Features of Mobile Subscriber Radio Telephone Set (LG P-2300/2310W Type)

1. Wave Type : G7W

2. Frequency Scope

- Send Frequency : 1850~1910MHz
- Receive Frequency : 1930~1990MHz

3. Rated Output

- 360mW

4. Output Conversion Method : This is possible by correcting the key board channel.

5. Voltage and Current Value of Termination Part Amplifier(Catalogue included)

Product	Type Name	Voltage	Current	Power
PWR AMP	RI-21108U	5.0V	450mA	250mW

6. Functions of Major Semi-Conductors

Classification	Function
MSM3000-PBGA	Terminal operation control and digital signal processing
FLASH MEMORY & STATIC RAM (MB84VA2103-10)	Flash Memory (16Mbit) → Storing of terminal operation program SRAM (2Mbit) → Temporary storing of the data created while busy
IFR3000	Converts IF signal into digital baseband signal
IFT3000	Converts digital baseband signal to IF signal

7. Frequency Stability

- ± 0.1PPM

CDMA Mobile Subscriber Unit
LGP-2300/2310W

SERVICE MANUAL

Table of Contents

General Introduction

The LGP-2300/2310W is a 1.9GHz CDMA(Code Division Multiple Access) PCS phone. CDMA technology with this phone adopts DSSS(Direct Sequence Spread Spectrum) ,which is also used in the military.

This feature of DSSS enables the phone to keep communication from being crossed and to use one frequency channel by multiple users in the same specific area, resulting that it increases the capacity 10 times more compared with that in the analog mode 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 the phone.

A CDMA PCS network consists of MSC (Mobile Switching Center), 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 ANSI J-STD-008 (Common Air Interface). MS meets the specifications of the below:

- ANSI J-STD-008	Personal Station - Base Station Compatibility Requirements for 1.8 to 2.0 GHz CDMA PCS
- ANSI J-STD-018	Recommended Minimum Performance Requirements for 1.8 to 2.0 GHz CDMA Personal Stations
- TIA/EIA IS-126-A	Mobile Station Loopback Service Options Standard
- TIA/EIA IS-127	Enhanced Variable Rate Voice Coder
- TIA/EIA IS-683	Over-the-Air Service Provisioning of Mobile Stations in Wideband Spread Spectrum Systems
- TIA/EIA-IS-707	Data Service Options for Wideband Spread Spectrum Systems

LGP-2300/2310W is composed of transceiver, desktop charger, Li-Ion Battery (1600mAh), hands-free kit, travel charger, cigar light charger and data kit. Hands-free kit is designed to operate in full duplex.

CHAPTER 1. System Introduction

1. System Introduction

1.1 CDMA Abstract

Currently,2 methods of PCS services are in use worldwide; One is TDMA and the other is CDMA. DCS-1800,which is based on the GSM protocol , TDMA technology, and 1.8GHz frequency range is in service in many areas including Europe. Japanese PHS(Personal Handy-phone System) is based on the TDMA/TDD technoogy and uses 1.9GHz frequency range. Meanwhile,in the United States,both of PCS-1900,a TDMA standard,and J-STD-018,a CDMA standard have been adopted commercially.

CDMA system can be explained as follows: TDMA or SDMA can be used to enable each person to talk alternately or provide a separate room for each person when two persons desire to talk with each other at the same time, whereas FDMA can be used to enable one person to talk in soprano, whereas the other in bass (one of the two talkers can carry out synchronization for hearing in case there is a bandpass filter function in the area of the hearer).
Another method available is to make two persons to sing in different languages at the same time, space, and frequency when wishing to let the audience hear the singing without being confused. This is the characteristics of CDMA.

On the other hand, when employing the CDMA technology, each signal has a different pseudo-random binary sequence used to spread the spectrum of carrier. A great number of CDMA signals share the same frequency spectrum. In the perspective of frequency area or time area, several CDMA signals are overlapped. Among these types of signals, only desired signal energy is selected and received through the use of pre-determined binary sequence; desired signals can be separated and then, received with the correlator used for recovering the spectrum into its original state. At this time, the spectrums of other signals that have different codes are not recovered into its original state and instead, processed as noise and appears as the self-interference of the system.

2. Features and Advantages of CDMA Mobile Phone

2.1 Various Types of Diversities

When employing the narrow band modulation (30kHz band) such as the analog FM modulation 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 serious 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 wider frequency band. The fading related to normal frequency can affect the normal 200~300kHz among signal bands and accordingly, serious effect 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 with 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 power 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 PCS 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 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 is 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 1.25msec (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 14400,7200,3600,1800 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).

Also,compared to the existing CDMA cellular system’s 9600 bps vocoder rate,the PCS’ vocoder rate is up to 14400 bps, providing relatively better voice quality (almost twice better than the existing 800MHz CDMA cellular system) almost comparable to the landline service.

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 encryption function on various authentication and calls for the double protection of call confidentiality.

2.5 Soft Handoff

During the soft hand-off, 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 can minimize call disconnection and prevent the user from detecting the hand-off.

2.6 Frequency Re-Use and Sector Segmentation

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 ° sector 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 the 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

The mobile station of the CDMA system is made up of a radio frequency part and a logic/control (digital) part. 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 60MHz band of 1850~1910MHz , whereas the receive frequency is the 60MHz band of 1930~1990MHz. The transmit/receive frequency is separated by 20MHz. 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 bandwidth. The IF output signals that have been filtered from spurious signals 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 receivers(fingers). 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 (C/I) 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 3 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 between the two cell sites. Moreover, 3 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 : 80 MHz

4.1.2 Number of Channels (Channel Bandwidth) : 48

4.1.3 Operating Voltage : DC 3.8V

4.1.4 Battery Power Consumption : DC 3.8V

	SLEEP	IDLE	MAX POWER
CDMA	3 mA	100 mA	450 mA (24 dBm)

4.1.5 Operating Temperature : -20° ~ +60°

4.1.6 Frequency Stability : ± 0.1PPM

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

4.1.8 Size and Weight

1) Size : 126✕23.7✕48(, L ✕ D ✕ W)

2) Weight : 155g (approximately with extended battery)

4.1.9 Channel Spacing : 1.25MHz

4.1.10 Battery Type, Capacity and Orerating Time. (condition: Slot Cycle 2)

		Extended (1600mAh)
Stand-By Time	**CDMA**	200 Hrs.(SCI = 2)
Talk Time	**CDMA**	180 Min.(typical duplexer,10dBm output)

4.2 Receive Specification

4.2.1 Frequency Range : 1930 MHz ~ 1990MHz

4.2.2 Local Oscillating Frequency Range : 1719.62MHz ~ 1779.62MHz

4.2.3 Intermediate Frequency : 210.38MHz

4.2.4 Sensitivity : -104dBm (or more)

4.2.5 Selectivity : 3dB C/N Degration (With Fch ± 1.25 kHz : -30dBm)

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.

4.3 Transmit Specification

4.3.1 Frequency Range : 1850 MHz ~ 1910 MHz

4.3.2 Local Oscillating Frequency Range : 1719.62MHz ~ 1779.62MHz

4.3.3 Intermediate Frequency : 130.38 MHz

4.3.4 Output Power : 360mW

4.3.5 Interference Rejection

1) Single Tone : -30dBm at 900 kHz
2) Two Tone : -43dBm at 900 kHz & 1700kHz

4.3.6 CDMA TX Frequency Deviation : ± 150Hz

4.3.7 CDMA TX Conducted Spurious Emissions

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

4.3.8 CDMA Minimum TX Power Control : - 50dBm below

4.4 MS (Mobile Station) Transmitter Frequency

Ch #	Center Freq.	Ch #	Center Freq.	Ch #	Center Freq.
25	1851.25	425	1871.25	825	1891.25
50	1852.50	450	1872.50	850	1892.50
75	1853.75	475	1873.75	875	1893.75
100	1855.00	500	1875.00	900	1895.00

125	1856.25	525	1876.25	925	1896.25
150	1857.50	550	1877.50	950	1897.50
175	1858.75	575	1878.75	975	1898.75
200	1860.00	600	1880.00	1000	1900.00
225	1861.25	625	1881.25	1025	1901.25
250	1862.50	650	1882.50	1050	1902.50
275	1863.75	675	1883.75	1075	1903.75
300	1865.00	700	1885.00	1100	1905.00
325	1866.25	725	1886.25	1125	1906.25
350	1867.50	750	1887.50	1150	1907.50
375	1868.75	775	1888.75	1175	1908.75

4.5 MS (Mobile Station) Receiver Frequency

Ch #	Center Freq.	Ch #	Center Freq.	Ch #	Center Freq.
25	1931.25	425	1951.25	825	1971.25
50	1932.50	450	1952.50	850	1972.50
75	1933.75	475	1953.75	875	1973.75
100	1935.00	500	1955.00	900	1975.00
125	1936.25	525	1956.25	925	1976.25
150	1937.50	550	1957.50	950	1977.50
175	1938.75	575	1958.75	975	1978.75
200	1940.00	600	1960.00	1000	1980.00
225	1941.25	625	1961.25	1025	1981.25
250	1942.50	650	1962.50	1050	1982.50
275	1943.75	675	1963.75	1075	1983.75
300	1945.00	700	1965.00	1100	1985.00
325	1946.25	725	1966.25	1125	1986.25
350	1947.50	750	1967.50	1150	1987.50
375	1948.75	775	1968.75	1175	1988.75

4.6 Desktop Charger : See Appendix

4.7 Travel Charger : See Appendix

4.8 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 a 110V 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 battery pack into the 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

1. Telephone Number Inputting Method

Telephone numbers can be inputted as follows in LGP2300W.

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

1) You can see ESN number : Press [ok]

2) You can see “ NAM1 PHONE NUMBER” : types proper phone number and press [ok]

3) Press [ok] ; press [ok]

2. NAM Program Method

The NAM inputting method of LGP2300W is as follows.

- Press MENU+4+0.
- Press the password made up of six digits (Default:000000).

1) You can see ESN number : Press [ok]

: If you press [akey] then you can insert akey with CRC checksum

2) You can see “ NAM1 PHONE NUMBER” : types proper phone number and press [ok]

3) You can see “ NAM1 HOME SID ” : types proper SID number and press [ok]

4) You can see “ NAM1 NAME “: types proper NAM name and press [EXIT] or [MORE]

If you choose [MORE] then following procedures are added

5) You can see “SERVICE SEC. CODE” : type security code number of just [ok]

6) You can see “NAM 1 MOBILE COUNTRY CODE” : types proper country codes number and press[ok]

7) You can see “NAM 1 NMSID” : press[ok]

- If you changed your phone number then you can see NMSID is changed to your 0000+phonenumber.

8) You can see “PHONE MODEL “: press [ok]

9) You can see “SLOT CYCLE INDEX” :types proper Slot cycle index and press [ok]

10) You can see “EXIT service programming” and phone will be rested.

CHAPTER 3. Circuit Description

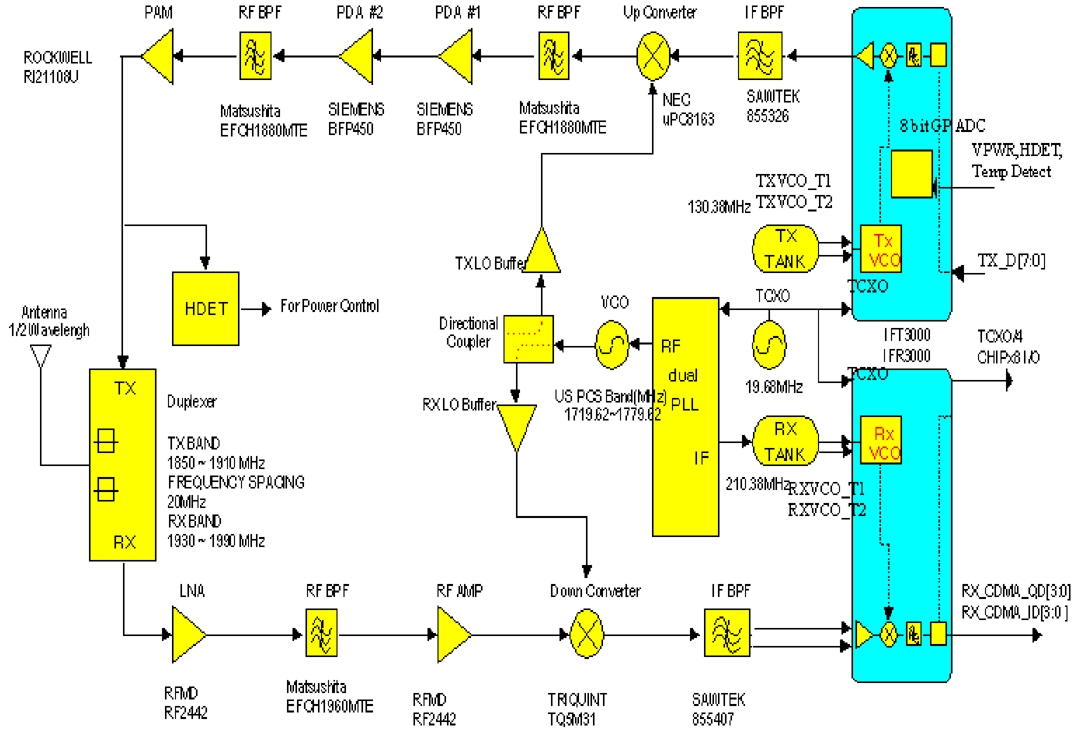
1. RF Transmit/Receive Part

1.1 Overview

The RF transmit/receive part employs the Super-Heterodyne system. The transmit/receive frequency is respectively 1850~1910 MHz and 1930~1990 MHz and the block diagram is shown in Appendix .

RF signals received through the antenna pass through the duplexer and then are fed into a low noise amplifier (LNA). Following this,the signals are inputted to a mixer(down converter),where the local oscillation signal from the frequency synthesizer and the received signals are mixed,thereby generate the intermediate frequency(IF) signals. This IF signals (210.38MHz) are band-pass filtered, adjusted through the AGC,demodulated to the baseband digital signals,and finally put into the MSM(Mobile Station Modem).

Follwing this,the signals are bandpass filtered at a RX SAW filter and fed into a 2nd RF amplifier.Then at the down-mixer, they are combined with the signals of a local oscillator (VCO) mixer in order to create intermediate frequency. The intermediate frequency created is sent out to an IF SAW filter, and then fed into an IFR3000 (Baseband ASIC). While being processed through the IFR3000,the signals are power-controlled by the AGC part ,then down-converted by the IF mixer and then converted to digital baseband by the ADC(A/D Converter) part. The digital baseband signals are now sent to the MSM,where they are demodulated by the modulator/demodulator.
While in transmission,the MSM3000 sends digital modulated signals to the IFT3000. While being processed through the IFT3000,the digital baseband signals from the MSM are first converted to analog baseband by the DAC part ,then up-converted to IF by the IF mixer part, and then power-controlled by the AGC part. The IF signals are now bandpass filtered by an IF SAW filter,and then fed into an up-mixer,where they are mixed with the VCO signals and converted to RF.Then,they are bandpass filtered at a RF SAW filter,sent through the drive amp part,bandpass filtered again at another RF SAW filter ,and finally amplified at the PAM. Finally, they are sent out to the cell site via the antenna after going through the duplexer.



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

1.2 Description of Receive Part Circuit

1.2.1 Duplexer (DP1)

The duplexer(DP1) consists of a receive part bandpass filter (BPF) and a transmit part bandpass filter(BPF). Its function is 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.

In addition, it suppresses video signals on IF signals. Insertion loss (IL) in the transmit band is 3.6dB (Max), whereas IL in the receive band is 4.5dB (Max). The receive band attenuation amount of transmit filter is 37dB (Min) and the transmit band attenuation amount of receive filter is 47dB or more (Min).

1.2.2 Receive End RF circuitry

The RF signals from the duplexer are first fed into the LNA(U201) ,and the maximally amplified signals (with noise figure of 1.8dB) from the LNA is then filtered by a BPF (U202) and amplified again by an RF amplifier(U203). At the down-converter(U204),the amplified signals from the RF amplifier are mixed with the UHF local oscillation signals from the frequency synthesizer,generating the added and the subtracted frequency components.As for the down-converter,we used a double balanced mixer in order to minimize the interference between the local oscillation signals and the IF signals. The major output from the down-converter are the signals at 210.38MHz.At this time,the gain of the LNA is 11dB,the insertion loss(IL) of the BPF is up to 3.5dB, and the attenuation in the transmit band (1850 – 1910 MHz) is 20dB(min).Also,the conversion loss of the RF amplifier and the down-converter are 11dB and 6dB respectively.

1.2.3 Receive End IF processing circuitry

The Receive end IF processing circuitry is composed of an IF BPF(U205), an IF AGC amplifier, an IF frequency synthesizer,and a QPSK demodulator.Of these,the IF AGC amplifier, the IF frequency synthesizer,and the QPSK demodulator are all in one chip(IFR3000,U402).

The IF signals from the down-converter(U204) are first fed into a matching circuitry and then into an IF BPF(U205).As for the BPF,we adopt the SAW filter,which meets attenuation of 30dB(Min) outside the pass band,thereby enhancing the RX sensitivity and the spurious suppression.

After passing through the SAW filter,the IF signals of 210.38MHz are fed into the AGC amplifier,where the signals are amplified or attenuated. The dynamic range of the AGC circuitry is 80dB(Min). This type of gain control is the power adjustment function used to reduce the loss resulting from the receive power of mobile terminal by maintaining the signal strength at the AGC input even if the received signals change according to the location of mobile terminal user.the AGC gain is controlled by varying the DC voltage on the voltage control input pin. The signals ,after the AGC amplifier stage,are input to the QPSK demodulator. The combined processing of the QPSK demodulator and the frequency synthesizer demodulate the received signals into baseband signals. Then,the signals are sent out to the IFR3000's LPFs.

1.2.4 AD conversion circuitry of the received signals

The IF receive signals centered at 210.38MHz with the bandwidth of ±630kHz are converted into I and Q baseband signals at the QPSK demodulator.With CDMA,the baseband is defined as from 1kHz to 630kHz. For the CDMA LPF in this stage, signals from above 750kHz are considered unwanted.

IF, together with the in-band loss and out-of-band suppression characteristics of the LPF, contributes to the enhancement of Rx sensitivity from the jamming effects of spurious signals. The use of I_OFFSET, Q_OFFSET control signals is for enhancing the received signals' sensitivity fed into the digital circuitry by adjusting the ADC inputs' offsets. These control signals are generated from the MSM(U503).

The CDMA ADC outputs digital signals on the falling edge of the 9.8304MHz clock. The CHIPx8 ADC clock frequency of 9.8304MHz is generated from the VCTCXO(U101)of 19.68MHz.

1.3 Transmit End Circuit Description

1.3.1 Description on the analog conversion circuitry

The IFT3000(U401) receives digital I/Q baseband data from the MSM chip(U503). The 8 bit transmit data are multiplexed and put into the IFT3000's DAC(Digital to Analog Converter). The input data are fed into I DAC on the rising edge of the transmit clock,and fed into the Q DAC on the falling edge. The I and Q data are fed in from the MSM with 1/2 clock cycle's difference. In order to filter out unwanted frequency components from each of the DAC outputs, BPFs with 630KHz's bandwidth are used.

1.3.2 Transmit End IF processing circuitry

The transmit End IF signal processing circuitry is composed of QPSK modulator (U401), frequency synthesizer (U401), AGC amplifier(U401),IF BPF(U301),Mixer(up-mixer,U302). The IFT3000 includes a programmable Tx PLL for synthesizing the TxIF frequency.The TxVCO oscillates at twice of 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. The I and Q baseband components from the DAC are mixed in quadrature with the TxIF frequency and added again to generate a modulated waveform centered at 130.38MHz IF frequency. The resulting signals are then fed into the AGC amplifier. A gain control signal TX_AGC_ADJ from the MSM is used to control the AGC operation. The signals from the AGC amplifier go through the matching circuitry first,IF BPF(U301) next,and then are fed into the RF up mixer(U302).The operation of the transmit end IF BPF is the same as that of the receive end IF BPF.The upconverter mixes the local oscillation signals in the UHF band with the 130.38MHz IF signals,thereby generating the subtracted and added frequency components. At this point,the local oscillation signals from the frequency synthesizer are separated into transmit and receive local oscillation signals respectively by a directional coupler. When the transmit signals and local oscillation signals are put into the upmixer,the nonlinear characteristics of the transistor generates combined signals of the 2 input signals,out of which the UHF band frequency will be output as the major one.

1.3.3 Transmit End RF signal processing circuitry

The signals from the upmixer are inputted to a TX RF BPF(U303). It's a SAW filter (Surface Acoustic Wave) with IL(Insertion Loss) of 3.5dB(Max),and with the attenuation of 20dB(Min) in the Rx band and the local oscillation band. There are 2 of this BPF in the Tx chain. We placed drive amps(U304,U305) with an average gain of 20dB between the 2 BPFs. The drive amps were cascade-designed using Siemens' BFP450 transistors. After the drive amp stage, the signals are filtered by another Tx RF BPF(U306),and then sent to a PAM(Power Amplifier Module , U307). Following this, the signals are sent to a duplexer(DP1) and an antenna ,and are finally transmitted to base stations. The PAM mentioned above is based on GaAs technology, and was designed such that maximum output of over +23.0dBm(0.2W) could be achieved at the duplexer output terminal. The PAM is driven by +5V. Also, a switching circuit is connected with the PAM for easy control of min & max power. The control signals for the switching circuit use TX_AGC_ADJ from the MSM.
Also, a power detection circuit is included which detects and compensates for power increase due to temperature

rise,and output error resulting from ripple variations. The signals from the PAM are then sent to the Tx input terminal of the duplexer,receptacle,and finally transmitted through the antenna.
The duplexer is essentially a dielectric filter that passes Tx and Rx signals along the respective paths,and suppresses spurious signals. Its IL(insertion loss) within the Tx band is 3.6dB(Max).

1.4 Description of Frequency Synthesizer Circuit

1.4.1 Voltage Controlled Temperature Compensation Crystal Oscillator (U101,VCTCXO)

VCTCXO is the reference frequency generator with frequency stability of ±2.0 ppm within the operational temperature range -30~+80 °C. The VCTCXO 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 to the frequency synthesizer of UHF band. The VCTCXO can achieve frequency deviation of up to ±5.5ppm(216.48Hz) depending on the voltage.The supply voltage for the VCTCXO is 3V.

1.4.2 UHF synthesizer

The UHF band frequency synthesizer is composed of an indirect frequency synthesizer(PLL,Phase Locked Loop,U102) ,a VCO (Voltage Controlled Oscillator,U151) with the center frequency of 1750MHz, a Loop Filter,and a directional coupler(U171). PLL IC’s phase detector compares the reference clock frequency divided down to 10kHz by the reference divider with a signal from the VCO divided by the PLL’s main divider,thus generating local oscillation signals with zero phase difference. These local oscillation signals are used both for Tx and Rx. The local oscillation signals are separated for Tx and Rx by the directional coupler,amplified respectively,and fed into mixers.

1.4.3 IF synthesizer

There are Rx and Tx IF synthesizers,respectively. The Tx IF synthesizer is composed of the IFT3000(U401),Tx Tank circuit,and the loop filter. The Tx phase detector within the IFT3000 receives the oscillation signals from the tank circuit,generating 130.38MHz Tx IF.
The Rx IF synthesizer is composed of the PLL(Dual Mode PLL),the IFR3000,the Rx Tank circuit,and the loop filter. The signal generated from the tank circuit is sent through the IFR3000 to the dual mode PLL’s phase detector. The PLL IC generates control voltage to the loop filter such that 210.38MHz Rx IF is synthesized.

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 the 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(U701).The audio codec is used to convert MIC signals into digital voice signals and digital voice signals into analog voice signals.The audio codec also has an amplifying part for amplifying the voice signals and sending them to the ear piece, and an amplifying part that amplifies signals coming out from MIC and transferring them to the audio processor,and an internal ring of tone generator.

2.2.3 MSM (Mobile Station Modem) Part (U503)

MSM is the core elements of CDMA terminal and carries out the functions of CPU, encoder, interleaver, deinterleaver, Viterbi decoder, Mod/Demod, and vocoder.

2.2.4 Memory Part

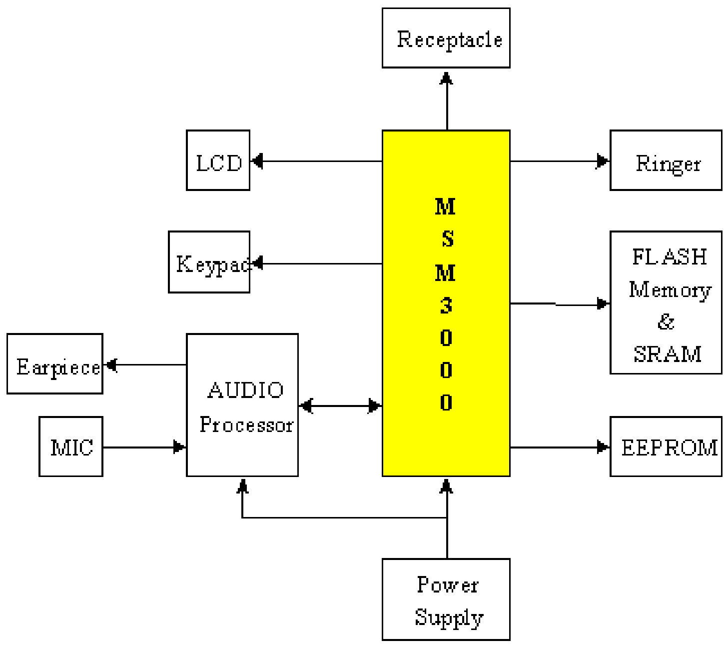
The memory part is made up of a flash memory & SRAM(U1) for storing data, and an EEPROM(U501).

2.2.5 Power Supply Part

The power supply part is made up of circuits for generating various types of power, used for the digital/voice processing part. +3.6V from The battery is fed into a DC/DC converter(U602) and 6 regulators(U603,U604,U605,U606, U607,U608).The DC/DC converter (U602) provides

+5V.U603,U604,U606,U607,U608 produce +3.0V for the logic part,the RX circuitry,IFT&IFR3000,the Codec,and the UI part, respectively.The regulator U605 provides +3.6 U603, for the Tx circuitry.

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 the MSM3000 for processing. In addition, when the key is pressed, the keypad lights up through the use of 8 LEDs. The terminal status and operation are displayed on the screen for the user with the characters and icons on the LCD(4 Line ×12 Characters and 18 Icons [1 Line])

Moreover, it exchanges audio signals and data with external sources through the receptacle and then, receives power from the battery or external batteries.

2.3.2 Audio Processing Part

MIC signals fed into the codec(U701). First, the signals are amplified through the mic preamp part and the mic amp part of the codec.Then the signals are filtered, digitally converted and fed into the MSM3000. Also,the digital audio signals outputted from the MSM3000 are converted into analog signals through the codec. First,the signals are digital-to-analog converted by the PCM DAC part,bandpass filtered,and then amplified by the amplifier part.Also,the signals of the codec’s ringer, together with the MSM 3000’s ringer,activates the buzzer by activating Q703 and Q704.

2.3.3 MSM Part

The MSM3000(U503) is the core element of CDMA system terminal. Subsystems within the MSM3000 include a CDMA processor, a QCELP(Qualcomm Code Excited Linear Predication) vocoder,an EVRC(Enhanced Variable Rate Codec) vocoder, an ARM microprocessor ,and assorted peripheral interfaces that are used to support other functions. The MSM3000,when operated in the CDMA mode, utilizes CHIPX8 (9.8304MHz) received from the IFR3000 as the reference clock primarily for CDMA and vocoder processing. The MSM3000 also uses TCXO/4 (4.92MHz) received from U101.

The CPU controls the terminal operation. Digital voice data that have been inputted are voice-encoded and variable-rated. Then, they are convolutionally encoded so that error detection and correction are possible. Coded symbols are interleaved in order to cope with multi-path fading. 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

Flash Memory/SRAM U1 is a MCP (Multi Chip Package) that contents 16 Mbit flash memory and 2 Mbit Static RAM. In the Flash Memory part of U1 (16Mbits), there are programs used for terminal operation. The programs can be changed through downloading after the assembling of terminals. On the SRAM(2Mbits) part, data generated during the terminal operation are stored temporarily. On the EEPROM U501,(128Kbits), non-volatile data such as unique numbers (ESN) of terminals are stored.

2.3.5 Power Supply Part

When the battery voltage (3.6V) is fed in and the PWR key of keypad is pressed, ON_SW ‘H’ signal is generated. Then,ON_SW_S/ ‘L’ is generated from Q602,and thus the MSM recognizes that POWER key has been pressed. During this time, MSM outputs PS_HOLD as 'H' ,and P_EN from D601 is turned ‘H’.This P_EN will enable U603 which provides power to the MSM.

DC-DC Converter U602 (SI9161) is operated by the control signal IDLE and RING_EN from the MSM3000. U602 generates +5V_VOUT. +5V_VOUT is mainly for the operation of the PAM and the ringer. The 3.0V generated through the regulator U604 is for the operation of the RX part ,the PLL and the VCO is controlled by

SLEEP/.The 3.6V generated by the regulator U605 is mainly for the TX part,and is controlled by IDLE/.The 3.0 V generated by the regulator U606 provides voltage for the IFR3000 and the IFT3000,and is controlled by P_EN.The regulator U603 generates +3.0V for the EEPROM,the Flash Memory, and the MSM3000,and is controlled by P_EN.Regulator U607 generates +3.0V for the codec and is controlled by AUDIO_EN.U608 generates +3.0V for the UI LED,and is controlled by P_EN.

2.3.6 Logic Part

The Logic part consists of internal CPU of MSM, RAM, ROM and EEPROM. The MSM3000 receives TCXO/4 (=4.92Mz) and CHIPX8 clock signals from the IFR3000 U402, and then controls the phone.The major components are as follows:

CPU : ARM microprocessor

FLASH MEMORY and SRAM : U1 (MB84VA2103-10)

- FLASH ROM : 16Mbits
- STATIC RAM : 2Mbits

EEPROM : U501 (X84129_BGA)

- 128Kbits EEPROM

CPU

The MSM3000 uses an embedded ARM microprocessor,and this controls most of the functionality for the mobile phone,including control of the external peripherals such as the keypad,LCD display,RAM,ROM and EEPROM devices. For the CPU clock, 27MHz is used.

FLASH ROM and SRAM

Flash ROM is used to store the terminal’s program. Using the down-loading program, the program can be changed even after the terminal is fully assembled.SRAM is used to store the internal flag information, call processing data, and timer data.

KEYPAD

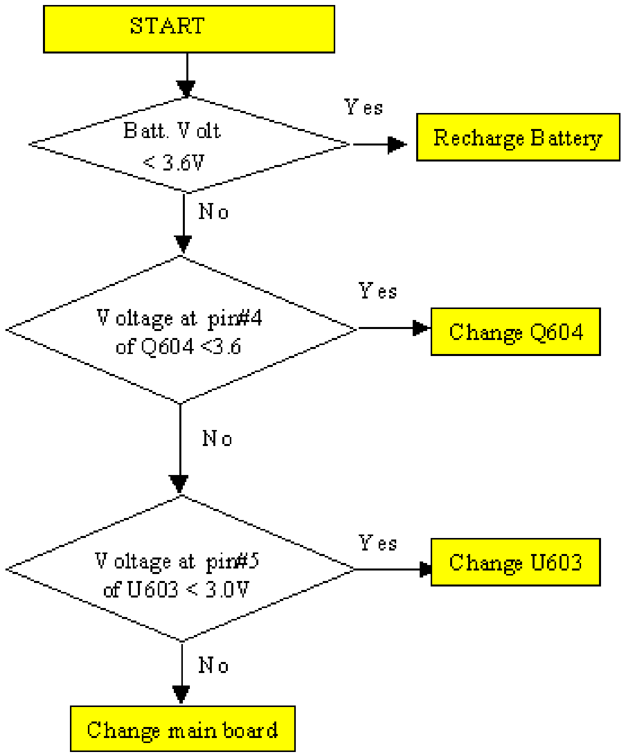
For key recognition, key matrix is setup using key sense 0-4 signals and GPIO0-5 of output ports of MSM. Eight LEDs and the backlight circuitry are included in the keypad for easy operation in the dark.

LCD MODULE

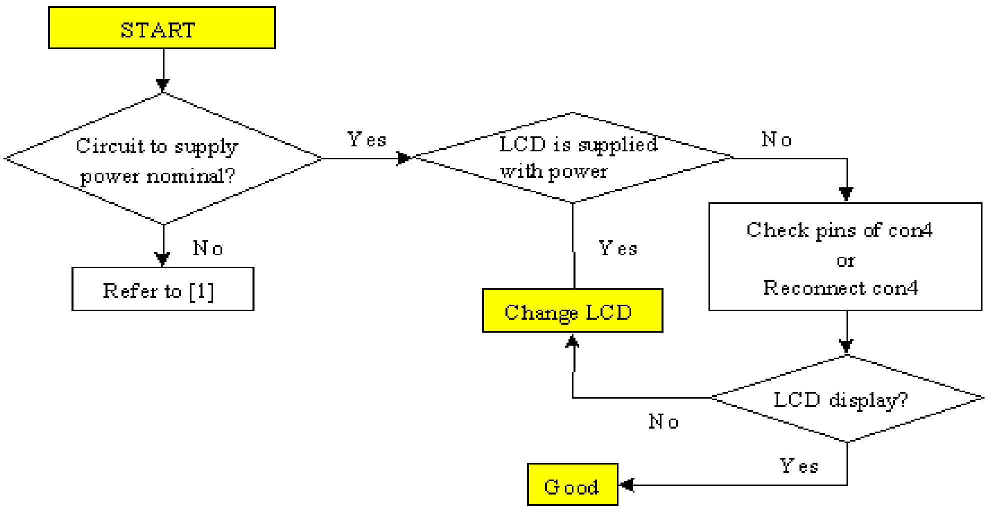
LCD module contains a controller which will display the information onto the LCD by 8-bit data from the MSM. It also consists a DC-DC converter to supply +3.3V for fine view angle and LCD reflect to improve the display efficiency.

CHAPTER 4. Trouble Shooting

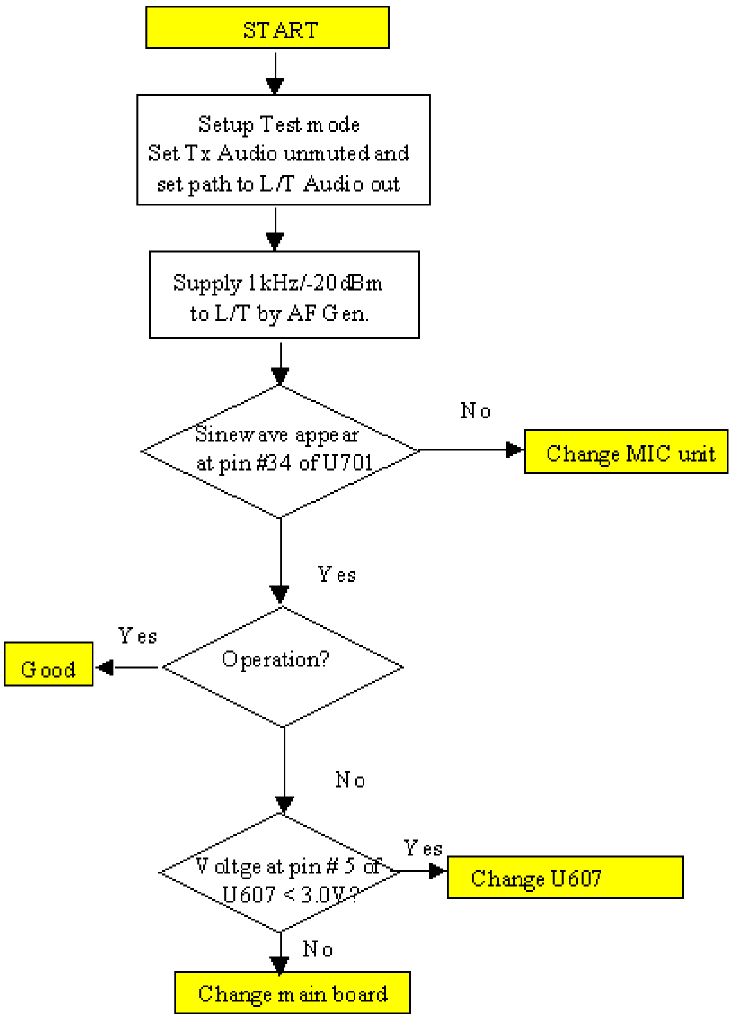
1. When power isn't "Turn On".



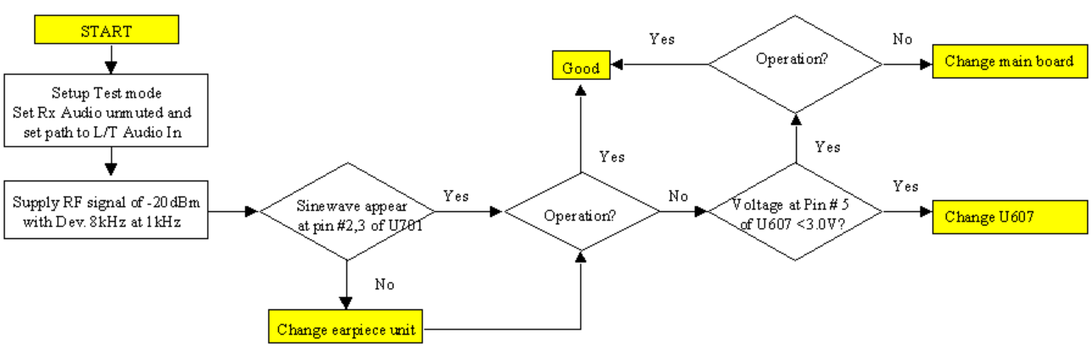
2. When LCD isn't displayed.



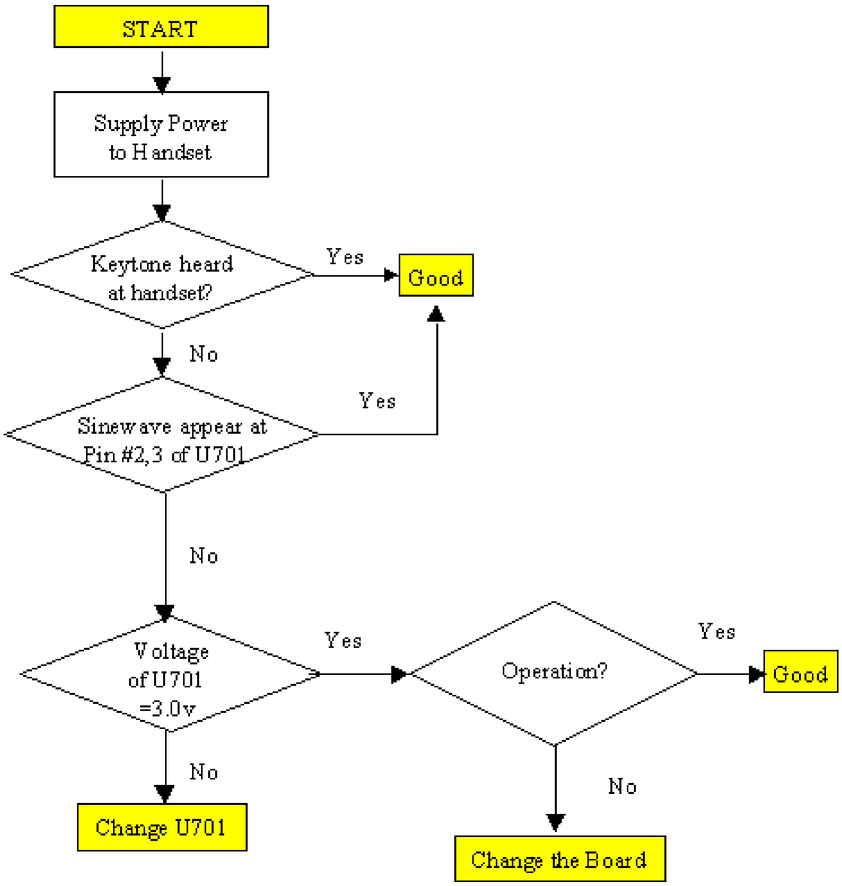
3. When Tx Audio (MIC) isn't transmitted.



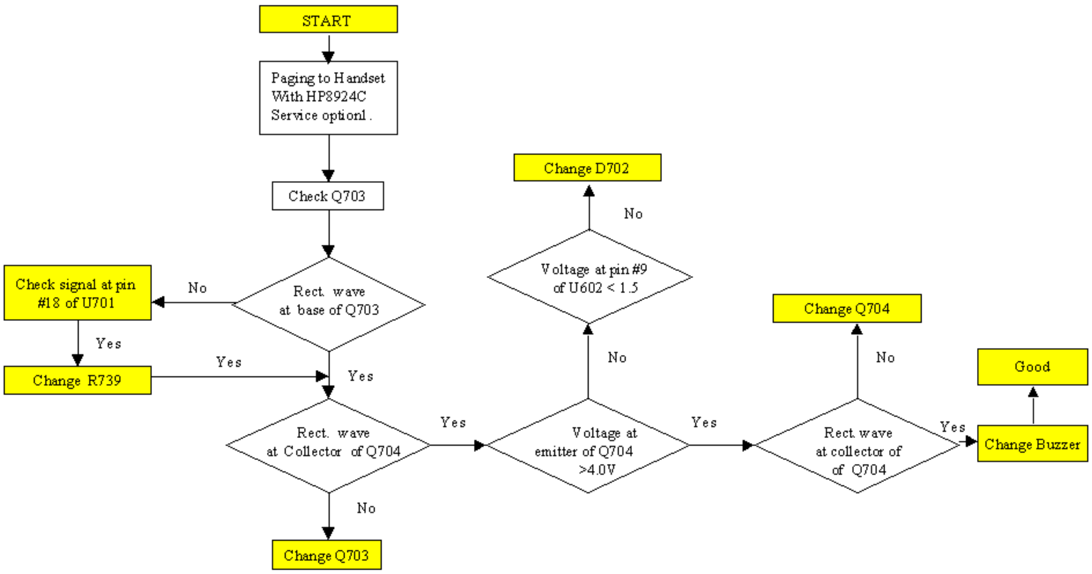
4. When Rx Audio (Speaker) isn't heard.



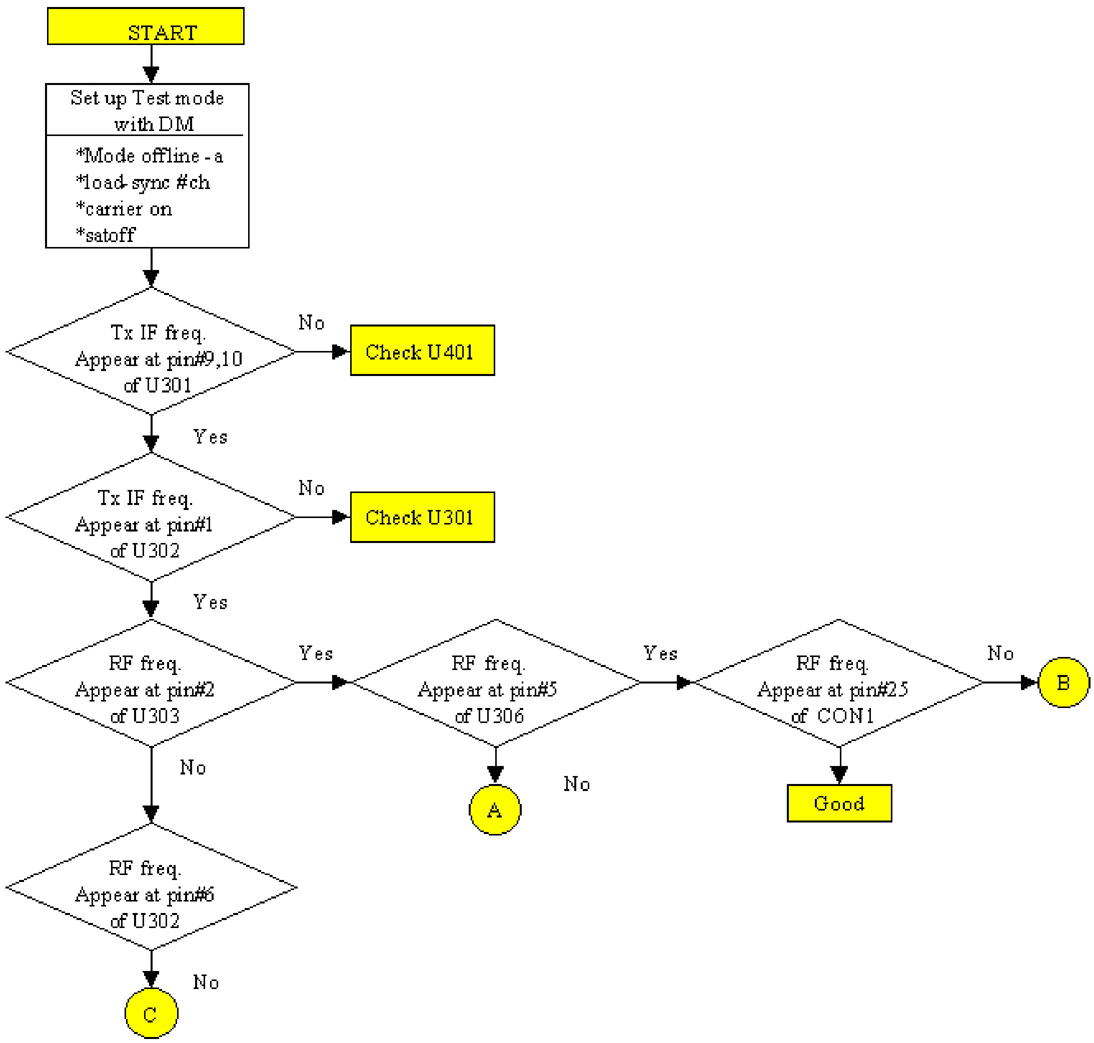
5. When Keytone isn't heard.

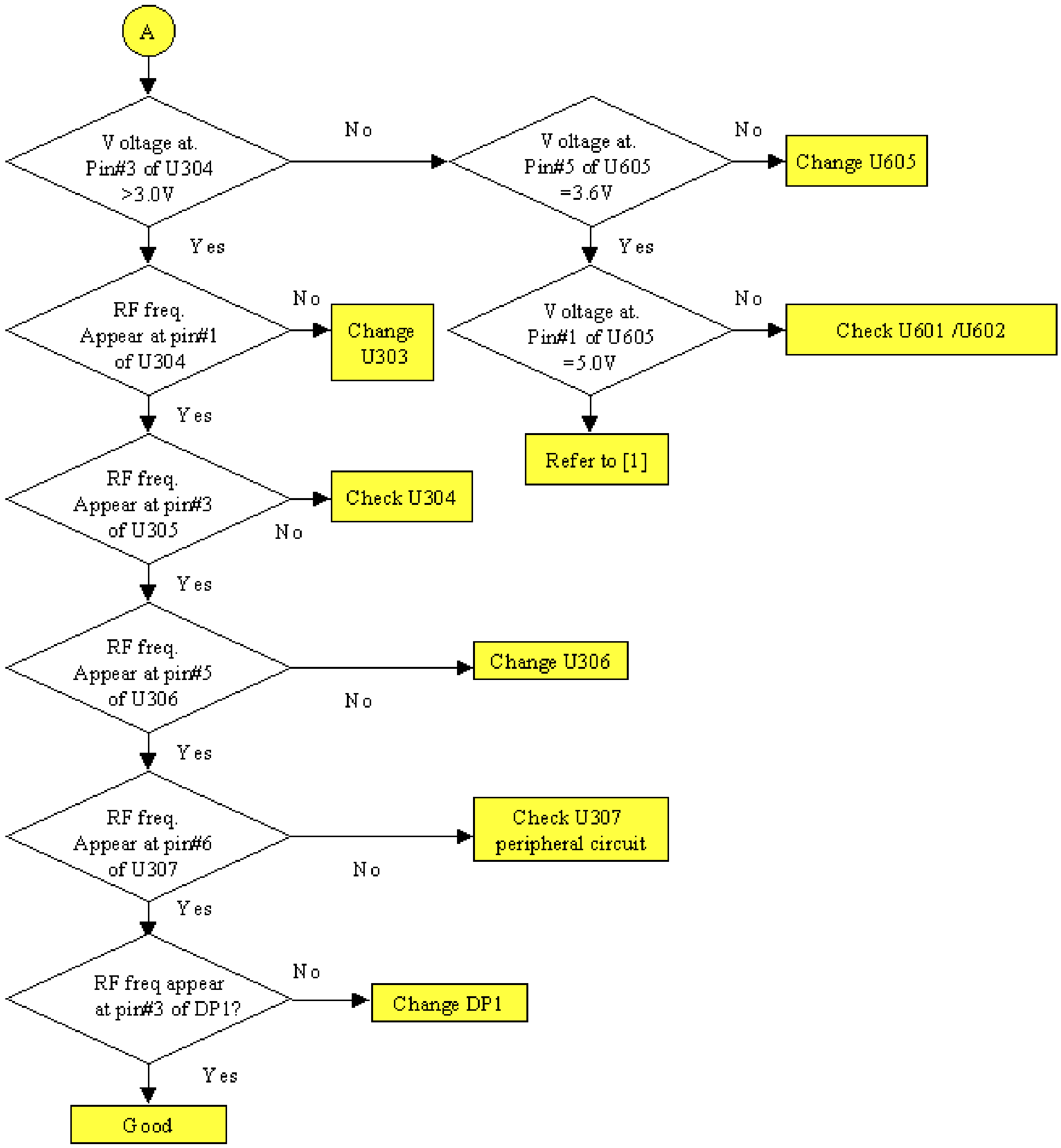


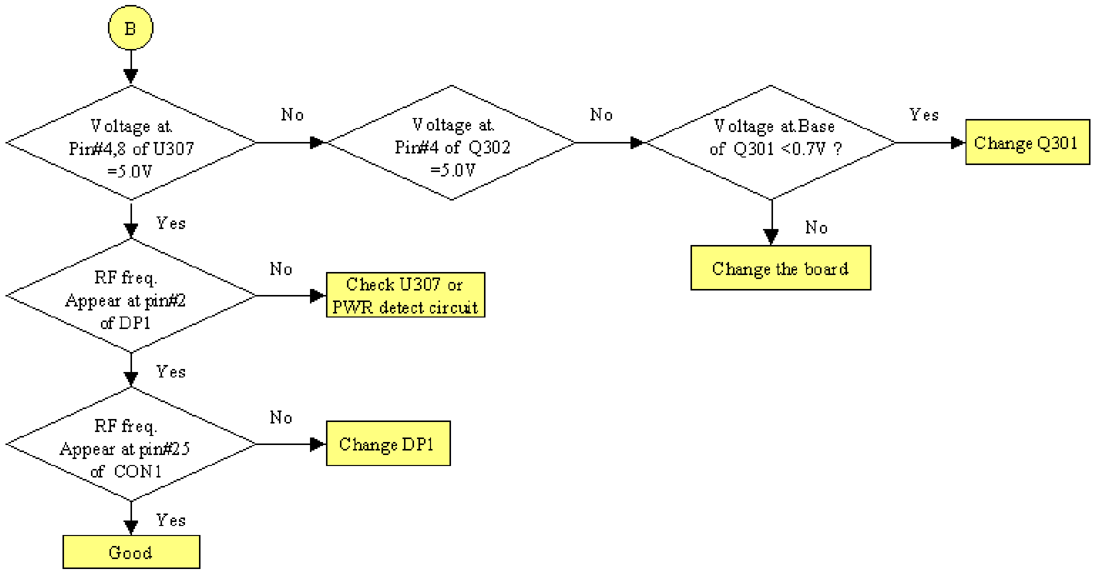
6. When Buzzer isn't rung.

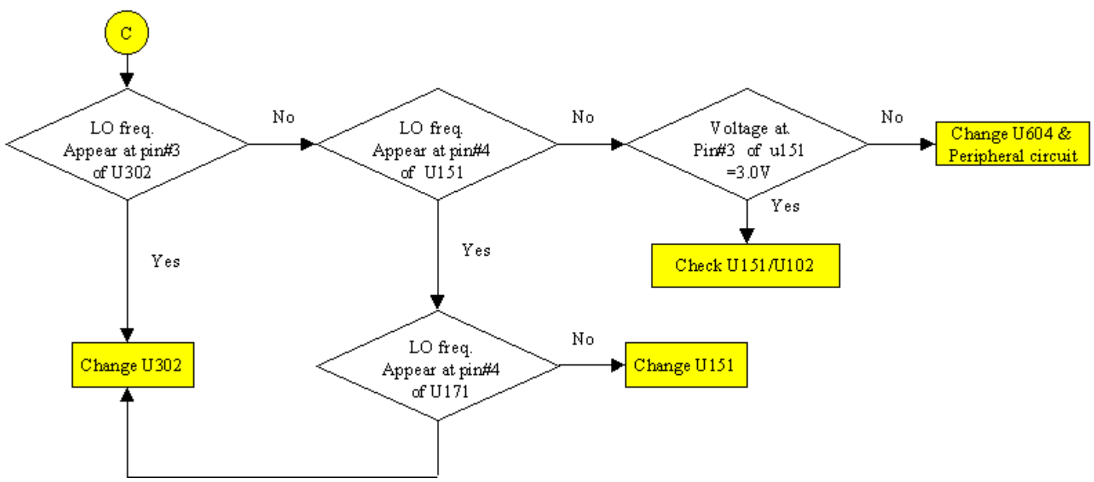


7. When Tx carrier isn't transmitted.

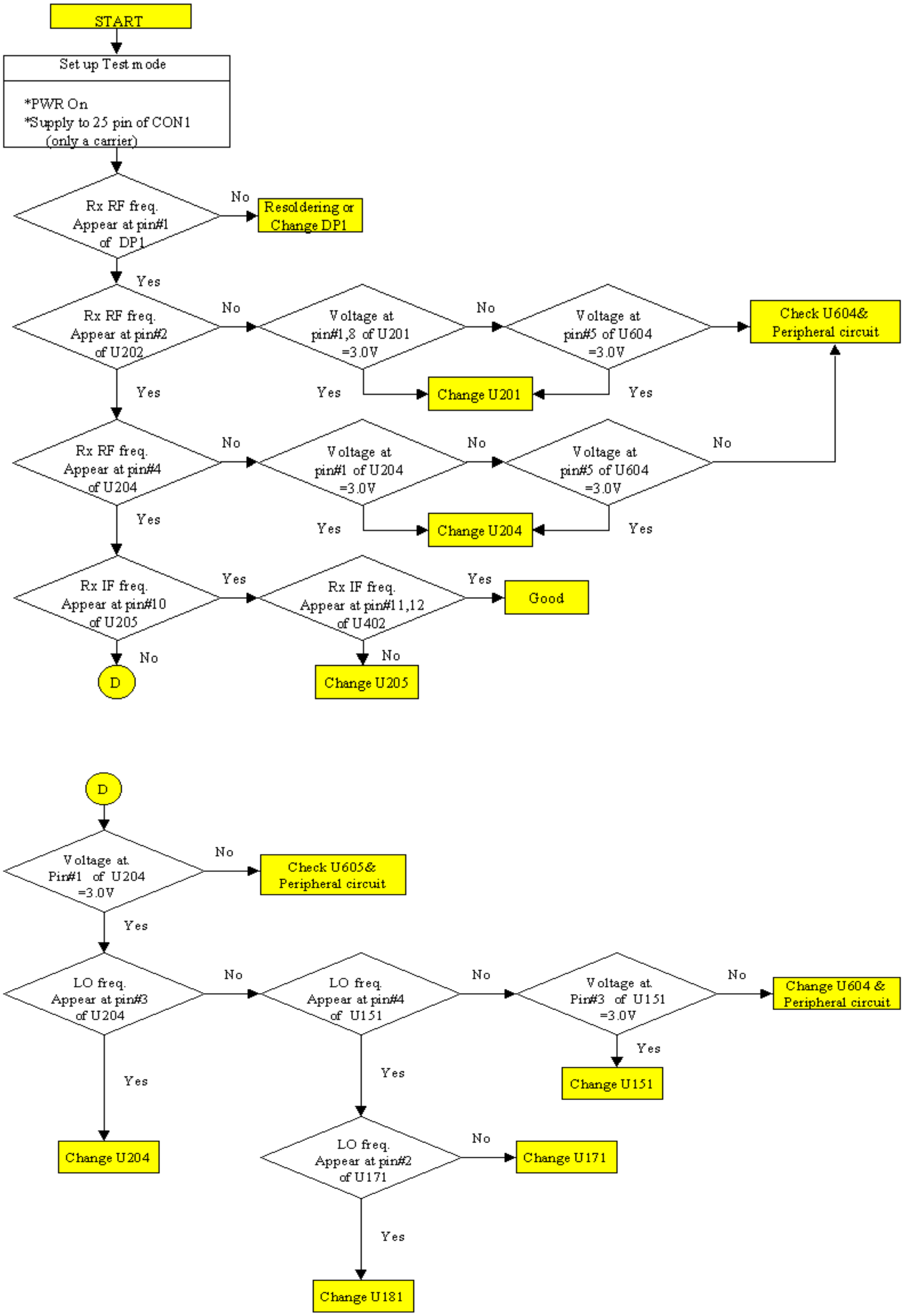



A
Voltage at. Pin#3 of U304 >3.0V
No
Voltage at. Pin#5 of U605 =3.6V
No
Change U605
Yes
Yes
RF freq. Appear at pin#1 of U304
No
Change U303
Voltage at. Pin#1 of U605 =5.0V
No
Check U601 /U602
Yes
Refer to [1]
RF freq. Appear at pin#3 of U305
Check U304
No
Yes
RF freq. Appear at pin#5 of U306
Change U306
No
Yes
RF freq. Appear at pin#6 of U307
Check U307 peripheral circuit
No
Yes
RF freq appear at pin#3 of DP1?
No
Change DP1
Yes
Good


B
Voltage at
Pin#4,8 of U307
=5.0V
No
Voltage at
Pin#4 of Q302
=5.0V
No
Voltage at Base
of Q301 <0.7V ?
Yes
Change Q301
No
Change the board
Yes
RF freq.
Appear at pin#2
of DP1
No
Check U307 or
PWR detect circuit
Yes
RF freq.
Appear at pin#25
of CON1
No
Change DP1
Yes
Good


C
LO freq.
Appear at pin#3
of U302
No
LO freq.
Appear at pin#4
of U151
No
Voltage at
Pin#3 of u151
=3.0V
No
Change U604 &
Peripheral circuit
Yes
Check U151/U102
Yes
Yes
Change U302
LO freq.
Appear at pin#4
of U171
No
Change U151

8. When Rx sensitivity isn't normal.



CHAPTER 5. Test Procedure

APPENDIX

1. Assembly and Disassembly Diagram
2. Block & Circuit Diagram
3. Part List
4. Component Layout
5. Accessories
   - Desktop Charger
   - Travel Charger
   - Cigar Lighter Charger
   - Hands Free Kit
   - Data Kit