

Features of LT-N050GP

1. Wave Type

- AMPS : F3E/F9X
- CELLULAR : G7W
- PCS : G7W

2. Frequency Scope

Transmit Frequency (MHz)			Receive Frequency (MHz)			
AMPS	CELLULAR	PCS	AMPS	CELLULAR	PCS	GPS
824.04 ~ 848.97	824.82 ~ 848.19	1850~1910	869.04~893.97	869.82~893.19	1930~1990	1575.42

3. Rated Output Power : AMPS = 3W
 CELLULAR = 0.251W
 PCS = 0.251W

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

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

MODE	Part Name	Voltage	Current	Power
AMPS	AWT6112	12V	1700mA	3.000W
CELLULAR	AWT6112	12V	450mA	0.251W
PCS	AWT6135	12V	450mA	0.251W

6. Functions of Major Semi-Conductors

Classification	Function
MSM6050-FBGA	Terminal operation control and digital signal processing
Memory	Flash Memory (32Mbit)---MX29LW320TXBI-70 S-RAM (16Mbit)---EM566168
RFR6000	Converts RF signal to baseband signal
RFT6100	Converts baseband signal to RF signal

7. Frequency Stability

- CELLULAR : $\pm 0.5\text{PPM}$
- AMPS : $\pm 2.5\text{PPM}$
- PCS : $\pm 0.1\text{PPM}$



CDMA Mobile Subscriber Unit LT-N050GP

SERVICE MANUAL

**TRI BAND, QUAD MODE
[PCS/GPS/CELLULAR/AMPS]
CDMA MOBILE MODEM**

Table of Contents

General Introduction	
.....	4
 CHAPTER 1. System Introduction	
1. System Introduction.....	5
2. Features and Advantages of CDMA Mobile Modem (For AMPS as well).....	6
3. Structure and Functions of dual-band CDMA Mobile Modem.....	8
4. Specification.....	10
5. Installation.....	18
 CHPATER 2. NAM Input Method	
1. NAM Program Method and TeleModem Number Inputting Method.....	20
 CHAPTER 3. Circuit Description	
1. RF Transmit/Receive Part.....	183
2. Digital/Voice Processing Part.....	30
 CHAPTER 4. Safety.....	35
 CHAPTER 5. Glossary.....	38
 APPENDIX.....	51

CHAPTER 1. General Introduction

The LT-N050GP has been designed to operate on the latest digital mobile communication technology, Code Division Multiple Access (CDMA). This CDMA digital technology has greatly enhanced voice clarity and can provide a variety of advanced features. Currently, CDMA mobile communication technology has been commercially used in Cellular and Personal Communication Service (PCS). The difference between them is the operating frequency spectrum. Cellular uses 800Mhz and PCS uses 1.9Ghz. The LT-N050GP support GPS Mode, we usually call it tri-band Modem. Also, LT-N050GP works on Advanced Mobile Modem Service (AMPS). We call it quad-mode Modem. If one of the Cellular, PCS and AMPS base stations is located nearby, Call fail rate of triple-mode Modem is less than dual-mode Modem or single-mode Modem.

The CDMA technology adopts DSSS (Direct Sequence Spread Spectrum). This feature of DSSS enables the Modem 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 Modem to reduce the call being interrupted in a middle of talking over the Modem.

Cellular and PCS CDMA network consists of MSO (Mobile Switching Office), BSC (Base Station Controller), BTS (Base station Transmission System), and MS (Mobile Station). The following table lists some major CDMA Standards.

CDMA Standard	Designator	Description
Basic air interface	TIA/EIA/IS-95-A/B/C ANSI J-STD-008	Protocol between MS and BTS for Cellular & AMPS Protocol between MS and BTS for PCS
Network	TIA/EIA/IS-634 TIA/EIA/IS/651 TIA/EIA/IS-41-C TIA/EIA/IS-124	MAS-BS PCSC-RS Intersystem operations Nom-signaling data comm.
Service	TIA/EIA/IS-96-B TIA/EIA/IS-99 TIA/EIA/IS-637 TIA/EIA/IS-657	Speech CODEC Assign data and fax Short message service Packet data
Performance	TIA/EIA/IS-97 TIA/EIA/IS-98 ANSI J-STD-018 ANSI J-STD-019 TIA/EIA/IS-125	Cellular base station Cellular mobile station PCS personal station PCS base station Speech CODEC

* TSB -74: Protocol between an IS-95A system and ANSI J-STD-008

1. System Introduction

1.1 CDMA Abstract

The CDMA mobile communication system has a channel hand-off function that is used for collecting the information on the locations and movements of mobile teleModems from the cell site by automatically controlling several cell site through the setup of data transmission routes, and then enabling one switching system to carry out the automatic remote adjustment. This is to maintain continuously the call state through the automatic location confirmation and automatic radio channel conversion when the busy subscriber moves from the service area of one cell site to that of another by using automatic location confirmation and automatic radio channel conversion functions. The 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.

In the cellular system, the cell site is a small-sized low output type and utilizes a frequency allocation system that considers mutual interference, in an effort to enable the re-use of corresponding frequency from a cell site separated more than a certain distance. The analog cellular systems are classified further into an AMPS system, E-AMPS System, NMT system, ETACS system, and JTACS system depending on technologies used.

Unlike the time division multiple access (TDMA) or frequency division multiple access (FDMA) used in the band limited environment, the Code Division Multiple Access (CDMA) system which is one of digital cellular systems is a multi-access technology under the interference limited environment. It can process more number of subscribers compared to other systems (TDMA system has the processing capacity three times greater than the existing FDMA system whereas CDMA system, about 12~15 times of that of the existing system).

CDMA system can be explained as follows; TDMA or CDMA 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 available method 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 characteristic 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 appears as the self-interference of the system.

2. Features and Advantages of CDMA Mobile Modem (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 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 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 received by the base station have same strength.

Moreover, the backward closed loop power control used by the mobile station is performed to control power using 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 base station and the 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 for cellular and 14400, 7200, 3600, 1800 bits per second for PCS, so PCS provide relatively better voice quality (almost twice better than the existing cellular system). In addition, this type of variable voice encoder utilizes adaptive threshold values on 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

Voice privacy is provided in the CDMA system by means of the private long code mask used for PN spreading. Voice privacy can be applied on the traffic channels only. All calls are initiated using the public long code mask for PN spreading. The mobile station user may request voice privacy during call setup using the origination message or page response message, and during traffic channel operation using the long code transition request order.

The Transition to private long code mask will not be performed if authentication is not performed. To initiate a transition to the private or public long code mask, either the base station or the mobile station sends a long code transition request order on the traffic channel.

2.5 Soft Handoff

A handoff in which the mobile station commences communications with a new base station without interrupting communications with the old base station. Soft handoff can only be used between CDMA channels having identical frequency assignments.

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. 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 stations.

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, 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 tri-band CDMA Mobile Modem

The hardware structure of CDMA mobile Modem is made up of radio frequency (RF) part and logic part. The RF part is composed of Receiver part (Rx), Transmitter part (Tx) and Local part (LO). For the purpose of operating on tri-band, It is necessary dual Tx path, tri Rx path, dual PLL and switching system for band selection. The mobile Modem antenna is connected with the frequency seperater which divide antenna input/output signals between cellular frequency band (824~894 Mhz) and PCS frequency band (1850~1990Mhz). Each separated path is linked with the cellular duplexer and PCS duplexer. Duplexer carries out seperating Rx band and Tx band. The Rx signals from the antenna are converted into intermediate frequency(IF) band by the frequency synthesizer and frequency down converter. And then, pass SAW filter which is a band pass filter for removing out image frequency. The IF output signals that have been filtered is converted into digital signals via Analog-to-Digital Converter (ADC). In front of the ADC, switching system is required to choose which band path should be open. The digital signals send 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, but 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. Output data that has been demodulated changes the data string in the combined data row as in the case of original signals(deinterleaving), and then, are demodulated by the forward error correction decoder which uses the Viterbi algorithm.

Mobile station user information send 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 :

- 1) CELLULAR : 45 MHz
- 2) AMPS : 45MHz
- 3) PCS : 80 MHz

4.1.2 Number of Channels (Channel Bandwidth)

- 1) CELLULAR : 20 Channels
- 2) AMPS : 832 Channels
- 3) PCS : 48 Channels

4.1.3 Operating Voltage : DC 12V

4.1.4 Power Consumption : DC 12V

	SLEEP	IDLE	MAX POWER
CELLULAR	1.5 mA	120mA	450 mA (24 dBm)
AMPS	N/A	100mA	1500 mA (34 dBm)
PCS	1.5 mA	120 mA	450 mA (24 dBm)

4.1.5 Operating Temperature : -40°C ~ +85°C

4.1.6 Frequency Stability

- 1) CDMA : $\pm 0.5\text{PPM}$
- 2) AMPS : $\pm 2.5\text{PPM}$
- 3) PCS : $\pm 0.1\text{PPM}$

4.1.7 Antenna : Active Antenna, 50 Ω

4.1.8 Size and Weight(NAD Board)

- 1) Size : 75*83*1.2mm
- 2) Weight : 45 (Approximately)

4.1.9 Channel Spacing

- 1) CELLULAR : 1.25MHz
- 2) AMPS : 30KHz
- 3) PCS: 1.25 MHz

4.1.10 Battery Type.

Vehicles Battery Used

4.2 Receive Specification

4.2.1 Frequency Range

- 1) CELLULAR : 869.820 MHz ~ 893.190 MHz
- 2) AMPS : 869.04 MHz ~ 893.97 MHz
- 3) PCS : 1930 MHz ~ 1990 MHz
- 4) GPS : 1575.42 MHz

4.2.2 Local Oscillating Frequency Range :

- 1) CELLULAR : 1738.08MHz ~ 1787.94MHz
- 2) AMPS : 1738.08MHz ~ 1787.94MHz
- 3) PCS : 1715.56MHz ~ 1768.89MHz
- 4) GPS : 3150.84MHz

4.2.3 No Intermediate Frequency : Direct conversion

4.2.4 Sensitivity

- 1) CELLULAR : -104dBm (C/N 12dB or more)
- 2) AMPS : -116dBm (12dB SINAD)
- 3) PCS : -104dBm (C/N 12dB or more)
- 4) GPS : -148.5dBm

4.2.5 Selectivity

- 1) CELLULAR : 3dB C/N Degration (With Fch $\pm$ 1.25 kHz : -30dBm)
- 2) AMPS : 16dB at Fch $\pm$ 30kHz, 60 dB at Fch $\pm$ 60kHz
- 3) PCS : 3dB C/N Degration (With Fch $\pm$ 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.

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

4.2.9 AMPS Expander

- Expansion Rate : 1:2

- Attack Time : within 3mS
- Recovery Time : within 13.5mS
- 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

- Transmit Band : below -60dBm
- 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 ~ 1.0 GHz	- 21 dBm

4.3 Transmit Specification

4.3.1 Frequency Range

- 1) CELLULAR : 824.820MHz ~ 848.190MHz
- 2) AMPS : 824.04MHz ~ 848.97MHz
- 3) PCS : 1850 MHz ~ 1910 MHz

4.3.2 Local Oscillating Frequency Range :

- 5) CELLULAR : 1738.08MHz ~ 1787.94MHz
- 6) AMPS : 1738.08MHz ~ 1787.94MHz
- 7) PCS : 1715.56MHz ~ 1768.89MHz

4.3.3 Intermediate Frequency : Direct Conversion

4.3.4 Output Power

- 1) CELLULAR : 0.251W
- 2) AMPS: 2.512W
- 3) PCS:0.251W

4.3.5 Interference Rejection

- 1) Single Tone : -30dBm at 900 kHz (CELLULAR), -30dBm at 1.25MHz(PCS)
- 2) Two Tone : -43dBm at 900 kHz & 1700kHz(CELLULAR), -43dBm at 1.25 MHz & 2.05 MHz

4.3.6 AMPS Carrier ON/OFF Conditions

“ ON ” condition : within ± 3 dB of specification output (in 2msec)

4.3.7 AMPS Compressor

- 1) Compression Rate : 2:1
- 2) Attack Time : 3msec
- 3) Recovery Time : 13.5msec
- 4) Reference Input : Input level for producing a nominal ± 2.9 kHz peak frequency deviation of transmitted carrier.

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

4.3.8 AMPS Maximum Frequency Deviation

- 1) F3 of G3 : ± 12 kHz ($\pm 10\%$)
- 2) Supervisory Audio Tone : ± 2 kHz ($\pm 10\%$)
- 3) Signaling Tone : ± 8 kHz ($\pm 10\%$)
- 4) Wideband Data : ± 8 kHz ($\pm 10\%$)

4.3.9 AMPS Post Deviation Limiter Filter

- 1) 3.0kHz ~ 5.9kHz : above $40\log(F/3000)$ dB
- 2) 5.9kHz ~ 6.1kHz : above 35dB
- 3) 6.1kHz ~ 15kHz : above $40\log(F/3000)$ dB
- 4) Over 15kHz : above 28dB

4.3.10 AMPS Spectrum Noise Suppression

- 1) For all Modulation
fo+20kHz ~ fo+45kHz : above 26dB
- 2) For Modulation by Voice and SAT

$f_o+45\text{kHz}$: above $63+10\log(P_y)$ dB

3) For Modulation by WBD (without SAT) and ST (with SAT)

$f_o+45\text{kHz} \sim f_o+60\text{kHz}$: above 45dB

$f_o+60\text{kHz} \sim f_o+90\text{kHz}$: above 65dB

$f_o+90\text{kHz} \sim 2f_o$: above $63+10\log(P_y)$ dB,

where f_o =carrier frequency, P_y =mean output power in watts.

4.3.11 AMPS Harmonic and Conducted Spurious Emissions : above $43+10\log(P_y)$ dB

4.3.12 CDMA TX Frequency Deviation :

1) CELLULAR: $\pm 300\text{Hz}$ or less

2) AMPS: $\pm 300\text{Hz}$ or less

3) PCS: $\pm 150\text{Hz}$

4.3.13 CDMA TX Conducted Spurious Emissions

1) CELLULAR : 900kHz : - 42 dBc/30kHz below

1.98MHz : - 54 dBc/30kHz below

2) PCS : -42 dBc / 30KHz below

4.3.14 CDMA Minimum TX Power Control

1) CELLULAR : - 50dBm below

2) PCS: -50dBm below

4.4 MS (Mobile Station) Transmitter Frequency

4.4.1 CELLULAR & AMPS mode

Ch #	Center Freq. (MHz)	Ch #	Center Freq. (MHz)
1011	824.640	404	837.120
29	825.870	445	838.350
70	827.100	486	839.580
111	828.330	527	840.810
152	829.560	568	842.040
193	830.790	609	843.270
234	832.020	650	844.500
275	833.250	697	845.910
316	834.480	738	847.140
363	835.890	779	848.370

4.4.2 PCS mode

Ch #	Center Freq (MHz)	Ch #	Center Freq (MHz)	Ch #	Center Freq (MHz)
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

4.5.1 CELLULAR & AMPS mode

Ch. #	Center Freq. (MHz)	Ch. #	Center Freq. (MHz)
1011	869.640	404	882.120
29	870.870	445	883.350
70	872.100	486	884.580
111	873.330	527	885.810
152	874.560	568	887.040
193	875.790	609	888.270
234	877.020	650	889.500
275	878.250	697	890.910
316	879.480	738	892.140
363	880.890	779	893.370

4.5.2 PCS mode

Ch #	Center Freq (MHz)	Ch #	Center Freq (MHz)	Ch #	Center Freq (MHz)
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

4.5.3 GPS mode : 1575.42MHz

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

1. NAM, SID, NID, CHANNEL Program Method

To control and perform any test for LG VCP, DM test scripts are used instead of UI test menu, because LG VCP doesn't have any display LCD or Keypad.

1. Please refer to
 “3. VCP_GEN6.3_Programming Instruction.doc “ and
 “4. VCP_GEN6.3_NAM_SID_NID_CHANNEL_programming_method.doc” .

CHAPTER 3. Circuit Description

1. RF Transmit/Receive Part

1.1 Overview

The Tx and Rx part employs the Direct Conversion system. The Tx and Rx frequencies are respectively 824.04~848.97 and 869.04~893.97 for cellular and 1850~1910 and 1930~1990 for PCS.

RF signals received through the antenna are separated by the frequency separator.

RF Signal fed into the low noise amplifier (in RFL) through the duplexer. Then, they are combined with the signals of local oscillator (VCO) at the down conversion mixer(in RFR) in order to create Base-band frequency). Then, this signal is changed into digital signal by the analog to digital converter (ADC, A/D Converter), and the digital circuit part of the MSM(Mobile Station Modem)6050 processes the data from ADC. The digital processing part is a demodulator.

In the case of transmission, RFT6100 receives QPSK-modulated analog signal from the MSM6050.

The RFT6100 connects directly with MSM6050 using an analog baseband interface. In RFT6100, the baseband quadrature signals are upconverted to the Cellular or PCS frequency bands and amplified to provide signal drive capability to the power amp.

After that, the RF signal is amplified by the Power Amp in order to have enough power for radiation. Finally, the RF signal is sent out to the cell site via the antenna after going through the isolator and duplexer.

1.2 Description of Rx Part Circuit

1.2.1 Frequency Separator(Antenna)

The main function of frequency separator is to prohibit cellular band signal from flowing into the PCS circuit and vice versa. RF designer can use common antenna regardless of frequency band (800 and 1.9Ghz). The specification of LT-N050GP frequency separator is described below:

	AMPS	Cellular	PCS	GPS
Frequency Range	824 – 894 MHz		1850-1990 MHz	1575.42MHz
Coxil IL	0.8dB Max		1.25 dB Max	1.15dB Max
Connector IL	0.25 Max			
VSWR	2.2 :1	2.2 : 1	2.2 : 1	1.9 : 1
Power Capacity	3W Max			
Temperature Range	-40 to +95 deg			

1.2.2 Duplexer (DP701, DP702)

The duplexer consists of the Rx bandpass filter (BPF) and the Tx BPF which has the function of separating Tx and Rx signals in the full duplex system for using the common antenna. The Tx part BPF is used to suppress noises and spurious out of the Tx frequency band. The Rx BPF is used to receive only Rx signal coming from the antenna, which is usually called preselector. It's main function is to limit the bandwidth of spectrum reaching the LNA and mixer, attenuate receiver spurious response and suppress local oscillator energy. As a result frequency sensitivity and selectivity of mobile Modem increase. The specification of LT-N050GP duplexer described below ;

- PCS duplexer:

	Tx	Rx	Tx to Rx (min)
Pass Band	1880 ± 30 MHz	1960 ± 30 MHz	
Insertion Loss	3.5dB max	4.0dB max	
Return Loss	10.0dB min	10.0dB min	
Attenuation	45dB min (1930~1990MHz)	54dB min (1850~1910MHz)	54dB (1850~1910MHz) 45dB (1930~1990MHz)

- Cellular & AMPS duplexer

	Tx	Rx	Tx to Rx (min)
Pass Band	836.5 ± 12.5 MHz	881.5 ± 12.5 MHz	
Insertion Loss	1.5dB max	2.2dB max	
Return Loss	13dB min	13 dB min	
Attenuation	42dB min (869~894MHz)	58dB min (824~849MHz)	58dB (824~849MHz) 42dB (869~894MHz)

1.2.3 LNA & MIXER (U703,U707)

The RFR6000 device performs all of the front-end receiver (Rx) signal processing required for IS-98 CDMA Cellular, J-STD-018 PCS and GPS single band, dual band and tri band applications. It contains all of the circuitry (with the exception of external filters) needed to support conversion of received CDMA and AMPS RF signals to base-band signals capable of driving the RFR6000 RF-to-Base-band Analog Receiver IC in any of the following three Modem platforms :PCS only, Dual Band (PCS CDMA, Cellular, AMPS), Tri Band (PCS CDMA, Cellular CDMA/AMPS, GPS) and Quad Mode (PCS CDMA, Cellular

CDMA, Cellular AMPS, GPS) . The two Low Noise Amplifiers (Cellular and PCS), two RF-to-base-band Down-converting Mixers (Cellular and PCS), and an LO Buffer Amplifier to buffer the RF VCO to the RF Transmit Up-converter. The LNA & mixer offers the most advanced and integrated CDMA Rx solution designed to meet cascaded Noise Figure (NF) and Third-order Intercept Point (IIP3) requirements of IS-98C and J-STD-018 specifications for Sensitivity, Two-Tone Inter-modulation, and Single-tone De-sense.

Gain control for the Cellular LNA is provided for improved dynamic range and Rx performance in the presence of High-level interfering signals. Operation modes and band selection are specially controlled from the Mobile Station Modem MSM6050.

The characteristics of Low Noise Amplifier (LNA) are low noise figure, high gain, high intercept point and high reverse isolation. The frequency selectivity characteristic of mobile Modem is mostly determined by LNA.

The specification of LT-N050GP LNA described below:

Parameter	Low gain			Middle gain			High gain			Units
	Cellular	PCS	GPS	Cellular	PCS	GPS	Cellular	PCS	GPS	
Gain	-2.37			5.15			16.55	16.45	17.9	dB
Noise Figure	1.8			4.7			1.25	1.42	1.3	dB
Input IP3	24.5			13.5			8.7	7.8	-14	dBm

The specification of LT-N050GP Mixer described below:

Parameter	Typ			Units
	Cellular (AMPS)	PCS	GPS	
Gain	12.15 (8.1)	14.38	17.4	dB
Noise Figure	6 (5.6)	6.48	4.8	dB
Input IP3	6.35 (6.6)	2.15	-1.5	dBm

1.2.4 Rx RF SAW FILTER(F701,F702,F704)

The main function of Rx RF SAW filter is to attenuate mobile Modem spurious frequency, attenuate direct RF frequency pick up, attenuate noise at the image frequency originating in or amplified by the LNA and suppress second harmonic originating in the LNA. The Rx RF SAW filter usually called image filter.

1.2.5 RFR6000(U707)

1.2.5.1 CDMA Rx SIGNAL

The circuit functions of the RFR6000 include Rx Automatic Gain Controller (AGC) with 90 dB dynamic range, quadrature RF mixers, down-conversion mixer from RF to base-band, low pass filters and Analog to Digital Converters (ADC) for converting to digital base-band. The RFR6000 includes clock generators that drive the digital processor and a VCO which generates the LO frequency for base-band down-conversion.

Switching system is located in front of the RFR6000 CDMA_IN+ and CDMA_IN- terminal and is for band selection between cellular and PCS. The Rx AGC either amplifies or attenuates the received CDMA RF signal to provide a constant-amplitude signal to the I/Q down-converter. The RF output of the Rx AGC amplifier separate into I-channel and Q-channel base-band components and down-converted by mixer with quadrature LO. LO signals are generated by a Voltage Controlled Oscillator (VCO) and frequency stabilized by external varactor-tuned resonant tank circuit. The I/Q down converter outputs the CDMA signals at baseband frequency. Low-pass filtering enables the receiver to select the desired baseband signals from the effects of unwanted noise or adjacent-channel interference. I/Q base band components are converted to digital signals by two identical 4-bit ADCs. The CDMA characteristic of RFR6000 described below;

- CDMA Receive Performance Parameters

	Min.	Typ.	Max.	Units
Min Input Signal	-102			dBm
Max Input Signal			-12	dBm
Gain Slope	10		70	dB/V
Spurious Content			-25	dBc
Isolation FM to CDMA	30			dB

1.2.5.2 FM Rx SIGNAL

The FM Rx signal path is designed to accept a differential signal with frequency modulation extending $\pm 15\text{kHz}$ from the center frequency to form a 30 kHz wideF channel. The signals are divided further into I and Q signals through the CDMA signaling process, and then converted into baseband signals and fed into ADC via each LPF. FM LPF has a bandwidth that is considerably lower than CDMA LPF. Since FM baseband signal has a very low bandwidth, ADC uses the low power 8-bit continuous approximation ADC. The serial 8-bit digital signal conversion of analog signal is carried out as follows; the FM clock

signals of MSM6050 are inputted into the FM_Rx_CLK terminals of RFR6000 in order to synchronize ADC. The FM strobe signal, another MSM6050 signal, is inputted into the RXFM_STROBE terminal and then, the sampling of I/Q signals is started. Signals that have been digitalized as above are inputted into MSM6050. The CDMA characteristic of RFR6000 described below:

	Min.	Typ.	Max.	Units
Min Input Signal	-98.3			dBm
Max Input Signal			-8.3	dBm
Gain Slope	10		70	dB/V
Spurious Content			-42	dBc

1.3 Description of Transmit Part Circuit

1.3.1 RFT6100 (U708)

The RFT6100 base-band-to-RF Transmit Processor performs all Tx signal-processing functions required between digital base-band and the Power Amplifier Modulator (PAM). The base-band quadrature signals are up-converted to the Cellular or PCS frequency bands and amplified to provide signal drive capability to the PAM. The RFT6100 includes an RF mixer for upconverting analog baseband to RF, a programmable PLL for generating Tx LO frequency, two cellular and two PCS driver amplifiers and Tx power control through an 85 dB VGA. As added benefit, the single sideband upconversion eliminates the need for a band pass filter normally required between the upconverter and driver amplifier.

I, I/, Q and Q/ signals proceed from the MSM6050 to RFT6100 are analog signal. In CDMA mode, These signals are modulated by Quadrature Phase Shift Keying (QPSK), But in AMPS mode These are baseband signal (audio signal, supervisory audio tone and signaling tone) directly converted from DAC. I and Q are 90 deg. out of phase, and I and I/ are 180 deg. Tx IF signal can be obtained by mixing analog signal with 228.6MHz(Cellular)/263.6(PCS) 1st local oscillator frequency which is generated by Tx VCO. The Tx IF signal is amplified by AGC controlled by MSM6050. The second mixer on RFT6100 converts IF signals into RF signals. After passing through the upconverter, RF signal is inputted into the Power AMP.

- RFT6100 Cellular and PCS CDMA RF Specifications

	Condition	Min.	Typ.	Max.	Units
--	-----------	------	------	------	-------

Rated Output Power	Average CDMA Cellular	8.0			dBm
	Average CDMA PCS	9.3			dBm
Min Output Power	Average CDMA Cellular			-77	dBm
	Average CDMA PCS			-77	dBm
RF Leakage at RF LO Input			-30		dBm
LO Leakage at RF Output				-10	dBm
ACPR	Cellular: Fc±885kHz	48			dBc/
	PCS: Fc±1.25MHz	48			30kHz

- RFT6100 FM RF Specifications

	Condition	Min.	Typ.	Max.	Units
Min Output Power				-25	dBm
Rated Output Power		10			dBm
RF Leakage at RF LO Input			-50		dBm

1.3.2 Power Amplifier(U705,U706)

The power amplifier that can be used in the PCS, 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 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 +17dBm and conversion gain is about 28dB. RF transmit signals that have been amplified through the power amplifier are sent to the duplexer.

1.4 Description of Frequency Synthesizer Circuit

1.4.1 Voltage Control Temperature Compensation Crystal Oscillator (VCTCXO, U902)

The temperature variation of mobile Modem can be compensated by TCXO. The reference frequency of a mobile Modem is -30~+85 °C. The receives frequency tuning signals called TRK_LO_ADJ from MSM as 0.5V~2.5V DC via R and C filter in order to generate the reference frequency of 19.2 and input it into the frequency synthesizer of UHF band. Frequency stability depending on temperature is ± 2.0 ppm.

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 Modem. 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 MSM (Mobile Station Modem) 6050 Part

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

2.2.2 Memory Part

The memory part is made up of a flash memory, PSEUDO RAM for storing data.

2.2.3 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.

2.3 Circuit Description

2.3.1 MSM Part

MSM6050 is the core element of CDMA system terminal that includes ARM7TDMI microprocessor core. It supports both CDMA and Digital FM, operating in both the cellular and PCS spectrums. The subsystems within the MSM6050 include a CDMA processor, a DFM processor, a multi-standard Vocoder, an integrated CODEC with earpiece and microModem amplifiers, general-purpose ADC for subsystem monitoring, an ARM7TDMI microprocessor, and both Universal Serial Bus(USB) and an RS-232 serial interfaces supporting forward link MDR data communications of 86.4 Kbps. And it also contains complete digital modulation and demodulation systems for both CDMA and AMPS cellular standards, as specified in IS-95-A/B/C.

In MSM, code 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.

2.3.2 Memory Part

Memory contents 32 Mbits flash memory and 16 Mbits Static RAM. In the Flash Memory part are programs used for terminal operation. The programs can be changed through down loading after the assembling of terminals. On the PSEUDO RAM(16Mbits) data generated during the terminal operation are stored temporarily.

2.3.3 Power Supply Part

Vehicles Battery Use. When the battery voltage (+12.0V) is fed and the NAD_ON PWR is Input, U901 is activated by the NAD_ON signal, and then the control signal (P_EN) is generated. And then, the regurator 1.9V_MSMC & 2.8V_MSMP, 2.6V_MSMA, are operated.

and The Rx part regulator(U909) is operated by the control signal SLEEP/ from MSM6050

The Tx part regulator(U904) is operated by the control signal IDLE/ from MSM6050.

2.3.4 Logic Part

The logic part consists of internal CPU of MSM, RAM, Flash Memory. The MSM6050 receives TCXO (=19.2MHz) from U902 and controls the Modem in both CDMA and FM modes. The major components are as follows:

CPU : ARM7TDMI microprocessor core

Flash Memory : 32Mbits , U911(MX29LW320TXBI-70)

Pseudo RAM : 16Mbits , U912(EM566168)

- CPU

The ARM7TDMI microprocessor includes a 3 stage pipelined RISC architecture, both 32-bit ARM and 16-bit THUMB instruction sets, a 32-bit address bus, and a 32-bit internal data bus. It has a high performance and low power consumption.

- Flash Memory

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.

- Pseudo RAM

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

CHAPTER 4. Safety

■ IMPORTANT

Read This Information Before Using Your Modem Cellular TeleModem

Your cellular Modem is a radio transmitter and receiver. When it is ON, it receives and also sends out radio frequency (RF) energy. The Modem operates in the frequency range of 824 MHz to 894 MHz and employs commonly used frequency modulation (FM) techniques. When you use your Modem, the cellular system handling your calls controls the power level at which your Modem transmits. The power level can range from 0.006 of a watt to .6 of a watt.

■ Exposure to Radio Frequency Energy

In 1991 the Institute of Electrical and Electronics Engineers (IEEE), and in 1992 the American National Standards Institute (ANSI) updates the 1982 ANSI Standard for safety levels with respect to human exposure to RF energy. Over 120 scientists, engineers, and physicians from universities, government health agencies, and industry, after reviewing the available body of research, developed this updated Standard. In March, 1993, the US Federal Communications Commission (FCC) proposed the adoption of this updated Standard.

The design of your Modem complies with this updated Standard. Of course, if you want to limit RF exposure even further than the updated ANSI Standard, you may choose to control the duration of your calls and operation your Modem in the most power efficient manner.

bills.

CHAPTER 5. Glossary

General Terms

Abbreviated Alert. An abbreviated alert is used to remind the mobile station user that previously selected alternative routing features are still active.

AC. See Authentication Center.

Access Attempt. A sequence of one or more access probe sequences on the Access Channel containing the same message. See also Access Probe and Access Probe Sequence.

Access Channel. A Reserve CDMA Channel used by mobile stations for communicating to the base station. The Access Channel is used for short signaling message exchanges such as call origination's, responses to pages, and registrations. The Access Channel is a slotted random access channel.

Access Channel Message. The information part of an access probe consisting of the message body, length field, and CRC.

Access Channel Message Capsule. An Access Channel message plus the padding.

Access Channel Preamble. The preamble of an access probe consisting of a sequence of all-zero frames that is sent at the 4800bps rate.

Access Channel Request Message. An Access Channel message that is autonomously generated by the mobile station. See also Access Channel Response Message.

Access Channel Response Message. A message on the Access Channel generated to reply to a message received from the base station.

Access Channel Slot. The assigned time interval for an access probe. An Access Channel slot consists of an integer number of frames. The transmission of an access probe is performed within the boundaries of an Access Channel slot.

Access Probe. One Access Channel transmission consisting of a preamble and a message. The transmission is an integer number of frames in length and transmits one Access Channel message. See also Access Probe Sequence and Access Attempt.

Access Probe Sequence. A sequence of one or more access probes on the Access Channel. The same Access Channel message is transmitted in every access probe of an access attempt. See also Access Probe and Access Attempt.

Acknowledgement. A Layer 2 response by the mobile station or the base station confirming that a signaling message was received correctly.

Action Time. The time at which the action implied by a message should take effect.

Active Set. The set of pilots associated with the CDMA Channels containing Forward Traffic Channels assigned to a particular mobile station.

Aging. A mechanism through which the mobile station maintains in its Neighbor Set the pilots that have been recently sent to it from the base station and the pilots whose handoff drop timers have recently expired.

A-key. A secret, 64-bit pattern stored in the mobile station. It is used to generate update the mobile station's Shared Secret Data. The A-key is used in the mobile station authentication process.

Analog Access Channel. An analog control channel used by a mobile station to access a system to obtain service.

Analog Color-Code. An analog signal (see Supervisory Audio Tone) transmitted by a base station on an analog voice channel and used to detect capture of a mobile station by an interfering base station or the capture of a base station by an interfering mobile station.

Analog Control Channel. An analog channel used for the transmission of digital control information from a base station to a mobile station or from a mobile station to a base station.

Analog Paging Channel. A forward analog control channel that is used to page mobile stations and send orders.

Analog Voice Channel. An analog channel on which a voice conversation occurs and on which brief digital messages may be sent from a base station to a mobile station or from a mobile station to a base station.

Authentication. A procedure used by a base station to validate a mobile station's identity.

Authentication Center (AC). An entity that manages the authentication information related to the mobile station.

Authentication Response (AUTHR). An 18-bit output of the authentication algorithm. It is used, for example, to validate mobile station registrations, origination and terminations. A method of registration in which the mobile station registers without an explicit command from the base station.

AWGN. Additive White Gaussian Noise.

Bad Frames. Frames classified as erasures (frame category 10) or 9600bps frames, primary traffic only with bit errors (frame category 9). See also Good Frames.

Base Station. A station in the Domestic Public Cellular Radio Telecommunications Service, other than a mobile station, used for communicating with mobile stations. Depending upon the context, the term base station may refer to a cell, a sector within a cell, an MSC, or other part of the cellular system. See also MSC.

Base Station Authentication Response (AUTHBS). An 18-bit pattern generated by the authentication algorithm. AUTHBS is used to confirm the validity of base station orders to update the Shared Secret Data.

Base Station Random Variable (RANDBS). A 32-bit random number generated by the mobile station for authenticating base station orders to update the Shared Secret Data.

BCH Code. See Bose-Chaudhuri-Hocquenghem Code.

Busy-Idle Bits. The portion of the data stream transmitted by a base station on a forward analog control channel that is used to indicate the current busy-idle status of the corresponding reverse analog control channel.

Call Disconnect. The process that releases the resources handling a particular call. The disconnect process beings either when the mobile station user indicates the end of the call by generating an on-hook condition

or other call release mechanism, or when the base station initiates a release.

Call History Parameter(COUNT). A modulo-64 event counter maintained by the mobile station and Authentication Center that is used for clone detection.

Candidate Set. The set of pilots that have been received with sufficient strength by the mobile station to be successfully demodulated, but have not been placed in the Active Set by the base station. See also Active Set, Neighbor Set, and Remaining Set.

. See Code Division Multiple Access

CDMA Channel. The set of channels transmitted between the base station within a given CDMA frequency assignment. See also Forward CDMA Channel and Reverse CDMA Channel.

CDMA Channel Number. An 11-bit number corresponding to the center of the CDMA frequency assignment.

CDMA Frequency Assignment. A 1.23MHz segment of spectrum centered on one of the 30KHz channels of the existing analog system.

Code Channel. A subchannel of a Forward CDMA Channels. A Forward CDMA Channel contains 64 code channels. Code channel zero is assigned to the Pilot Channel. Code channels 1 through 7 may be assigned to the either Paging Channels or the Traffic Channels. Code Channel 32 may be assigned to either a Sync Channel or a Traffic Channel. The remaining code channels may be assigned to Traffic Channels.

Code Division Multiple Access (CDMA). A technique for spread-spectrum multiple-access digital communications that creates channels through the use of unique code sequences.

Code Symbol. The output of an error-correcting encoder. Information bits are input to the encoder and code symbols are output from the encoder. See Convolutional Code.

Continuous Transmission. A mode of operation in which Discontinuous Transmission is not permitted.

Control Mobile Attenuation Code(CMAC). A 3-bit field in the Control-Filler Message that specifies the maximum authorized power level for a mobile transmitting on an analog reverse control channels.

Convolution Code. A type of error-correcting code. A code symbol can be considered as the convolution of the input data sequence with the impulse response of a generator function.

CRC. See Cyclic Redundancy Code.

Cyclic Redundancy Code (CRC). A class of linear error detecting codes which generate parity check bits by finding the remainder of a polynomial division.

Data Burst Randomizer. The function that determines which power control groups within a frame are transmitted on the Reverse Traffic Channel when the data rate is lower than 9600 bps. The data burst randomizer determines, for each mobile station, the pseudo random position of the transmitted power control groups in the frame while guaranteeing that every modulation symbol is transmitted exactly once.

DBc. The ratio(in dB) of the sideband power of a signal, measured in a given bandwidth at a given frequency offset from the center frequency of the same signal, to the total inband power of the signal. For CDMA, the total inband power of the signal is measured in a 1.23MHz bandwidth around the center

frequency of the CDMA signal.

DBm. A measure of power expressed in terms of its ration (in dB) to one milliwatt.

DBm/Hz. A measure of power spectral density. DBm/Hz is the power in one Hertz of bandwidth. Where power is expressed in units of dBm.

DBW. A measure of power expressed in terns of its ration (in dB) to one Watt.

Dedicated Control Channel. An analog conrtol channel used for the transmisson of digital control information from either a base station or a mobile station.

Deinterleaving. The process of unpermuted the symbols that were permuted by the interleaver..

Deinterleaving is performed on reveived symbols prior to decoding.

Digital Color Code(DCC). A digital signal transmitted by a base station on a forward analog control channel that is used to detect capture of a base station by an interfering mobile station.

Dim-and-Burst. A frame in which primary traffic is multiplexed with either secondary traffic or signaling traffic.

Discontinuous Transmission (DTX). A mode of operation in which a mobile station transmitter autonomously switches between two transmitter power levels while the mobile station is in the conversation state on an analog voice channel.

Distance-Based Registration. An autonomous registration method in which the mobile station registers whenever it enters a cell whose distance from the cell in which the mobile station last registered exceeds a given threshold.

DTMF. See Dual Tone Multifrequency.

Dual-Tone Multifrequency(DTMF). Signaling by the simultaneous transmission of two tones, one from a group of low frequencies and another from a group of high frequencies. Each group of frequecies consists of four frequencies.

Eb. The energy of an information bit.

Ec/I0. The ratio in (dB) between the pilot energy accumulated over one PN chip period(E_c) to the power spectral density in the received bandwidth(I_0).

Effective Radiated Power (ERP). The transmitted power multiplied by the antenna gain referenced to a half wave dipole.

Electronic Serial Number(ESN). A 32-bit number assigned by the mobile station manufacturer, uniquely identifying the mobile station equipment.

Encoder Tail Bits. A fixed sequence of bits added to the end of a block of data to reset the convolutional encoder to a known state.

ERP. See Effective Radiated Power.

ESN. See Electronic Serial Number.

Extended Protocol. An optional expansion of the signaling message between the base station and mobile station to allow for the addition of new system features and operational capabilities.

Fade Timer. A timer kept by the mobile station as a measure of Forward Traffic Channel continuity. If

the Fade timer expires, the mobile station drops the call.

Flash. An indication sent on an analog voice channel or CDMA Traffic Channel indicating that the user Directed the mobile station to invoke special processing.

Foreign NID Roamer. A mobile station operating in the same system (SID) but a different network (NID) from the one in which service was subscribed. See also Foreign SID Roamer and Roamer.

Foreign SID Roamer. A mobile station operating in a system (SID) other than the one from which service was subscribed. See also Foreign NID Roamer and Roamer.

Forward Analog Control Channel (FOCC). An analog voice channel used from a base station to a mobile station.

Forward Analog Voice Channel (FVC). An analog voice channel used from a base station to a mobile station.

Forward CDMA Channel. A CDMA Channel from a base station to mobile stations. The Forward CDMA Channel contains one or more code channels that are transmitted on a CDMA frequency assignment using a Particular pilot PN offset. The code channels are associated with the Pilot Channel, Sync Channel, Paging Channels, and Traffic Channels. The Forward CDMA Channel always carries a Pilot Channel and may carry up to one Sync Channel, up to seven Paging Channels, and up to 63 Traffic Channels, as long as the total number of channels, including the Pilot Channel, is no greater than 64.

Forward Traffic Channel. A code channel used to transport user and signaling traffic from the base station to the mobile station.

A basic timing interval in the system. For the Access Channel, Paging Channel, and Traffic Channel, a frame is 20 ms long. For the Sync Channel, a frame is 26.666...ms long.

Frame Category. A classification of a received Traffic Channel frame based upon transmission data rate, the Frame contents (primary traffic, secondary traffic, or signaling traffic), and whether there are detected error in the frame.

Frame Offset. A time skewing of Traffic Channel frames from System Time in integer multiples of 1.25 ms. The maximum frame offset is 18.75 ms..

Frame Quality Indicator. The CRC check applied to 9600 bps and 4800 bps Traffic Channel frames.

Global Positioning System (GPS). A US government satellite system that provides location and time Information to users. See Navstar GPS Space segment / Navigation User interfaces ICD-GPS-200 for Specifications.

Half Frame. A 10 ms interval on the paging Channel. Two half frames comprise a frame, the first half frame begins at the same time as the frame.

Handoff. The of transferring communication whth a station mobile station from one base station to another.

Hard Handoff. A handoff characterized by a temporary disconnection of the Traffic Channel. Hard handoffs Occur when the mobile station is transferred between disjoint Active Sets, the CDMA frequency assignment changes, the frame offset changes, or the mobile station is directed from a CDMA Traffic

Channel to an analog voice channel, See also Soft Handoff.

Hash Function. A function used by the mobile station to select one out of N available resource. The hash function distributes the available resources uniformly among a random sample of mobile stations.

HLR. See Home Location Register.

Home Location Register (HLR). The location register to which a MIN is assigned for record purposes such as subscriber information.

Home System. The cellular system in which the mobile station subscribes for service.

Idle Handoff. The act of transferring reception of the Paging Channel from one bass station to another, when the mobile station is in the *Mobile Station Idle State*.

Implicit Registration. A registration achieved by a successful transmission of an origination or page response on the Access Channel.

Interleaving. The process of permuting a sequence of symbols.

kHz. KiloHertz (10^3 Hertz).

ksps. Kilo-symbols per second (10^3 symbols per second).

Layer 1. See Physical Layer.

Layer 2. Layer 2 provides for the correct transmission and reception of signaling messages, including partial duplicate detection. See also Layering and Layer 3.

Layer 3. Layer 3 provides the control of the cellular teleModem systems. Signaling messages originate and terminate at layer 3. See also Layering and Layer 2.

Local Control. An optional mobile station feature used to perform manufacturer-specific functions.

A PN sequence with period $2^{42}-1$ that is used for scrambling on the Forward CDMA Channel and spreading on the Reverse CDMA Channel. The long code uniquely identifies a mobile station on both the Reverse Traffic Channel and the Forward Traffic Channel. The long code provides limited privacy. The long code also separates multiple Access Channels on the same CDMA channel. See also Public Long Code and Private Long Code.

Long Code Mask. A 42-bit binary number that creates the unique identity of the long code. See also Public Long Code, Private Long Code, Public Long Code Mask, and Private Long Code Mask.

LSB. Least significant bit.

Maximal Length Sequence (m-Sequence). A binary sequence of period $2^n - 1$, n a positive integer, with no internal periodicities. A maximal length sequence can be generated by a tapped n -bit shift register with linear feedback.

Mcps. Megachips per second (10^6 chips per second).

Mean Input Power. The total received calorimetric power measured in a specified bandwidth at the antenna connector, including all internal and external signal and noise sources.

Mean Output Power. The total transmitted calorimetric power measured in a specified bandwidth at the antenna connector when the transmitter is active.

Message. A data structure that conveys control information or application information. A message consists of a length field (MSG_LENGTH), a message body (the part conveying the information), and a CRC.

Message Body. The part of the message contained between the length field (MSG_LENGTH) and the CRC field.

Message Capsule. A sequence of bits comprising a single message and padding. The padding always follows the message and may be of zero length.

Message CRC. The CRC associated with a message. See also Cyclic Redundancy Check.

Message Field. A basic named element in a message. A message field may consist of zero or more bits.

Message Record. An entry in a message consisting of one or more field that repeats in the message.

MHz. Megahertz. (10^6 Herz)

MIN. See Mobile Station Identification Number.

Mobile Protocol Capability Indicator (MPCI). A 2-bit field used to indicate ☞ mobile station's capabilities.

Mobile Station. A station in the Domestic Public Cellular Radio Telecommunications Service intended to be used while in motion or during halts at unspecified points. Mobile station include portable units (e.g., handheld personal units) and units installed in vehicles.

Mobile Station Class. Mobile station classes define mobile station characteristics such as slotted operation and transmission power.

Mobile Station Identification Number (MIN). The 34-bit number that is a digital representation of the 10-digit directory teleModem number assigned to a mobile station.

Mobile Station Originated Call. A call originating from a mobile station.

Mobile Station Terminated Call. A call received by a mobile station (not to be confused with a disconnect or call release).

Mobile Switching Center (MSC). A configuration of equipment that provides cellular radioteleModem service. Also called the Mobile TeleModem Switching Office (MTSO)

Modulation Symbol. The output of the data modulator before spreading. On the Reverse Traffic Channel,

64-ary orthogonal modulation is used and six code symbol (when the data rate is 9600bps) or each repeated code symbol (when the data rate is less than 9600bps) is one modulation symbol.

Ms. Millisecond.

MSB. Most significant bit.

MSC. See Mobile Switching Center.

Multiplex Option. The ability of the multiplex sublayer and lower layer to be tailored to provide special capabilities. A multiplex option defines such characteristics as the frame format and the rate decision rules. See also Multiplex Sublayer.

Multiplex Sublayer. One of the conceptual layers of the system that multiplexes and demultiplexes primary traffic, secondary traffic, and signaling traffic.

NAM. See Number Assignment Module.

Narrow Analog. A type of voice channel that uses 10kHz channel spacing and subaudible signaling.

Neighbor Set. The set of pilots associated with the CDMA Channel that are probable candidates for handoff. Normally, the Neighbor Set consists of the pilots associated with CDMA Channel that cover geographical areas near the mobile station. See also Active Set, Candidate Set, and Remaining Set.

- A network is a subset of a cellular system, such as an area-wide cellular network, a private group of base stations, or a group of base stations set up to handle a special requirement. A network can be as small or as large as needed, as long as it is fully contained within a system. See also System.

Network Identification (NID). A number that uniquely identifies a network within a cellular system. See also System Identification.

NID. See Network Identification.

Non-Autonomous Registration. A registration method in which the base station initiates registration. See also Autonomous Registration.

Non-Slotted Mode. An operation mode of the mobile station in which the mobile station continuously monitors the Paging Channel when in the Mobile Station Idle State.

Ns. Nanosecond.

NULL. Not having any value.

Null Traffic Channel Data. One or more frames of 16 '1's followed by eight '0's sent at the 1200bps rate.

Null Traffic Channel data is sent when no service option is active and no signaling message is being sent.

Null Traffic Channel data serves to maintain the connectivity between the mobile station and the base station.

Number Assignment Module (NAM). A set of MIN-related parameters stored in the mobile station.

Numeric Information. Numeric information consists of parameters that appear as numeric fields in message exchanged by the base station and the mobile station and information used to describe the operation of the mobile station.

OLC. See Overload Class (CDMA) or Overload Control (analog).

Optional Field. A field defined within a message structure that is optionally to the message recipient.

Order. A type of message that contains control codes for either the mobile station or the base station.

Ordered Registration. A registration method in which the base station orders the mobile station to send registration related parameters.

Overhead Message. A message sent by the base station on the Paging Channel to communicate base-station-specific and system-wide information to mobile station.

Overload Class. The means used to control system access by mobile stations, typically in emergency or other overload conditions. Mobile station are assigned one (or more) of sixteen overload classed, Access to the CDMA system can then be controlled on a per class basis by persistence values transmitted by the base station.

Overload Control (OLC). A means reverse analog control channel accesses by mobile stations. Mobile station are assigned one(or more) of sixteen control levels. Access is selectively restricted by a base station setting one or more OLC bits in the Overload Control Global Action Message.

Packet. The unit of information exchanged between the service option applications of the base station and the mobile station.

Padding. A sequence of bits used to fill from the end of a message to the end of a message capsule, typically to the end of the frame or half frame. All bits in the padding are '0'.

Paging. The act of seeking a mobile station when a call has been placed to that mobile station.

Paging Channel (Analog). See Analog Paging Channel.

Paging Channel (CDMA). A code channel in a Forward CDMA Channel used for transmission of control information and pages from a base station to a mobile station.

Paging Channel Slot. An 80ms interval on the Paging Channel. Mobile station operating in the slotted mode are assigned specific slots in which day monitor messages from the base station.

Parameter-Change Registration. A registration method in which the mobile station registers when certain of its stored parameters change.

Parity Check Bits. Bits added to a sequence of information bits to provide error detection, correction, or both.

Persistence. A probability measure used by the mobile station to determine if it should transmit in a given Access Channel Slot.

Physical Layer. The part of the communication protocol between the mobile station and the base station that is responsible for the transmission and reception of data. The physical layer in the transmitting station is presented a frame by the multiplex sublayer and transforms it into an over-the-air waveform. The physical layer in the receiving station transforms the waveform back into a frame and presents it to the multiplex sublayer above it.

Pilot Channel. An unmodulated, direct-sequence spread spectrum signal transmitted continuously by each CDMA base station. The Pilot Channel allows a mobile station to acquire the timing of the Forward CDMA Channel, provides a phase reference for coherent demodulation, and provides a means for signal strength comparisons between base station for determining when to handoff.

Pilot PN Sequence. A pair of modified maximal length PN sequences with period 2^{15} used to spread the Foward CDMA Channel and the Reserve CDMA Channel. Different base station are identified by

different pilot PN sequence offsets.

Pilot PN Sequence Offset Index. The PN offset in units of 64 PN chips of a pilot, relative to the zero offset pilot PN sequence.

PN Chip. One bit in the PN sequence.

PN Sequence. Pseudonoise sequence. A periodic binary sequence.

Power Control Bit. A bit sent in every 1.25ms interval on the Forward Traffic Channel to signal the mobile station to increase or decrease its transmit power.

Power Control Group. A 1.25ms interval on the Forward Traffic Channel and the Reverse Traffic Channel.

See also Power Control Bit.

Power-Down Registration. An autonomous registration method in which the mobile station registers on power up.

PPM. Parts per million.

Preamble. See Access Channel Preamble and Traffic Channel Preamble.

Primary CDMA Channel. A CDMA Channel at a pre-assigned frequency assignment used by the mobile station for initial acquisition. See also Secondary CDMA Channel.

Primary Paging Channel (CDMA). The default code channel (code channel 1) assigned for paging on a CDMA Channel.

Primary Traffic. The main traffic stream carried between the mobile station and the base station, supporting the active promaty service option, on the Traffic Channel. See also Secondary Traffic, Signaling Traffic, and Servic3e Option.

Private Long Code. The long code characterized by the private long code mask. See also Long Code.

Private Long Code Mask. The long code mask used to form the private long code. See also Public Long Code Mask and Long Code.

Public Long Code. The long code characterized by the public long code mask.

Public Long Code Mask. The long code mask used to form the private long code. The mask contains the ESN of the mobile station. See also Private Long Code Mask and Long Code.

Punctured Code. An error-correcting code generated from another error-correcting code by deleting (i.e., puncturing) code symbols from the code output.

Quick Repeats. Additional transmissions of identical copies of a message within a short interval to increase the probability that the message is received correctly.

Receive Objective Loudness Rating (ROLR). A perceptually weighted transducer gain of teleModem receivers relating electrical excitation from a reference generator to sound pressure at the earModem. The receive objective loudness tating is normally specified in dB relative to one Pascal per millivolt. See IEEE Standard 269-1992, IEEE Standard 661-1979, CCITT Recommendation P.76, and CCITT Recommendation P.79.

Registration. The process by which a mobile station identifies its location and parameters to a base station.

Registration Zone. A collection of one or more base stations treated as a unit when determining whether a

mobile station should perform zone-based registration.

Release. A process that the mobile station and base station use to inform each other of call disconnect.

The set of all allowable pilot offsets as determined by PILOT_INC, excluding the pilot offsets of the pilots in the Active Set, Candidate Set, and Neighbor Set. See also Active Set, Candidate Set, and Neighbor Set.

Request. A layer 3 message generated by either the mobile station or the base station to retrieve information, ask for service, or command an action.

Response. A layer 3 message generated as a result of another message, typically a request.

Reverse Analog Control (RECC). The analog control channel used from a mobile station to a base station.

Reverse Analog Voice Channel (RVC). The analog voice channel used from a mobile station to a base station.

Reverse CDMA Channel. The CDMA Channel from the mobile station to the base station. From the base station's perspective, the Reverse CDMA Channel is the sum of all mobile station transmissions on a CDMA frequency assignment.

Reverse Traffic Channel. A Reverse CDMA Channel used to transport user and signaling traffic from a single mobile station to one or more base stations.

Roamer. A mobile station operating in a cellular system (or network) other than the one from which service was subscribed. See also Foreign NID Roamer and Foreign SID Roamer.

ROLR. See Receive Objective Loudness Rating.

SAT. See Supervisory Audio Tone.

Scan of Channels. The procedure by which a mobile station examines the signal strength of each forward analog control channel.

SCI. Synchronized Capsule Indicator bit.

Search Window. The range of PN sequence offsets that a mobile station searches for a pilot.

Secondary CDMA Channel. A CDMA Channel at a preassigned frequency assignment used by the mobile station for initial acquisition. See also Primary CDMA Channel.

Secondary Traffic. An additional traffic stream that can be carried between the mobile station and the base station on the Traffic Channel. See also Primary Traffic and Signaling Traffic.

Seizure Precursor. The initial digital sequence transmitted by a mobile station to a base station on a reverse analog control channel.

Seizure Option. A service capability of the system. Service options may be applications such as voice, data, or facsimile.

Shard Secret Data (SSD). A 128-bit pattern stored in the mobile station (in semi-permanent memory) and known by the base station. SSD is a concatenation of two 64-bit subsets: SSD_A, which is used to support the authentication procedures and SSD_B, which serves as one of the inputs to the process generating the encryption mask and private long code.

Short Message Services (SMS). A suite of services which include SMS Text Delivery, Digital Paging (i.e., Call Back Number – CBN), and Voice Mail Notification (VMN).

SID. See System Identification.

Signaling Tone. A 10kHz tone transmitted by a mobile station on an analog voice channel to: 1) confirm orders, 2) signal flash requests, and 3) signal release requests.

Signal Traffic. Control message that are carried between the mobile station and base station on the Traffic Channel. See also Primary Traffic and Secondary Traffic.

Slot Cycle. A periodic interval at which a mobile station operating in the slotted monitors the Paging Channel.

Slotted Mode. An operation mode of the mobile station in which the mobile station monitors only selected slots on the Paging Channel when in the Mobile Station Idle State.

Soft Handoff. A handoff occurring while the mobile station is in the Mobile Station Control on the Traffic Channel State. This handoff is characterized by commencing communications with a new base station on the same CDMA frequency assignment before terminating communications with the old base station. See also Hard Handoff.

SOM. Start-of-Message Bit.

SPS. Symbols per second.

- An identification of certain characteristics of a mobile station. Classes are defined in Table 2.3.3-1.

Status Information. The following status information is used to describe mobile station operation when using the analog system.

- **Serving-System Status.** Indicates whether a mobile station is turned to channels associated with System A or System B.
- **First Registration ID Status.** A status variable used by the mobile station in association with its processing of received Registration ID messages.
- **First Location Area ID Status.** A status variable used by the mobile station in association with its processing of received Location Area ID messages.
- **Location Registration ID Status.** A status variable used by the mobile station in association with its processing of power-up registration and location-based registration.
- **First Idle ID Status.** A status variable used by the mobile station in association with its processing of the Idle Task.
- **Local Control Status.** Indicates whether a mobile station must respond to local control messages.
- **Roam Status.** Indicates whether a mobile station is in its home system.
- **Termination Status.** Indicates whether a mobile station must terminate the call when it is on an analog voice channel.

Supervisory Audio Tone (SAT). One of three tones in the 6 kHz region that is transmitted on the forward analog voice channel by a base station and transponder on the reverse analog voice channel by as mobile station.

Supplementary Digital Color Code (SDCC1, SDCC2). Additional bits assigned to increase the number of color codes from four to sixty four, transmitted on the forward analog control channel.

Symbol. See Code Symbol and Modulation Symbol.

Sync Channel. Code channel 32 in the Forward CDMA Channel which transports the synchronization message to the mobile station.

Sync Channel Superframe. An 80ms interval consisting of three Sync Channel frames (each 26.666...ms in length).

System. A system is a cellular teleModem service that covers a geographic area such as a city, Metropolitan region, country, or group of countries. See also Network.

System Time. The time reference used by the system. System Time is synchronous to UTC time(except for leap seconds) and used the same time origin as GPS time. Offset by the propagation delay from the base station to the mobile station. See also Universal coordinated Time.

Timer-Based Registration. A registration method in which the mobile station registers whenever a counter reaches a predetermined value. The counter is incremented an average of once per 80 ms period.

Time Reference. A reference established by the mobile station that is synchronous with the earliest arriving multipath component used for demodulation.

TOLR. See Transmit Objective Loudness Rating.

Traffic Channel. A communication path between a mobile station and base station used for user and signaling traffic. The term Traffic Channel implies a Forward Traffic Channel and Reverse Traffic Channel pair. See also Forward Traffic Channel and Reverse Traffic Channel.

Traffic Channel Preamble. A sequence of all-zero frames that is sent at the 9600 bps rate by the mobile station on the Reverse Traffic Channel. The Traffic Channel preamble is sent during initialization of the Traffic Channel.

Transmit Objective Loudness Rating(TOLR). A perceptually weighted transducer gain of teleModem transmitters relation sound pressure at the microModem to voltage at a reference electrical termination. It is normally specified in dB relative to one millivolt per Pascal. See IEEE Standard 269-1992, IEEE Standard 661-1979, CCITT Recommendation P.76 , and CCITT Recommendation. P.79

Unique Challenge-Response Procedure. An exchange of information between a mobile station and a base station for the purpose of confirming the mobile station's identity. The procedure is initiated by the base station and is characterized by the use of a challenge-specific random number(i.e., RANDU) instead of the random variable broadcast globally(RAND).

Unique Random Variable(RANDU). A 24-bit random number generated by the base station in support of the Unique Challenge-Response procedure.

Universal Coordinated Time(UTC). An internationally agreed-upon time scale maintained by the Bureau International de l'Heure(BIH) used as the time reference by nearly all commonly available time and frequency distribution systems i.e., WWW, WWVH, LORAN-C, Transit, Omega, and GPS.

UTC. Universal Temps Coordine. See Universal Coordinated Time.

Voice Channel. See Analog Voice Channel.

Voice Mobile Attenuation Code(VMAC). A 3-bit field in the Extended Address Word commanding the

initial mobile power level when assigning a mobile station to an analog voice channel.

Voice Privacy. The process by which user voice transmitted over a CDMA Traffic Channel is afforded a modest degree of protection against eavesdropping over the air.

Walsh Chip. The shortest identifiable component of a Walsh function. There are 2^N Walsh chips in one Walsh function where N is the order of the Walsh function. On the Forward CDMA channel one Walsh chip equals 1/1.2288MHz, or 813.802...ns. On the Reverse CDMA Channel, one Walsh chip equals 4/1.2288MHz, or 3.255...μs.

Walsh Function. One of 2^N time orthogonal binary functions (note that the functions are orthogonal after mapping '0' to 1 and '1' to -1).

Zone-Based Registration. An autonomous registration method in which the mobile station registers whenever it enters a zone that is not in the mobile station's zone list.

μs. Microsecond

Appendix

1. Assembly and Disassembly Diagram
2. Block & Circuit Diagram
3. Part List
4. Component Layout
5. Accessories
6. WLPST (LGE Product Support Tool For Win95)