the system. But the increasing demand for mobile service required the radio telephone system to achieve high capacity with limited radio spectrum, while at the same time covering very large areas.

The cellular concept was a major breakthrough in sloving the problem of spectral congestion and user capacity. The cellular concept ,which starts from the frequency reuse technique, is a system level idea which calls for replacing a single, high power transmitter (large cell) with many low power transmitter(small cells), each providing coverage to only a small portion of the service area. Each base station is allocated a portion of the total number of channels available to the entire system, and nearby base stations are assigned different groups of channels so that all the available channels are assigned to a relative small number of neighboring base stations. Neighboring base stations are assigned different groups of channels so that the interference between base stations (and the mobile users under their control) is minimized. This technique is called channel assignment stategy.

In the cellular system, the channel handoff operation is inevitably needed to keep a call while a user moves one cell to another. This function not only involves identifying a new base station, but also eruires that the voice and control signals be allocated to channel associated with new base station. The handoff between different swithcing systems is called roaming. It is call state can be maintained continuously by the information exchange between switching systems when the busy subscriber moves from one cellular system area to the other cellular system area.

1.2 Multiple Access Techniques for the Cellular System

In cellualr systems, it is often desirable to allow the subscriber to send simultaneously infoermation to the base station while receiving information from the base station. This is called deplexing. Duplexing is done using frequency or time domain rechniques. Frequency Division Duplexing(FDD) provides two distinct bands of freqeuncies for every user. In FDD, any duplex channel actually consist of two simplex channels, and a device called a duplexer is used inside handsets and base stations. Time Division Duplexing(TDD) uses time instead of frequency to provide both a forward and reverse link. If the time split between the forward and reverse time slot is small, then the transmission and reception of data appears simultaneous to the user.

Multiple access techniques are used to share the available channel resources(frequency bandwidth). Frequency Division Multiple Access(FDMA), Time Division Multiple Access(TDMA), Code Division Multiple Access(CDMA) are the three major techniques in cellular systems.

FDMA allocates a unique frequencys to a channel. These channels are assigned on demand to users who request service. During the period of the call, no other user can share the same frequency band. In FDD systems, the users are assigned a channel as a pair of frequencies; one frequency is used for the forward channel, while the other frequency is used for the reverse channel. This system is called FDD/FDMA system. Most of analog cellular systems(AMPS, E-AMPS, NMT, ETACS, JTACS, etc.) are FDD/FDMA system.

TDMA systems devide the radio spectrum into time slots, and each slot only one user is allowed to ether transmit or receive. Each user occupies a cyclically repeating time slot, so a channel may be thought of as particular time slot that reoccurs every frame, where N time slots comprise a frame. TDMA systems can apply in both TDD and FDD.

Code Division Multiple Access (CDMA) is a radically new concept in wireless communications. It has gained widespread international acceptance by cellular radio system operators as an upgrade that will dramatically increase both their system capacity and the service quality. It has likewise been chosen for deployment by the majority of the winners of the United States Personal Communications System spectrum auctions. It may seem, however, mysterious for those who aren't familiar with it. This site is provided in an effort to dispel some of the mystery and to disseminate at least a basic level of knowledge about the technology.

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CDMA is a form of spread-spectrum, a family of digital communication techniques that have been used in military applications for many years. The core principle of spread spectrum is the use of noise-like carrier waves, and, as the name implies, bandwidths much wider than that required for simple point-to-point communication at the same data rate. Originally there were two motivations: either to resist enemy efforts to jam the communications (anti-jam, or AJ), or to hide the fact that communication was even taking place, sometimes called low probability of intercept (LPI). It has a history that goes back to the early days of World War II.

The use of CDMA for civilian mobile radio applications is novel. It was proposed theoretically in the late 1940's, but the practical application in the civilian marketplace did not take place until 40 years later. Commercial applications became possible because of two evolutionary developments. One was the availability of very low cost, high density digital integrated circuits, which reduce the size, weight, and cost of the subscriber stations to an acceptably low level. The other was the realization that optimal multiple access communication requires that all user stations regulate their transmitter powers to the lowest that will achieve adequate signal quality.

CDMA changes the nature of the subscriber station from a predominately analog device to a predominately digital device. Old-fashioned radio receivers separate stations or channels by filtering in the frequency domain. CDMA receivers do not eliminate analog processing entirely, but they separate communication channels by means of a pseudo-random modulation that is applied and removed in the digital domain, not on the basis of frequency. Multiple users occupy the same frequency band. This universal frequency reuse is not fortuitous. On the contrary, it is crucial to the very high spectral efficiency that is the hallmark of CDMA. Other discussions in these pages show why this is true.

CDMA is altering the face of cellular and PCS communication by:

- Dramatically improving the telephone traffic (Erlang) capacity
- Dramatically improving the voice quality and eliminating the audible effects of multipath fading
- Reducing the incidence of dropped calls due to handoff failures
- Providing reliable transport mechanism for data communications, such as facsimile and internet traffic
- Reducing the number of sites needed to support any given amount of traffic
- Simplifying site selection
- Reducing deployment and operating costs because fewer cell sites are needed
- Reducing average transmitted power
- Reducing interference to other electronic devices
- Reducing potential health risks

2. Features and Advantages of CDMA Mobile Phone (For AMPS as well)

2.1 Various Types of Diversities

When employing the narrow band modulation (30kHz band) that is the same as the analog FM modulation system used in the existing cellular system, the multi-paths of radio waves create a serious fading. However, in the CDMA broadband modulation(1.25MHz band), three types of diversities (time, frequency, and space) are used to reduce the multi-path fading problems generated from radio channels in order to obtain high-quality calls.

Time diversity can be obtained through the use of code interleaving and error correction code whereas frequency diversity can be obtained by spreading signal energy to more wider frequency band. The fading related to normal frequency can affect the normal 200~300kHz among signal bands and accordingly, serious affect can be avoided. Moreover, space diversity (also called path diversity) can be realized with the following three types of methods.
First, it can be obtained by the duplication of cell site receive antenna. Second, it can be obtained through the use of multi-signal processing device that receives a transmit signal having each different transmission delay time and then, combines them. Third, it can be obtained through the multiple cell site connection (Soft Handoff) that connects the mobile station and more than two cell sites at the same time.

2.2 Power Control

The CDMA system utilizes the forward (from a base station to mobile stations) and backward (from the mobile station to the base station) power control in order to increase the call processing capacity and obtain high-quality calls. In case the originating signals of mobile stations are received by the cell site in the minimum call quality level (signal to interference) through the use of transmit power control on all the mobile stations, the system capacity can be maximized.
If the signal of mobile station is received too strong, the performance of that mobile station is improved. However, because of this, the interference on other mobile stations using the same channel is increased and accordingly, the call quality of other subscribers is reduced unless the maximum accommodation capacity is reduced.
In the CDMA system, forward power control, backward open loop power control, and closed loop power control methods are used. The forward power control is carried out in the cell site to reduce the transmit power on mobile stations less affected by the multi-path fading and shadow phenomenon and the interference of other cell sites when the mobile station is not engaged in the call or is relatively nearer to the corresponding cell site. This is also used to provide additional power to mobile stations having high call error rates, located in bad reception areas or far away from the cell site.
The backward open loop power control is carried out in a corresponding mobile station; the mobile station measures power received from the cell site and then, reversely increases/decreases transmit power in order to compensate channel changes caused by the forward link path loss and terrain characteristics in relation to the mobile station in the cell site. By doing so, all the mobile office transmit signals in the cells are received by the cell site in the same strength.
Moreover, the backward closed loop power control used by the mobile station to control power with the commands issued out by the cell site. The cell site receives the signal of each corresponding mobile station and

compares this with the pre-set threshold value and then, issues out power increase/decrease commands to the corresponding mobile station every 1.25 msec (800 times per second).
By doing so, the gain tolerance and the different radio propagation loss on the forward/backward link are complemented.

2.3 Voice Encoder and Variable Data Speed

The bi-directional voice service having variable data speed provides voice communication which employs voice encoder algorithm having power variable data rate between the mobile telephone cell site and mobile station. On the other hand, the transmit voice encoder performs voice sampling and then, creates encoded voice packets to be sent out to the receive voice encoder, whereas the receive voice encoder demodulates the received voice packets into voice samples.
One of the two voice encoders described in the above is selected for use depending on inputted automatic conditions and message/data; both of them utilize four-stage frames of 9600, 4800, 2400, and 1200 bits per second. In addition, this type of variable voice encoder utilizes adaptive threshold values when selecting required data rate. It is adjusted in accordance with the size of background noise and the data rate is increased to high rate only when the voice of caller is inputted.
Therefore, background noise is suppressed and high-quality voice transmission is possible under the environment experiencing serious noise. In addition, in case the caller does not talk, data transmission rate is reduced so that the transmission is carried out in low energy. This will reduce the interference on other CDMA signals and as a result, improve system performance (capacity, increased by about two times).

2.4 Protecting Call Confidentiality

CDMA signals have the function of effectively protecting call confidentiality by spreading and interleaving call information in broad bandwidth. This makes the unauthorized use of crosstalk, search receiver, and radio very hard substantially. Also included is the encryption function on various authentication and calls specified in IS-95 for the double protection of call confidentiality.

2.5 Soft Handoff

The handoff , which is basic function of the cellular system, can maintain a call when user moves one cell site to another. In analog cellular, the cell sites use different frequecy channel, the handoff means frequence change. This mechanism also uses in CDMA. CDMA has many Frequency Allocation(FA)s. When the handoff carry out between different Fas, it is called Hard Handoff. The soft handoff means the handoff without change of the FA.

During the soft hand, the cell site already in the busy state and the cell site to be engaged in the call later participate in the call conversion. The call conversion is carried out through the original call connection cell site, both cell sites, and then, new cell site. This method do not change frquency , so minimize call disconnection and prevent the user from detecting the hand-off.

2.6 Frequency Re-Use(Segmentation) and Sectorization

Unlike the existing analog cellular system, the CDMA system can reuse the same frequency at the adjacent cell and accordingly, there is no need to prepare a separate frequency plan. Total interference generated on mobile station signals received from the cell site is the sum of interference generated from other mobile stations in the same cell site and interference generated from the mobile station of adjacent cell site. That is, each mobile station signal generates interference in relation to the signals of all the other mobile signals.

Total interference from all the adjacent cell sites is the ratio of interference from all the cell sites versus total interference from other mobile stations in the same cell site (about 65%). In the case of directional cell site, one cell normally uses a 120¡ Æsector antenna in order to divide the sector into three. In this case, each antenna is used only for 1/3 of mobile stations in the cell site and accordingly, interference is reduced by 1/3 on the average and the capacity that can be supported by the entire system is increased by three times.

2.7 Soft Capacity

The subscriber capacity of CDMA system is flexible depending on the relation between the number of users and service classes. For example, the system operator can increase the number of channels available for use during the busy hour despite the drop in call quality. This type of function requires 40% of normal call channels in the standby mode during the handoff support, in an effort to avoid call disconnection resulting from the lack of channels.

In addition, in the CDMA system, services and service charges are classified further into different classes so that more transmit power can be allocated to high class service users for easier call set-up; they can also be given higher priority of using hand-off function than the general users.

3. Structure and Functions of CDMA Mobile Phone (For AMPS as well)

The mobile station of CDMA system is made up of a radio frequency part and logic/control (digital) part. The mobile station is fully compatible with the existing analog FM system. The mobile station antenna is connected with the transmitter/receiver via a duplexer filter so that it can carry out the transmit/receive function at the same time.

The transmit frequency is the 25MHz band of 824~849MHz, whereas the receive frequency is the 25MHz band of 869~894MHz. The transmit/receive frequency is separated by 45MHz. The RF signal from the antenna is converted into intermediate frequency(IF) band by the frequency synthesizer and frequency down converter and then, passes the bandpass SAW filter having the 1.25MHz band. IF output signals that have been filtered from spurious signal are converted into digital signals via an analog-to-digital converters(ADC) and then, sent out respectively to 5 correlators in each CDMA de-modulator. Of these, one is called a searcher whereas the remaining 4 are called data receiver(finger). Digitalized IF signals include a great number of call signals that have been sent out by the adjacent cells. These signals are detected with pseudo-noise sequence (PN Sequence). Signal to interference ratio (SINAD) on signals that match the desired PN sequence are increased through this type of correlation detection process. Then, other signals obtain processing gain by not increasing the ratio. The carrier wave of pilot channel from the cell site most adjacently located is demodulated in order to obtain the sequence of encoded data symbols.

During the operation with one cell site, the searcher searches out multi-paths in accordance with terrain and building reflections. On three data receivers, the most powerful four paths are allocated for the parallel tracing and receiving. Fading resistance can be improved a great deal by obtaining the diversity combined output for de-modulation. Moreover, the searcher can be used to determine the most powerful path from the cell sites even during the soft handoff during the two cell sites. Moreover, four data receivers are allocated in order to carry out the de-modulation of these paths. Data output that has been demodulated change the data string in the combined data row as in the case of original signals(deinterleaving), and then, are de-modulated by the forward error correction decoder which uses the Viterbi algorithm.

On the other hand, mobile station user information sent out from the mobile station to the cell site pass through the digital voice encoder via a mike. Then, they are encoded and forward errors are corrected through the use of convolution encoder. Then, the order of code rows is changed in accordance with a certain regulation in order to remove any errors in the interleaver. Symbols made through the above process are spread after being loaded onto PN carrier waves. At this time, PN sequence is selected by each address designated in each call.

Signals that have been code spread as above are digital modulated (QPSK) and then, power controlled at the automatic gain control amplifier (AGC Amp). Then, they are converted into RF band by the frequency synthesizer synchronizing these signals to proper output frequencies. Transmit signals obtained pass through the duplexer filter and then, are sent out to the cell site via the antenna.

4. Specification

4.1 General Specification

4.1.1 Transmit/Receive Frequency Interval : 45 MHz

4.1.2 Number of Channels (Channel Bandwidth)

1) CDMA : 20 CH

2) AMPS : 832 CH

4.1.3 Operating Voltage : DC 3.6V

4.1.4 Battery Power Consumption : DC 3.5V

	SLEEP	IDLE	MAX POWER
CDMA	2.3 mA	103 mA	740 mA (24 dBm)
AMPS	¦ ¡	99 mA	845 mA (28 dBm)

4.1.5 Operating Temperature : -30° ~ +60°

4.1.6 Frequency Stability

1) CDMA : ¡ ¾0.5PPM

2) AMPS : ¡ ¾2.5PPM

4.1.7 Antenna : Retractable Type (Herical+Whip), 50 Ｗ

4.1.8 Size and Weight

1) Size : 120 ✕ 47.3 ✕ 27 § §(Batt : STD)

120 ✕ 47.3 ✕ 23.2 § §(Batt :Option)

2) Weight : 140 ~150g (Batt : STD)

120 ~ 130g (Batt : Option)

4.1.9 Channel Spacing

1) CDMA : 1.25MHz

2) AMPS : 30KHz

4.1.10 Battery Type, Capacity and Orerating Time.

Unit = Hours : Minutes

		Standard (1400mA)	Option (900mA)
Stand-By Time	**CDMA**	240 Hrs	140 Hrs
	AMPS	25 Hrs	15Hrs

Talk Time	**CDMA**	300 Mins	180 Mins
	AMPS	140 Mins	90 Mins

4.2 Receive Specification

4.2.1 Frequency Range

1) Digital : 869.820 MHz ~ 893.190 MHz

2) Analog : 869.04 MHz ~ 893.97 MHz

4.2.2 Local Oscillating Frequency Range : 966.88MHz¡ ¾12.5MHz

4.2.3 Intermediate Frequency : 85.38MHz

4.2.4 Sensitivity

1) CDMA : -104dBm (C/N 12dB or more)

2) AMPS : -116dBm (12dB SINAD)

4.2.5 Selectivity

1) CDMA : 3dB C/N Degration (With Fch¡ ¾1.25 kHz : -30dBm)

2) AMPS : 16dB at Fch¡ ¾30kHz, 60 dB at Fch¡ ¾60kHz

4.2.6 Spurious Wave Suppression : Maximum of -80dB

4.2.7 CDMA Input Signal Range

- Dynamic area of more than -104~ -25 dB : 79dB at the 1.23MHz band.

4.2.8 AMPS DE-Emphasis : -6dB/OCT within 0.3~3kHz

4.2.9 AMPS Expander

1) Expansion Rate : 1:2

2) Attack Time : within 3mS

3) Recovery Time : within 13.5mS

4) Reference Input : Output level to a 1000Hz tone from a carrier
within +2.9kHz peak frequency deviation.

4.2.10 AMPS Sensitivity : 12dB SINAD/-116dBm

4.2.11 AMPS Intermodulation Spurious Response Attenuation : Above 65dB

4.2.12 AMPS RSSI Range : Above 60dB

4.2.13 AMPS Protection Against Spurious Response Interference : Above 60dB

4.2.14 AMPS In Band Conducted Spurious Emissions

1) Transmit Band : below –60dBm

2) Receive Band : below –80dBm

4.2.15 AMPS Out of Band Conducted Spurious Emissions : Below -47dBm

4.2.16 AMPS Radiated Spurious Emissions

Frequency Range	Maximum allowable EIRP
25 ~ 70 kHz	- 45 dBm
70 ~ 130 kHz	- 41 dBm
130 ~ 174 kHz	- 41 ~ - 32 dBm
174 ~ 260 kHz	- 32 dBm
260 ~ 470 kHz	- 32 ~ - 26 dBm
470 ~ 1 GHz	- 21 dBm

4.3 Transmit Specification

4.3.1 Frequency Range

1) Digital : 824.820MHz ~ 848.190MHz

2) Analog : 824.04MHz ~ 848.97MHz

4.3.2 Local Oscillating Frequency Range : 966.88 MHz ¡¾12.5 MHz

4.3.3 Intermediate Frequency : 130.38 MHz

4.3.4 Output Power

1) CDMA : 0.32W

2) AMPS : 0.6W

4.3.5 Interference Rejection

1) Single Tone : -30dBm at 900 kHz

2) Two Tone : -43dBm at 900 kHz & 1700kHz

4.3.6 AMPS Carrier ON/OFF Conditions

" ON" condition : within ±3dB of specification output (in 2mS)

4.3.7 AMPS Compressor

- Compression Rate : 2:1
- Attack Time : 3mS
- Recovery Time : 13.5mS

- Reference Input : Input level for producing a nominal ±2.9kHz peak requency deviation of transmitted carrier.

4.3.7 AMPS Preamphasis : 6dB/OCT within 0.3 ~ 3 kHz

4.3.8 AMPS Maximum Frequency Deviation

- F3 of G3 : ¡ ¾12kHz (¡ ¾10%)
- Supervisory Audio Tone : ¡ ¾2kHz (¡ ¾10%)
- Signaling Tone : ¡ ¾8kHz (¡ ¾10%)
- Wideband Data : ¡ ¾8kHz (¡ ¾10 %)

4.3.9 AMPS Post Deviation Limiter Filter

- 3.0kHz ~ 5.9kHz : above 40LOG (F/3000) dB
- 5.9kHz ~ 6.1kHz : above 35dB
- 6.1kHz ~ 15kHz : above 40LOG (F/3000) dB
- Over 15kHz : above 28dB

4.3.10 AMPS Spectrum Noise Suppression

- For all Modulation
  fo+20kHz ~ fo+45kHz : above 26dB
- For Modulation by Voice and SAT
  fo+45kHz : above 63+10LOG (Py) dB
- For Modulation by WBD (without SAT) and ST (with SAT)
  fo+45kHz ~ fo+60kHz : above 45dB
  fo+60kHz ~ fo+90kHz : above 65dB
  fo+90kHz ~ 2fo : above 63+10LOG (Py) dB

(where fo=carrier frequency, Py=mean output power in watts)

4.3.11 AMPS Harmonic and Conducted Spurious Emissions : above 43+10LOG (Py) dB

4.3.12 CDMA TX Frequency Deviation : ±300Hz or less

4.3.13 CDMA TX Conducted Spurious Emissions

- 900kHz : - 42 dBc/30kHz below
- 1.98MHz : - 54 dBc/30kHz below

4.3.14 CDMA Minimum TX Power Control : - 50dBm below

4.4 MS (Mobile Station) Transmitter Frequency

FA NO.	CH.NO.	CENTER FREQUENCY	FA NO.	CH.NO.	CENTER FREQUENCY
1	1011	824.640 MHz	11	404	837.120 MHz
2	29	825.870 MHz	12	445	838.350 MHz
3	70	827.100 MHz	13	486	839.580 MHz
4	111	828.330 MHz	14	527	840.810 MHz
5	152	829.560 MHz	15	568	842.04 MHz
6	193	830.790 MHz	16	609	843.270 MHz
7	234	832.020 MHz	17	650	844.500 MHz
8	275	833.250 MHz	18	697	845.910 MHz
9	316	834.480 MHz	19	738	847.140 MHz
10	363	835.890 MHz	20	779	848.370 MHz

4.5 MS (Mobile Station) Receiver Frequency

FA NO.	CH.NO.	CENTER FREQUENCY	FA NO.	CH.NO.	CENTER FREQUENCY
1	1011	869.640 MHz	11	404	882.120 MHz
2	29	870.870 MHz	12	445	883.350 MHz
3	70	872.100 MHz	13	486	884.580 MHz
4	111	873.330 MHz	14	527	885.810 MHz
5	152	874.560 MHz	15	568	887.04 MHz
6	193	875.790 MHz	16	609	888.270 MHz
7	234	877.020 MHz	17	650	889.500 MHz
8	275	878.250 MHz	18	697	890.910 MHz
9	316	879.480 MHz	19	738	892.140 MHz
10	363	880.890 MHz	20	779	893.370 MHz

4.6 Desktop Charger : See Appendix

4.7 Travel Charger : See Appendix

4.8 Cigar Lighter Charger : See Appendix

4.9 Hands-Free Kit : See Appendix

5. Installation

5.1 Installing a Battery Pack

1) The Battery pack is keyed so it can only fit one way. Align the groove in the battery pack with the rail on the back of the phone until the battery pack rests flush with the back of the phone.
2) Slide the battery pack forward until you hear a "click", which locks the battery in place.

5.2 For Desktop Charger Use

1) Plug the charger into a wall outlet. The charger can be operated from either a 110V or a 220V source. When AC power is connected to the desktop charger, both the green and red LED's blink once.
2) Insert the phone with the installed battery pack or a spare battery pack into the individual battery pack slot. Red light indicates battery is being charged.. Green light indicates battry is fully charged.

5.3 For Mobile Mount

5.3.1 Installation Position

In order to reduce echo sound when using the Hands-Free Kit, make sure that the speaker and microphone are not facing each other and keep microphone a generous distance from the speaker.

5.3.2 Cradle Installation

Choose an appropriate flat surface where the unit will not interface with driver's movement or passenger's comfort. The driver/user should be able to access the phone with ease. Using the four self-tapping screws provided, mount the supplied braket on the selected area. Then with the four machine screws provided, mount the counterpart on the reverse side of the reverse side of the cradle. Secure the two brackets firmly together by using the two bracket joint screws provide. The distance between the cradle and the interface box must not exceed the length of the main cable.

5.3.3 Interface Box

Choose an appropriate flat surface (somewhere under the dash on the passenger side is preferred) and mount the IB bracket with the four self-tapping screws provided. Clip the IB into the IB bracket.

5.3.4. Microphone Installation

Install the microphone either by cliiping I onto the sunvisor (driver's side) or by attaching it to door post (driver's side), using a velcno adhesive tape (not included).

5.3.5 Cable Connections

5.3.5.1 Power and Ignition Cables

Connect the red wire to the car battery positive terminal and the black wire to the car ground. Connect the green wire to the car ignition sensor terminal. (In order to operate HFK please make sure to connect green wire to ignition sensor terminal.) Connect the kit's power cable connector to the interface box power receptacle.

5.3.5.2 Antenna Cable Connection

Connect the antenna coupler cable connector from the cradle to the external antenna connector. (Antenna is not included.)

CHAPTER 2. NAM Input Method (Inputting of telephone numbers included)

1. Telephone Number and NAM Programming Method

- Press **MENU**+4+0 and then, press the password made up of six digits(Default:000000).

  Then, the following Menu is appeared.

```
1 : Prog Mode
2 : Pref. Mode
3 : ER Mode
4 : PRL
```

- Press **1** to program the telephone number and NAM.

```
1 : NAM 1
2 : NAM 2
3 : NAM 3
4 : NAM 4
```

- Select one NAM (the registration requires NAM1 as default).

```
ESN
```

- Edit ESN(if you want, but not recommended) , then press [OK].

```
NAM 1 PHONE
NUMBER
```

- Enter the phone number, then press [OK].

```
NAM 1 HOME SID
```

- Edit NAM 1 HOME SID, then press [OK].

NAM 1 NAME

- Edit the name of NAM1, the press [OK]. 'NAM 1 NAME' may display the name of the service provider.

BASIC NAM 1
PROGRAMMING
IS COMPLETED

- Now, the basic programming is completed. To reset the handset, press [EXIT]. If you want to program detail informtions for NAM 1, press [MORE].

The detail programming method is same as basic programming. Set up required values and then, press the [OK] soft key in an effort to move to the next screen. To return to the last item, press the left arrow (◀ *). The editable NAM items are followed:

SERVICE SEC. CODE
NAM 1 LOCK_OUT SYSTEM 1
NAM 1 CDMA PHONE MUNBER
NAM 1 MOBILE COUNTRY CODE
NAM 1 MOBILE NETWORK CODE
NAM 1 MOBILE STATION ID #
NAM 1 CDMA HOME SID 1
NAM 1 CDMA HOME NID 1
NAM 1 CDMA HOME SID 2
NAM 1 CDMA HOME NID 2
NAM 1 CDMA HOME SID 3
NAM 1 CDMA HOME NID 3
NAM 1 CDMA HOME SID 4
NAM 1 CDMA HOME NID 4
NAM 1 AMPS PHONE NUMBER
NAM 1 AMPS HOME SID
PHONE MODEL
SLOT CYCLE INDEX

¡ ØEditing this items is not recommended.

CHAPTER 3. Circuit Description

1. RF Transmit/Receive Part

1.1 Overview

The RF transmit/receive part employs the Super-Heterodyne system. The transmit/receive frequency is respectively 824.04~848.97 MHz and 869.04~893.97 MHz and the block diagram is shown in ~~Appendix 4~~.

RF signals received through the antenna are fed into the low noise amplifier (LNA) through the duplexer. Then, they are combined with the signals of local oscillator (VCO) at the frequency mixer in order to create intermediate frequency (IF).

Intermediate frequency created is sent out to each bandpass filter (BPF) through the FM (Analog) or CDMA (Digital) path and then, fed into IFR (RX IF BASEBAND converter), signals are auto gain controlled and, are changed into baseband signals.

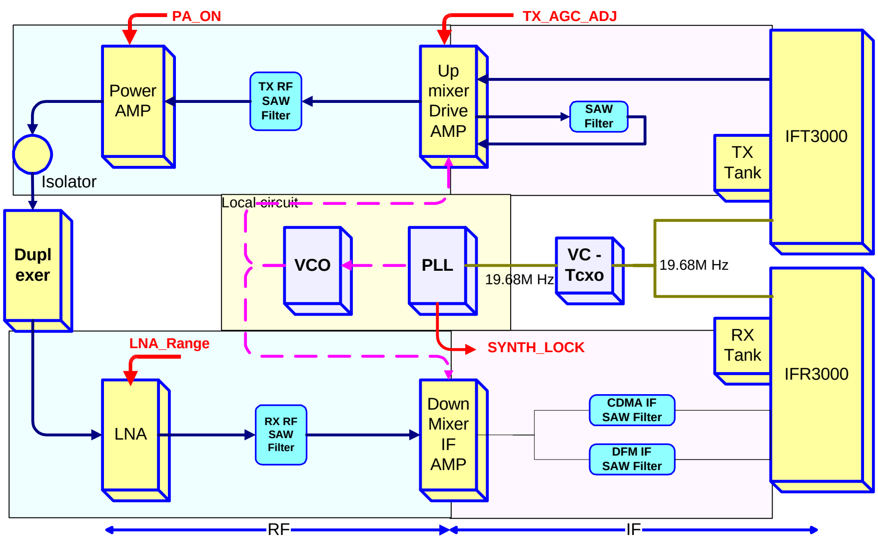
These signals are then, changed into digital signals by the analog/digital converter (ADC, A/D Converter) and then, sent to the MSM (Mobile Station Modem) of the digital circuit part. Then, they are demodulated by the modulator/demodulator.

In the case of transmission, IFT receives modulated digital signals from the MSM of the digital circuit and then, changes them into analog signals by the digital/analog converter (DAC, D/A Converter) in order to create baseband signals. Created baseband signals are changed into IF signals by IFT and then, are auto gain controlled.

IF signals that have been fed are mixed with the signals of VCO and changed into the RF signals and amplified with dynamic range.

They are amplified at the Power AMP. Finally, they are sent out to the cell site via the antenna after going through the isolator and duplexer.

Block Diagram of RF



[Figure 1-1] Block Diagram of RF Transmit/Receive Part

1.2 Description of Receive Part Circuit

1.2.1 Duplexer

The duplexer(DP1) consists of the receive part bandpass filter (BPF) and the transmit part bandpass filter (BPF) which have the function of separating transmit/receive signals in the full duplex system using the transmit/receive common antenna. The transmit part BPF is used to suppress noises and spurious waves entering the receive band among transmit signals in order to prevent the drop in receive sensitivity characteristics. The receive part BPF blocks the signals sent out from entering the receive end in order to improve sensitivity characteristics.
Insertion loss (IL) in the transmit band is 2.4dB (Max), whereas IL in the receive band is 3.3dB (Max).
The receive band attenuation amount of transmit filter is 58dB (Min) and the transmit band attenuation amount of receive filter is 43dB or more (Min).

1.2.2 Downconverter

The downconverter is made up largely of low noise amplifiers(U2) and a frequency active gain DOWN mixer(U14).
RF signals (869.04 ~ 893.97 MHz) received from the Duplexer are amplified after obtaining the gain of 19dB through the LNA. Then, they are passed through the BPF. At this time, about 3dB IL is generated.
The output signals are fed to the mixer input terminal(U14.4). The mixer synchronizes the RF signals with local oscillating signal that has been inputted to the local input terminal(U14.3) in order to create the IF (85.38MHz) signals. At this time, the conversion gain of 10dB is added the signals.
Local oscillating signals through other paths are fed into the mixer of transmit terminal.
The signal suppression rate of RF signal band on local oscillating signals is 40dB on th average whereas the IF signal band signal suppression rate is 33 dB.
IF signals have two paths after passing the Mixer. One is the digital path (CDMA) while the other is the analog path (FM).
The paths to be selected are determined by receiving output signals FM/ of MSM3000 through the IF select terminal. IF signals that have selected the FM path are inputed to FM IF BPF(F8) for FM through the FM path.
IF signals that have selected the CDMA path are passed CDMA IF saw filter(F6) and then, are inputed to IFR3000.

1.2.3 Receive End Bandpass Filter

Receive RF signals (869.04-893.97 MHz) from the LNA are fed into RF BPF. RX RF filter has IL of 3dB (Max) on the average whereas the ripple of passband is about 2.0dB (Max) and the RF signal suppression rate on transmit band is 30dB.

The impedance of input/output terminal is 50Ω and the maximum power that can be inputted is about 25dBm. IF BPF for CDMA signals (85.38MHz¡¾630kHz) can receive the IF signal of 20dBm which is the maximum input signal from the Down mixer. The side band signal suppression rate is 41dB and IL is 10.3dB.
IF BPF for FM has the 3dB bandwidth of 85.38MHz¡¾15kHz. IL is 5dB (Max) whereas the ripple of passband is 1.5dB (Max).

1.2.4 Description of IFR3000 Internal Circuit

The IFR3000 is a key circuit element in the Rx signal path of the CDMA/AMPS subscriber unit. It is located between RF system and the MSM digital processor. The analog inputs of IFR3000 interface directly with the IF receive circuitry of the subscriber unit. The digital inputs and outputs of IFR3000 interface directly with MSM3000.

1.2.4.1 CDMA Rx Signal Path

The IFR3000 consists of a received signal path, clock synthesis, buffering circuits and mode control logic.
The CDMA Rx signal path comprises the Rx AGC amplifier, mixer, CDMA low-pass filters, and A/D converters. With its CDMA_IF and CDMA_IF/ terminals, the IFR3000 receives two IF signals that have been modulated (CDMA Spreading Power Density Modulation) extending ± 630kHz from 85.38MHz Center Frequency.
The Rx AGC amplifiers or attenuates the received CDMA IF signal to provide a constant-amplitude signal to the I/Q downconverter.
This type of gain control is the power adjustment function to reduce the loss resulting from the receive power of a mobile station by maintaining the constant signal strength at the IFR3000 receive end even if the received signals change according to the location of a mobile station user.
The AGC gain is controlled by varying the DC voltage on the Vcontrol input pin.
The AGC's 90dB dynamic range is available over the full power supply range of the device. The IF output of the Rx AGC amplifier is further classified into I and Q signals and downconverted by mixing with quadrature local oscillator signals. The local oscillator signals are generated by a voltage controlled oscillator onboard the IFR3000 and frequency stabilized by external varactor-tuned resonant tank circuitry. The I and Q phasing of the receive section is spectrally inverted from a standard quadrature demodulator when the IF input signal frequency is above the IF center frequency. The I/Q down converter outputs the CDMA I and Q signals haing the bandwidth of 1kHz ~630kHz through CDMA LPF. The use of LPF in IFR3000 suppresses spurious signals entering the receiver in order to improve the CDMA baseband signal selectivity.

CDMA analog I and Q baseband components are converted to digital signals by 2 4-bit ADCs.The ADCs output a new 4-bit parallel digital value on each rising edge of the ADCs synchronous clock input signal,CHIP×8.
The CHIP×8 ADC clock frequency of 9.8304 MHz is developed in the IFR3000 by multiplying the 19.68MHz system crystal oscillator frequency by 512/1025.
At the 2 4 bit ADCs, Q_OFFSET and I_OFFSET signals are inputted to MSM3000.
These signals are very important during the digital signal processing process of receive signal paths and accordingly, the adjustment should be made in such a way that the MSM3000 detects the difference from ADC digital output RXID[3:0] and RXQD[3:0] and then, generates PDM (Pulse Density Modulation) signals for compensating the variation. This PDM signal passes the single-pole RC LPF and then, is converted into DV voltage before being inputted to the I-OFFSET and Q-OFFSET terminals of the IFR3000.

1.2.4.2 FM Rx Signal Path

The Fm received signal Path is designed to accept a differential IF signal with frequency modulation extending ±15kHz from the IF center frequency to form a 30Hz wide IF channel. The IF center frequency is same as the CDMA IF center frequency, 85.38MHz.

The RX AGC amplifier interface with the IF subsystem of the subscriber unit. The Rx AGC either amplifiers or attenuates the received FM IF signal to provide a constant amplitude.
Constant amplitude signals go through the I/Q downconverter.
The AGC amplifier conditions the received IF signal to optimize between low IF output power level and high signal intellegibility and reliability. The AGC gain is controlled by varing a DC voltage on the Vcontrol input pin. The AGC's 90dB dynamic range is availiable over the full power supply range of the device.

The IF output of the Rx AGC amplifier is separated into I-Channel and Q-channel baseband compoments and downconverted by mixing with quadrature local oscilliator signals.
The I and Q phasing of the receive section is spectrally inverted form a standard quadrature demodulator when the IF input signal frequency is above the IF center frequency.
The I/Q down converter outputs the FM signals at baseband frequency. Low pass filtering enables the receiver to select the desired baseband signal from the jamming effects of unwanted noise or adjacent-channel interference.

FM analog I and Q baseband components are converted to digital FM(DFM) signals by two 8-bit ADCs. The FM ADCs' outputs are inputted into MSM3000 through RXIFMDATA and RXQFMDATA terminals.

1.3 Transmit Part Circuit Description

1.3.1 Description on the Internal Circuit of IFT3000

1.3.1.1 CDMA Tx Signal Path

8 bits I and Q transmit signals are inputted into 2 DACs (Digtal to Analog Converter) from the output terminal TX_IQDATA[7:0] of the MSM 3000 through the input terminals TXD[7:0] of the IFT3000.
In the signals coming out of the DACs, there are spurious frequency ingredients resulting from DAC output transition edge and parasite ingredients, transmit clock frequencies and harmonics which are unwanted signals. Accordingly, spurious ingredients are removed by passing the signals through LPF of passband 630kHz.
Unlike the receive end, the transmit end LPF requires no OFFSET adjustment.
The IFT3000 includes a programmable Tx PLL for synthesizing the TxIF frequency.
The TxVCO oscillates at twice the TxIF frequency. The 260.76MHz created in the IFT3000's internal VCO are divided by half into frequency 130.38MHz having the phase difference of 90 degrees.
Analog I and Q baseband components are mixed in quadrature with the Tx IF frequency and added again to generate a modulated waveform centered at 130.38MHz IF frequency.

A temperature-compensated Tx AGC amplifier with 84dB gain range is included in the IFT3000. The transmit output power level of the subscriber unit is directly controlled by varying the gain of this Tx AGC amplifier.A PDM output from the MSM3000 's TX_AGC_ADJ pin is RC low-pass filtered and turned to a DC voltage level. This voltage level linearly controls the gain of the Tx AGC amplifier.

1.3.1.2 FM Tx Signal Path

Once 8 bits digital transmit signals are transferred to IFT3000 from MSM3000.
They are inputted into LPF through DAC for Q signal, which is one of two DACs.
During this time, all the paths for the spread spectrum algorithm do not operate and accordingly, power consumption can be reduced. FM transmit signals that pass through LPF are outputted after being changed into the FM modulation signal FM_MODE of band 30KHz.

The use of Tx AGC is same as the CDMA Tx signal path.

1.3.2 Upconverter and Drive AMP

Upconverter(U13) is made up of a mixer part and a amplifier part. The mixer part is used to receive double-balanced OUT+ and OUT- of IFT3000 and mixes the output of Dual PLL Module with UHF output signal.
Upconverter's output operation range is 800MHz~960MHz (RF frequency) and has the conversion gain of 5 dB.
In addition, the suppression of spurious signals which are unwanted noise(885kHz offset) is about -50 dBc when

being compared to RF output.
Amplifier part is consisted on RF AMP that has linear Gian control on 26dB, is controlled by TX_AGC_ADJ from MSM.
Between Upconverter and Drive Amp , there is a band pass filter(F3).

1.3.3 Transmit End Bandpass Filter

Transmit signals that have been converted from IF signals into RF signals after passing through the upconverter are inputted into the Power Amp, after passing once again through RF BPF in order to filter out noise signals amplified.
This is carried out in order to create power level inputted to the Power AMP via RF BPF . IL of two RF BPFs is 3.5dB (Max) as a maximum, whereas the ripple in the passing band is 2dB(Max). The degree of the suppression of transmit signals on receive band is at least 25dB or greater. The maximum power that can be inputted is about 10dBm.

1.3.6 Power Amplifier and Isolator

The power amplifier(P1) that can be used in the CDMA and FM mode has linear amplification capability, whereas in the FM mode, it has a high efficiency.
For higher efficiency, it is made up of one MMIC (Monolithic Microwave Integrated Circuit) for which RF input terminal and internal interface circuit are integrated onto one IC after going through the AlGaAs/GaAs HBT (heterojunction bipolar transistor) process.
The module of power amplifier is made up of an output end interface circuit including this MMIC.
The maximum power that can be inputted through the input terminal is +7dBm and conversion gain is about 30dB.
RF transmit signals that have been amplified through the power amplifier are sent to the duplexer via isolator(ISO1) and then, sent out to the cell site through the antenna in order to prevent any damages on circuits, that may be generated by output signals reflected from the duplexer and re-inputted to the power amplifier output end. The maximum power of that can be inputted is 5W (Max) and IL is 0.65dB (Max). Input/output separation is at least 15dB (Min).

1.4 Description of Frequency Synthesizer Circuit

1.4.1 Voltage Control Temperature Compensation Crystal Oscillator

The temperature range that can be compensated by VC-TCXO(X3) which is the reference frequency generator of a mobile station is -30~+80 °C.

VC-TCXO receives frequency tuning signals called TRK_LO_ADJ from MSM as 0.5V~2.5V DC via R and C filters in order to generate the reference frequency of 19.68MHz and input it into the frequency synthesizer of UHF band. Frequency stability depending on temperature is ¡ ¾2.0 ppm.

1.4.2 Dual PLL Module

Reference frequency that can be inputted to PLL(U8) is 19.68MHz.

It is the dual mode frequency synthesizer (PLL) that can synthesize frequencies band 954MHz~980MHz and IF oscilation frequency 170.76MHz. PLL that receives the reference frequency of 19.68MHz from VC-TCXO creates the phase detect frequency of 30kHz with the use of internal program and then, changes the frequency of 900MHz band. And then, two signal differences are calculated from the internal phase comparator.

The calculated difference is inputted to DC for adjusting the frequency of PLL. In addition, outputs of other PIN3 are inputted into IFR after going through the VRACTOR diode and tank circuit so that the outputs of IFR internal receive end VCO are adjusted to 170.76MHz.

PLL that generates the LO frequency of a mobile station have good spurious characteristics (ref. supurious at 30kHz from carrier = -70dBc (Max)).

2. Digital/Voice Processing Part

2.1 Overview

The digital/voice processing part processes the user's commands and processes all the digital and voice signal processing in order to operate in the phone. The digital/voice processing part is made up of a keypad/LCD, receptacle part, voice processing part, mobile station modem part, memory part, and power supply part.

2.2 Configuration

2.2.1 Keypad/LCD and Receptacle Part

This is used to transmit keypad signals to MSM3000. It is made up of a keypad backlight part that illuminates the keypad, LCD part that displays the operation status onto the screen, and a receptacle that receives and sends out voice and data with external sources.

2.2.2 Voice Processing Part

The voice processing part is made up of an audio codec used to convert MIC signals into digital voice signals and digital voice signals into analog voice signals,
amplifying parts for amplifying the voice signals and MIC signals are on Codec.

2.2.3 MSM3000 (Mobile Station Modem) Part

MSM3000 is the core elements of a CDMA mobile station and carries out the functions of CPU, encoder, interleaver, deinterleaver, Viterbi decoder, Mod/Demod, and vocoder.

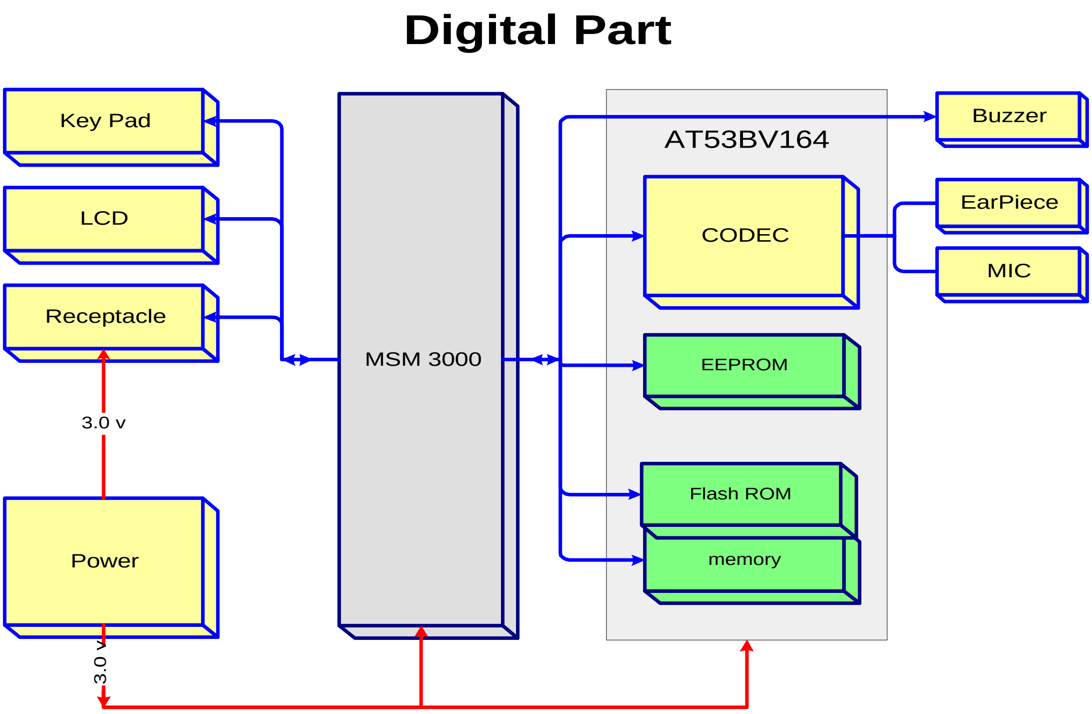
2.2.4 Memory Part

The memory part is made up of a flash memory, a SRAM, and an EEPROM.

2.2.5 Power Supply Part

The power supply part is made up of 5 Regulators and direct connet to Batt.
Regulator(150mA)s give the power each Circuits(TX chain, RX chain, IFT and ITR, Codec).
Regulator(200mA) gives the power MSM and memory .
PAM, Motor, LED is directly conneted to Batt.

2.3 Circuit Description



[Figure 2-1] Block Diagram of Digital/Voice Processing Part

2.3.1 Keypad/LCD and Receptacle Part

Once the keypad is pressed, the key signals are sent out to MSM3000(U16) for processing. In addition, when the key is pressed, the keypad lights up through the use of 16 LEDs. The status and operation of a mobile station are displayed on the screen for the user with the characters and icons on the LCD.

Receptacle(CON3) exchanges audio signals and data with external sources and then, receives power from the battery or external batteries.

2.3.2 Audio Processing Part

MIC signals are inputted into the audio codec, and amplified with programmable gain(2dB step), and converted into digital signals(PCM). Then, they are inputted into MSM3000.

In addition, digital audio signals(PCM) outputted from MSM3000 are converted into analog signals after going through the audio codec. These signals are amplified with programmable gain on codec's internal AMP and transferred to the ear piece. Then, the signals of ringer activate the ringer is generated in MSM3000 and drive the ringer circuit(Q10, Q11).

2.3.3 MSM Part

MSM3000 is the core element of a CDMA mobile station. Subsystems within the MSM3000 include a CDMA processor,a QCELP(qualcomm Code Excited Linear Predication) vocoder,an EVRC(Enhanced Variable Rate Codec) vocoder, an ARM7TDMI microprocessor ,and assorted peripheral interfaces that are used to support other functions. MSM3000, when operated in the CDMA mode, utilizes CHIP×8 (9.8304MHz) received from the IFR3000 as the reference clock primarily for CDMA and vocoder processing.MSM3000 also uses TCXO/4 (4.92MHz) received from IFR3000.

The CPU controls total operations of the subscriber unit. Digital voice data, that have been inputted, are encoded using the QCELP algorithm. Then, they are convolutionally encoded so that error detection and correction are possible. Coded symbols are interleaved in order to avoid a burst error. Each data channel is scrambled by the long code PN sequence of the user in order to ensure the confidentiality of calls.

Moreover, binary quadrature codes are used based on Walsh functions in order to discern each channel. Data created thus are 4-phase modulated by one pair of Pilot PN code and they are used to create I and Q data.

When received, I and Q data are demodulated into symbols by the demodulator and then, de-interleaved in reverse to the case of transmission. Then, the errors of data received from Viterbi decoder are detected and corrected. They are voice decoded at the vocoder in order to output digital voice data.

The MSM3000 also supports Enhanced Variable Rate Coder (EVRC) operation in addition to the standard 8k and 13k vocoding rating.

2.3.4 Memory Part

The memory part consists of a 16Mbits Flash Memory, a 4Mbits SRAM(Static Random Access Memory), and a 256kbits EEPROM(Electrically Erasable and Programmable Read Only Memory). In the Flash Memory, there are programs used for the operation of a mobile station. The programs can be changed through down loading after the assembling of mobile stations. On the SRAM, data generated during the operation of a mobile station are stored temporarily. On the EEPROM, the non-volatile data of the mobile station such as a ESN(Electronic Serial Number) are stored.

2.3.5 Power Supply Part

turn ON

When the battery voltage (4.2V ~ 3.0V) is fed and the PWR key of keypad is pressed, Q8 is activated by the +VPWR and ON_SW signal and then, ON/ is generated. Based on this ON/, regurator U3 is operated and +3.0V_MSM is generated.

operating

During the phone is on operating state,

LDO for MSM is always enable and gives the power MSM and memory part

LDO for IFT_IFR are always enable and gives the power IFT, IFR and VC-TCXO.

LDO for TX part is enable on IDLE state, and gives the power TX part devices. But PAM is given the power directly from Batt.

LDO for RX part is enable on SLEEP state, and gives the power RX part devices and PLL block.

LDO for audio part is enable on audio enable state, and gives the power Codec.

Turn OFF

When the PWR key is pressed during a few seconds, Q8(DTC144EE) is turned on by ON_SW and then, 'Low' is outputted on ON_SW_S/. MSM3000 receives this signal and then, recognizes that the POWER key has been pressed. During this time, MSM3000 outputs PS_HOLD as low and turn off all devices

2.3.6 Logic Part

The Logic part consists of internal CPU of MSM3000, RAM, ROM and EEPROM.

The MSM3000 receives TCXO/4 clock(19.68Mz) and CHIPX8 clock signals from the IFR3000, and then controls the phone during the CDMA and the FM mode. The major components are as follows:

CPU : ARM7TDMI core

MEMORY :

- FLASH Memory : 16M bits
- STATIC RAM : 4M bits
- EEPROM : 265kbits

CPU

ARM7TDMI 32-bit microprocessor is used and CPU controls all the circuitry. Some of the features of the ARM microprocessor include a 3 stage pipelined RISC architecture, both 32-bit ARM and 16bit THUMB instruction setsm, a 32-bit address bus, and a 32-bit internal data bus.

FLASH Memory

Flash Memory is used to store the program of the mobile station. Using the down-loading program, the program can be changed even after the mobile station is fully assembled.

SRAM

SRAM is used to store the internal flag information, call processing data, and timer data.

KEYPAD

For key recognition, key matrix is setup using key sense0-4 signals and GPIO0-4 of output ports of MSM. Backlight circuitry are included in the keypad for easy operation in the dark.

LCD MODULE

LCD module contains a controller which will display the information onto the LCD by 8-bit data from the MSM.

It has a black and white full graphic 112(W) ¥ ¹64(H) dots