Kyocera 200 Module Data Book

82-M8862-1, Rev. 003

1 February, 2005

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KYOCERA WIRELESS CORP.
10300 CAMPUS POINT DRIVE
SAN DIEGO, CA 92121

82-M8862-1, Rev. 003

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Contents

Caution !

The Kyocera 200 is an Electrostatic Discharge Sensitive (ESDS) product.

To protect the Kyocera 200 Module from electrostatic discharge, it must be completely enclosed with protective conductive packaging during storage and handling. Prior to opening the protective packaging, the part must be placed on a conductive workstation surface to dissipate any charge that has built up on the packaging.

Once the Kyocera 200 Module has been removed from its protective packaging, it must be handled by an operator grounded through a conductive wrist strap or foot strap to ensure the Module is not subjected to electrostatic discharge.

1 Kyocera Wireless Corp.

Introduction

Kyocera Wireless Corp. (KWC) is a wholly-owned subsidiary of Kyocera International, Inc. (KII), the North American headquarters and holding company of Kyocera Corporation. KII established Kyocera Wireless Corp. after acquiring QUALCOMM Incorporated's consumer wireless phone business in February 2000. KWC incorporates QUALCOMM's CDMA technology in developing, manufacturing, and marketing innovative wireless communications products for a wide range of markets and applications.

Kyocera Corporation background

Kyocera Corporation, the parent and global headquarters of the Kyocera Group, was founded in 1959 as a producer of advanced ceramics. By combining these engineered materials with metals and plastics, and integrating them with other technologies, Kyocera has become a leading supplier of telecommunications equipment, semiconductor packages, electronic and automotive components, cameras, laser printers, copiers, solar energy systems, and industrial ceramics. Approximately 80 percent of Kyocera's revenue is currently derived from products that are telecommunications- or information-related. In the year ended March 31, 2002, Kyocera Corporation's consolidated net sales totaled 1035 billion yen (US$7.8 billion) with net income of 32 billion yen (US$240 million). Kyocera Corporation has been recognized by *Industry Week* magazine as one of "The World's 100 Best-Managed Companies."

Kyocera Wireless Corp. CDMA consumer products

Kyocera Wireless Corp. is one of the world's largest manufacturers of CDMA digital subscriber equipment, and continues to set the industry standard for high-quality CDMA digital phones. KWC handsets feature a tremendous range of advanced communications capabilities beyond voice calling. All Kyocera handsets are fundamentally designed as data devices. Unlike handsets based on other technologies, Kyocera handsets are constructed to receive, process, and transmit data in its purest format, completely bypassing the use of the vocoder required for conversion of audio voice signals to binary codes, and maximizing the unit's data processing speed and efficiency. Voice calling, in fact, is more accurately seen as just one of many data services that the handsets are designed to support. Kyocera offers quick, cost-effective, and reliable wireless data solutions for mobile phones. Leading the way with new information services tailored to wireless users, the Kyocera brand is becoming synonymous with wireless data innovation. All KWC products are designed with the usage patterns and needs of the end user in mind.

2 CDMA and Cellular Fundamentals

CDMA

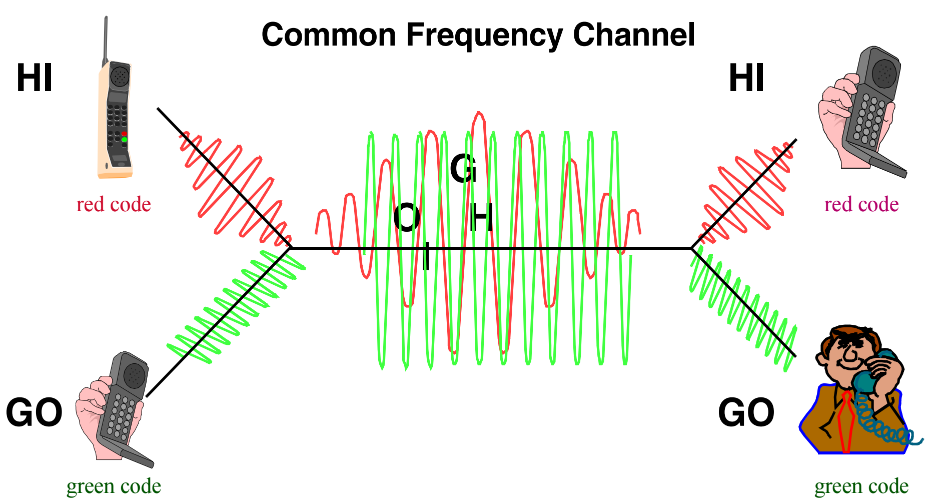
CDMA uses 1.23 MHz per channel. This means all users can transmit at the same time, relying on codes to differentiate the users. CDMA also uses sectored cells to increase capacity, like in the advanced mobile phone service (AMPS), but CDMA can use one frequency in all sectors of the cell instead of following a frequency reuse scheme.

CDMA uses correlative codes to let each user operate under substantial interference. For example, in a crowded cocktail party, people are talking at the same time but you are able to listen and understand only one person at a time. This is because your brain can sort out the voice characteristics of the one with whom you are speaking and differentiate that voice from the others. As the party grows larger, each person must talk louder and the size of the talk zone grows smaller. Thus the number of conversations is limited by the overall noise interference in the room.

CDMA is similar to this cocktail party analogy, but the recognition is based on digital codes. The interference is the sum of all other users on the same CDMA frequency, both from within and outside the home cell and from delayed versions of these signals. It also includes the usual thermal noise and atmospheric disturbances. Delayed signals caused by multipath are separately received and combined in CDMA.

CDMA cocktail party example

How CDMA works



Cellular frequency reuse patterns

One of the major capacity gains with CDMA is from its frequency reuse efficiency. To eliminate interference from adjacent cells, narrowband FM systems must physically separate cells using the same frequency. Complex frequency reuse planning must be done in such a system to maximize capacity while eliminating interference. A reuse pattern for analog and time division multiple access (TDMA) systems employs only one-seventh of the available frequencies in any given cell. With CDMA, the same frequencies are used in *all* cells and can be used in all sectors of all cells.

This reuse is possible because CDMA is designed to decode the proper signal in the presence of high interference. Adjacent cells using the same frequency in CDMA simply cause an apparent increase in the channel background noise. By allowing the use of the same frequencies in every cell, CDMA has approximately six times the capacity of existing analog cellular systems.

CDMA concept

CDMA starts with a narrowband signal. Through specialized codes this spreads to a bandwidth of 1.23 MHz. The ratio of the spread data rate to the initial data rate is called the processing gain. For IS-95 standard CDMA with an 8 kbps vocoder, the processing gain is 21 dB. When transmitted, a CDMA signal experiences high levels of interference dominated by the coded signals of other CDMA users. This takes two forms:

- Interference from other users in the same cell
- Interference from adjacent cells

The total interference also includes background noise and other spurious signals.

When the signal is received, the correlator recovers the desired signal and rejects the interference. The correlators use the processing gain to pull the desired signal out of the noise. Since a signal-to-noise ratio of 7 dB is required for acceptable voice quality, this leaves 14 dB of extra processing gain to extract the desired signal from the noise. This is possible because the interference sources are uncorrelated (orthogonal in the case of the forward link).

CDMA versus analog FM

CDMA channels are defined by various digital codes as well as by frequency.

The capacity for CDMA is soft, not rigid. In analog systems, when all available channels are in use, no further calls can be added. Capacity in CDMA can be increased with some degradation of the error rate or voice quality, or can be increased in a given cell at the expense of reduced capacity in the surrounding cells.

Another advantage of CDMA is the use it makes of diversity. There are three types of diversity:

- Spatial diversity
- Frequency diversity
- Time diversity

Spatial diversity

Spatial diversity takes two forms:

- Two antennas

  The base station uses two receive antennas for greater immunity to fading.

  This is the classical version of spatial diversity. AMPS analog cellular base stations use this type of diversity for improved fading resistance.

- Multiple base stations

  Multiple base stations simultaneously talk to the mobile phone during soft handoff.

Frequency diversity

Frequency diversity is inherent in a spread-spectrum system. A fade of the entire signal is less likely than with narrowband systems. Fading is caused by reflected images of an RF signal arriving at the receiver such that the phase of the delayed (reflected) signal is 180° out of phase with the direct RF signal.

Since the direct signal and the delayed signals are out of phase, they cancel each other, causing the amplitude seen by the receiver to be greatly reduced. In the frequency domain, a fade appears as a notch and is on the order of one over the difference in the arrival time of two signals. For a 1 μsec delay, the notch is approximately 1 MHz wide.

The Telecommunications Industry Association (TIA) CDMA system prescribes a 1.23 MHz bandwidth, so only those multipaths of time less than 1 μsec actually cause the signal to experience a deep fade. In many environments, the multipath signals arrive at the receiver after a much longer delay, causing only a narrow portion of the signal to be lost. In a fade 20 to 200 kHz wide, this results in the complete loss of an analog or TDMA signal but only reduces the power in a portion of a CDMA signal. As the spreading width of a CDMA signal increases, so does its multipath fading resistance.

Time diversity

Time diversity is a technique common to most digital transmission systems. Signals are spread in time through interleaving. Interleaving the data improves the performance of the error correction by spreading errors over time.

Errors in the real world during radio transmission usually occur in clumps, so when the data is de-interleaved, the errors are spread over a greater period of time. This allows the error correction to fix the resulting smaller, spread-out errors. Forward error correction is applied, along with maximal likelihood detection. The particular scheme used for CDMA is convolutional encoding in the transmitter with Viterbi decoding using soft decision points in the receiver.

Another form of time diversity occurs in the base station when transmitting at reduced data rates. When transmitting at a reduced data rate, the base station repeats the data resulting in full rate transmission. The base station also reduces the transmitted power when it operates at reduced data rates. This added redundancy in the transmitted signal results in less interference (power is lowered) and improves the CDMA mobile station receiver performance during high levels of interference.

Synchronization

For any direct sequence spread spectrum radio system to operate, all mobiles and base stations must be precisely synchronized. If they are not synchronized, it becomes nearly impossible to recover the codes used to identify individual radio signals. Precise synchronization also leads to other benefits:

- It allows such services as precise location reporting for emergency or travel usage.
- It allows the use of rake receivers for improved reception in multipath fading conditions.

Rake receiver

Instead of trying to overpower or correct multipath problems, CDMA takes advantage of the multipath to provide improved reception quality. CDMA does this by using multiple correlating receivers and assigning them to the strongest signals. This is possible because the CDMA mobile is synchronized to the serving base station. The mobile receiver can distinguish between direct and reflected (multipath) signals because of the time delay in receiving the reflected signals.

Special circuits called searchers are also used to look for alternate multipaths and for neighboring base station signals. The searchers slide around in time until they find a strong correlation with their assigned code. Once a strong signal is located at a particular time offset, the search assigns a receiver element to demodulate that signal. The mobile receiver uses three receiving elements, and the base station uses four. This multiple correlator system is called a rake receiver.

As conditions change, the searchers rapidly reassign the rake receivers to handle new reception conditions. While each signal being processed by an individual rake receiver experiences fading, the fades are independent because different path lengths are experienced by each signal. Thus the receiver can coherently recombine the outputs of the three rake receivers to reconstruct a much more robust version of the transmitted signal. In this way, CDMA uses multipath signals to create a more robust receiver. The rake receivers also allow soft handoff as one or more receivers can be assigned to another base station.

There are some limitations to this scheme. If strong, short transmission paths are present, such as in a very narrow canyon, the rake receiver system cannot function. If the arrival time of a multipath signal is less than one clock cycle of the CDMA system, the rake receiver cannot tell the difference between direct and reflected signals. It has been found, however, that in real world situations longer time-delayed signals coexist when very strong short multipath signals are present. This allows the searchers to find these other longer delayed signals under these difficult propagation conditions.

CDMA reverse link power control

One of the fundamental enabling technologies of CDMA is power control. Since the limiting factor for CDMA system capacity is the total interference, controlling the power of each mobile is critical to achieve maximum capacity. CDMA mobiles are power controlled to the minimum power that provides acceptable quality for the given conditions. As a result, all mobile signals arrive at the base station at approximately equal levels. In this way, the interference from one unit to another is held to a minimum.

Two forms of power control are used for the reverse link:

- Open loop power control
- Closed loop power control

Open loop power control

Open loop power control is based on the similarity of the loss in the forward path to the loss in the reversed path. (Forward refers to the base-to-mobile link, while reverse refers to the mobile-to-base link.)

Open loop power control sets the sum of transmit power and receive power to a constant, nominally -73 dBm (IS-98-A). A reduction in signal level at the receive antenna results in an increase in signal power from the transmitter. For example, when the received power from the base station is -85 dBm, this is the total energy received in the 1.23 MHz receiver bandwidth. It includes the composite signal from the serving base station as well as from other nearby base stations on the same frequency.

The open loop transmit power setting for a received power of -85 dBm would be +12 dBm. By the IS-98 specification, the open loop power control slew rate is limited to match the slew rate of closed loop power control directed by the base station. This eliminates the possibility of a sudden transmission of excessive power by the open loop power control in response to a receiver signal-level dropout.

Closed loop power control

Closed loop power control is used to allow the power from the mobile unit to deviate from the nominal as set by open loop control. This is done with a form of delta modulation. The base station monitors the power received from each mobile station and commands the mobile to either raise power or lower power by a fixed step of 1 dB. This process is repeated 800 times per second, or every 1.25 msec.

The power control data sent to the mobile from the base station is added to the data stream by replacing the encoded voice data. This process is called “puncturing” because the power control data is written into the data stream by overwriting the encoded voice data. The power control data occupies 103.6 μsec of each 1.25 msec of data transmitted by the base station.

Because the mobile’s power is controlled no more than is needed to maintain the link at the base station, a CDMA mobile typically transmits much less power than an analog phone. The base station monitors the received signal quality 800 times per second and directs the mobile to raise or lower its power until the received signal quality is adequate. This operating point varies with propagation conditions, the number of users, and the density and loading of the surrounding cells.

Analog cellular phones must transmit enough power to maintain a link even in the presence of a fade. Analog phones usually transmit excess power. CDMA radios are controlled in real time and kept at a power level that maintains a quality transmission based on the changing RF environment. The benefits include longer battery life and smaller, lower cost amplifier design.

Mobile power bursting

Each 20 msec frame in IS-95 is divided into 16 power control groups. When the mobile transmits, each power control group contains 1536 data symbols (chips) at a rate of 1.2288 Mbps. When the vocoder moves to a lower data rate, the CDMA mobile bursts its output by sending only the appropriate number of power control groups. For example, transmitted groups are randomized to spread the transmitted power over time. For each lowering of the data rate, the transmitted power is reduced by 3 dB.

CDMA system time

As mentioned earlier, both mobiles and base station in direct sequence CDMA must be synchronized. In the IS-95 system, synchronization is based on the Global Positioning System (GPS) time. Each CDMA base station incorporates a GPS receiver to provide exact system timing information for the cell. The base station then sends this information to each mobile via a special channel. In this manner, all radios in the system can maintain near-perfect synchronization.

Most designs also include atomic clocks to provide a backup timing reference. These are capable of maintaining synchronization for up to several hours. The GPS clock used for CDMA system time is then used to drive the long code pseudo-random sequence generator.

Closed loop power control puncturing

Once the data has been scrambled with the user-specific long code, the closed loop power control data is then punctured into the data stream. Power control bits are sent every 1.25 msec—once in every power control group (a CDMA frame is 20 msec, with each frame having 16 1.25 msec power control groups).

Since the power control bits replace the encoded voice data, holes (missing data) are introduced into the data stream from the receiver's point of view. These holes are accepted and the system uses the Viterbi decoder in the receiver to restore the data lost by puncturing. The recovery of the missing data uses some of the available processing gain in the system. The resulting loss of capacity has been accounted for in the system's design.

Another way to think of this is that slightly more power is required to maintain the link because of the missing data introduced by the power control puncturing. The power control data is sent only once in the 14.4 kbps case since the reduced processing gain results in higher power being transmitted from the base station to maintain an acceptable signal-to-noise ratio. The higher power results in a much lower symbol error rate and the need to send the power control data twice is eliminated.

Walsh code spreading

In the forward channel (cell-site-to-mobile), the Walsh codes provide a means for uniquely identifying each user. A Walsh code generator provides 1 of the 64 codes to scramble the encoded voice data.

- Walsh code 0 = pilot channel
- Walsh code 32 = synchronous channel
- Walsh code 1 to 7 = paging channels
- Other Walsh codes = forward paging channel

Respreading the short sequence

If all cells used the same 64 Walsh codes without another layer of scrambling, the resulting interference would severely limit the system capacity.

Since all cells can use the same frequency (frequency domain), and all cells use the same Walsh codes (code domain), the only other means to allow cells to reuse the same Walsh codes is by using time offset (time domain). This final layer of scrambling uses another code called the short code to allow reuse of the Walsh codes and to provide a unique identifier to each cell.

Because everything in CDMA is synchronized to system time, it is possible to have each cell site identified by using a time offset in the short sequence. These "PN offsets" are separated by multiples of 64 1.2288 Mbps clock chips. This allows for 512 unique time offsets for cell identification (32768 bits/64 bits = 512 offsets). By scrambling the Walsh encoded channels with the short code, each base station can reuse all 64 Walsh codes and be uniquely identified from other adjacent cells using the same frequency.

Forward link channel format

The base station transmitter signal is the composite of many channels (with a minimum of four). The pilot channel is unmodulated (Walsh code 0); it consists of only the final spreading sequence (short sequences). The pilot channel is used by all mobiles linked to a cell as a coherent phase reference and also provides a means for mobiles to identify cells from each other. The other three channels are:

- Sync channel
- Paging channel
- Traffic channel

These channels use the same data flow, but different data are sent on each channel.

Sync channel

The sync channel transmits time-of-day information. This allows the mobile and base to align clocks, which form the basis of the codes that are needed by both to make a link. Specifically, one message sent by the sync channel contains the state of the long code feedback shift registers 320 msec in the future. By reading this channel, the CDMA mobile can load the data into its long code generator, and then start the generator at the proper time. Once this has been accomplished, the CDMA mobile has achieved full synchronization. The sync channel always uses Walsh code channel 32.

Paging channel

The paging channel is the digital control channel for the forward link. Its complement is the access channel, which is the reverse link control channel. One base station can have multiple paging channels and access channels if needed. Up to seven Walsh code channels can be allocated for use as paging channels. The first paging channel is always assigned to Walsh code 1. When more paging channels are required, Walsh codes 2 through 7 are used.

Traffic channel

The traffic channel is equivalent to the analog voice channel. This is where actual conversation takes place. The remaining Walsh codes are assigned to traffic channels as required. At least 55 Walsh codes are available for use as traffic channels. The actual number that can be used is determined by the total interference levels experienced in any given cell. Nominal full loading would typically be around 30 traffic channels in use for equally loaded cells.

Once all of the various channels are Walsh modulated, they are converted into I/Q format, re-spread with the I and Q short sequences, low pass filtered to reduced occupied bandwidth, and converted into analog signals. The resulting analog I and Q signals from all channels are summed together and then sent to the I/Q modulator for modulation into an RF carrier.

CDMA reverse link physical layer

The CDMA reverse link uses a different coding scheme to transmit data. Unlike the forward link, the reverse link does not support a pilot channel for synchronous demodulation (since each mobile station would need its own pilot channel). The lack of a pilot channel is partially responsible for the reverse link's lower capacity than the forward link. In addition, Walsh codes cannot be used for channelization since the varying time delays from each mobile to the base station destroys the orthogonality of the Walsh codes. (Varying arrival time makes the Walsh codes non-orthogonal.)

Since the reverse link does not benefit from non-interfering channels, this reduces the capacity of the reverse link when compared to the forward link (all mobiles transmitting interfere with each other). To aid reverse link performance, the 9600 bps voice data uses a one-third (1/3) rate convolutional code for more powerful error correction. For the 14,400 bps vocoder, the convolutional encoder is only a half rate encoder that doubles the data rate. Thus the data rate coming out of the convolutional encoder is the same for either the 9.6 or 14.4 Kbps voice channels. Then, six data bits at a time are taken to point at one of the 64 available Walsh codes. The data, which is at 307.2 Kbps, is then XOR'ed with the long code to reach the full 1.2288 Mbps data rate. This unique long code is the channelization for the reverse link.

Reverse error protection

To improve the performance of the reverse link, a more powerful convolution encoder is used. The third-rate encoder used in the reverse link outputs three 9600 bps data streams when driven with a single 9600 data stream. This provides increased error correction capability, but also increases the data rate to 28,800 bps.

64-ary modulation

Walsh codes are not used to provide the channelization in the reverse link. In the reverse link they are used to randomize the encoded voice data with a modulation format that is easy to recover. Each six serial data bits output from the convolutional encoder are used to point to one of the 64 available Walsh codes (26 = 64). This modulation has the effect of increasing the data rate 10.67 times to 307 Kbps. As the incoming voice data changes, a different Walsh code is selected. Since this type of modulation can output one of 64 possible codes, it is referred to as 64-ary modulation.

Reverse channel long code spreading

The channelization in the reverse link must provide for unique code assignments for each operational phone. Walsh codes could not be used for the reverse channelization, since they would not provide enough unique channels. Since the long code is 42 bits in length, this allows 242 (4.3 billion) unique channel assignments. Thus the long code imprinted with your unique mask is used to provide the channelization in the reverse link. This allows all mobiles in even very large systems to have unique channel assignments. Since the long codes are simply uncorrelated and not orthogonal to each other, the recovery and demodulation process is more difficult for CDMA base stations. The high-speed searcher circuits in the base station let it quickly search over the wide range of long codes to lock on a particular user's signal. These modules represent a good design trade-off, since it is more feasible to design complex hardware/software into a base station than into a mobile phone.

Reverse channel short sequence spreading

CDMA mobiles use the same pseudo-random number (PN) sequences as the base for final short sequence scrambling. An extra one half period clock delay in the mobile's Q channel produces offset quadrature phase shift keying (QPSK) modulation rather than straight QPSK modulation. Thus mobiles can use a simpler and more efficient power amplifier design. Offset QPSK modulation prevents the signal from going to zero magnitude and greatly reduces the dynamic range of the modulated signal. Less costly amplifiers can be used on CDMA mobiles because of the reduced linear dynamic range obtained with offset QPSK modulation.

CDMA turn-on process

System access

When the mobile is first powered on, it must find the best base station. This is similar to analog, where the phone scans all control channels and selects the best one. In CDMA, the mobile unit scans for available pilot signals, which are all on different time offsets. This process is made easier because of the fixed nature of these offsets.

The timing of any base station is always an exact multiple of 64 system clock cycles (called chips) offset from any other base station. The mobile selects the strongest pilot tone and establishes a frequency and time reference from this signal. The mobile then demodulates the sync channel, which is always on Walsh code 32. This channel provides master clock information by sending the state of the 42 bit long code shift register 320 ms in the future. Once the mobile has read the sync channel and established system time, the mobile uses the parameters from the sync channel to determine the long code mask being used by the cell site it is acquiring.

Sync channel message

The sync channel messages contains:

- CDMA protocol revision supported by the cell site
- Minimum protocol revision supported by a CDMA mobile to work with the cell site

- System and network identification numbers for the cell site
- PN offset of the cell site
- Paging channel data rate
- Timing parameters – including such items as local time offset from system time and a flag for indicating if daylight savings time is active in the area

Read the paging channel

At this point the mobile demodulates the paging channel and decodes all of the data contained in the various messages supplied on the paging channel. If required by the parameters on the paging channel, the phone then registers with the base station. If the phone is a slotted mode phone, it must first register with the base station before it can be paged.

The slotted paging channel mode lets the phone save power by going to sleep and only awakening when it is time to check for a page from the base station. During registration, the time slot for the phone to wake up and listen is negotiated between the base and mobile. Once this is completed, the phone is ready to place or receive phone calls.

Paging channel messages

The paging channel is the heart of a CDMA base station. All parameters and signaling necessary for the proper operation of a CDMA cell site are handled by the paging channel. The paging channel supports a number of distinct messages that provide information and send messages.

The system parameters message provides the mobile with system information such as the network, system and base station identification numbers, the number of paging channels supported, registration information, and the soft handoff thresholds.

The access parameters message provides information to the mobile that dictates the behavior of access probes when a CDMA mobile initiates a call.

The neighbor list message tells the mobile that the PN offsets of surrounding cell sites may become likely candidates for soft handoffs.

The CDMA channel list reports the number of CDMA frequencies supported by the cell site as well as the configuration of surrounding cell sites.

The slotted and non-slotted page messages lets the cell site page CDMA phones for incoming calls. CDMA mobiles operating in the slotted mode must first register with the cell site before they can be paged. This registration is required to establish which slot is used by the cell site to transmit the page to the mobile.

The channel assignment message is used to communicate the information needed to get the mobile onto a traffic channel.

Other supported messages on the paging channel include various types of signaling messages and authentication.

CDMA idle state handoff

The mobile has searchers scanning for alternative pilot channels at all times. If a pilot channel is found from another base station that is strong enough for a link, the mobile requests a soft handoff if it crosses into a new zone. In this case, the CDMA cells must have commanded the CDMA mobile to perform zone-based registration to reregister the phone.

CDMA call initiation

Keying in a phone number and pressing the Send key initiates an access probe. The mobile uses a special code channel called the access channel to make contact with the cell site. CDMA mobiles can transmit two types of channels on the single physical channel provided by the reverse link. These two channels are distinguished by the types of coding used.

The access channel is used by the mobile to initiate calls. The other possible channel is the traffic channel, which is used once a call is established. The long code mask used for access probes is determined from parameters obtained from the sync and paging channels. The parameters are the access channel number, the paging channel number, the base station ID, and the pilot PN offset used by the base station.

Before a link is established, closed-loop power control is not active. The mobile uses open-loop control to estimate an initial level. Multiple tries are allowed, with random times between the tries to avoid collisions that can occur on the access channel. For each cell site there is also a limited number of supported access channels, again to reduce the odds of collisions because of the limited number of access channel receivers in the base station.

CDMA call completion

After each access attempt, the mobile listens to the paging channel for a response from the base station. If the base station detects the access probe from the mobile, it responds with a channel assignment message. This message contains all of the information required to get the mobile onto a traffic channel. This message includes such information as the Walsh code channel to be used for the forward traffic channel, the frequency being used, and the frame offset to indicate the delay between the forward and reverse links.

Once the mobile has acknowledged the channel assignment message, the base station initiates the land link and the mobile moves from the access channel to the traffic channel. To accommodate signaling, IS-95 supports two methods for temporarily grabbing the traffic channel:

- Blank and burst signaling
- Dim and burst signaling

Both are similar except that the blank and burst steals a contiguous block of frames to transmit signaling messages, while dim and burst reduces the vocoder rate and then uses the remaining traffic channel time to more slowly send signaling messages.

AMPS cellular overview

The cellular radio frequency spectrum has been divided by the Federal Communications Commission (FCC) into two equal segments or bands to allow two independent cellular carriers to coexist and compete in the same geographic coverage area. Each band occupies one half of the available channels in the cellular spectrum. Initially, there are 832 channels.

To guarantee nationwide compatibility, the signaling channel frequencies have been preassigned to each segment (band). The two bands and their assigned channels are defined as follows:

A Band	**Channels**
Primary Control Channels (21):	313 - 333
Secondary Control Channels (21):	688 - 708
Voice Channels (395):	001 - 312, 667 - 716, and 991 - 1023

B Band	**Channels**
Primary Control Channels (21):	334 - 354
Secondary Control Channels (21):	737 - 757
Voice Channels (395):	355 - 666 and 717 - 799

Control (data) channels

A cellular telephone in the cellular system is under the indirect control of the switch, or central controller. The central controller uses dedicated control channels to provide the signaling required to establish a telephone call. Control channels are used to send and receive only digital data between the base station and the cellular telephone.

Voice channels are used for both audio and signaling once a call is established. The 21 control channels in each band may be dedicated according to access and paging channels. The data on the forward control channel generally provides some basic information about the particular cellular system, such as the system ID and the range of channels to scan to find the access and paging channels.

Access channels are used to respond to a page or originate a call. The system and the cellular telephone use access channels where two-way data transfer occurs to determine the initial voice channel.

Paging channels, if used, are the normal holding place for the idle cellular telephone. When a call is received at the central controller for a cellular telephone, the paging signaling occurs on a paging channel.

In many systems both control channel functions are served by the same control (access) channel for a particular cell. Only in very high density areas is multiple control (paging) channels required.

Voice channels

Voice channels are primarily used for conversation, with signaling being employed as necessary to handle cell-to-cell handoffs, output power control of the cellular radio-telephone, and special local control features. Data from the cell site (known as FORWARD DATA) and data from the mobile or portable (known as REVERSE DATA) is sent using frequency shift keying. In AMPS signaling, various control and response tones are used for a variety of applications to be described later.

Signaling protocol

In 1983, when the Federal Communications Commission (FCC) licensed cellular telephony, the signaling protocol used was AMPS. The AMPS signal protocol, an invention of Bell Labs, was ultimately adopted by all governments in the western hemisphere and eventually several other governments throughout the world.

Under the original AMPS protocol there were 21 control channels assigned to each of two possible carriers in any metropolitan area, with a total of 333 channels assigned to each carrier. Prior to 1987 the FCC had allocated 312 channels to voice (voice, DTMF, or data) applications for each carrier. In 1987 the FCC expanded the cellular spectrum (Expanded Spectrum) from a total of 666 channels to 832 channels, allowing for an increase of 83 voice channels for each carrier. But the number of control channels remained constant, with 21 control channels for each carrier. Each control channel had a bandwidth of 30 kHz and used the signaling protocol.

Signaling tone (ST)

In AMPS, signaling tone is a 10 kHz signal used by the mobile or portable on the reverse voice channel (REVC) to signal certain activities or acknowledge various commands from the cell site, including handoffs, alert orders, and call terminations, and to indicate switch-hook operation.

Various burst lengths are used for different ST activities. Four uses of signaling tone are:

- Indicates ringing
- Acknowledges a handoff
- Indicates call termination
- Indicates switch hook

Supervisory audio tone (SAT)

The supervisory audio tone (SAT) is one of three frequencies around 6 kHz used in AMPS signaling. SAT is generated by the cell site, checked for frequency or accuracy by the cellular telephone, then transponded (that is, not merely reflected but generated and returned) to the cell site on the REVC.

The cellular telephone uses SAT to verify that it is tuned to the correct channel after a new voice channel assignment. When the central controller (switch) signals the mobile regarding the new voice channel, it also informs the mobile of the SAT frequency vector to expect on the new channel. The returned SAT is used at the cell site to verify the presence of the telephone's signal on the designated channel.

Placing a call (mobile-to-land or mobile-to-mobile)

When a cellular telephone user originates a call, the cellular telephone re-scans the access channels to ensure that it is still tuned to the strongest one. The cellular telephone then transmits data at the rate of 10 kilobits per second on the control channel to notify the switch of its mobile identification number (MIN) and the number it wants to reach. The switch verifies the incoming data and assigns a voice channel, and when a SAT is correct, the telephone transponds the SAT back to the cell site and unmutes the forward audio.

At this point both forward and reverse audio paths are unmuted and the cellular telephone user can hear the other end ring, after which conversation can take place. The SAT is sent and received more or less continuously by both the base station and the cellular telephone. However, the SAT is not sent during data transmissions and the cellular telephone does not transpond the SAT continuously during voice operated transmit VOX operation. Notice that SAT and signaling tones are only used on AMPS voice channels, and that the signaling tone is transmitted only by the cellular telephone.

Receiving a call (land-to-mobile)

Once a cellular telephone has gone into service, it periodically scans the overhead message information in its memory and monitors the paging messages for its telephone number. When a page match occurs the cellular telephone scans each of the access channels and tunes into the strongest one. The cellular telephone then acknowledges the page on that access channel and notifies the central controller of its cell location. The switch then assigns a voice channel and a SAT to the cellular telephone. The cellular telephone tunes to the voice channel, verifies the presence of the proper SAT frequency, and transponds the signal back to the cell site.

At the cell site, the reception of SAT signals the central controller that the cellular telephone is ready for the call. An alert order is then sent to the cellular telephone which responds with a 10 kHz signaling tone. The subscriber unit rings for 65 seconds or until someone answers. Then the 10 kHz signaling tone is terminated to alert the central controller that someone has answered. The switch then connects the incoming call to the appropriate circuit leading to the cell in contact with the cellular telephone. At this point both forward and reverse audio paths are unmuted and the conversation can take place. The SAT is sent more or less continuously by the base station and transponded by the cellular telephone, except during data transmission.

Power steps

As a call progresses, the site continuously monitors the reverse channel for signal strength.

Analog cellular telephones have eight power steps, but portable models are prevented from using the two highest power steps by the cell site. (Power steps 0 and 1 are the same as power step 2). Transmit power level commands are sent to the cellular telephone as required to maintain the received signal strength within prescribed limits.

This is done to minimize interference possibilities within the frequency re-use scheme. If the signal received from the cellular telephone is higher than the prescribed limit (such as when the unit is very near the cell site), the subscriber unit is instructed to step down to a lower level.

Handoffs

If the cellular telephone is at its maximum allowed power for the cell site it is using, and the received signal at the cell site is approaching the minimum allowable (typically -100 dBm), the cell site signals the switch to consider the subscriber unit for a handoff. The central controller (switch) in turn has a scanning receiver at each of the surrounding cell sites measure the cellular telephone’s signal strength. The site with the strongest signal is the site to which the call is handed if there are available voice channels.

On an AMPS channel, the handoff is executed by interrupting the conversation with a burst of data (called blank and burst) containing the new voice channel assignment. The telephone acknowledges the order by a 50 millisecond burst of 10 kHz signaling tone on the originally assigned voice channel. The mobile telephone then drops the original voice channel and tunes to the newly assigned voice channel, keying up on that channel and transponding the assigned SAT.

Once the handoff has been accomplished, the newly assigned cell site then alerts the switch that the handoff has been completed and the old voice channel is dropped.

Note

This data exchange occurs very quickly, within only 260 milliseconds. However, when data or signaling tones are transmitted, audio is muted for the duration of that transmission and a syllable or two may be dropped from conversation.

This is normally not a problem, but during data signaling, such as that employed for telefacsimile, answering machine, and computer communications, significant amounts of information may be lost. For this reason it is recommended that when the cellular connection is used the vehicle should be stationary to avoid data loss during handoffs and other data transmission. Otherwise, the equipment should employ an error correction protocol.

CDMA carriers

The following is a partial list of CDMA carriers worldwide for PCS (1900 MHz) and cellular (800 MHz), and is subject to change. (For a current listing of CDMA carriers, please visit the Web site for the CDMA Development Group at CDG http://www.cdg.org.) Please verify that your carrier supports the Kyocera 200 Module.

Asia - Pacific

Australia

- AAPT Ltd.
- Hutchison Telecom Australia (Orange)
- Leap Wireless International (Oz Phone Pty)
- Orange
- Telestra Corporation Limited

Bangladesh

- Pacific Bangladesh Telecom Limited

China/Hong Kong

- China Unicom
- Hutchison Telecom (HK) Ltd.

India

- Mahanagar Telephone Nigam Limited (MTNL)
- Reliance India Mobile
- Shyam Telelink Limited
- Tata Teleservices Limited

Indonesia

- Komunikasi Selular Indonesia (Komselindo)

Japan

- DDI Corporation

Korea

- Korea Telecom Freetel, Inc.
- LG Telecom, Ltd.
- SK Telecom

New Zealand

- Telecom Mobile Limited

Europe - Russia

Russia

- Leap Wireless International

Global

- BellSouth International

Caribbean - Latin America

Argentina

- CTI Movil
- Movicom - Bellsouth

Brazil

- Vivo

Chile

- Bell South
- Smartcom PCS

Columbia

- Bell South

Dominican Republic

- Centennial Dominicana
- Codetel

Ecuador

- Bell South

Guatemala

- PCS Digital

Honduras

- Celtel

Mexico

- IUSACELL
- Operadora UNEFON SAde CV
- Telefonica.

Nicaragua

- Bell South

Panama

- Bell South

Peru

- Bell South
- Telefonica

Puerto Rico

- Centennial Wireless de Puerto Rico
- Movistar
- Sprint PCS
- Verizon

Uruguay

- Bell South

Venezuela

- Moviluet

Africa - Middle East

Angola

- Angola Telecom

Israel

- Pele-Phone Communications, Ltd.

North America

Canada

- Bell Mobility
- SaskTel
- Telus Mobility Cellular, Inc.

United States

- 3Rivers Wireless
- Alaska Digital
- Alltel Communications
- Amica Wireless
- Blackfoot Communications
- Cleartalk
- Cricket Communications
- First Cellular
- Hargray Communications
- Leap Wireless International (Chase Telecommunications)
- Nextel Communications, Inc.
- NTELOS
- PCS Digital
- Poka Lambro Wireless
- PVT Networks
- Pine Belt Wireless
- PYXIS Communications
- Qwest Wireless
- RCS Wireless
- San Isabel
- South Central Communications
- Sprint PCS
- SRT
- US Cellular
- Verizon Wireless
- Wireless North

Please note that this is only a partial list of CDMA carriers worldwide for PCS (1900 MHz) and cellular (800 MHz), and it is subject to change.

3 CDMA2000 3G

3G

The International Telecommunications Union (ITU), working with worldwide industry bodies, implemented the IMT-2000 program to develop standards for 3G systems. CDMA2000, one of the most important of the ITU IMT-2000 standards, is the first 3G technology to be commercially deployed.

cdma2000 3G standard

Five terrestrial standards were developed as part of the IMT-2000 program. CDMA2000 1X, like CDMA2000 3X, is an ITU-approved, IMT-2000 (3G) standard. It is part of what the ITU has termed IMT-2000 CDMA MC, and was sanctioned along with four other terrestrial IMT-2000 standards (listed below) when ITU-R completed the Recommendations in late 1999.

IMT2000 terrestrial radio interfaces:

- IMT-2000 CDMA Multi-Carrier (MC) – CDMA2000 1X and 3X
- IMT-2000 CDMA Direct Spread (DS) – WCDMA (UMTS)
- IMT-2000 CDMA TDD – Ultra TDD and TD-SCDMA
- IMT-2000 TDMA Single Carrier – UWC-136/EDGE
- IMT-2000 FDMA/TDMA – DECT

the cdma2000 family of standards

The cdma2000 family of standards specifies a spread-spectrum radio interface that uses Code Division Multiple Access (CDMA) technology to meet the requirements for 3G wireless communication systems. The standards in the family are:

IS-2000-1, *Introduction to cdma2000 Standards for Spread Spectrum Systems*

IS-2000-2, *Physical Layer Standard for cdma2000 Spread Spectrum Systems*

IS-2000-3, *Medium Access Control (MAC) Standard for cdma2000 Spread Spectrum Systems*

IS-2000-4, *Signaling Link Access Control (LAC) Standard for cdma2000 Spread Spectrum Systems*

IS-2000-5, *Upper Layer (Layer 3) Signaling Standard for cdma2000 Spread Spectrum Systems*

IS-98-D, *Recommended Minimum Performance Standards for cdma2000 Spread Spectrum Systems*

In addition, the family includes a standard that specifies analog operation, to support dual-mode mobile stations and base stations:

IS-2000-6, *Analog Signaling Standard for cdma2000 Spread Spectrum Systems*

Relationship to TIA/EIA-95-B

cdma2000 provides full backward compatibility with TIA/EIA-95-B. This permits cdma2000 infrastructure to support TIA/EIA-95-B mobile stations and permits cdma2000 mobile stations to operate in TIA/EIA-95-B systems. The cdma2000 family also supports reuse of existing TIA/EIA-95-B service standards, such as those that define speech services, data services, Short Message Services, and Over-the-Air Provisioning and Activation services, with the cdma2000 physical layer.

cdma2000 and spectrum

cdma2000 is not constrained to only the IMT band; it is defined to operate in all existing allocated spectrum for wireless telecommunications, thereby maximizing flexibility for operators. Furthermore, cdma2000 delivers 3G services while occupying a very small amount of spectrum (1.25 MHz per carrier), protecting this precious resource for operators.

These bands include:

- Cellular (824–849 and 869–894 MHz)
- PCS (1850–1910 and 1930–1990 MHz)
- TACS (872–915 and 917–960 MHz)
- JTACS (887–925 and 832–870 MHz)
- KPCS (1750–1780 and 1840–1870 MHz)
- NMT-450 (411–493 MHz, not continuous 10 MHz spacing)
- IMT-2000 (1920–1980 and 2110–2170 MHz)
- 700 MHz (776–794 and 746–764 MHz)

cdma2000 evolution

cdma2000 is evolving to continue to meet the future demands of the wireless marketplace. The cdma2000 1xEV standards will provide data-optimized channels, offering data rates well in excess of the ITU IMT-2000 2 Mbps requirement.

cdmaOne (IS-95-A):

- Voice
- Data up to 14.4 Kbps

cdmaOne (IS-95-B):

- Voice
- Data up to 115 Kbps

cdma2000 1X:

- 2X increases in voice capacity
- Up to 307 Kbps packet data on a single (1.25 MHz or 1X) carrier in new or existing spectrum
- First 3G system for any technology worldwide

cdma2000 1X has been commercially available since October 2000.

cdma2000 1xEV:

- Optimized, very high-speed data (Phase 1)
- Up to 2.4 Mbps (downlink) packet data on a single (1.25 MHz) carrier
- Integrated voice and data (Phase 2); up to 4.8 Mbps

cdma2000 1xEV is an evolution of cdma2000 1X. 1xEV-DO (Data Only) uses a separate 1.25 MHz carrier for data and offers peak data rates of 2.4 Mbps. 1xEV-DV (Data-Voice) integrates voice and data on the same carrier.

Kyocera 200 Module and cdma2000

The Kyocera 200 Module implements cdma2000 1X technology. The Module provides tri-mode operation with AMPS and CDMA in the 800 MHz cellular band and CDMA PCS in the 1900 MHz PCS band. The Kyocera 200 Module also supports data rates up to 153.6 Kbps in the reverse and forward links.

Support of E911 Phase 2 Position Location

It is a requirement of the FCC that 25% of new handset sales be Automatic Location Identification (ALI)-capable by December 31, 2001. AFLT (Advanced Forward Link Trilateration) alone is not accurate enough to meet the accuracy requirements of the mandate. With AGPS and AFLT, the Kyocera 200 Module provides the capabilities required for a handset-based voice solution utilizing an assisting element on the network called the PDE (Position Determination Equipment). Messaging between the Module and the network is supported by IS-801.1. The FCC's accuracy requirement for a system supporting E911 Phase 2 is 50 meters 67% of the time and 150 meters 95% of the time.

4 Module Overview

What is the Module?

The Kyocera 200 Module is intended for use by vendors and manufacturers who would like to design, build, and sell a wireless product using CDMA technology. The Module is suited for business applications like remote metering or security, point of sale, wireless vending, and vehicle tracking. It can support enterprise-wide needs like wireless voice and data solutions for automotive telematics and handheld devices.

The Module's continuing utility is ensured by advanced features like trimode capability (AMPS 800 MHz, CDMA digital 800 MHz, and CDMA PCS 1900 MHz), A-GPS position location capability, and support for IS-2000 data rates.

Embedded Module

The Kyocera 200 Module is a fully functional wireless phone designed to be embedded into another piece of hardware. It then provides wireless connectivity to that device for the purposes of transferring telemetry data and providing remote monitoring, control, and asset tracking.

The Module integrates easily with your device through a board-to-board connector. Just supply power, attach an antenna, and use the two serial ports to make and take calls, send and receive SMS messages, get status, and get a GPS location fix. (It incorporates A-GPS.)

The Module provides state-of-the-art wireless data technology to take advantage of the nationwide footprint of the 1xRTT networks. It works equally well on both the 800 and 1900 networks and can even communicate via the legacy AMPS analog network.

We at Kyocera Wireless Corp. have applied our expertise in design and manufacturing of CDMA phones to the creation of an extremely robust, high-performance module. And because the Kyocera 200 Module is provisioned like a phone, you can get service for it through CDMA cellular service providers.

What can it do?

The CDMA service providers support voice and various levels of data services, SMS messaging, and GPS location capabilities. Because the Kyocera 200 Module is designed around the core technology upon which we build our phones, it can utilize all of those services.

Today, well over 100 million consumers worldwide rely on CDMA for clear, reliable voice communications and leading-edge data transmission. In North America CDMA is the dominant wireless technology, and elsewhere it is being adopted in Central and South America as well as in Australia, China, and India. Over 35 countries have either commercial or trial activity ongoing. CDMA will continue to lead in delivering the most advanced 3G services around the world. Kyocera Wireless Corp. has approved devices operating on many carriers' networks, and the list is continually growing.

Will it work in my application?

The chances are: Yes.

Please call us so that we can answer your questions concerning the integration of our technology into yours.

What is the process to evaluate the Module?

Our Module Development Kit is available for evaluation upon execution of a nondisclosure agreement. With our Module Development Kit you can begin working with the Module immediately to try out its capabilities.

What is the process to evaluate the Module?

Our Module Development Kit is available for evaluation upon execution of a nondisclosure agreement.

What is included in the development kit?

We provide everything you need to get started, including extensive documentation and an interface board for immediate connection to your computer's serial ports.

Specific contents of our Module Development Kit are shown in Chapter 12.

How do I integrate the Module into my product from a mechanical perspective?

The Module footprint, pinout, and connector specifications are provided in Chapters 14 and 15.

How do I integrate the Module into my product from an electronic perspective?

Integration is made easy with serial ports at TTL levels.

How do I integrate the Module into my product from a software perspective?

UART1 uses the IS-707 AT command set. UART2 uses our proprietary KMIP protocol for enhanced power and flexibility.

What must I do to get my final product approved for service?

There is a certification process for FCC and carrier approval. But we will help you get through the process quickly and keep the costs to a minimum.

Module type

The Kyocera 200 Module provides:

- Envelope dimensions 64 mm x 48 mm, 11.4 mm thick
- Serial control and data interface
- Two sub-miniature RF connectors, 50 ohm
- 3.6 VDC to 4.2 VDC input
- Analog audio interface
- CDMA data up to 153.6 Kbps (forward and reverse link) depending on services available from your carrier
- AMPS 800 MHz mode for voice only
- Software stacks including ANSI J-STD-008, IS-95, IS-707-A (formerly IS-99 circuit switched data and fax, IS-657 packet data), and IS-637-A (two-way SMS including Broadcast SMS capabilities) (as carriers support these features)
- IS-2000 (CDMA2000 Release 0) MOB_P_REV6 radio configurations and features as supported by the MSM5100 and infrastructure
- IS-95-A/IS-95-B (J-STD-008) backward compatibility (MOB_P_REV1,3,4,5)
- 13 Kbps QCELP and EVRC vocoder support, compatible with TTY/TDD with operations in support of Telecommunications Act, Section 255
- IS-683-A support; OTASP and OTAPA
- IS-707-A service options (async/fax and packet data)
- IS-835 (TCP/IP/PPP) simple IP and mobile IP
- Quick Net Connect (single and double stack)
- Dual NAM support

Module benefits

The tri-mode CDMA Module provides access to the CDMA wireless networks without need for engineering a CDMA product from ASIC level up. The time-to-market advantage saves resources and provides access to the latest wireless data technology.

The Module is the core technology of KWC's CDMA phones. It has been repackaged to provide a ready-to-integrate product. The developer can then concentrate on the specific application and hardware development application. The CDMA technology within the Module includes the RF and digital signal processing, analog audio interface, and serial interface. This is the basis from which to build a device.

User features

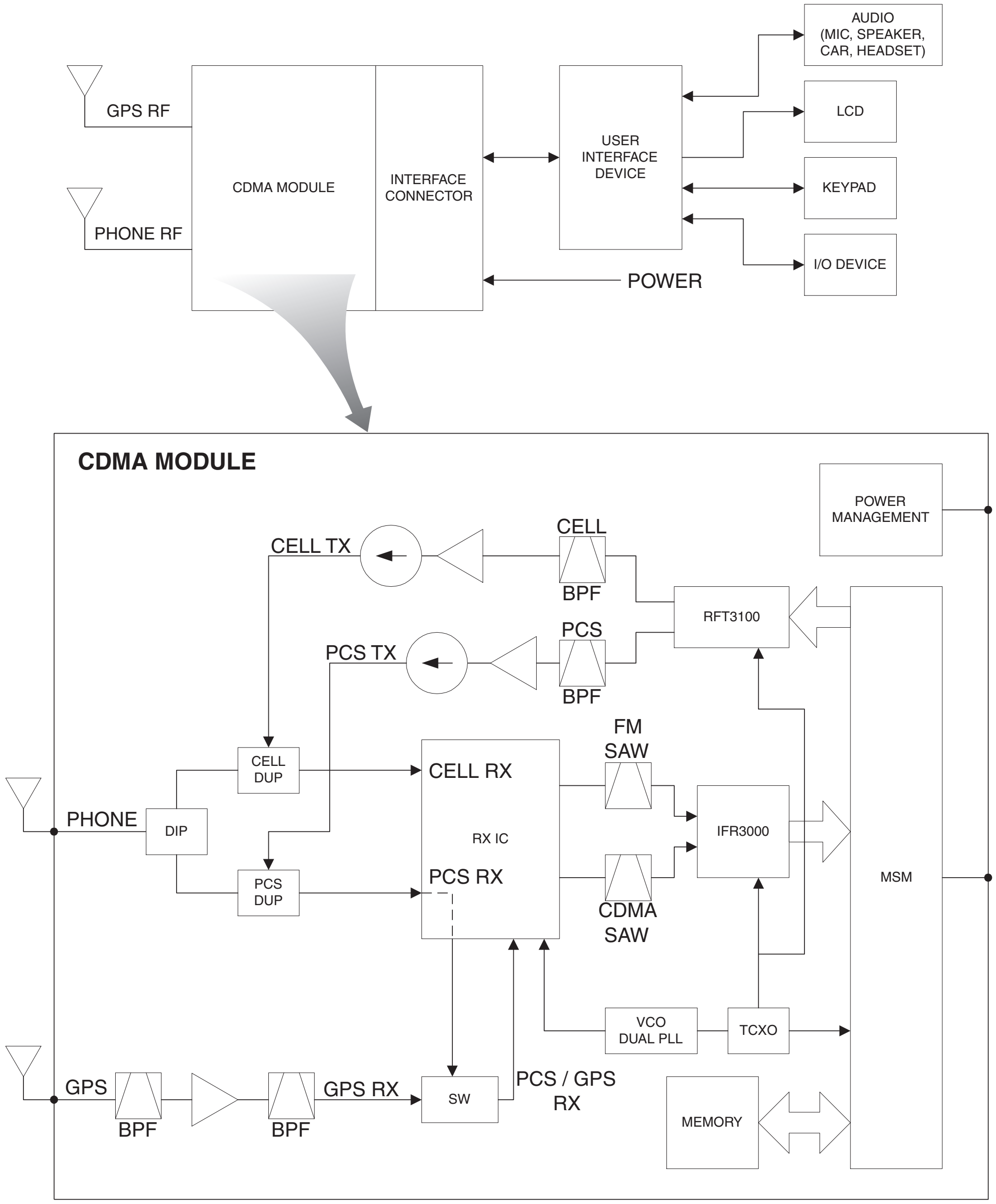
The phone Module provides a complete solution to all functionality of a tri-mode cellular phone minus the keypad, display, and battery. The Module was developed to allow the system integrator to build CDMA-based devices and to allow very fast time to market. Applications might include a complete phone, a data modem, or an embedded component in a more powerful device that needs voice and/or data connectivity in a small form factor.

Definitions of subsystems

Module

The Module card includes MSM ASIC, TCXO, synthesizers for frequency conversion, MSM clocking, necessary filtering to meet performance requirements, AGC circuits, DC power conditioning circuits, volume control, Rx circuitry, and memory.

The following figure shows that it is possible to build a full-featured voice phone with the addition of an external user microprocessor, LCD, keypad, and battery. This figure also shows a typical module interface.



The Module card includes the following circuits, with the necessary filtering and AGC circuits to meet performance requirements.

- MSM5100 ASIC
- Memory
- Power management
- Audio
- Transmit and receive

RF interface/antenna port

Two 50 ohm coaxial RF connectors have been provided for Module testing and integration into an end user device. The OEM developer must provide a 50 ohm antenna that works in the desired frequency band of operation. Refer to Chapter 11 for more details.

Wireless data service

The convergence of wireless telephony with mobile computing is making wireless data services a reality. Among the services and capabilities that can be expected are:

- Direct access to the Internet
- Diagnostic and monitoring applications
- Email capabilities for telephones, PDAs, and connected devices
- Access to corporate intranets from vehicles and remote sites

Data standards supported

- IS-99 – Circuit Switched Data
- IS-657 – Packet Switched Data
- IS-707-A – The combined CDMA Data Standard
- Quick Net Connect (not a standard)

Full documentation for TIA standards can be obtained from Global Engineering in Colorado (http://www.global.ihs.com) at 800-854-7179.

References

- http://www.3GPP2.com
- http://www.tiaonline.com
- http://www.cdg.org
- http://www.fcc.gov

Carrier requirements must be acquired from each individual operator.

5 Environmental Specifications

This chapter provides nonoperating and operating environmental requirements for the CDMA Module and includes specifications for the following:

- Temperature
- Humidity
- Vibration
- Mechanical shock
- Drop

Nonoperating

Temperature

Storage temperature for the CDMA Module shall be -40°C to +85°C. After exposure of the Module to either temperature extreme for 96 hours and stabilization at normal conditions, no damage or abnormal operation of performance resulted.

Vibration

The Module showed no signs of abnormality in operation and performance criteria after the following swept-sine vibration conditions in three mutually penpendicular directions: 1.5g acceleration, 5-500-5 Hz sinusoidal vibration, swept at 1.0 octave per minute.

Mechanical shock

The Module showed no signs of abnormality in operation and performance criteria after the following shock conditions: three shocks in both positive and negative directions along each of the three orthogonal axes, with input level of 20g at 7 to 11 ms, half-sine waveform.

Drop

The Module showed no signs of abnormality in operation and performance criteria after the following drop conditions: Dropped six times, on all six faces, from 12 cm (4.9 in.) off the ground onto concrete covered with 1/8-inch vinyl tile.

Operating

Temperature

The Module shall meet all the operational requirements over the temperature range of -30°C to +60°C.

Humidity

The Module shall meet operational requirements over humidity conditions ranging from 0% to 85% relative humidity (non-condensing).

Vibration

The Module shall meet operational requirements under the following vibration conditions:

- Swept-sine — 1.5g acceleration, 5-500-5 Hz sinusoidal vibration, swept at 0.1 octave per minute
- Random — 1.5g rms overall from 5 to 500 Hz, 0.025 power spectral density from 5 to 50 Hz with 6 dB per octave roll-off from 50 to 500 Hz for 60 minutes in each axis.

6 System Specifications

Operating temperature

The Kyocera 200 Module is capable of operating in ambient air inside the user equipment from -30°C to +60°C (-22°F to +140°F).

Dimensions

The Kyocera 200 Module has “envelope” dimensions of 64.8 mm × 48.2 mm (56.4 mm with mounting tabs) × 11.4 mm. (See mechanical drawing in Chapter 14.) Other formats may be developed over time.

Weight

The weight of the Kyocera 200 Module, as measured, is 39 grams.

Antennas

The Kyocera 200 Module provides two 50 ohm RF connectors, one for CDMA/AMPS and one for A-GPS. The antenna matching circuits on the circuit board are matched to 50 ohms (see chapter 15).

User interface

The Kyocera 200 Module has a serial interface that provides access to user interface functions. This interface is capable of the following basic features by the use of specially formatted information packets.

- Basic phone keypad operability
- Received Signal Strength Indicator (RSSI) level
- Basic phone setting adjustments for carrier selection, roaming, service programming
- Call control, setup, teardown, and maintenance
- Volume control
- Data services control

Interface connector

Refer to Chapter 14 A for detailed technical information about the interface connector.

The *Kyocera 200 Module User's Guide*, 82-M8863-1, contains detailed technical information. This document is part of the complete CDMA Module Developer's Kit (MDK) and is made available for purchase and license under the terms of certain module supply or module licensing agreements with the signing of a Non-Disclosure Agreement.

7 Features

Standard features

Indicators and displays

The CDMA Module does not have any visible indicators or displays.

Audible indicators

The CDMA Module does not have any audible indicators.

Volume controls

The Module takes serial port input commands for volume controls and uses these to set the gain factor in the codec stream. This allows you to control the audio volume without having to build an external volume control interface.

Power on/off

The Module has a power on/off sequence to ensure that the system has been shut down properly. Refer to the *Kyocera 200 Module User's Guide*, 82-M8863-1, for details.

Call processing features

The Module supports the following features with support packets in the serial interface. The customer is responsible for implementing the displays or actions taken from these features.

Indicators and display support features

- Incoming call
- Call dropped alert
- "Missed call" indicator

Audible indicators

The Module supports the following indicators. Where possible, these are output on the audio output.

- Service warning-dropped call
- Low voltage warning
- Voice mail alert

- Minute alert
- SMS alert

Keypad and dialing features

The Module supports the following features.

- Adjustable audio output volume controls
- Full dialing keypad simulation
- Voice and text access/retrieval
- Send key
- End key
- Phone number storage/memory
- DTMF tone length
- DTMF mute
- Mute

Convenience features

- Call timer
- Total call timer
- Subscriber number display
- Reprogrammable memory
- Call waiting
- Call forwarding – if supported by carrier
- Three-party call – if supported by carrier
- Clock – requires CDMA service
- Caller ID – when available on the CDMA system

8 Software Description

This chapter contains information on the software (Firmware) that runs on the Module.

Software

Software on the Module controls all aspects of its operation. The latest version is loaded onto the Module at the factory and is configured in accordance with the customer's preferred service provider.

The Phone Support Toolkit (PST), which is included with the Module Development Kit, is the Windows-based application that enables you to flash new software to the Module when upgrades become available. The PST also allows you to view and load a Preferred Roaming List (PRL).

Note The AT command 'AT+GMR' will return the software version number and the PRL verson number.

The Module is loaded with a PRL file. This file tells the Module how to acquire the network to which it has been assigned. It serves as an authorization between carriers for subscribers to utilize another carrier's coverage area. Documentation is included with the PST.

Interface

There are two UARTs (RS232 communication ports) on the Module.

UART 1 is used for communicating with the Module in AT command mode. AT commands can initiate calls (voice, packet data, asynchronous data) and query the Module for status and configuration information. Chapter 7 of the *Kyocera 200 Module Reference Guide* provides a complete AT command listing.

UART 2 is used to communicate with the Module using Kyocera Multiplex Interface Protocol (KMIP). KMIP is a stop-and-wait protocol using HDLC-like frames. This interface protocol gives a broad range of Module control including capability to query the Module; make calls; send, receive, and acknowledge SMS messages; and access the A-GPS feature of the Module. The Reference Guide fully details this protocol.

Kyocera Wireless Phone Support Toolkit (included with the MDK)

The Phone Support Toolkit is a set of Windows-based tools designed to interface with, control, and test Kyocera Wireless Corp. phones and modules. The Phone

Support Toolkit server can keep track of multiple phones and modules on local host machines. System requirements are shown below.

Computer:	Desktop or laptop computer, 166 MHz Pentium®, running Microsoft® Windows 95, Windows 98, Windows NT (with Service Pack 3 or later), Windows 2000, or Windows ME
RAM:	32 MB or greater
Hard drive:	Application requires 20 MB of available space. Additional space is recommended for storing backup and download files.
CD-ROM drive:	For installing Kyocera Wireless Phone Support Toolkit
Video monitor:	Minimum display resolution of 800x600
Serial communications:	Free serial I/O (COM) ports for up to eight phone connections

The Phone Support Toolkit currently consists of the server application (which has no interface) and the following six component (or "client") applications.

Kyocera Wireless PST Configuration

This client application provides basic phone status display (MIN, ESN, model) and allows phone control and monitoring.

Service Programming

This application saves service programming data to file, allows download of the same service programming to multiple phones, and allows download of dialing plan, carrier plan, carrier information, and roaming list.

Software Download

This application downloads software to connected Kyocera Wireless Corp. phones. It also backs up and restores nonvolatile (NV) memory contents between downloads.

Phone Configuration Transfer

This application provides personality transfer for Kyocera Wireless Corp. phones of the same model. It guides you through the transfer process using a wizard-based interface.

Service Console

This application allows the service center to record a problem phone's fault codes inside the phone itself.