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SERVICE MANUAL

CDMA Development Kit
DTS-800 CDK

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Introduction

The CDMA development kit (CDK -800) is designed for the test and simulation of the CDMA wireless data communications. User can connect the development kit to your PC or Notebook and easily test the wireless communications. User can use this to develop your applications software even before user's own hardware is ready. It also can be used as a debugging during user's hardware test.

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FCC RF Exposure Information

Warning! Read this information before using this device.

In August 1996 the Federal Communications Commission (FCC) of the United States with its action in Report and Order FCC 96-326 adopted an updated safety standard for human exposure to radio frequency electromagnetic energy emitted by FCC regulated transmitters. Those guidelines are consistent with the safety standard previously set by both U.S. and international standards bodies. The design of this device complies with the FCC guidelines and these international standards.

CAUTION

- ***Operating Requirements***

  - The user can not make any changes or modifications not expressly approved by the party responsible for compliance, otherwise it could void the user's authority to operate the equipment.
  - To satisfy FCC RF exposure compliance requirements for a mobile transmitting device, this device and its antenna should generally maintain a separation distance of 20cm or more from a person's body.

Special accessories

In order to ensure this device in compliance with FCC regulation, the special accessories are provided with this device and must be used with the device only. The user is not allowed to use any other accessories than the special accessories given with this device

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General Introduction

The DTS-800 CDK functions digital cellular module worked in CDMA (Code Division Multiple Access) mode. CDMA type digital mode applies DSSS (Direct Sequence Spread Spectrum) mode which is used in military.

This feature enables the phone to keep communication from being crossed and 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 phone.

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

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

DTS-800 CDK is digital mode is designed to be operated in full duplex.

CHAPTER 1. System Introduction

1. System Introduction

1.1 CDMA Abstract

The cellular system has a channel hand-off function that is used for collecting the information on the locations and movements of radio mobile telephones from the cell site by automatically controlling several cell site through the setup of data transmission routes and thus, 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 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 Module

2.1 Various Types of Diversities

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

2.2 Power Control

The CDMA system utilizes the forward (from a base station to mobile stations) and backward (from the mobile station to the base station) power control in order to increase the call processing capacity and obtain high-quality calls. In case the originating signals of mobile stations are received by the cell site in the minimum call quality level (signal to interference) through the use of transmit power control on all the mobile stations, the system capacity can be maximized.
If the signal of mobile station is received too strong, the performance of that mobile station is improved. However, because of this, the interference on other mobile stations using the same channel is increased and accordingly, the call quality of other subscribers is reduced unless the maximum accommodation capacity is reduced.
In the CDMA system, forward power control, backward open loop power control, and closed loop power control methods are used. The forward power control is carried out in the cell site to reduce the transmit power on mobile stations less affected by the multi-path fading and shadow phenomenon and the interference of other cell sites when the mobile station is not engaged in the call or is relatively nearer to the corresponding cell site. This is also used to provide additional power to mobile stations having high call error rates, located in bad reception areas or far away from the cell site.
The backward open loop power control is carried out in a corresponding mobile station; the mobile station measures power received from the cell site and then, reversely increases/decreases transmit power in order to compensate channel changes caused by the forward link path loss and terrain characteristics in relation to the mobile station in the cell site. By doing so, all the mobile office transmit signals in the cells are received by the cell site in the same strength.
Moreover, the backward closed loop power control used by the mobile station to control power with the commands issued out by the cell site. The cell site receives the signal of each corresponding mobile station and compares this with the pre-set threshold value and then, issues out power increase/decrease commands to the corresponding mobile station every 1.25 msec (800 times per second).
By doing so, the gain tolerance and the different radio propagation loss on the forward/backward link are complemented.

2.3 Voice Encoder and Variable Data Speed

The bi-directional voice service having variable data speed provides voice communication which employs voice encoder algorithm having power variable data rate between the mobile telephone cell site and mobile station. On the other hand, the transmit voice encoder performs voice sampling and then, creates encoded voice packets to be sent out to the receive voice encoder, whereas the receive voice encoder demodulates the received voice packets into voice samples.

One of the two voice encoders described in the above is selected for use depending on inputted automatic conditions and message/data; both of them utilize four-stage frames of 9600, 4800, 2400, and 1200 bits per second. In addition, this type of variable voice encoder utilizes adaptive threshold values when selecting required data rate. It is adjusted in accordance with the size of background noise and the data rate is increased to high rate only when the voice of caller is inputted.

Therefore, background noise is suppressed and high-quality voice transmission is possible under the environment experiencing serious noise. In addition, in case the caller does not talk, data transmission rate is reduced so that the transmission is carried out in low energy. This will reduce the interference on other CDMA signals and as a result, improve system performance (capacity, increased by about two times).

2.4 Protecting Call Confidentiality

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

2.5 Soft Handoff

During the soft hand, the cell site already in the busy state and the cell site to be engaged in the call later participate in the call conversion. The call conversion is carried out through the original call connection cell site, both cell sites, and then, new cell site. This method 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 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 Module

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

The transmit frequency is the 25MHz band of 824~849MHz, whereas the receive frequency is the 25MHz band of 869~894MHz. The transmit/receive frequency is separated by 45MHz. The RF signal from the antenna is converted into intermediate frequency(IF) band by the frequency synthesizer and frequency down converter and then, passes the bandpass SAW filter having the 1.25MHz band. IF output signals that have been filtered from spurious signal are converted into digital signals via an analog-to-digital converters(ADC) and then, sent out respectively to 5 correlators in each CDMA de-modulator. Of these, one is called a searcher whereas the remaining 4 are called data receiver(finger). Digitalized IF signals include a great number of call signals that have been sent out by the adjacent cells. These signals are detected with pseudo-noise sequence (PN Sequence). Signal to interference ratio (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 four paths are allocated for the parallel tracing and receiving. Fading resistance can be improved a great deal by obtaining the diversity combined output for de-modulation. Moreover, the searcher can be used to determine the most powerful path from the cell sites even during the soft handoff during the two cell sites. Moreover, four data receivers are allocated in order to carry out the de-modulation of these paths. Data output that has been demodulated change the data string in the combined data row as in the case of original signals(deinterleaving), and then, are de-modulated by the forward error correction decoder which uses the Viterbi algorithm.

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

Signals that have been code spread as above are digital modulated (QPSK) and then, power controlled at the automatic gain control amplifier (AGC Amp). Then, they are converted into RF band by the frequency synthesizer synchronizing these signals to proper output frequencies.

Transmit signals obtained pass through the duplexer filter and then, are sent out to the cell site via the antenna.

4. Specification

4.1 General Specification

4.1.1 Transmit/Receive Frequency Interval : 45 MHz

4.1.2 Number of Channels (Channel Bandwidth)

CDMA : 20 CH (BW: 1.23MHz)

41.3 Operating Voltage : DC 6V

4.1.4 Operating Temperature : -30° ~ +60°

4.1.5 Frequency Stability : ±300 Hz

4.1.6 Antenna : Whip antenna, 50 Ω

4.1.7 Size and Weight

1) Size : 102mm x 80mm x 36mm (L x W x D)

2) Weight : About 180g

4.1.8 Channel Spacing : *1.25MHz*

4.2 Receive Specification

4.2.1 Frequency Range

Digital : 869.04 MHz ~ 893.97 MHz

4.2.2 Local Oscillating Frequency Range : 966.88MHz±12.5MHz

4.2.3 Intermediate Frequency : 85.38MHz

4.2.4 Sensitivity : -104dBm Under

4.2.5 Selectivity

CDMA : 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~ -25dBm : 79dB at the 1.23MHz band.**

4.3 Transmit Specification

4.3.1 Frequency Range

824.04 MHz ~ 848.97 MHz

4.3.2 Local Oscillating Frequency Range : 966.88 MHz±12.5 MHz

4.3.3 Intermediate Frequency : 130.38 MHz

4.3.4 Output Power : 0.32W

4.3.5 Interference Rejection

1) Single Tone : -30dBm at 900 kHz

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

4.3.7 CDMA TX Frequency Deviation : ±300Hz or less

4.3.8 CDMA TX Conducted Spurious Emissions

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

4.3.9 CDMA Minimum TX Power Control : - 50dBm below

4.4 MS (Mobile Station) Transmitter Frequency

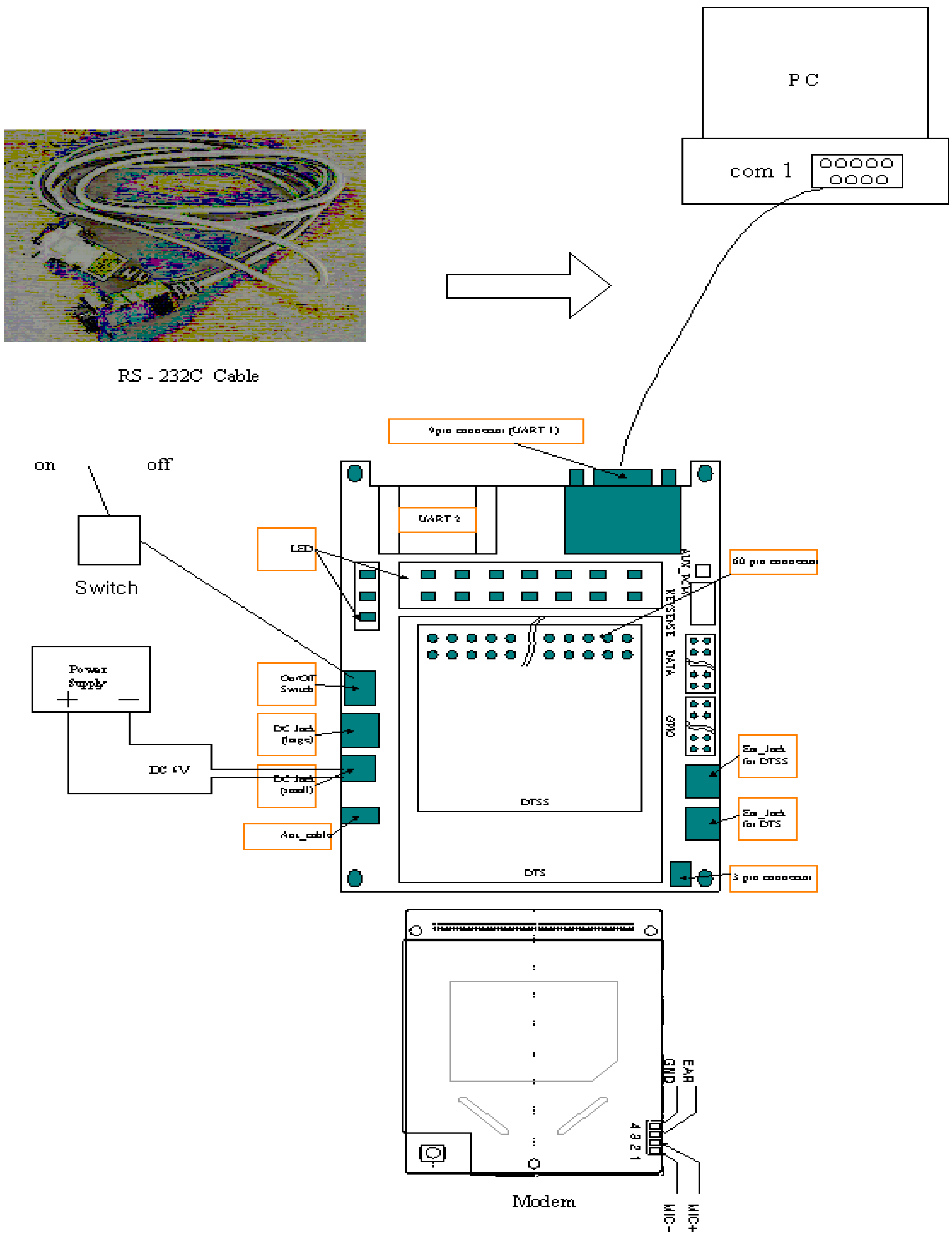
FA NO.	CH.NO.	CENTER FREQUENCY	FA NO.	CH.NO.	CENTER FREQUENCY
1	1011	824.640 MHz	11	404	837.120 MHz
2	29	825.870 MHz	12	445	838.350 MHz
3	70	827.100 MHz	13	486	839.580 MHz
4	111	828.330 MHz	14	527	840.810 MHz
5	152	829.560 MHz	15	568	842.04 MHz
6	193	830.790 MHz	16	609	843.270 MHz
7	234	832.020 MHz	17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

4.5 MS (Mobile Station) Receiver Frequency

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

CHAPTER 2. NAM Input Method

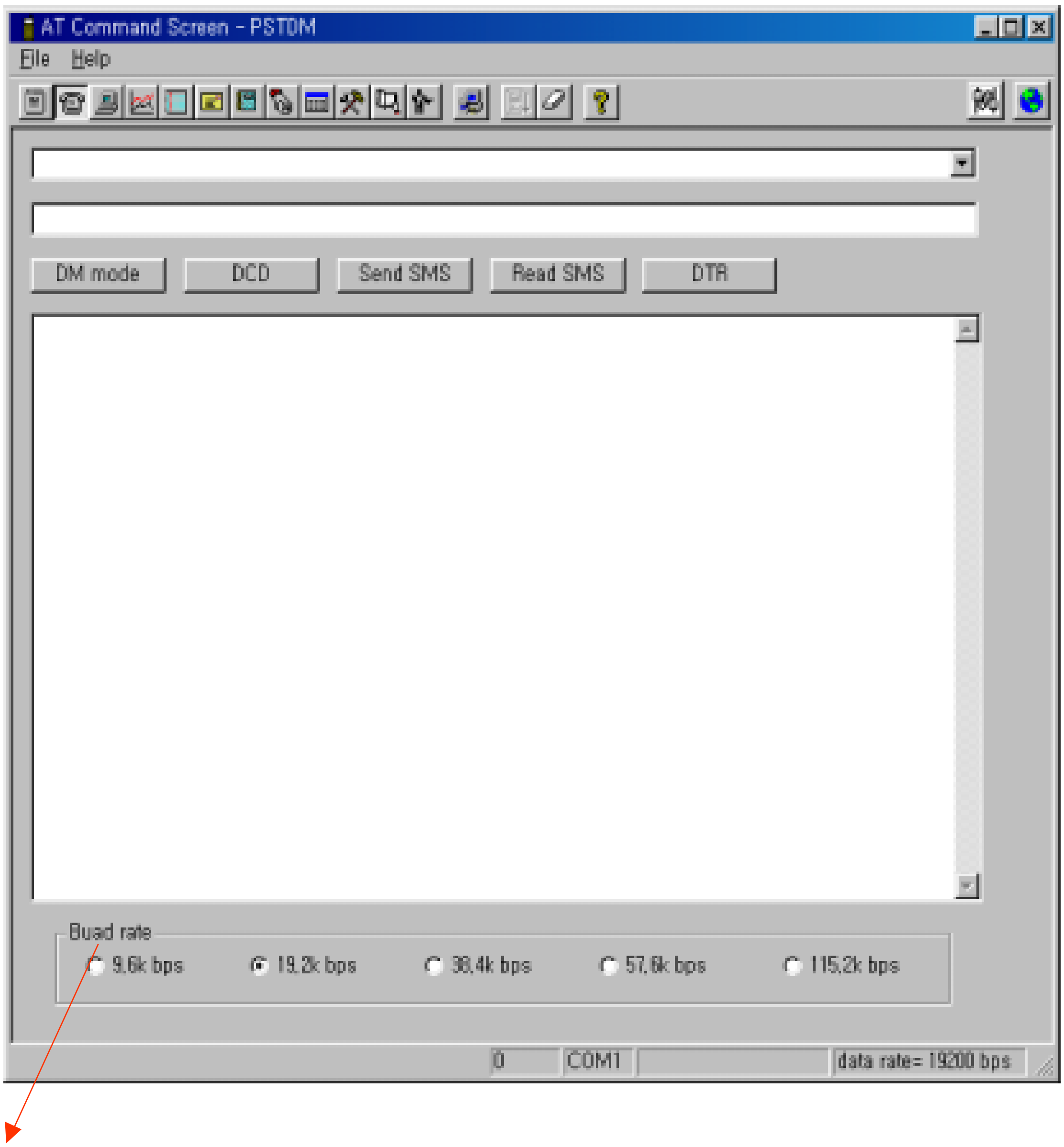
1.INSTALLATION METHOD



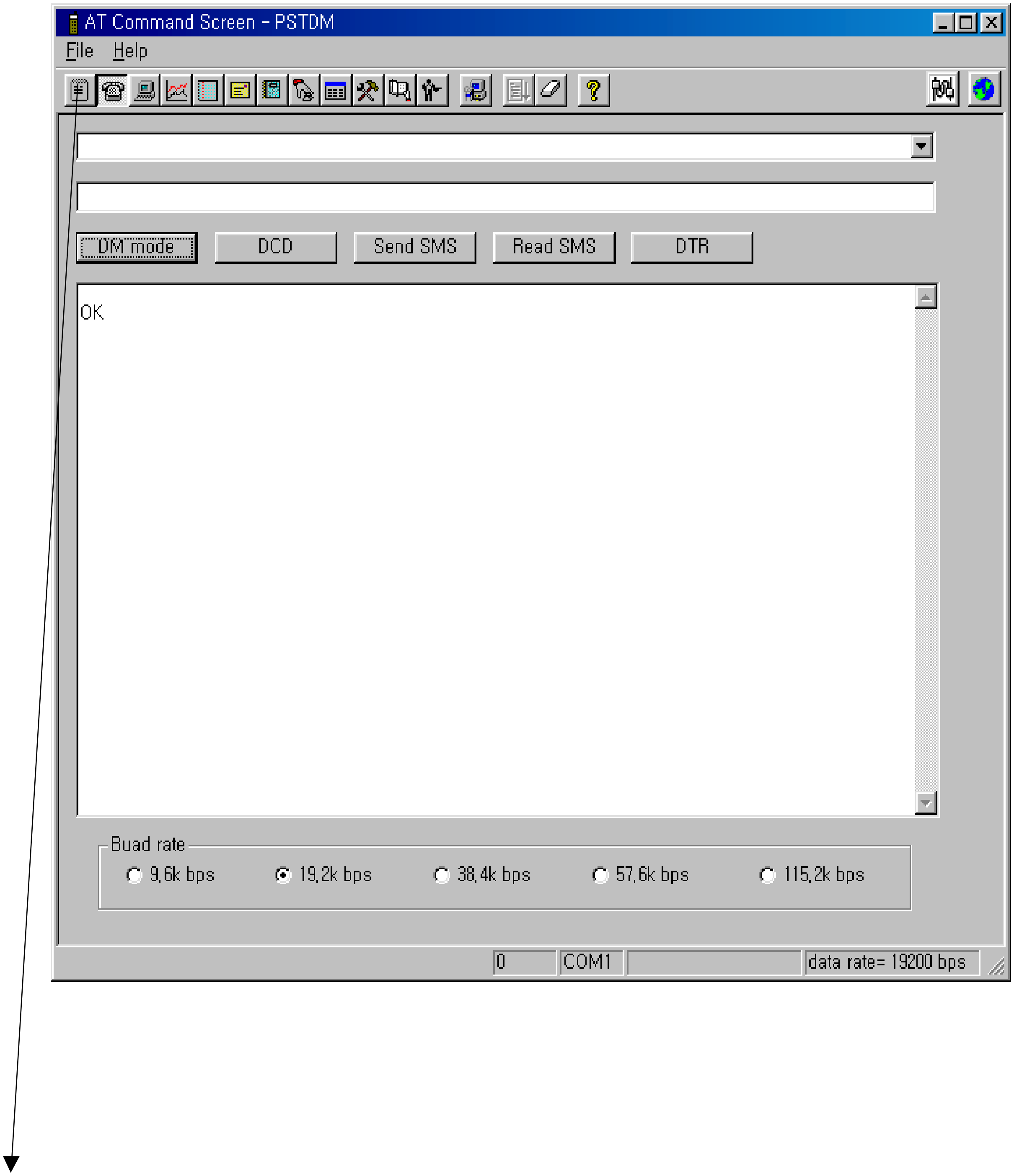
1) Connect the MODEM to 60pin connector of Level Translator.
2) Supply the voltage of 5~7V to small or large jack of Level Translator.
3) Switch the power on.
4) Connect the UART1 to PC COM1 port with the RS-232C cable.
5) Install the operating program.

2. OPERATION METHOD

1) Run PSTDM program at Windows95 or Windows98

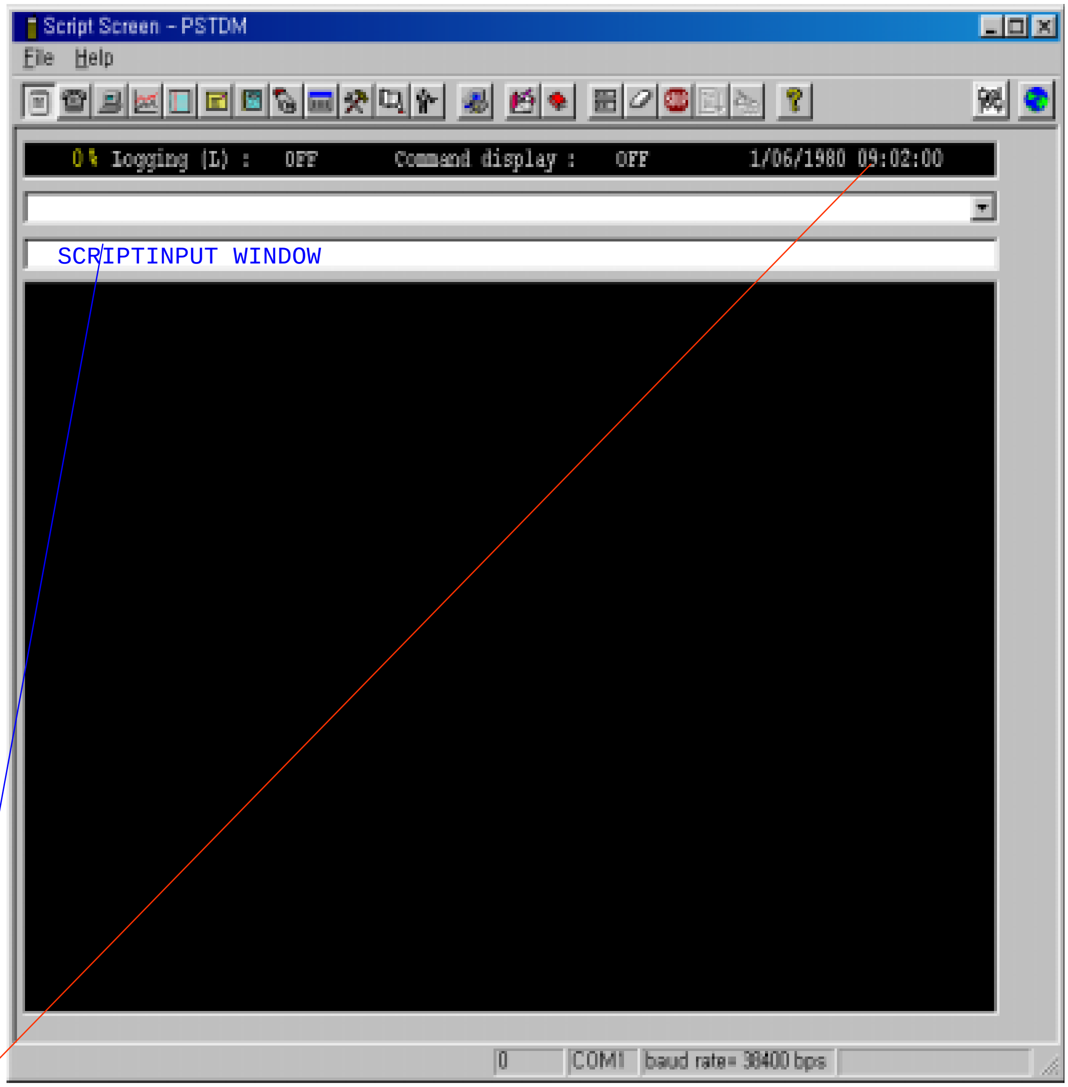


2) Set Buad rate to the modem's.
3) Click [DM mode]



4) If OK is displayed in the message box, modem is now ready for ommunication with PC.

5) Click MENU BAR icon.



6) As shown in the picture above, service file input plane will be displayed (See if clock is running. If it isn't, communication with PC is not activated.

Repeat step 1 through 5, or reset the power of modem and repeat step 1 through 5)

7) Type NAM Programming script like the example shown below,

<NAM Programming script example>

```
Mode offline-d                                          [ENTER]
nv_write name_nam {0," AnyDATA telecom "}         [ENTER]
nv_write name_nam {1," AnyDATA telecom "}         [ENTER]
Mode reset                                            [ENTER]
```

CHAPTER 3. Circuit Description

1. Overview

IRT3000 receives modulated digital signals from the MSM of the digital circuit and then, changes them into analog signals by the digital/analog converter (DAC, D/A Converter) in order to create baseband signals. Created baseband signals are changed into IF signals by IFT3000 and then, fed into the Mixer after going through AGC. IF signals that have been fed are mixed with the signals of VCO and changed into the RF signals and then, they are amplified at the Power AMP. Finally, they are sent out to the cell site via the antenna after going through the isolator and duplexer.

2. RF Transmit / Receive Part

2.1 CDMA Transmit End

8 bit I and Q transmit signals are inputted into 2 DACs (DIGITAL-TO-ANALOG CONVERTER) from the output terminal TX_IQDATA0 ~ TX_IQDATA7 of MSM through the input terminals TXD0~TXD7 of BBA. Transmit signal input speed is two times of TXCLK+, TXCLK- which are two transmit/receive reference frequency.

Among transmit signals being inputted, signals are inputted into I signal DAC when the transmit clock is in the rise edge, whereas signals are inputted into Q Signal DAC during the drop edge. I and Q transmit signals are compensated and outputted at MSM in order to compensate the 1/2 clock time difference generated between reference clocks. In the signals coming out from the output terminal of DAC, there are spurious frequency ingredients resulting from DAC output transition edge and parasite ingredients, transmit clock frequencies and harmonics which are unwanted signals. Accordingly, spurious ingredients are removed by passing the signals through LPF of passband 6.30KHz. Unlike the receive end, the transmit end LPF requires no OFFSET adjustment. Analog baseband signals that have passed the CDMA LPF are mixed with I and Q signals of frequency 130.38 MHz (260.76 MHz created in the BBA internal VCO are divided by half into frequency 130.38MHz having the phase difference of 90 degrees) in two mixers. The mixed signals are added again and converted into IF frequency 130.38 MHz ±630 KHz (CDMA Spread Power Density Modulated Signals) and then, outputted.

2.2. Tx IF/Baseband Processors, IFT3000 (U105)

The IFT3000 includes digital-to-analog converters(DAC) for converting digital baseband to analog baseband, low-pass filters, a mixer for up-converting to IF and an 85 dB dynamic range Tx AGC amplifier. The IFT3000 includes a fully programmable phase-locked loop(PLL) for generating Tx LO and IF frequencies. The IFT3000 also has an 8-bit general purpose ADC with three selectable inputs for monitoring battery level, RF signal strength and phone temperature.

2.3. Upconverter (U104)

Upconverters made up of a mixer part and Driver AMP part. The mixer part is used to receive double-balanced OUT+ and OUT- of transmit AGC from baseband and mix the output of VCO (U171) with UHF output signal, whereas the Amp part is used to buffer the output of this mixer. U105 has the operation range of RF500MHz~1500MHz and has the conversion gain of 0 dB. In addition, the suppression of spurious signals which are unwanted noise is about 30 dBc when being compared to RF output. The IF input signal range of the mixer is DC~200MHz. The isolation on RF output terminal and LO signal input terminal at the IF input terminal is 30dB. The range of LO signal that can be inputted is 300~1700MHz and power level is -6~0 dBm.

2.4. Transmit Bandpass Filter (F102, F103)

Transmit signals that have been converted from IF signals into RF signals after passing through the upconverter U105 are inputted into the Power Amp U102 after passing once again through RF BPF F102 in order to filter out noise signals amplified during the amplification of RF signals after going through upconverter(U105). This is carried out in order to create power level inputted to the Power AMP via RF BPF F102. IL of two RF BPFs is 4dB as a maximum, whereas the ripple in the passing band is 2dB(maximum). The degree of the suppression of transmit signals on receive band is at least 20dB or greater. The maximum power that can be inputted is about 25dBm.

2.5. Power Amplifier (U102)

The power amplifier U102 that can be used in the CDMA and FM mode has linear amplification capability, whereas in the FM mode, it has a high efficiency. For higher efficiency, it is made up of one MMIC (Monolithic Microwave Integrated Circuit) for which RF input terminal and internal interface circuit are integrated onto one IC after going through the AlGaAs/GaAs HBT (heterojunction bipolar transistor) process. The module of power amplifier is made up of an output end interface circuit including this MMIC. The maximum power that can be inputted through the input terminal is +17dBm and conversion gain is about 28dB. RF transmit signals that have been amplified through the power amplifier are sent to the duplexer and then, sent out to the cell site through the antenna in order to prevent any damages on circuits, that may be generated by output signals reflected from the duplexer and re-inputted to the power amplifier output end.

2.6. Description of Frequency Synthesizer Circuit

2.6.1 Voltage Control Temperature Compensation Crystal Oscillator(U174, VCTCXO)

The temperature range that can be compensated by U174 which is the reference frequency generator of mobile terminal is -30 ~ +80 degrees. U174 receives frequency tuning signals called TRK_LO_ADJ from MSM as 0.5V~2.5V DC via R and C filters in order to generate the reference frequency of 19.68MHz and input it into the frequency synthesizer of UHF band. Frequency stability depending on temperature is ± 2.0 ppm.

2.6.2 UHF Band Frequency Synthesizer (U172)

Reference frequency that can be inputted to U172 is 3MHz~40MHz. It is the dual mode
frequency synthesizer (PLL) that can synthesize the frequencies of UHF band 50MHz~1200MHz and IF band 20MHz~300MHz. U172 that receives the reference frequency of 19.68MHz from U174 creates 30kHz comparison frequency with the use of internal program and then, changes the frequency of 900MHz band inputted from X200 which is the voltage adjustment crystal oscillator into the comparison frequency of 30kHz at the prescaler in U172. Then, two signal differences are calculated from the internal phase comparator. The calculated difference is inputted to DC for adjusting the frequency of U174 through U172 No.2 PIN and external loop filter in order to generate UHF signals. In addition, outputs of other PIN17 are inputted into BBA after going through the VRACTOR diode and tank circuit so that the outputs of BBA internal receive end VCO are adjusted to 170.76MHz.

2.6.3 Voltage Control Crystal Oscillator (U171)

U171 that generates the LO frequency (900MHz) of mobile terminal receives the output voltage of PLL U172 and then, generates the frequency of 954MHz at 0.7V and the frequency of 980MHz at 2.7V. The sensitivity on control voltage is 23MHz/v and the output level is 1dBm(maximum). Since LO frequency signal is very important for the sensitivity of mobile terminal, they must have good spurious characteristics. U174 is -70dBc(maximum).

3. Digital/Voice Processing Part

3.1 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 receptacle part, voice processing part, mobile station modem part, memory part, and power supply part.

3.2 Configuration

3.2.2 Voice Processing Part

The voice processing part is made up of an audio codec into digital voice signals and digital voice signals into analog voice signals, amplifying part for amplifying the voice signals and sending them to the ear piece, amplifying part that amplifies ringer signals coming out from MSM3000, and amplifying part that amplifies signals coming out from MIC and transferring them to the audio processor.

3.2.3 MSM (Mobile Station Modem) 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.

3.2.4 Memory Part

The memory part is made up of a flash memory, SRAM for storing data, and EEPROM.

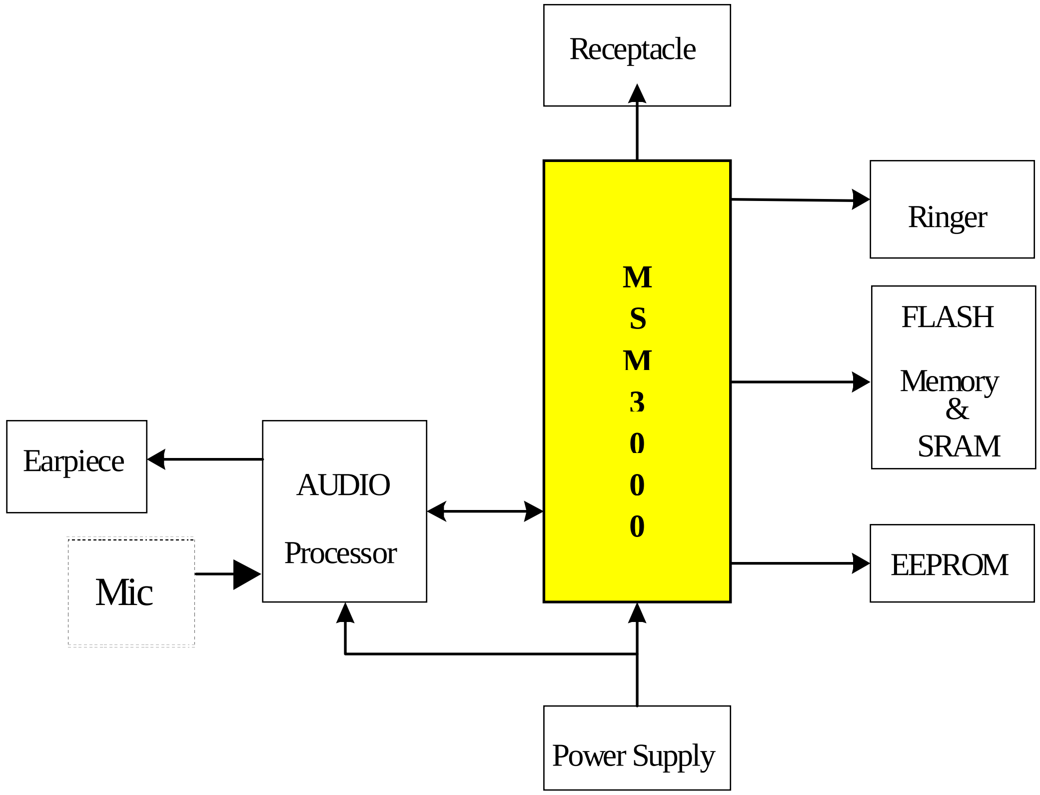
3.2.5 Power Supply Part

The power supply part is made up of circuits for generating various types of power, used for the digital/voice processing part.

+4.2V from external DC (+6V) is fed into five regulators(U605,U603,U602,U604,U606).

The five regulators produces +3.0V for the IFR3000(U204) and for Tx Parts.

3.3 Circuit Description



[Figure 3-1] Block Diagram of Digital/Voice Processing Part

3.3.2 Audio Processing Part

MIC signals are amplified through the audio codec which is U401 (TWL1103), and converted into digital signals. Then, they are inputted into MSM3000. In addition, digital audio signals outputted from MSM3000 are converted into analog signals after going through the audio codec to be amplified. and then transferred to the ear piece.

3.3.3 MSM Part

MSM3000, which is U301, is the core element of CDMA system terminal that includes ARM7TDMI microprocessor core. It is made up of a CPU, encoder, interleaver, deinterleaver, Viterbi decoder, MOD/DEM, and vocoder. MSM3000, when operated in the CDMA mode, utilizes CHIPX8 (9.8304MHz) as the reference clock that is received from IFR3000, and uses TCXO (19.68MHz) that is received from U174. 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 has a improved feature not found on the MSM2300. The MSM3000 supports Enhanced Variable Rate Coder (EVRC) operation in addition to the standard 8k and 13k vocoding rating.

3.3.4 Memory Part

Memory part consisit of Flash Memory,SRAM and EEPROM.
In the Flash Memory part included SRAM of U308 (8M x 2M bits), there are programs used for terminal operation. The programs can be changed through down loading after the assembling of terminals. On the SRAM(2Mbits), data generated during the terminal operation are stored temporarily. On EEPROM (128Kbits) which is U307, non-volatile data such as unique numbers (ESN) of terminals are stored.

3.3.5 Power Supply Part

When the External DC (4.2V) is fed to the five regulators generated +3.0V. The generated voltages are used for MSM3000, IFT3000,IFR3000, audio codec, and other LOGIC parts. PWR ASIC is operated by the control signal SLEEP/ from MSM3000 and POWER_EN signal. Q606(DTC114EE) is turned on by ON_SW_SEN
SE/ and then, 'L' is outputted on ON_SW_SENSE/. MSM receives this signal and then, recognizes that the POWER key has been pressed. During this time, MSM outputs PS_HOLD as 'H' and then, continues to activate D603 in order to maintain power even if the PWR key is separated.

3.3.6 Logic Part

The Logic part consists of internal CPU of MSM, RAM, ROM and EEPROM. The MSM3000 receives TCXO (=19.68Mz) from U7 and CHIPX8 clock signals from the IFR3000, and then controls the phone during the CDMA and the FM mode. The major components are as follows:

CPU : ARM7TDMI core

FLASH MEMORY + SRAM: U308 (LRS13061)

- FLASH ROM : 8Mbits
- STATIC RAM : 2Mbits

EEPROM : U307 (X84129S161-2.5)

- 128Kbits EEPROM

<u>CPU</u>

ARM7TDMI CMOS type 16-bit microprocessor is used and CPU controls all the circuitry. For the CPU clock, 27MHz is used.

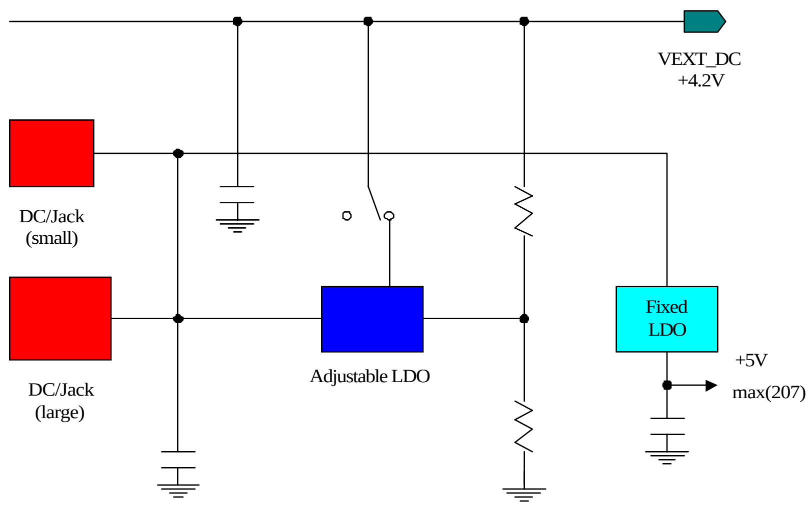
<u>FLASH ROM and SRAM</u>

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.

4. Level Translator Part

4.1 L/T supply power to Modem(4.2V).



[Fig 4-1] The Block Diagram of Source (in brief)

4.2 UART Interface

The Universal Asynchronous Receiver Transmitter (UART) communicates with serial data that conforms the RS-232 Interface protocol. The modem provides 3.0V CMOS level outputs and 3.0V CMOS switching input level. And all inputs have 5.0V tolerance but 3.0V or 3.3V CMOS logic compatible signals are highly recommended.

All the control signals of the RS-232 signals are active low, but data signals of RXD, and TXD are active high.

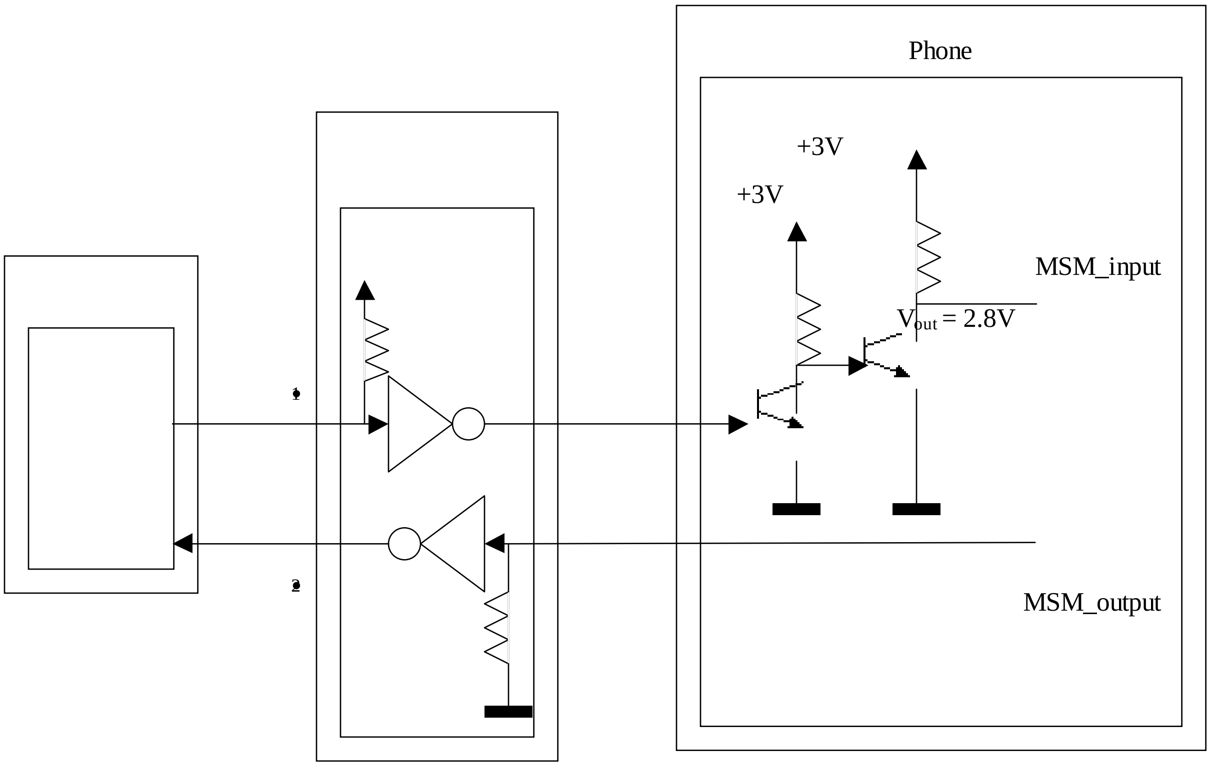
The UART has a 64byte transmit (TX) FIFO and a 64byte receive (RX) FIFO. The UART Features hardware handshaking, programmable data sizes, programmable stop bits, and odd, even, no parity. The UART operates at a 115.2kbps maximum bit rate.

4.2.1 UART Inter Pinouts

NAME	DESCRIPTION	CHARACTERISTIC
DP_DCD/	Data Carrier Detect	Network connected from the modem
DP_RI/	Ring Indicator	Output to host indicating coming call
DP_RTS/	Request to Send	Ready for receive from host
DP_TXD	Transmit Data	Output data from the modem

NAME	DESCRIPTION	CHARACTERISTIC
DP_DTR/	Data Terminal Ready	Host ready signal
DP_RXD	Receive Data	Input data to the modem
DP_CTS/	Clear to Send	Modem output signal
GND	Signal Ground	Signal ground

4.2.2 Signal level of RXD/TXD



RS232		PHONE	
TX1	RX2	TX4	RX3
V_{MAX} = 7.68V V_{MIN} = -7.68V	V_{MAX} = 6.00V V_{MIN} = -5.84V	V_{MAX} = 3.00V V_{MIN} = 0V	V_{MAX} = 4.88V V_{MIN} = 0V

[Figure 4-2] Signal Level of RXD, TXD

4.3 LED State Indication

	Name	Enable	Description
1	D17(SMS)	Low	Shot Message Service
2	D1(BUSY)	Low	State that Data transmit and receive between DTE and DCE
3	D2(IDLE)	Low	Stable State

4.4 The function of Real Audio Test(including Voice Test)

NAME	TYPE	DESCRIPSION
MIC+	I	Microphone audio input
MIC-	IS	Ear/microphone set detect
EAR	O	Ear audio output
GND_A		Audio ground

CHAPTER 4. FCC Notice

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

APPENDIX

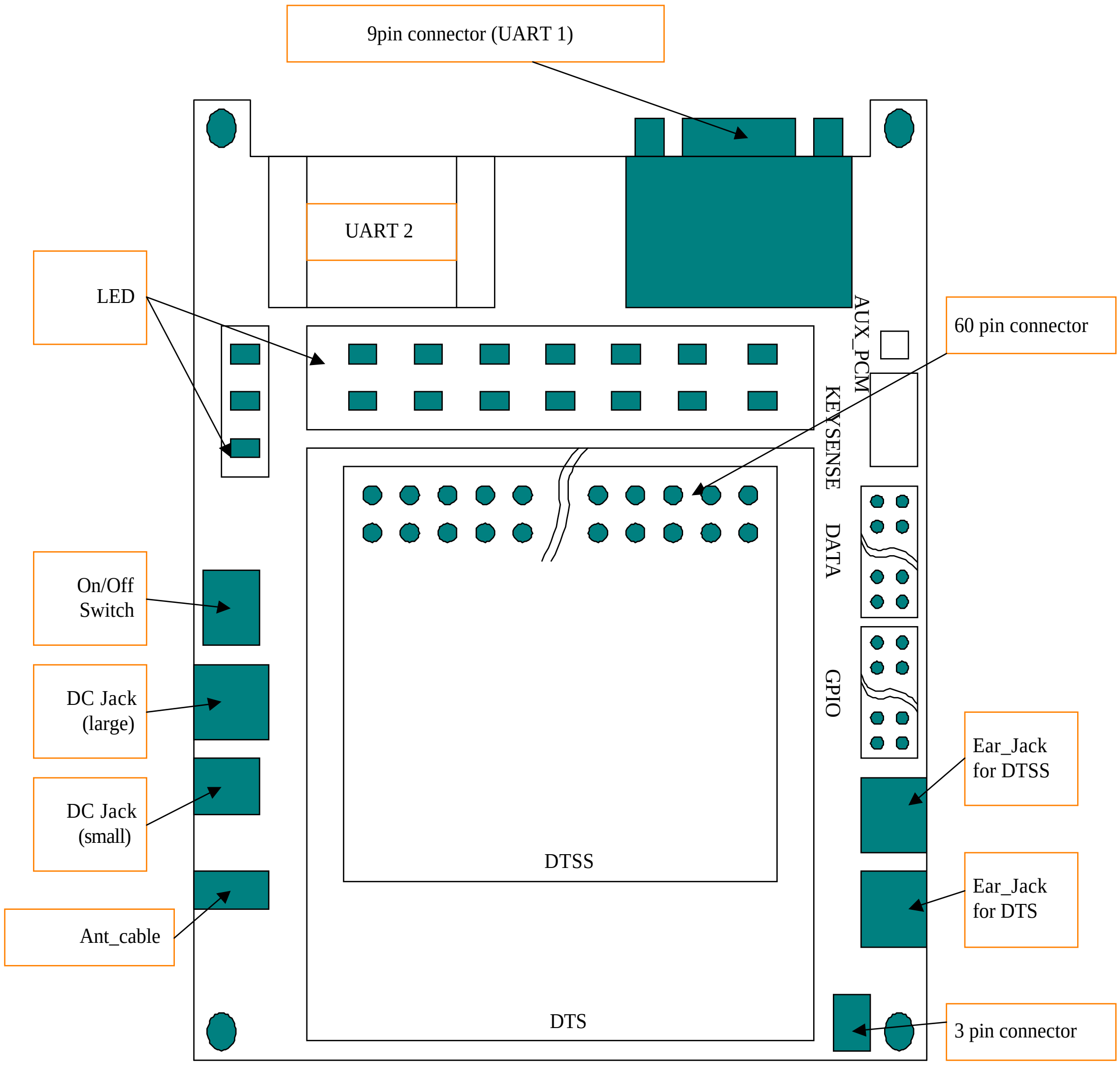
1. Assembly and Disassembly Diagram

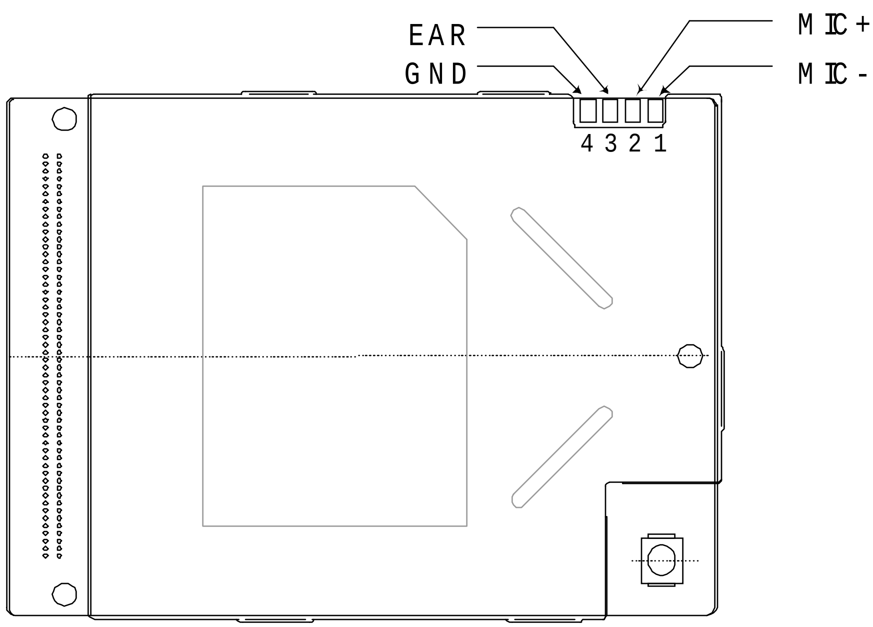
2. Block & Circuit Diagram

3. Part List

4. Component Layout

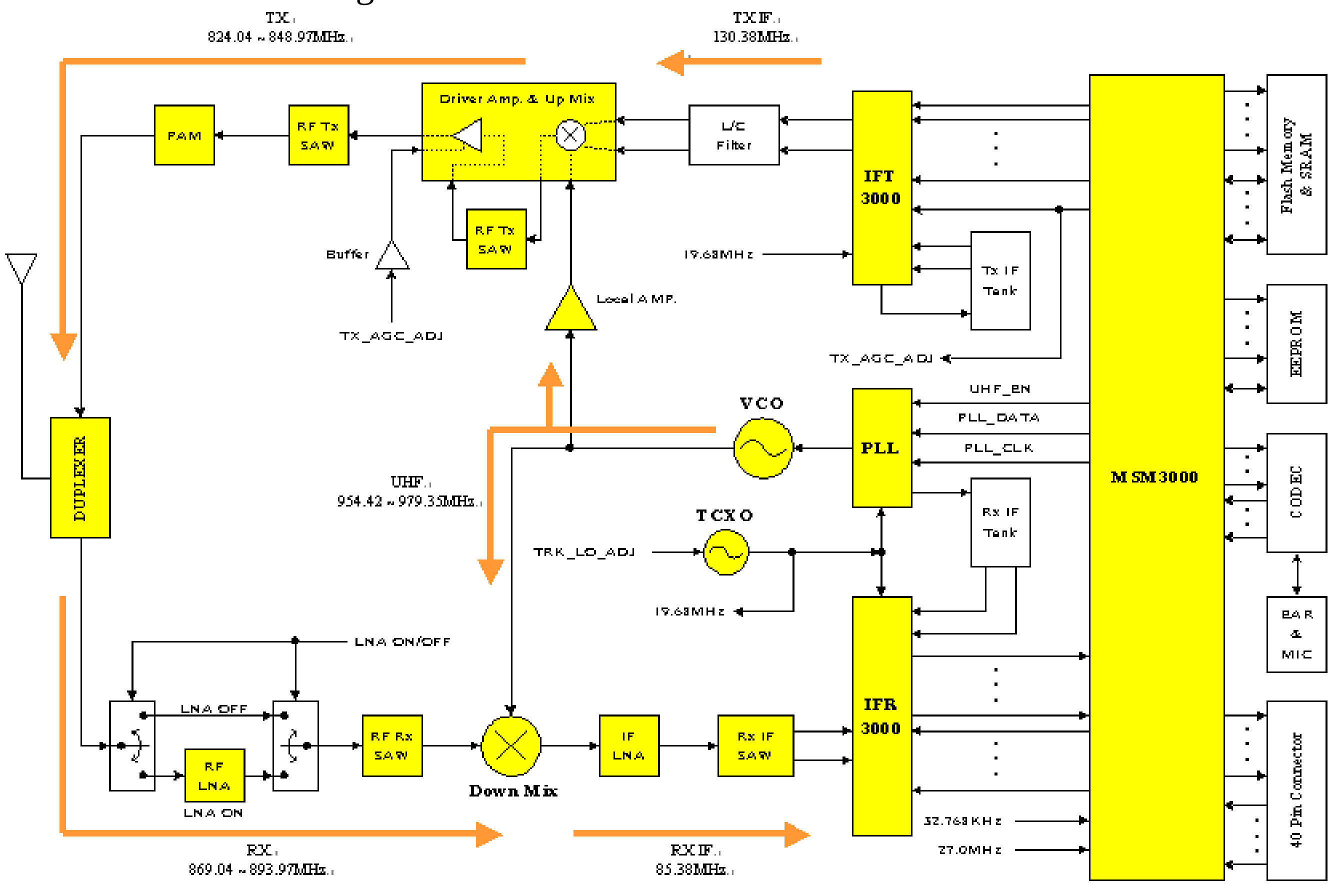
1. Assembly and Disassembly Diagram



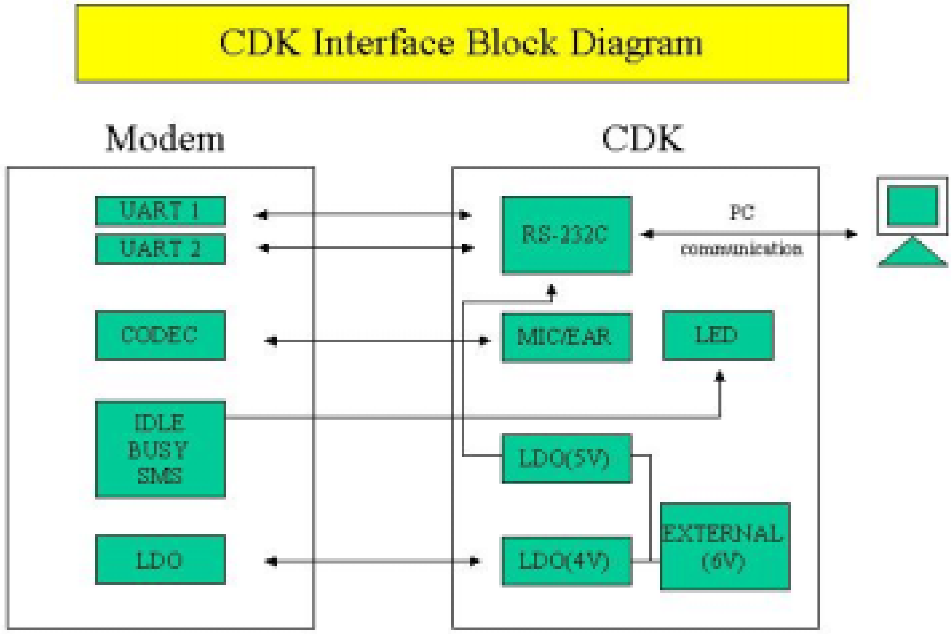


2. Block & Circuit Diagram

2.1. MODEM Block Diagram



2.2. CDK Block Diagram



3. Part List

3-1. MODEM Part List

NO	COMPONENT NAME	DESCRIPTION	Lay.	DESIGN NUMBER	Q'ty	MAKER
1	1SV273	Varactor Diode	Top	D104,D105,D203,D204	4	Toshiba
2	2SC4617	TR	Top	Q501	1	ROHM
3	2SC5006-T1	TR-IF AMP	Top	Q201	1	NEC
4	CMY210	Down Mixer	Top	U203	1	SIEMENS
5	DTC124EE	TR	Top	Q101,Q502,Q503,Q504	4	ROHM
6	DTA143EE	TR	Top	Q601	1	ROHM
7	F0805B3R00FW	Fuze	Bot	L605	1	AVX
8	FDC634P	MODFET	Top	U103	1	FAIRCHILD
9	FDDG8388A1	Duplexer	Top	F101	1	LG
10	FS0085D5	RX IF SAW	Top	F202	1	LG
11	FS0836B1	TX RF SAW	Top	F102,F103	2	LG
12	FS0881B1	RX RF SAW	Top	F201	1	LG
13	HSMP389C	Diode	Top	D201,D202	2	HP
14	IFR3000	RX AGC+BBA	Top	U204	1	QUALCOMM
15	IFT3000	TX AGC+BBA	Top	U105	1	QUALCOMM
16	KT16-DC30L-19.68M	VCTCXO	Top	U174	1	AVX
17	LMX2332-LTMG	PLL IC	Top	U172	1	NS
18	LMC7101AIM	OP AMP	Top	U151	1	MICREL
19	LRS13061	Flash + SRAM	Bot	U308	1	SHARP

20	MCA-ST-00T	Mobile Switch	Bot	MS101	1	SUNRIDGE
21	MIC5219-3.0	LDO	Bot	U605	1	MICREL
22	MIC5245-3.0BM5	LDO : +3.0V/150mA	Top	U602,U603,U606	3	RICOH
			Bot	U604	1	
23	MRFIC0954	Up MIX+Dr AMP	Top	U104	1	MOTOROLA
24	MSM3000-BGA	uBGA	Bot	U301	1	QUALCOMM
25	NC7SZ125P5	Delay Device	Bot	U306	1	FAIRCHILD
26	NDS332P	P-CH FET	Bot	Q350	1	FAIRCHILD
27	NT732ATD 683K	Thermistor	Top	TH151	1	KOA
28	RI23124U	PAM	Top	U102	1	CONEXANT
29	RF2361	LNA	Top	U201	1	RFMD
30	SSP-7T	32.768KHz OSC	Bot	X302	1	SEIKO
31	SSR27.00-BR-C15	Resonator	Bot	X301	1	AVX
32	TC7WH04FK	Invertor	Top	U202	1	TOSHIBA
33	TC7S04FU	•	Bot	U350	1	TOSHIBA
34	TWL1103-PBSR	CODEC	Bot	U401	1	TI
35	UMC4N	TR	Top	Q102,Q505	2	ROHM
36	UMH2N	TR	Bot	Q405	1	ROHM
37	UPC8151TB	Buffer	Top	U173	1	NEC
38	VC-3R0A80-0967A	VCO	Top	U171	1	FUJITSU
39	VA-A1608-5R5J	•	Bot	VD501	•	CERATECH
40	X84129S161-2.5	EEPROM	Bot	U307	1	XICOR
41	0805CS-270XGBC	27nH-2012 Coil Ind	Top	L114	1	COIL CRAFT
42	0805CS-680XGBC	68nH-2012 Coil Ind	Top	L217	1	COIL CRAFT
43	0805CS-121XJBC	120nH-2012 Coil Ind	Top	L111,L143	2	COIL CRAFT
44	0805CS-180XJBC	180nH-2012 Coil Ind	Top	L214,L215	2	COIL CRAFT
45	CI-B1608-12NKJT	1.2nH-1608 Inductor	Top	L109	1	CERATECH
46	CI-B1608-33NKJT	3.3nH-1608 Inductor	Top	L203	1	CERATECH
47	CI-B1608-68NSJT	6.8nH-1608 Inductor	Top	L105,L107,L207	3	CERATECH
48	CI-B1608-82NKJT	8.2nH-1608 Inductor	Top	L218,L211	2	CERATECH
49	CI-B1608-100JJT	10nH-1608 Inductor	Top	L106,L173	2	CERATECH
50	CI-B1608-120JJT	12nH-1608 Inductor	Top	L104,L108,L206	3	CERATECH
51	CI-B1608-150KJT	15nH-1608 Inductor	Top	L209	1	CERATECH
52	CI-B1608-680KJT	68nH-1608 Inductor	Top	L213	1	CERATECH
53	CI-B1608-820KJT	82nH-1608 Inductor	Top	L110	1	CERATECH
54	CI-B1608-101KJT	100nH-1608 Inductor	Top	L201,L202,L204,L205	4	CERATECH
55	FI-B1608-271KJT	270nH-1608 Inductor	Top	L220	1	CERATECH

56	FI-B1608-182KJT	1.8uH-1608 Inductor	Top	L112,L113	2	CERATECH
57	FI-A1608-272KJT	2.7uH-1608 Inductor	Top	L212	1	CERATECH
58	HB-1M2012-601JT	INDUCTOR (Bead)	Bot	L402	1	CERATECH
59	HB-1B2012-222JT	INDUCTOR (Bead)	Bot	L401	1	CERATECH
60	BLM11A601SPT	INDUCTOR (Bead)	Top	L115,L121,L172,L174,L190, L210,L216, L230,L602	9	CERATECH
			Bot	L604	1	
61	GRM36C0G0R5C50PT	0.5pF-1005 Capacitor	Top	C188	1	MURATA
62	GRM36C0G1R5C50PT	1.5pF-1005 Capacitor	Top	C120,C225	2	MURATA
63	GRM36C0G020C50PT	2pF-1005 Capacitor	Top	C209,C223	2	MURATA
64	GRM36C0G030C50PT	3pF-1005 Capacitor	Top	C219	1	MURATA•
65	GRM36C0G040C50PT	4pF-1005 Capacitor	Top	C144,C145,C213,C222	4	MURATA
66	GRM36C0G060C50PT	6pF-1005 Capacitor	Top	C113	1	MURATA
67	GRM36C0G070D50PT	7pF-1005 Capacitor	Top	C123,C124,C143,C147,C148	5	MURATA
68	GRM36C0G080D50PT	8pF-1005 Capacitor	Top	C237,C226,C227	3	MURATA
69	GRM36C0G100D50PT	10pF-1005 Capacitor	Top	C146,C152,C216	3	MURATA
			Bot	C323	1	
70	GRM36C0G120J50PT	12pF-1005 Capacitor	Top	C138	1	MURATA
71	GRM36COG150J50PT	15pF-1005 Cap	Top	C125	1	MURATA
			Bot	C329,C330,C302,C303	4	
73	GRM36C0G270J50PT	27pF-1005 Capacitor	Top	C190	1	MURATA
74	GRM36C0G330J50PT	33pF-1005 Capacitor	Top	C217,C220	2	MURATA
75	GRM36C0G560J50PT	56pF-1005 Capacitor	Top	C136,C137	2	MURATA
76	GRM36C0G820J50PT	82pF-1005 Capacitor	Top	C235,C236	2	MURATA
77	GRM36COG101J50PT	100pF-1005 Cap	Top	C108,C112,C114,C121,C122, C175,C177,C178, C179,C180, C187,C189,C192,C193,C197, C201,C204,C207,C208,C212, C240,C506	22	MURATA
			Bot	C407,C408	2	
78	GRM36COG471J50PT	470pF-1005 Cap	Top	C502,C504,C505,C507,C508, C509,C510, C511,C631,C632, C634	11	MURATA

			Bot	C417,C421,C501,C503,C521, C522,C523,C524,C525,C526, C527,C528,C529,C530,C531, C533,C534,C535,C536,C537, C538,C539,C540,C541,C543, C545,C546,C547,C548,C549, C550,C551,C552,C553,C554, C556,C557,C558,C559,C560, C561,C562,C563,C610,C633	45	
79	GRM36X7R102K50PT	1nF-1005 Capacitor	Top	C110,C116,C119,C172,C173, C181,C191,C195, C215	9	MURATA
80	GRM36X7R103K50PT	10nF-1005 Cap	Top	C111,C115,C127,C128,C129, C130,C134,C135,C139,C151, C171,C174,C176,C196,C203, C206,C211,C218,C221,C224, C229,C231,C232,C233,C234, C238,C243,C245,C246,C248, C312,C313,C315,C316,C317, C318,C605,C607,C612	39	MURATA
			Bot	C311,C314,C322,C324,C609, C615,C622	7	
81	GRM36X7R223K50PT	22nF-1005 Capacitor	Bot	C409	1	MURATA
82	GRM36X5R683K10PT	68nF-1005 Capacitor	Top	C155	1	MURATA
83	GRM36Y5V104Z25PT	100nF-1005 Cap	Top	C106,C126,C132,C149,C194, C239,C241,C242,C244	9	MURATA
			Bot	C309,C310,C320,C321,C401, C402,C403, C404,C405,C613	10	
84	GRM36Y5V105Z10PT	1uF-1005 Capacitor	Top	C230	1	MURATA
85	GRM39X7R183K25PT	18nF-1608 Capacitor	Top	C183	1	MURATA
86	GRM39X7R223K50PT	22nF-1608 Capacitor	Top	C185	1	MURATA
87	GRM39Y5V224Z16PT	220nF-1608 Cap	Top	C133,C182,C184	3	MURATA
			Bot	C308	1	
88	GRM39Y5V684Z25PT	680nF-1608 Cap	Top	C131	1	MURATA
			Bot	C301	1	
89	GRM39Y5V105Z10PN	1uF-1608 Cap	Bot	C413	3	MURATA
90	TA-6R3TCMS4R7M-PR	Tan Cap (4.7uF/6.3V/P)	Top	C109,C140,C186,C228,C604, C606	6	TOWA
			Bot	C608	1	

91	TA-010TCM4R7S-AR	4.7uF/10V/A	Bot	•	0	TOWA
92	TA-6R3TCMS100M-PR	Tan Cap (10uF/6.3V/P)	Top	C199,C621	2	TOWA
			Bot	C350,C406,C410,C416	4	
93	TA-010TCMS100K-AR	10uF/10V/A	Bot	C611	1	TOWA
94	TA-6R3TCMS220K-AR	22uF/10V/A	Bot	C415	1	TOWA
95	TA-6R3TCMS470K-B2	Tan Cap (47uF/6.3V/B2)	Bot	C630	1	TOWA
96	MCR01MZSJX000	0Ω 5%-1005 Resistor	Top	R121,R197,R224,R247,R248	4	ROHM
			Bot	R542,R555	2	
97	MCR01MZSJ100	10Ω-1005 Resistor	Bot	R401	1	ROHM
98	MCR01MZSJ120	12Ω-1005 Resistor	Top	R141	1	ROHM
99	MCR01MZSJ150	15Ω-1005 Resistor	Top	R170,R207	2	ROHM
100	MCR01MZSJ220	22Ω-1005 Resistor	Top	R177,R181	2	ROHM
101	MCR01MZSJ560	56Ω-1005 Resistor	Top	R208	1	ROHM
102	MCR01MZSJ101	100Ω-1005 Resistor	Top	R111,R176,R183,R201,R203	5	ROHM
103	MCR01MZSJ221	220Ω-1005 Resistor	Top	R179	1	ROHM
104	MCR01MZSJ331	330Ω-1005 Resistor	Bot	R406,R407,R408	3	ROHM
105	MCR01MZSJX471	470Ω 5%-1005 Resistor	Top	R142,R144,R204,R504,R507, R508,R519,R520	8	ROHM
			Bot	R501,R502,R521,R522,R523, R524,R525,R526,R527,R528, R529,R530,R531,R533,R534, R535,R536,R537,R538,R539, R540,R541,R543,R545,R546, R547,R548,R549,R550,R551, R552,R553,R554,R556,R557 ,R558,R559,R560,R561,R562, R563	41	
106	MCR01MZSJ751	750Ω-1005 Resistor	Bot	R306	1	ROHM
107	MCR01MZSJ821	820Ω-1005 Resistor	Bot	R338	1	ROHM
108	MCR01MZS102	1kΩ-1005 Resistor	Top	R109,R143,R171,R172,R173, R209	5	ROHM
109	MCR01MZSJ152	1.5kΩ-1005 Resistor	Bot	R317	1	ROHM
110	MCR01MZSJ182	1.8kΩ-1005 Resistor	Bot	R318	1	ROHM
111	MCR01MZSJ202	2KΩ 5%-1005 Resistor	Top	R205	1	ROHM
			Bot	R403	1	
112	MCR01MZSJ272	2.7kΩ-1005 Resistor	Top	R174,R206	2	ROHM
113	MCR01MZSJX332	3.3KΩ 5%-1005 Resistor	Top	R112	1	ROHM

			Bot	R303	1	
114	MCR01MZSJ392	3.9kΩ-1005 Resistor	Top	R175	1	ROHM
115	MCR01MZSJX472	4.7KΩ 5%-1005 Resistor	Top	R532	1	ROHM
			Bot	R304,R316,R340,R402	4	
116	MCR01MZSJ822	8.2kΩ-1005 Resistor	Top	R213	1	ROHM
117	MCR01MZSJX103	10KΩ 5%-1005 Resistor	Top	R108,R117,R118,R119,R210, R211,R505, R510,R513,R514	10	ROHM
			Bot	R301,R302,R305,R312,R313, R349,R350,R615	8	ROHM•
118	MCR01MZSJ183	18kΩ-1005 Resistor	Bot	R608	1	ROHM
119	MCR01MZSJX223	22KΩ 5%-1005 Resistor	Top	R503,R509,R512,R515	4	ROHM
			Bot	R307,R315,R614	3	
120	MCR01MZSJ363	36kΩ-1005 Resistor	Top	R114,R212	2	ROHM
121	MCR01MZSJ393	39kΩ-1005 Resistor	Top	R511	1	ROHM
122	MCR01MZSJ473	47kΩ-1005 Resistor	Bot	R405,R410	2	ROHM
123	MCR01MZSJX104	100KΩ 5%-1005 Resistor	Top	R113,R202	2	ROHM
			Bot	R421,R422	2	
124	MCR01MZSJ224	220kΩ-1005 Resistor	Top	R110,R115,R214	3	ROHM
125	MCR01MZSF2492	24.9kΩ 1%-1005 Resistor	Top	R165	1	ROHM
126	MCR01MZSF4992	49.9kΩ 1%-1005 Resistor	Top	R151	1	ROHM
127	MCR01MZSF6192	61.9kΩ 1%-1005 Resistor	Top	R116	1	ROHM
128	MCR01MZSF6802	68kΩ 1%-1005 Resistor	Top	R152	1	ROHM
129	MCR01MZSF8062	80.6kΩ 1%-1005 Resistor	Top	R164	1	ROHM
130	MCR01MZSF1003	100kΩ 1%-1005 Resistor	Bot	R404	1	ROHM
131	MCR01MZSF1743	174kΩ 1%-1005 Resistor	Top	R157	1	ROHM
132	MCR01MZSF2003	200kΩ 1%-1005 Resistor	Top	R159	1	ROHM
133	MCR01MZSF4703	470kΩ 1%-1005 Resistor	Top	R156,R158	2	ROHM
134	MCR01MZSFX1004	1MΩ 1%-1005 Resistor	Top	R166,R167	2	ROHM
			Bot	•	0	
135	DTS-800 V1.0 PCB	Main PCB	•	•	1	LGE

136	B06F-4001-016	60 Pin Connector	Top	CN501	1	SAMTEK
137	DTS800 REAR	REAR CASE			1	JUNG IL
138	DTS800 FRONT	FRONT CASE			1	JUNG IL
139	DTS800 LABEL	LABEL			1	SHINHUNG
140	DNI	•	Top	C107,C198,C202,C205,C210, L102,L103,L208,R153,R154, R155,R178,R180,R182	14	•
141	DNI	•	Bot	C305,C411,C412,C414,C542, C555,C614,C616,L403,L404, R308,R310,R314,R333,R337, R339,R409,R604,R605,R607, R612,R613,Q302, Q602,Q604, D602,D603,	27	•

3-2. Level Translator Partlist

NO	COMPONENT NAME	DESCRIPTION	Lay.	DESIGN NUMBER	Q'ty	MAKER
1	SP207-EA(24pin SSOP)	RS232 TRANSCEIVER	Bot	U1,U2	2	SIPEX
2	MIC29150-5.0BU	LDO (5V)	Bot	U4	1	MICREL
3	EZ1086CM	LDO (Adjustable)	Bot	U3	1	SEMTECH
4	HDEP-9P	9 PIN CONN.(ANGLE TYPE)	Top	CN4,CN5	2	HIROSE
5	CON60_1.27_3	60 PIN CONN. (MALE)	Top	CN1	1	SKY
6	HSJ1621-019011	EAR JACK	Top	U5,U15	2	HOSIDEN
7	MCA R/A TO MCX R/A	ANT_CABLE	Top	U7	1	KUKJE CON.
8	DC JACK(Large)	DC POWER JACK(large)	Top	J1	1	KUKJE CON.
9	DC JACK(Small)	DC POWER JACK(small)	Top	J2	1	KUKJE CON.
10	53047-0310	3 PIN CONN	Top	CN10	1	KUKJE CON.
11	Toggle 2p S/W	SWITCH	Top	SW1	1	KUKJE CON.
12	UMT2907A	TR(PNP)	Bot	Q1,Q2, Q3	3	ROHM
13	MB-S800	ANTENNA	-		1	HANKOOK ANT
14	SML-310MTT86	LED GREEN	Bot	D4,D6,D8,D10,D12,D14,D16	7	ROHM
15	SML-310YTT86	LED YELLOW GREEN	Bot	D3,D5,D7,D9,D11,D13,D15	7	ROHM
16	SML-310LTT86	LED RED	Bot	D1,D2, D17	3	ROHM
17	595D107X0016C2T	TANTAL CAP. (100UF/16V)	Bot	C10,C11	2	VISHAY
18	595D227X0010T2T	TANTAL CAP. (220UF/10V)	Bot	C9	1	VISHAY
19	TA-035TCMR10M-AR	TANTAL CAP. (0.1UF/35V)	Bot	C1~C8	8	TOWA
20	MCR03MZSJX102	RESISTOR(1608) 1K	Bot	R7~R13	7	ROHM

21	MCR04MZSJX101	RESISTOR (1608) 100R	Bot	R3,R4,R14,R16,R17,R18	6	ROHM
22	MCR05MZSJX331	RESISTOR (1608) 330R	Bot	R5	1	ROHM
23	MCR06MZSJX681	RESISTOR(1608) 680R	Bot	R6	1	ROHM
24	MCR07MZSJX332	RESISTOR (1608) 3.3K	Bot	R1,R2,R15	3	ROHM