INTEGRATED DISPATCH RADIO SYSTEM

ARIB STANDARD

RCR STD – 32A

Fascicle 2

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Association of Radio Industries and Businesses (ARIB)

General notes for the English version of the ARIB Standard 32A

The original "Integrated Dispatch Radio System ARIB Standard (RCR STD–32A)" is written in Japanese and has been approved by the 2nd Standard Assembly (November 15, 1995). This document is the translation of the Standard into English.

The note about IPR (Industrial Property Rights) in the INTRODUCTION of Fascicle 1 of this document applies to the use of Essential IPR for the ARIB Standard in Japan. If the ARIB Standard is adopted outside Japan, Essential IPR will be treated in accordance with policies stated by each IPR owner. The IPR owners are, however, expected to apply the rules of the preface of the "Guidelines for Treatment of Industrial Property Rights in connection with the ARIB Standard" (September 5, 1995, approved by the 1st Standard Assembly). The preface of these Guidelines states that it is "desirable that the Essential IPR which relates to any or all parts of the contents of the ARIB Standard should be used free of charge by anyone and that it would not block the use of such Essential IPR in any other country where such an ARIB Standard is adopted".

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PART 2 DIGITAL JSMR SYSTEM

PART 2 DIGITAL JSMR SYSTEM

Chapter 1 General

1.1 Overview

This standard specifies the radio section interface of the telecommunication system used for digital multichannel access system in the 800 MHz and 1.5GHz frequency bands (hereinafter, in this Part 2 "Digital JSMR System").

This system specifies the land mobile telecommunication specified in accordance with article 49-7-2 of the Japanese Radio Facility Regulation ("Musen Setsubi Kisoku").

The general term of the system in both Part 1 and Part 2 of this standard is called "Digital MCA system".

1.2 Scope of the Standard

This digital JSMR system consists of a base station, mobile stations, and control stations. This standard specifies the radio section interface of the digital JSMR system as indicated in Fig. 1.2-1

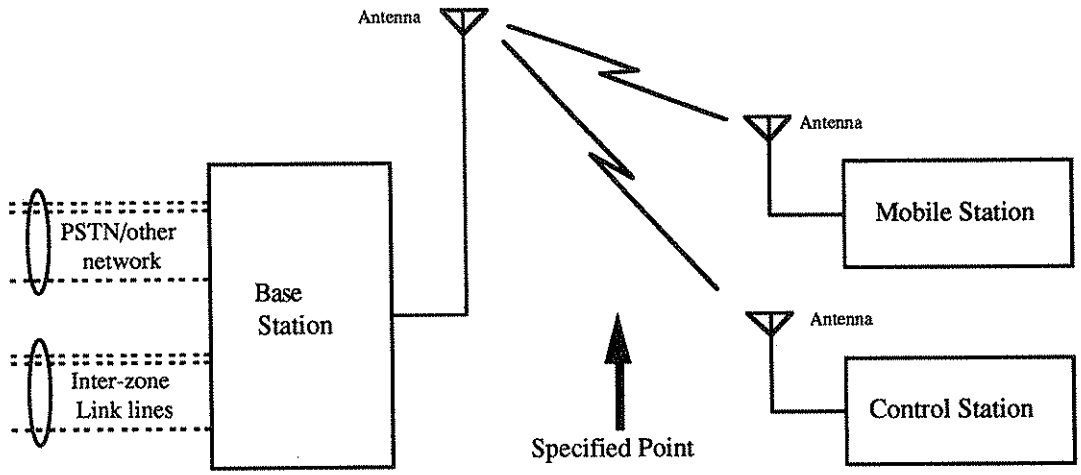


Fig. 1.2-1 Configuration of the Digital JSMR Land Mobile Communication System

1.3 Principles for Standardization

This standard specifies the following items, considering coexistence and mutual connectivity of the systems.

(A) The descriptions of Chapter 3 "Specification of Radio Equipment"

(B) Next specifications

- Essential specifications to perform basic connection and basic services

- Optional specifications, such as protocols, which will be able to be selected and which are next importance to the above essential specifications.

In addition, future expandability and flexibility of the selections are taken into account. Careful consideration should be taken, as well, not to hamper non-standardized specifications.

The following rules apply to the unused information elements in Chapter 4 "Communication Control System".

Reserved : Refer to the field or bit pattern reserved for the future expansion of this standard .

Use is restricted to that specified in the this standard.

Reserved field must be transmitted with '0's unless otherwise specified.

Option : Refer to the field or bit pattern; used arbitrarily.

Preparatory : The usage is the same as for "Option". It is called "Preparatory" in the cases where the RCR standard recommends using an extension of a particular information element.

Chapter 2 Outline of the System

2.1 System Configuration

The digital JSMR system consists of control stations, mobile stations (including portable stations), and a base station. The basic communication occurs between a control station and a mobile station, or between mobile stations using the base station.

A collection of control station(s) with mobile stations, or mobile stations only (hereinafter, *Fleet*), among which communications occur, has its own unique identification code (Fleet ID). All radio stations in the fleet perform their communication on the radio channel specified by the base station using MCA system.

The basic concept of the digital JSMR system is illustrated in Fig. 2.1-1.

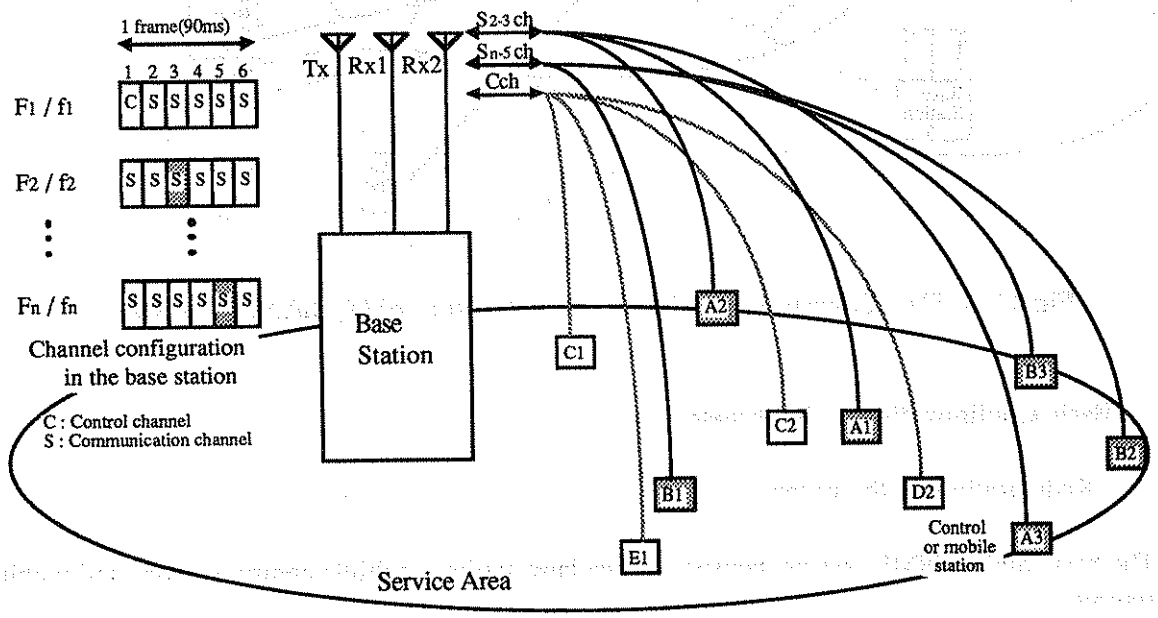


Fig. 2.1-1 Basic Concept of the Digital JSMR System

The digital JSMR system consists of a base station, control stations, and mobile stations. In Fig. 2.1-1 the symbols ("A1", "B2", etc.) represent each control station or mobile station. The letters represent a fleet ID; the numeric following represents an individual ID within the fleet. The shaded parts represent the radio stations carrying out the communication or radio channels in use, and the unshaded parts represent radio stations in an idle state or radio channels not in use.

As shown on the left side of Fig. 2.1-1, the required frequency resource (Outbound carrier frequency/Inbound carrier frequency : F1/f1, F2/f2, ~ Fn/fn) is assigned to the base station of the digital JSMR system concerned, from the total frequency resource allocated for digital JSMR . The control channel is assigned to a carrier frequency. A control station or a mobile station transmits a call request to the base station via that control channel. The base stations then perform the call control process on that request.

The base station assigns one or more available channels, from the assigned frequency resource to the fleet where the requesting station belongs. In Fig. 2.1-1, "Cch" represents the control channel, and "S2 - 3 ch" and "Sn - 5 ch" represent communication channels. The first number following 'S' represents a carrier number and the second number represents a slot number.

In the Fig. 2.1-2, The concept figure of multi-zone structure is shown. The multi-zone structure with handover function can be composed by connecting the plural base stations via the inter-zone link line.

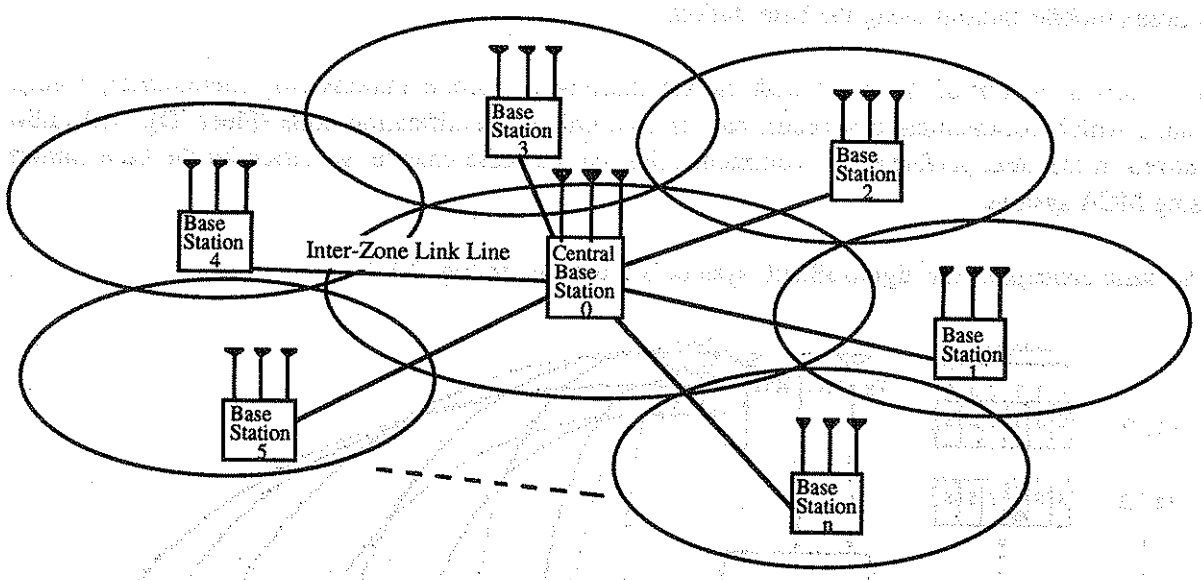


Fig.2.1-2 The Concept Figure Multi-zone Structure of Digital JSMR System

2.1.1 Basic Configuration of the System

(1) Radio stations in the system

The basic digital JSMR system consists of one base station, multiple control stations and mobile stations.

(2) Structure of Radio Channel

(A) Radio Channels

The radio channels used for communications include the control channel and the communication channel. These channels are described below.

Table 2.1-1 Physical Channel Type

Control channel	This is a physical channel to be used to control call connection.
Communication channel	This is the channel on which communication occurs after it is assigned to a fleet (or a part of mobile stations and control stations in a single fleet) by the base station. "Communication" includes non-voice signal transmissions such as data, fax, etc..

However, the radio channels contain TDM/TDMA in the digital JSMR system, so that the radio channel described does not have one-to-one correspondence with the radio carrier (as in the analog JSMR system). In the TDM/TDMA system, the radio carrier is segmented into frames at regular time intervals, then the frame is further divided into slots depending on the number of multiplex. Consequently, the radio channels are formed with the collection of slots occupying the same position in successive frames.

In the digital JSMR system, a combination (one or more) of the control channels with multiple communication channels (managed by the control channels) forms a radio channel system. The radio channel arrangement is outlined below.

(a) Control Channel

One control channel can consist of one or more slots in a frame on a single carrier. Multiple control channels can be arranged either on a single carrier or on several different carriers.

(b) Communication Channel

Using a base station, the system assigns a communication channel to a fleet or to mobile stations and control stations in the fleet every time a call is requested. Communication includes not only normal voice signal transmission, but also non-voice signal transmissions such as data, FAX, etc.. In principle, the communication channel assigned by the base station consists of one slot in a frame; however, it may also consist of multiple slots as required.

The radio carrier containing one or more control channels is defined as the control carrier, while the radio carrier consisting of communication channels is the communication carrier.

(B) Other channels for Communication

In the digital JSMR system, it is possible to link to the PSTN/PSDN/ISDN (provided by the first-class telecommunications common carriers) at the base station or control station.

It is also possible to link to other base stations with a dedicated line or other means.

(3) Equipment Configuration

A base station, a control station, and a mobile station in the digital JSMR system include the radio equipment, the adapter equipment, and the power supply equipment (as shown in Fig. 2.1-2 and Fig. 2.1-3, respectively).

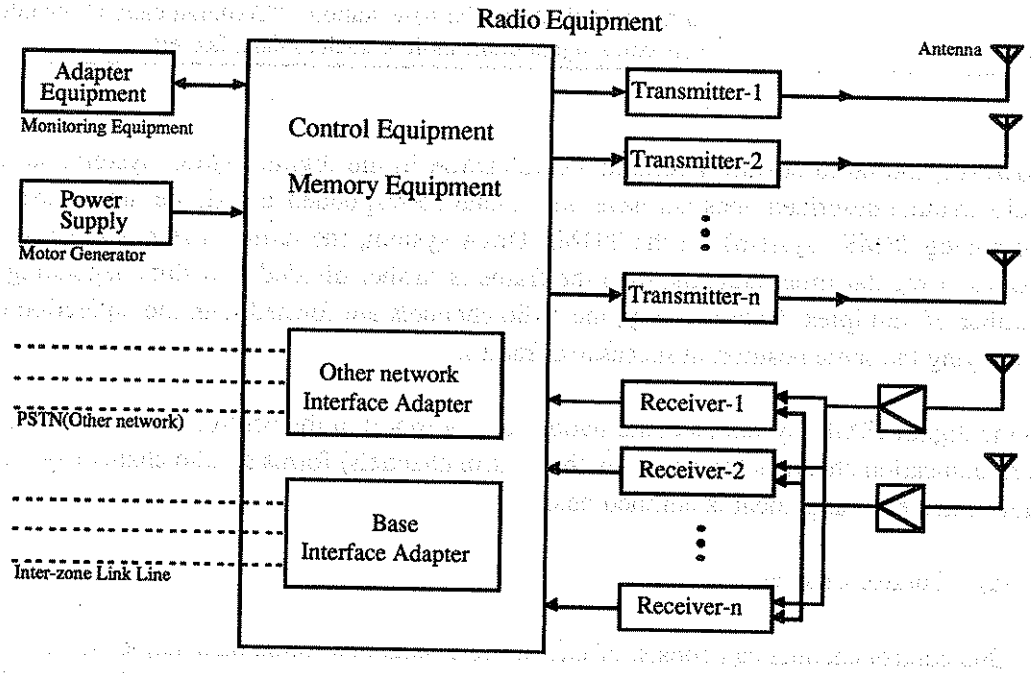


Fig. 2.1-2 Base Station Configuration of the Digital JSMR System

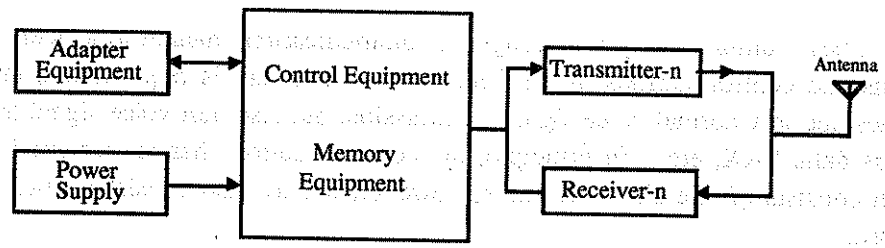


Fig. 2.1-3 Mobile Station / Control Station / Configuration of the Digital JSMR System

2.1.2 Offered Services

The services offered by the digital JSMR system include basic services, optional services, and other network interconnect services. The optional services and the other network interconnect services may be offered, along with the basic services.

(1) Basic Services

Transmission contents	Voice communication	Voice signal
	Nonvoice communication	Data, Video, Fax, etc.
Communication mode	Group call	A Radio belonging to a fleet can transmit to all or A part of radio stations in the same fleet.
	Individual call	A Radio belonging to a fleet can transmit to one of radio stations contained in the same fleet.
Connection mode	Local call	a call at a single base station
	Inter-zone call	a call at plural linked base stations It is possible for handover function to be equipped with.

(2) Optional Services

Plural channel assignment	Voice-Nonvoice simultaneous communications	Simultaneous communications with different transmission contents can take place by assigning multiple communication channels for a call.
	High speed data communication	Data transmission at higher rates can take place by assigning multiple communication channels for a call.
	Full-duplex communication	Communication can take place in full-duplex mode by assigning multiple communication channels for a call.
	Simultaneous plural calls within a single fleet	Two or more of simultaneous and independent calls can take place by subgroups made up of radio stations comprised in a single fleet.
Special channel assignment	Prioritized channel assignment	Communication channel can be assigned with priority for an emergency call, etc..
Special communication service	Scrambled communication function	Secured communication can take place.

Note 1: A subgroup consists of apart of radio stations among all mobile and control stations that organize a fleet.

(3) Network Interconnect Services

PSTN/PSDN interconnect service	Communication can take place with PSTN/PSDN provided by the first class telecommunications common carriers at the base station or a control station.

2.2 Basic Functions of the System

The following section describes the basic and optional functions of the digital JSMR system. The use of the optional functions is permitted; however, the adoption of the optional functions is limited so they don't significantly affect typical traffic, based on the operation of the basic functions only.

2.2.1 Basic Functions Required

The digital JSMR system must include the following essential functions:

(A) Fleet Identification Function

A unique IDentification code (ID) is assigned to a fleet, a collection of one or more control stations and mobile stations, or mobile stations only, among which communication can occur. The system includes the ability to identify the fleet with this ID.

(B) Channel Set-up Function

The system includes a channel set-up function. The Multi Channel Access (JSMR) system has a dedicated control channel (hereinafter called a "Common Access Channel"), and the base station can assign the communication channel to control stations and mobile stations existing in a single fleet.

(C) Channel Set-up Function with a Call Stand-by System

The system includes the channel set-up function, with a call stand-by system in the channel set-up process (to reduce the blocking probability).

(D) Relay Function

The system provides a relay function to carry out communications among the radio stations in a single fleet. Accordingly, the communication mode at the base station must be the full-duplex mode. The bit-recovery relay mode is the basic relay mode; however, the error correcting relay mode also is provided. The transmission contents is voice and nonvoice (data, video text, FAX, etc.).

(E) Group Call Function

The system is equipped with a group call function in which a radio station belonging to a fleet can transmit to all or a part of the radio stations containeded in the same fleet.

(F) Simplex Call Function

The system provides the simplex call function, so that mobile stations and control stations can carry out group calls on a pair of inbound and outbound communication channels. Accordingly, the communication mode must be simplex mode in this case.

(G) Individual Call Function

The system provides an individual call function, so that a radio station belonging to a fleet can transmit to a single radio station in the same fleet.

(H) Communication Time-out Time Function

The system includes a communication time-out time function, to seek to provide the most efficient use of the frequency.

(I) Continuous Transmission Prevention Function

The system provides a function to allow a control stations and a mobile stations to discontinue transmission automatically when continuous transmission is caused by a radio failure.

2.2.2 Optional Functions

The digital JSMR system may provide the following optional functions:

(A) PSTN/PSDN Interconnection

By installing the required adapter equipment, it is permitted to link to the PSTN/PSDN or other networks provided by the first class telecommunications common carriers. The connection to the first-class telecommunication common carrier telephone line that the user independently subscribes to, within the scope of private communications, occurs at the base station or the control station.*

(B) Multi-zone Connection

By installing the required adapter equipment, it is permitted to link multiple zones mutually at the base stations with dedicated lines or other means within the scope of private communications.*

(C) Duplex Communication

Full-duplex communication is to be possible when any of the following conditions exists:

(a) When linked to the other telecommunication networks at the base station.

(b) When assigning multiple communication channels to a single call to perform an efficient communication in data transmission, etc..

(c) When there are enough available channels to assign multiple communication channels to a single call for voice communications, etc..

(D) Simultaneous Communications with Voice and Non-voice

By assigning multiple communication channels to a single call, simultaneous communication with different contents to be transmitted can take place.

(E) Data Transmission at Higher Rate

By assigning multiple communication channels to a single call, data transmission at higher rates can occur.

(F) Simultaneous Multiple Calls Within a Single Fleet

The system provides a function so that two or more of independent calls can occur simultaneously by subgroups consisted of the mobile stations belonging to a single fleet.

(G) Prioritized Channel Assignment

The system includes a function that allows it to assign the communication channels with priority for an emergency call, etc..

(H) Secure Communications

The system provides the ability to communicate messages that are coded.

(*) : The communication coverage and purpose are specified in the radio station license .

2.3 Communication Control System

2.3.1 Transmission System

The TDM/TDMA with multiplex number of six (as shown in Table 2.3-1) is the standard radio channel access mode in the digital JSMR system. When the full rate is applied, the voice coding rate (including error correcting codes) is 7.467 kbps or less.

Table 2.3-1 Specification of the Transmission System

Item	Specification	
Communication mode	Half-duplex mode (Outbound TDM/Inbound TDMA)	
Number of TDMA multiplex	6 (when full rate is applied)	
Carrier spacing	25 kHz	
Frequency separation between transmit and receive carriers	800 MHz band	55 MHz
	1.5 GHz band	48 MHz
Modulation	M16QAM (M = 4)	
Transmission rate	64 kbps (4 k baud)	

2.3.2 Structure of the Functional Channels

The structure of the functional channels in the digital JSMR system is shown in Table 2.3-2.

Table 2.3-2 Structure of the Functional Channels

<table>
<tr><td rowspan="6">Control Channel</td><td colspan="2">Slot Information Channel (SICH)</td></tr>
<tr><td rowspan="3">Primary Control Channel (PCCH)</td><td>Broadcast Control Channel (BCCH)</td></tr>
<tr><td>Common Control Channel (CCCH)</td></tr>
<tr><td>Random Access Channel (RACH)</td></tr>
<tr><td colspan="2">Temporary Control Channel (TCCH)</td></tr>
<tr><td colspan="2">Dedicated Control Channel (DCCH)</td></tr>
<tr><td rowspan="2">Communication Channel</td><td colspan="2">Associated Control Channel (ACCH)</td></tr>
<tr><td colspan="2">Traffic Channel (TCH)</td></tr>
<tr><td colspan="2">Packet Channel (PCH)</td></tr>
</table>

(A) Slot Information Channel (SICH)

SICH is an outbound-only channel used for transmission of slot control information.

(B) Primary Control Channel (PCCH)

PCCH is a multiple-access channel used for transmission of Layer 3 Control signaling between the base station and mobile stations. Each cell has one PCCH. The Outbound PCCH is subdivided into the Broadcast Control Channel (BCCH) and the Common Control Channel (CCCH).

(a) Broadcast Control Channel (BCCH)

The BCCH is used for messages containing general system information and parameters. Data messages directed to particular mobile station or groups of mobile stations do not appear on the BCCH.

(b) Common Control Channel (CCCH)

The CCCH is reserved for data messages directed to particular mobile station or groups of mobile stations.

(c) Random Access Channel (RACH)

The Inbound PCCH is called the Random Access Channel (RACH). All Slots of the RACH are used at Random Access mode.

(C) Temporary Control Channel (TCCH)

The TCCH is a multiple-access channel used for Layer 3 Control signaling on a channel. A TCCH is temporarily allocated by Layer 3 Control to provide a means for Inbound Random Access. A TCCH is usually used on a reserved access channel.

(D) Dedicated Control Channel (DCCH)

The DCCH is allocated for Layer 3 Control signaling between the network side and an individual mobile station and used for the specific purpose.

(E) Associated Control Channel (ACCH)

The ACCH provides for supervision and control of its associated Traffic Channel. The main application of the ACCH is to support whatever Layer 3 Control signaling requires for Traffic Channel supervision. It can also be used for user data. A ACCH is obtained dynamically by symbol stealing on the TCH.

(F) Traffic Channel (TCH)

The TCH provides for transmission of voice signal and data. A TCH is allocated by means of L3 Control signaling.

(G) Packet Channel (PCH)

The PCH provides for packet-mode data transmission.

2.3.3 Radio Channel Control

(1) Control Procedure

The control procedure must be specified, based on the unified communication rule at a single base station. In addition, the following conditions must exist:

(A) Communication Time-out Time

The communication time-out time is controlled by the broadcast signal from the base station. The communication time-out time must be within 300 seconds, and the communication time-out limit can be configured, depending on the status of communication channel usage.

(B) Conditions of Call Termination

A call is terminated when any of the following conditions is met:

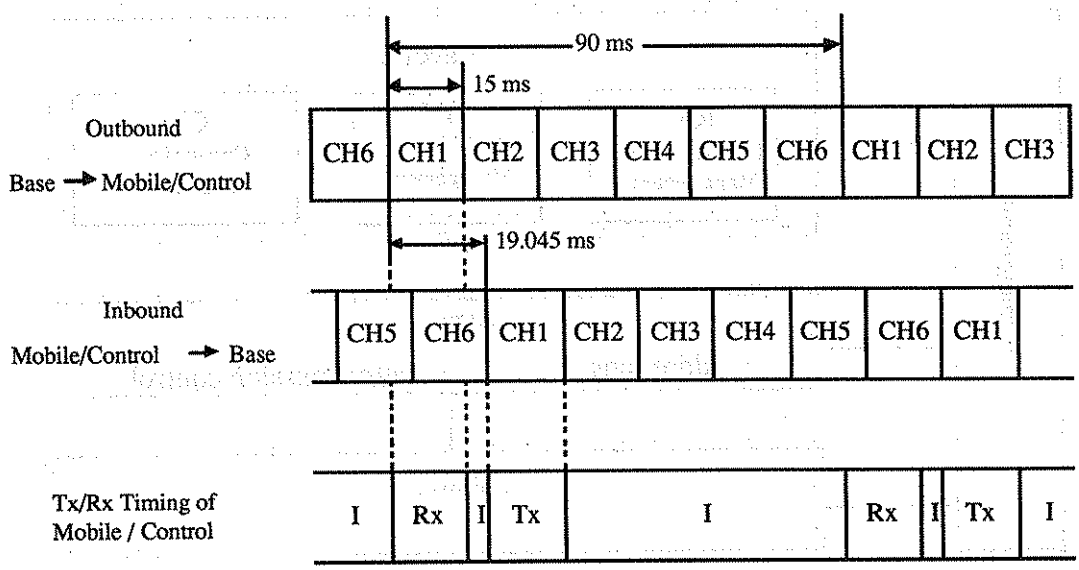
(a) When a call disconnection message is received.

(b) When degradation of receive signals is detected.

(c) When the communication time-out time elapsed.

(2) Slot Arrangement

Fig. 2.3-1 displays the transmit and receive slot arrangement of the base station and mobile stations / control stations in the six-channel TDMA frame format.



CH*i* (*i* =1~6) : Slot (Physical channel), Tx : Transmission, Rx : Reception, I : Idle

Fig. 2.3-1 Slot Arrangement

2.4 Signal Form

2.4.1 Signal Structure

The Signal structure of Digital JSMR System is shown in Fig. 2.4-1. The structure conforms to the OSI model that can be divided into layer 1 to 3.

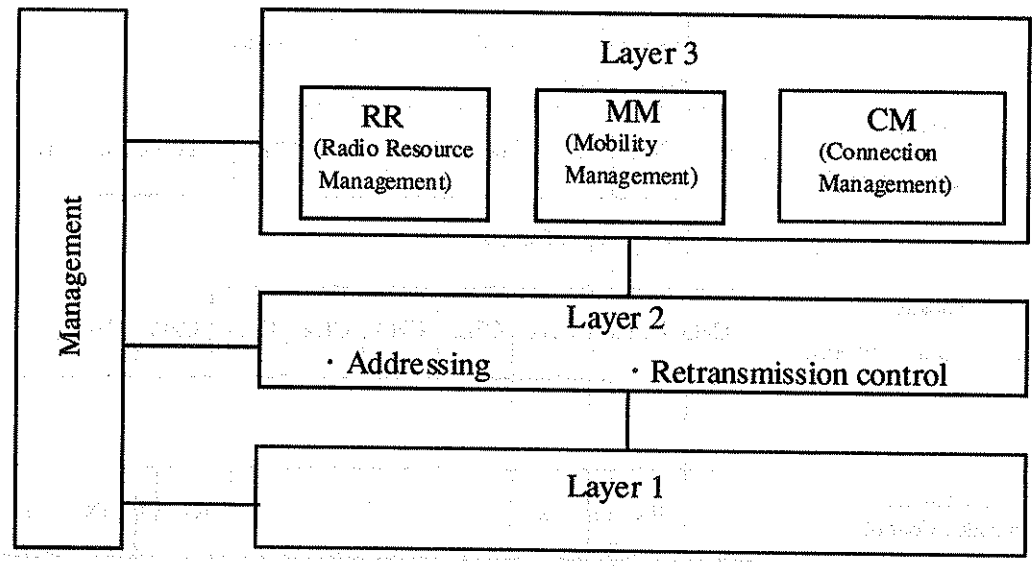


Fig. 2.4-1 Hierarchical Structure

2.4.2 Principle Rules of Protocol

In the digital JSMR system, the following three layers exist for every phase referring to the OSI model; however, it does not strictly match the standard model, because push-to-talk communication is the basic operation (so the protocol that provides faster responses is requested).

Layer-1 : This layer specifies the physical structure of the channels. The usable physical structure (basic slot format, subslot format, etc.) differs in each phase. In this Layer-1, TDM synchronization, modulation /demodulation and compensation of fading distortion are executed, and control signals are transmitted and received for them.

Layer-2 : This layer provides the communication channel for receiving and transmitting messages between layer 1 and 3. The protocol and the functional channel are selected every message. The method for error control and the data mapping into slots depend on the functional channel which is used.

Layer-3 : This layer is the same as the OSI model and provides the functions divided into three sublayers.

(1) Radio Resource Management (RR)

This sublayer provides the function of the cell selection, channel assignment and handover and connection management for the MM sublayer.

(2) Mobility Management (MM)

This layer provides the function of location registration, authentication and the CM sublayer

(3) Connection Management (CM)

This layer controls call connections and provides the interface to the higher layer.

2.5 ID Code Scheme

This standard assumes the use of the following IDs in the digital JSMR, shown as below .

(1) International Mobile Equipment Identifier (IMEI)

An IMEI is given by the mobile station manufacturer and includes the information shown as below.

(A) Equipment Manufacture's Code

This code identifies the manufacture.

(B) Manufacturer's Serial Number

This number is individually allocated in sequential order by the manufacture.

(C) Equipment Class Field

This field transmits the equipment type, such as whether it is a mobile station or portable station.

(2) International Mobile Station Identifier (IMSI)

An IMSI is the ID given to identify the mobile station by the service provider and it includes the information shown as below.

(A) Mobile Country Code

This code is encoded as corresponds to CCITT E.212.

(B) National Domain Code

This code is encoded as corresponds to the CCITT E.213.

(C) Service Domain Code

This code is used to identify the services provided.

(D) Local Mobile Station Identifier

This ID is used to identify the mobile station having the same service code.

(3) Temporary Mobile Station Identifier (TMSI)

An abbreviated or short form code which is assigned to the mobile station on a temporary basis for use instead of its IMSI name.

(4) Local Group Identifier (LGI)

LGI is a short form code used to execute group call, and ID group or fleet and soon. LGI is composed of three IDs shown as below.

(A) fleet IDs : This code identifies the number of the fleet attached to mobile station.

(B) group IDs : This code identifies the number of the group attached to mobile station.

(C) individual IDs : This is the number to individually identify a mobile station.

(5) Regional Network Code (RNC)

This code is used to identify the system.

Chapter 3 Specification of Radio Equipment

3.1 Outline

This chapter describes the technical requirements and specifications of the radio equipment in the digital JSMR system.

In this chapter, "a mobile station" includes both a mobile station and a control station.

3.2 General Specification

(1) Radio Frequency Bands

The frequency bands to be used are 800 MHz and 1.5 GHz bands.

800 MHz band : 850 ~ 860 MHz (Outbound)
905 ~ 915 MHz (Inbound)

1.5 GHz band : 1501 ~ 1525 MHz (Outbound)
1453 ~ 1477 MHz (Inbound)

(2) Carrier Frequency Spacing

A carrier frequency spacing is 25 kHz.

(3) Transmit and Receive Frequency Separation

800 MHz band : 55 MHz
1.5 GHz band : 48 MHz

(4) Antenna Power

Antenna power is 2 W or less for a mobile station, and 40 W or less for a base station.

(5) Modulation Scheme

Modulation scheme is the M16QAM ('M' represents "Multi-subcarrier" and the number of subcarriers. 'M' is to be 4).

For the mobile station, an AGC preamble (composed of a carrier signal) is transmitted to improve demodulation of the received signals at the base station. A mobile station may also require linearizer or other technology to improve non-linear distortion of transmit signal. An AGC preamble signal may be used for training. (Refer to Annex-1).

(6) Access Mode

Access mode is TDMA (Time Division Multiple Access).

(7) Number of Multiplex

As to the number of multiplex of TDMA, a six-plex system is the basic system for voice transmission.

(8) Communication Mode

Communication mode is half-duplex using TDM (Time Division Multiplex) for the outbound (base station to mobile station) and TDMA for the inbound (mobile station to base station). However, a mobile station may operate with full-duplex in individual communication (including when connecting to the other communication network system).

At the base station, the bit-recovery relay mode is the basic, however, the error correcting relay mode is also possible.

(9) Transmission Rate

A transmission rate of the signal is 64 kbps.

(10) Voice Coding System

The voice coding system is arbitrary. The voice coding rate is 7.467 kbps (672 bits/90 ms) or less, including error correcting codes.

(11) Frame Length

A frame length of 90 ms (6-plex configuration) is the basic length.

(12) Diversity

A base station uses the diversity reception. It is not specified for a mobile station.

(13) Automatic Frequency Control(AFC)

Transmitter of a mobile station is equipped with AFC.

(14) Antenna Power Control of the Mobile Station

A mobile station has a function to control antenna power for minimum required level (hereinafter "transmission power control").

(15) Time Alignment Control

A mobile station is capable of adjusting its transmission timing, according to the command from a base station.

(16) Fading Compensation

At the transmitting end, the signals (which contain same number of pilot symbols in each subcarrier and their locations are properly offset among each of the subcarriers) are transmitted so that proper interpolation is performed for fading compensation at the receiving end. (Annex-2)

(17) Security Measures

A mobile station is able to have a unique code to prevent unauthorized usage. An encipher system may be used as necessary, to guard the privacy of communicated information.

(18) Measures for Electromagnetic Environment

Considerable countermeasures prevents the possibility of electromagnetic interference between the mounted mobile station and automotive electronics devices.

(19) Radio station Identification(ID) Numbers

A system of ID numbers and transmission procedure is defined, sufficiently considering efficient management of the radio stations as well as security of communication privacy.

(20) Measures for Irregular Emissions

In a mobile station, no emission is allowed, unless a mobile station ID number and system parameters have been provided, and the required signals from the base station are being received.

For the base station, functions and capability are installed to update the carrier and channel configuration (to minimize system damage caused by irregular emissions).

(21) Processing Delay Characteristics

Delays (caused by voice coding, time division multiplexing, and other processing) are within a range so that conversation flow is not affected.

(22) Prohibition of Continuous Transmission

A mobile station has a function to automatically stop transmission within 600 seconds when transmitting continuously by a failure.

3.3 Specification Regarding the Modulation

(1) Modulation Scheme

The modulation is the M16QAM.

The modulation procedure that specifies the modulation scheme is shown in Fig. 3.3-1.

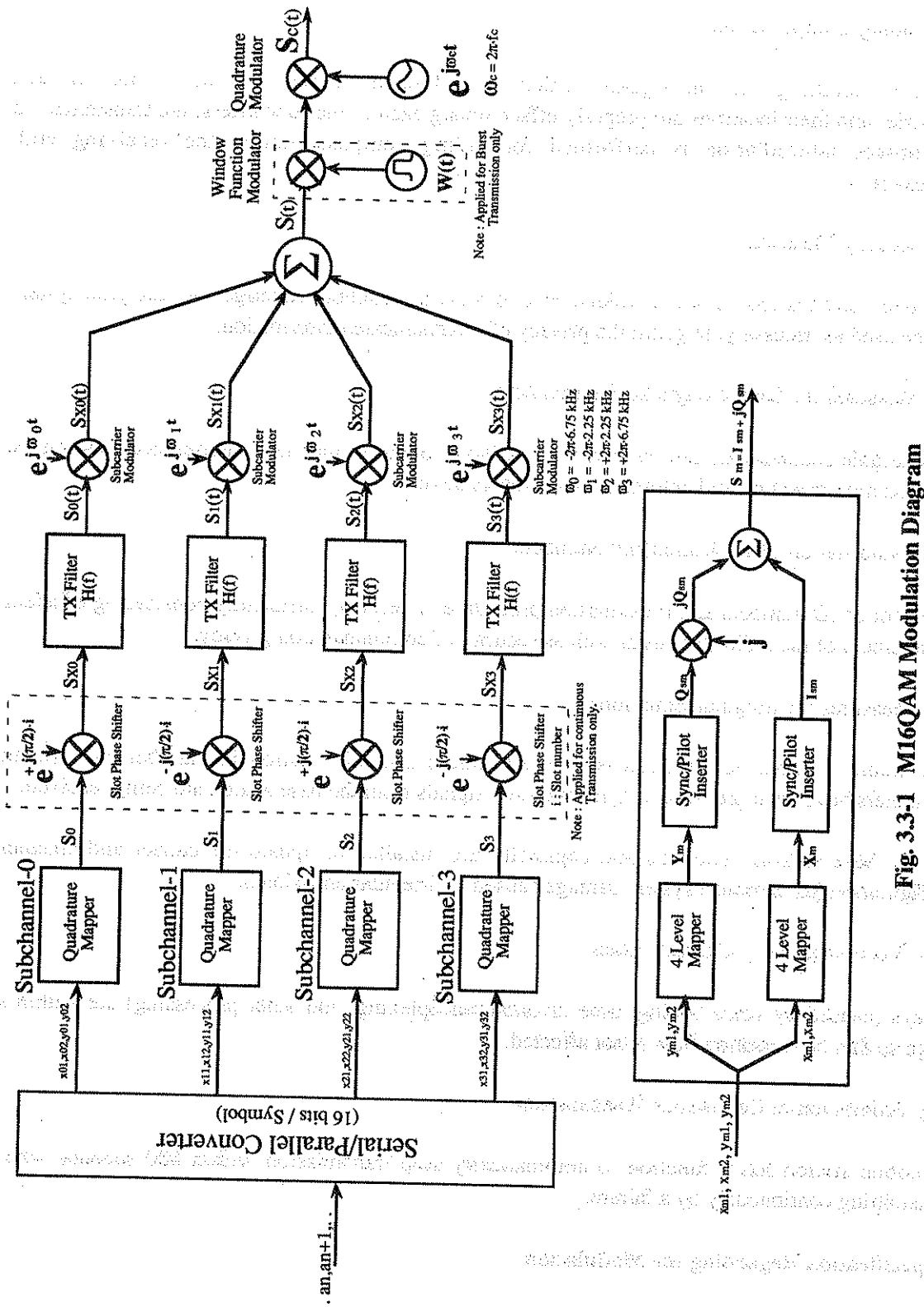


Fig. 3.3-1 M16QAM Modulation Diagram

(2) Coding

(A) Serial/Parallel Conversion

The serial input of the binary data stream a(n) is converted into four sets of 4-bit parallel data [(x_{m1}, x_{m2}), (y_{m1}, y_{m2})] (m=0~3) by every 16 bits. Then each of 4-bit parallel data is input to the corresponding subchannel signal path.

The serial/parallel conversion and bit-mapping to the subcarriers are shown in Table 3.3-1.

Table 3.3-1 Serial/Parallel Conversion

Parallel Data	Sub - 0	Sub - 1	Sub - 2	Sub - 3
x_{m1}	a (n+0)	a (n+4)	a (n+8)	a (n+12)
x_{m2}	a (n+1)	a (n+5)	a (n+9)	a (n+13)
y_{m1}	a (n+2)	a (n+6)	a (n+10)	a (n+14)
y_{m2}	a (n+3)	a (n+7)	a (n+11)	a (n+15)

(B) Quadrature Mapping

Each 4-bit parallel data [(x_{m1}, x_{m2}), (y_{m1}, y_{m2})] (m=0~3) input to each subchannel is further divided into two sets of 2-bit data (x_{m1}, x_{m2}), (y_{m1}, y_{m2}), and fed to the 4-level mappers of I and Q channels, then converted into 16-level quadrature code (Xm, Ym).

Four-level mapping rule is shown in Table 3.3-2. The signal constellation diagram of the 16-level quadrature code is shown in Fig. 3.3-2.

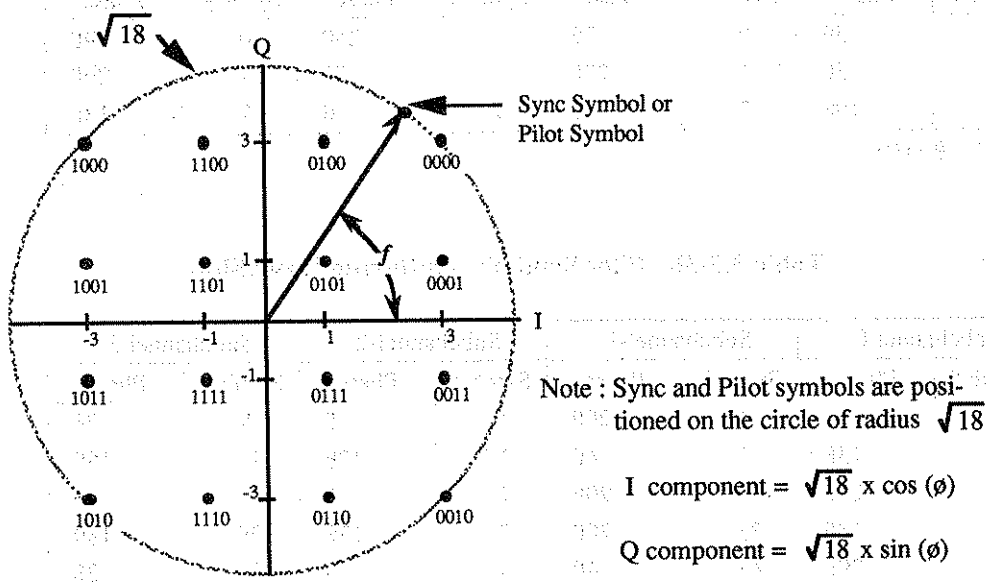


Fig. 3.3-2 Signal Constellation Diagram

Table 3.3-2 4-Level Mapping Rule

xm1, xm2 or ym1, ym2	10	11	01	00
Xm or Ym	-3	-1	+1	+3

(C) Sync/Pilot Symbol Insertion

The sync and pilot symbols are added to the stream of the 16-level quadrature code (Xm, Ym), to form the stream of the subsymbols (Ism, Qsm) on each subchannel. A set of sub symbols at the same position in the four subchannels is referenced as a symbol.

Hereinafter, a complex expression simplifies the following descriptions.

Now, the subsymbol is expressed as Sm = Ism + jQsm (m = 0 ~ 3) in complex value (Multiply Q channel component Qsm by j, then added to the I channel component Ism).

Sync and Pilot symbols are arranged on the circle radius $\sqrt{18}$ that contains the ideal maximum signal points. The plots of the sync and pilot symbols on the signal constellation diagram are shown in Fig. 3.3-2. The values(phase angle) of these sync and pilot symbols and their locations in a slot (symbol number) are as shown in Table 3.3-3. The slot structures used in the digital JSMR system are as shown in Fig. 3.3-3. Details of the slot structure is described in "4.2.2.2 Slot structure".

Table 3.3-3a Sync Symbols

Subchannel-0		Subchannel-1		Subchannel-2		Subchannel-3	
Symb #	Phase	Symb #	Phase	Symb #	Phase	Symb #	Phase
0	3θ	0	7θ	0	25θ	0	29θ
1	3θ	1	27θ	1	5θ	1	29θ
2	19θ	2	31θ	2	θ	2	13θ

Note 1: θ=π/16

Table 3.3-3b Pilot Symbols (Outbound Basic Slot)

Subchannel-0		Subchannel-1		Subchannel-2		Subchannel-3	
Symb #	Phase	Symb #	Phase	Symb #	Phase	Symb #	Phase
5	29θ	9	20θ	9	θ	5	2θ
13	13θ	17	4θ	17	17θ	13	18θ
21	29θ	25	20θ	25	θ	21	2θ
29	13θ	33	20θ	33	17θ	29	18θ
37	29θ	41	4θ	41	θ	37	2θ
45	13θ	49	20θ	49	17θ	45	18θ
53	29θ	57	4θ	57	θ	53	2θ

Note 1: θ=π/16

Table 3.3-3c Pilot Symbols (Inbound Basic Slot)

Subchannel-0		Subchannel-1		Subchannel-2		Subchannel-3	
Symb #	Phase	Symb #	Phase	Symb #	Phase	Symb #	Phase
5	31θ	9	13θ	9	26θ	5	9θ
13	15θ	17	29θ	17	10θ	13	25θ
21	31θ	25	13θ	25	26θ	21	9θ
29	15θ	33	29θ	33	10θ	29	25θ
37	31θ	41	13θ	41	26θ	37	9θ
45	15θ	49	29θ	49	10θ	45	25θ
52	19θ	52	9θ	52	15θ	52	17θ

Note 1: $\theta=\pi/16$

Table 3.3-3d Pilot Symbols (Inbound Subslot)

Subchannel-0		Subchannel-1		Subchannel-2		Subchannel-3	
Symb #	Phase	Symb #	Phase	Symb #	Phase	Symb #	Phase
5	31θ	9	13θ	9	26θ	5	9θ
13	15θ	16	9θ	16	9θ	13	25θ
19	29θ	19	23θ	19	θ	19	7θ

Note 1: $\theta=\pi/16$

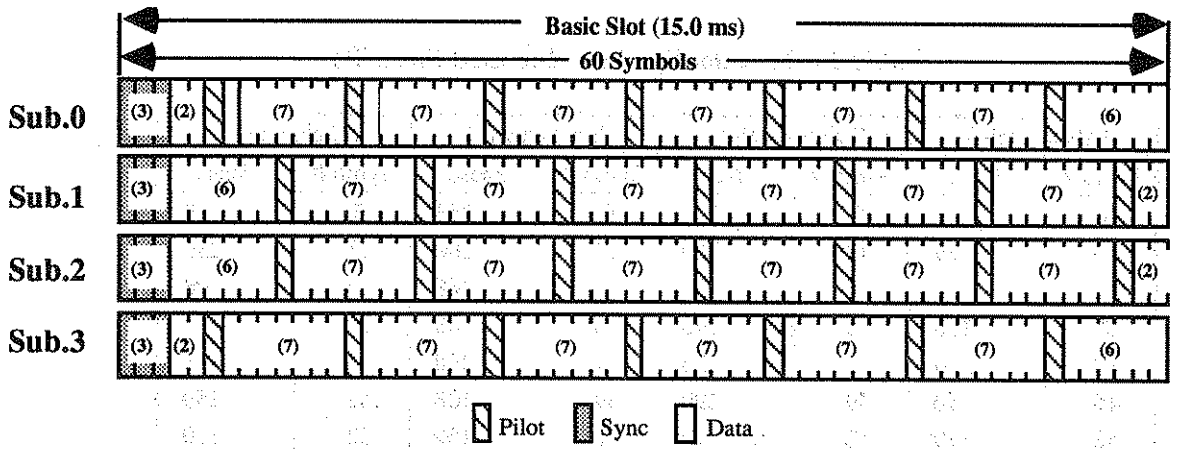


Fig. 3.3-3A Structure of Outbound Basic Slot

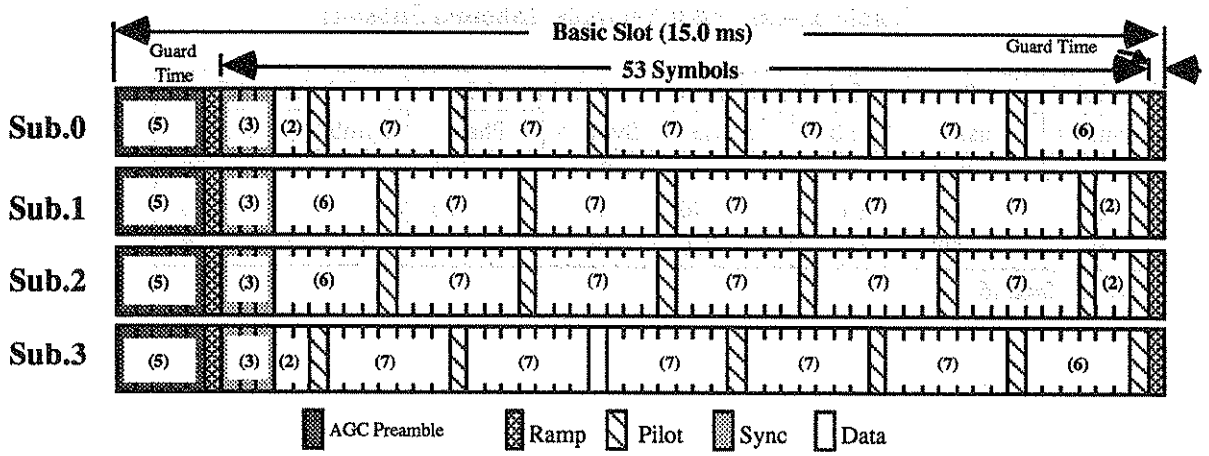


Fig. 3.3-3B Structure of Inbound Basic Slot

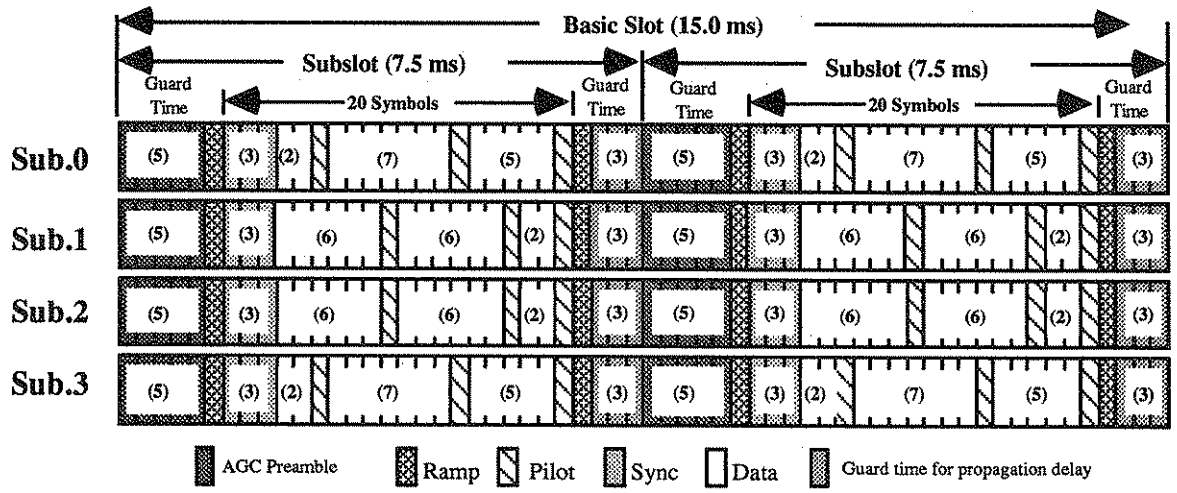


Fig. 3.3-3C Structure of Inbound Subslot

Fig. 3.3-3 Slot Structure

(D) Rotation of the Signal Constellation (Subcarrier Phase Control)

When a base station (outbound) transmits slot signals continuously, the sub symbols Sm (m = 0~ 3) are rotated in their phases (on the signal constellation plane) at the beginning of every slot, and converted to the rotated sub symbols Sxm (m = 0~ 3). The phase rotation procedure is shown in Fig. 3.3-1. Slot number 'i' is the serial number, 0 at the first slot, then incremented by 1 at every subsequent slot.

(3) Baseband Filtering

The rotated sub symbols Sxm (m = 0~ 3) are baseband filtered by the transmission filter specified below, and converted to the subchannel signal Sm(t) (m = 0~ 3).

(A) The baseband filtering uses the Root Nyquist Raised Cosine Spectrum H(f) specified by the following formula ;

$$|H(f)| = \begin{cases} 1 & |f| < (1-a)/2T \\ \cos\left[\frac{T}{4a}\left(2\pi|f| - \pi(1-a)/T\right)\right] & (1-a)/2T \le |f| < (1+a)/2T \\ 0 & (1+a)/2T \le |f| \end{cases}$$

where, T = 250 μs (4 k symbols/sec)

(B) Roll-off factor is 'a' 0.2.

(C) Phase characteristic of H(f) is linear.

(4) Quadrature Modulation

(A) Subcarrier Modulation

Each of the baseband filtered subchannel signal Sm(t) (m = 0 ~ 3) modulates the corresponding subcarrier, then produces the subcarrier signal Sxm(t).

$Sxm(t) = Sm(t) \cdot \exp(j\omega_m \cdot t)$
where, $Sm(t) = F^{-1}[H(f) \cdot F\{Imk(t)\}] + j \cdot F^{-1}[H(f) \cdot F\{Qmk(t)\}]$

'm' represents subchannel number, 'k' represents symbol number, F[x] and $F^{-1}[X]$ represent Fourier transformation and its inverse transformation, respectively.

$\omega_m = 2\pi \cdot fm$ represents angular frequency of subcarriers, and each subcarrier frequency is as shown below ;

$f_1 = -6.75$ kHz
$f_2 = -2.25$ kHz
$f_3 = +2.25$ kHz
$f_4 = +6.75$ kHz

All subcarrier phases are aligned to 0° at the first sync symbol time (when symbol output becomes maximum). For a base station, subcarrier phase is controlled by the rotation of the signal constellation after the first slot.

(B) Subcarrier Signal Combining

Subcarrier signals are combined, then produce M16QAM signal S(t).

$$S(t) = \sum_{m=1}^{4} [Sxm(t)] \qquad m : \text{Subcarrier number}$$
$$= Sx1(t) + Sx2(t) + Sx3(t) + Sx4(t)$$

(C) Carrier Modulation

The quadrature modulation modulates the carrier with the M16QAM signal.

$$Sc(t) = Re[S(t) \cdot \exp(j\omega_c \cdot t)$$
$$= Re[\{ I(t) + j \cdot Q(t) \} \cdot \exp(j\omega_c \cdot t)]$$
$$= I(t) \cdot \cos(\omega_c \cdot t) - Q(t) \cdot \sin(\omega_c \cdot t)$$

where, $Sc(t) = F^{-1}[H(f) \cdot F\{ I_k(t) \}] + j \cdot F^{-1}[H(f) \cdot F\{ Q_k(t) \}]$

'k' represents symbol number; F [x] and F^{-1} [X] represent Fourier transformation and its inverse transformation, respectively.

(5) AGC Preamble

A mobile station transmits an AGC preamble signal (composed of the carrier signal prior to the burst signal) to improve the receive characteristic of the base station, and for training the transmitter linearizer, etc..

(A) Waveform (envelop) of the AGC preamble meets the timings and power levels specified in Fig. 3.3-4 or Fig. 3.3-5, and Table 3.3-4 and Table 3.3-5. The timings are those internal to a mobile station; the power levels are those relative to the average power of the burst signal modulated with the digital signal.

(B) Transmission spectrum of the AGC preamble meets 3.4.1 (5) "Adjacent Channel Coupled Power ".

Table 3.3-4 AGC Preamble Timing

Time	Operation Item	Min.	Typical	Max.
t0	Transmitter turns on	-	-45	-
t1	AGC preamble starts	25	40	65
t2	AGC preamble rises min. power level	365	500	515
t3	AGC preamble falls min. power level	675	750	905
t4	AGC preamble ends	-	-	1000
t5	M16QAM burst starts	-	ts-(4/3)T	-
ts	First symbol output	-	1625	-

Note 1 : Values are in μs. T(symbol time) is 250 μs.

Table 3.3-5 AGC Preamble and M16QAM Burst Power

Power	Operation Item	Typical
a0	Carrier-off leakage power	32nW (-45 dBm)
a1	Power level when no signal	a(av) - 19 dB
a2	AGC preamble min. power level [Note-1]	a(av) + 0 dB
a3	AGC preamble peak power level (Min.) [Note-2]	a(av) + 5 dB
	(Typ.)	a(av) + 8 dB
	(Max.)	a(av) + 14 dB
a4	Upper limit of peak power within a slot	a(av) + 14 dB
a(av)	Average power of M16QAM burst	0 dB

Note s 1 : AGC preamble level is below the power level (a2) during the time segment t2 ~ t3.

2 : AGC preamble level reaches the power level (a3) within the time segment t2 ~ t3.

(6) Transient Response Characteristic of the Burst Transmission

To avoid interference with the other carriers (caused by the rapid changes in amplitude at rising and falling edges of the burst), the window function controls the envelop at the burst edges.

(A) Transmission Timings and Power Ranges of the Burst

The envelop of the burst signal modulated with the digital signal meets the timings and power levels specified in Fig. 3.3-4, Fig. 3.3-5, Table. 3.3-5 and Table. 3.3-6. The timings are those internal to the mobile station.

Table 3.3-6 M16QAM Burst Signal Timing

Time	Operation Item	Typical	Tolerance
t5(twb1)	Front window function starts	ts - (4/3)T	-
t6(twe1)	Front window function ends	ts - (2/3)T	-
ts	First symbol output	1625	-
te	Last symbol output [Note-2]	ts + T (n - 1)	-
T	Symbol Time	250	-
t7(twb2)	Post window function starts	te + (2/3)T	-
t8(twe2)	Post window function ends	te + (4/3)T	+50
t9	Transmitter turns off	t8 + 241.7	+50

Note s 1 : Values are in μs. T(symbol time) is 250 μs.

2 : Number of symbols in a burst is 53 symbols(Basic slot) or 20 symbols(Subslot)

(B) Treatment of the Rising Edge of the Burst

The window function W1(t), shown below, limits impulse responses at the rising edge of the burst.

$$W1(t) = \begin{cases} 0 & t < twb1 \\ \{ 1 - \cos [\pi (t - twb1)/(twe1 - twb1)] \} /2 & twb1 \le t < twe1 \\ 1 & twe1 \le t \end{cases}$$

Where, twb1 is ts - (4/3) T, and twe1 is ts - (2/3) T. 'ts' represents the first sync symbol timing; 'T' represents the symbol time(250 μs).

(C) Treatment of the Falling Edge of the Burst

The window function W2(t) shown below is used to limit impulse responses at the falling edge of the burst.

$$W2(t) = \begin{cases} 1 & t < twb2 \\ \{ 1 + \cos [\pi (t - twb2)/(twe2 - twb2)] \} /2 & twb2 \le t < twe2 \\ 0 & twe2 \le t \end{cases}$$

Where, twb2 is te + (2/3) T, and twe2 is te + (4/3) T. 'te' represents the last pilot symbol timing; 'T' represents the symbol time(250 μs).

(7) Transmission Spectrum

Transmission spectrum meets 3.4.1 (5) "Adjacent Channel Coupled Power".

(8) Modulation Rate

The modulation rate of each subcarrier is 4 k symbols/sec (16 kbps).

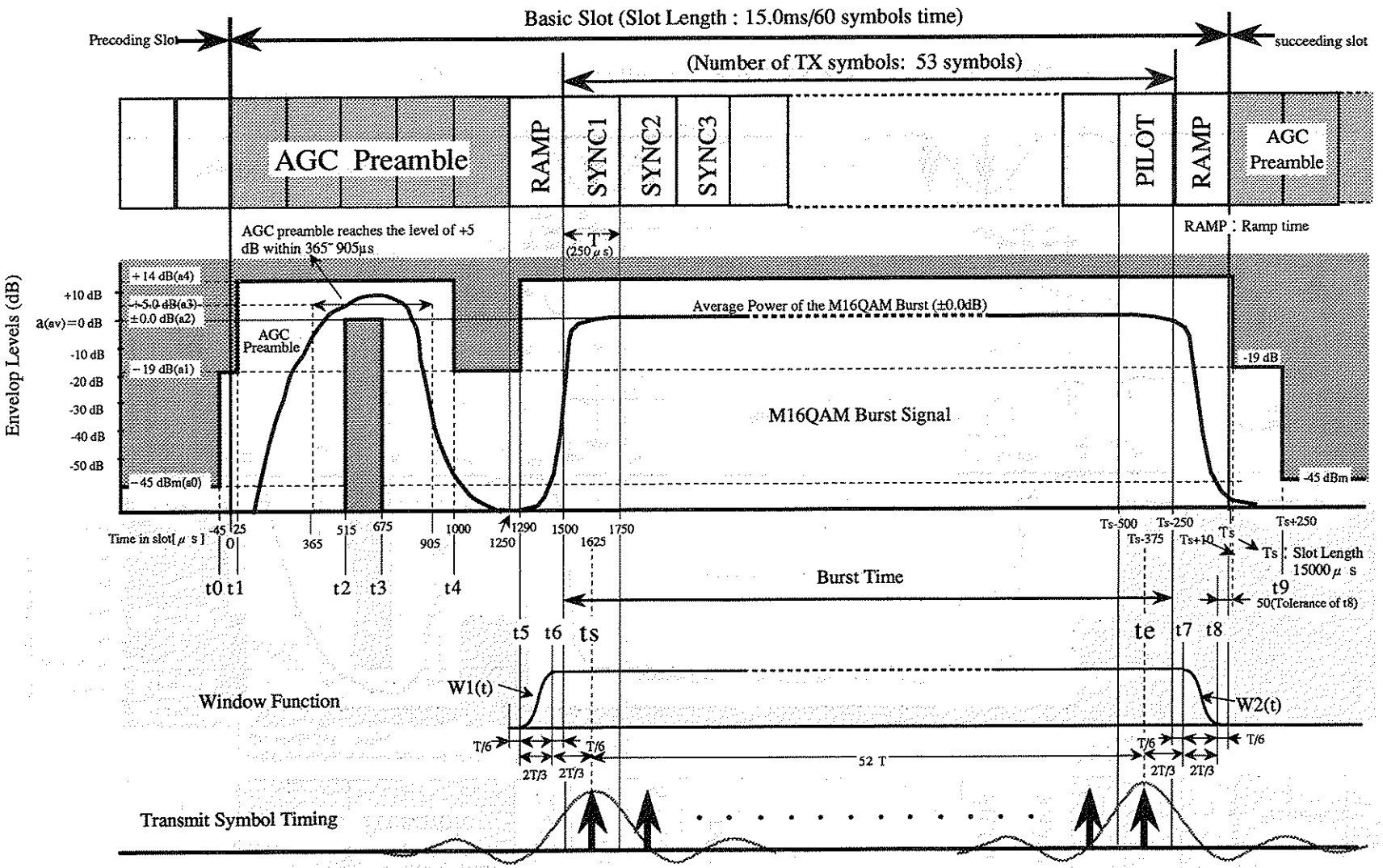


Fig. 3.3-4 AGC Preamble and M16QAM Burst Timings (Basic Slot)

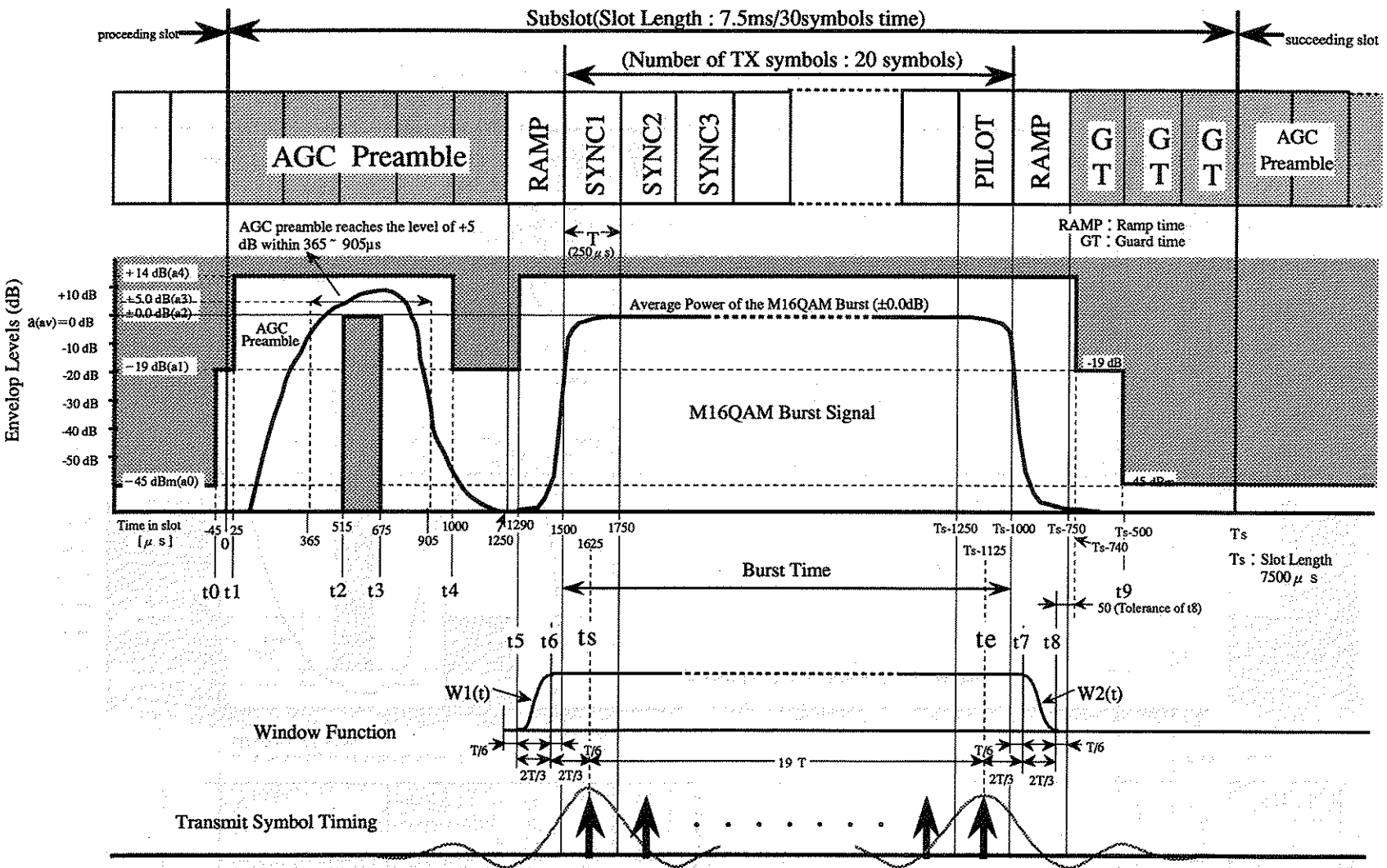


Fig. 3.3-5 AGC Preamble and M16QAM Burst Timings (Subslot)

3.4 Specifications of Transmitter and Receiver

3.4.1 Transmitter

(1) Frequency Tolerance

For a base station, frequency tolerance is within $\pm 0.1 \times 10^{-6}$ or less.

For a mobile station, it is within $\pm 0.15 \times 10^{-6}$ or less when tracking, and within $\pm 2.0 \times 10^{-6}$ when not tracking.

(2) Spurious Emission

For a base station, the greatest allowed strength of spurious emission is –60 dB or less relative to the output power, or 2.5μW.

For a mobile station, it is –60 dB or less relative to the output power, or 0.25μW or less.

(3) Occupied Bandwidth

Occupied bandwidth is 20 kHz or less.

(4) Antenna Power Tolerance

Antenna power tolerance is within +20% and -50%. Where, antenna power of a mobile station means an average power within a time segment transmitting a burst.

(5) Adjacent Channel Coupled Power

Adjacent channel coupled power is the power emitted within the ±9.0 kHz bandwidth centering the frequencies at ±25 kHz away from the carrier frequency concerned, and it is as follows ;

For a base station, it is at least -55 dB or less relative to the output power.

For a mobile station, it is 6.3μW or less and –50 dB or less relative to the output power.

(6) Carrier-off Leakage Power

The power emitted into the slots not transmitting is 32 nW or less for the occupied bandwidth of the transmitting frequency, 4 nW or less for the frequency within the transmission frequency band except for the transmitting frequency, and –60 dB or less relative to the output power, or 0.25μW or less for the frequencies outside of the transmission frequency band.

(7) Radiated Spurious Emission

Radiated spurious emission is 2.5μW or less.

(8) Transmission Power Control

A mobile station has the autonomous power control functions.

When the forced power control is inactive, autonomous power control function always works. The output power of the burst is controlled, depending on the average of the receiving signal level just before the transmission. However, the power control level does not change during a burst.

Table 3.4-1 Autonomous Power Control

Receive Signal Level	Output Power
40 dBμ or greater	240 mW or less
50 dBμ or greater	24 mW or less

(9) Accuracy of Transmission Rate

Accuracy of the transmission rate is within $\pm 5.0 \times 10^{-6}$.

(10) Modulation Accuracy

The modulation accuracy is 15 % or less, which is the root-mean-square of the subsymbol error (i.e., the ratio of the difference between actual signal point and the corresponding ideal signal point to the ideal maximum signal points($\sqrt{18}$)). Errors of subsymbols in four subcarriers to the ideal signal points are individually divided by $\sqrt{18}$, squared and summed together. The sum is divided by the number of subsymbols, then square rooted. The sync and pilot (sub)symbols are included in the measurement.

(11) Tolerance of Subcarrier Frequency

Tolerance of Subcarrier Frequency is within $\pm 5.0 \times 10^{-6}$.

(12) Symbol Timing Alignment

Symbol timing alignment among subchannels is defined as: the relative timing error of subsymbol modulation among the four subchannels. It is within 7.0 μs for the pair of subchannels giving the largest timing error.

(13) Time Alignment Control

The time alignment control range is 0 ~ 750 μs. The step of the time alignment control is 62.5 μs.

(14) Burst Transmission Timing

Burst transmission timing is specified by the position of the sync symbols. It is within ±45.0 μs referring to the standard transmission timing determined by the outbound signal.

3.4.2 Receiver

(1) Frequency Variation of Local Oscillator

The frequency variation of the local oscillator is not specified.

(2) Receiver Sensitivity

The signal modulated with the 511-bit binary pseudo random noise sequence is applied to the receiver. The receiver input levels, which give the Bit Error Rate (BER) equal to 1×10^{-2} under the static condition and 3×10^{-2} under the faded condition, meet the values shown in Table 3.4-2 and 3.4-3 below.

Table 3.4-2 Receiver Sensitivity for a Base Station

Bit Error Rate(BER)	1×10^{-2} (Static)	3×10^{-2} (Faded)
Receiver Input Level	9.0 dBμ or less (Standard Sensitivity)	7.0 dBμ or less

Fading conditions : Maximum Doppler Frequencies are 70 Hz at 1.5 GHz band, and 40 Hz at 800 MHz band.

Table 3.4-3 Receiver Sensitivity for a Mobile Station

Bit Error Rate(BER)	1×10^{-2} (Static)	3×10^{-2} (Faded)
Receiver Input Level	9.0 dBμ or less (Standard Sensitivity)	13.0 dBμ or less

Fading conditions : Maximum Doppler Frequencies are 70 Hz at 1.5 GHz band, and 40 Hz at 800 MHz band.

(3) Spurious Response

The desired signal with a level equal to the [Standard Sensitivity *+ 3 dB] is applied to the receiver. Then, the interference signal modulated with the digital signal (32,767-bit binary PN sequence) and detuned ±50 kHz or more from the desired signal is added. Then the level is adjusted for BER of 1×10^{-2}. The ratio of the interference signal level to the [Standard Sensitivity *+ 3 dB] is 53 dB or greater.

* Standard Sensitivity: See Tables 3.4-2 and 3.4-3.

(4) Adjacent Channel Selectivity

The desired signal with a level equal to the [Standard Sensitivity* + 3 dB] is applied to the receiver. Then, the interference signal(detuned ±25 kHz from the desired signal) modulated with the digital signal (32,767-bit binary PN sequence) is added to the desired signal. Then the level is

adjusted for BER of 1 x 10^{-2} . The ratio of the interference signal level to the [Standard Sensitivity *+ 3 dB] is 42 dB or greater.

* Standard Sensitivity: See Tables 3.4-2 and 3.4-3.

(5) Intermodulation Characteristics

The desired signal with a level equal to the [Standard Sensitivity* + 3 dB] is applied to the receiver. Then, the interference signals, unmodulated and detuned ±50 kHz from the desired signal, and detuned ±100 kHz and modulated with the digital signal (32,767-bit binary PN sequence), are added. The interference signal levels are adjusted for BER of 1 x 10^{-2}. The ratio of the interference signal level to the [Standard Sensitivity* + 3 dB] is 53 dB or greater.

* Standard Sensitivity: See Tables 3.4-2 and 3.4-3.

(6) Conducted Spurious Emission

Conducted spurious emission is 4 nW or less.

(7) Radiated Spurious Emission

Radiated spurious emission is 4 nW or less for the frequencies at 1 GHz or lower, and 20 nW or less for the frequencies between 1 GHz ~ 3 GHz.

(8) Burst Reception Timing

A base station must be able to receive a burst signal on a subslot within the range -45 ~ +795 μs from the reference timing (the receive timing when there is no propagation delay).

On a basic slot, the base station must also receive the burst signal within the range that the reception timing range (specified by a base station) and the burst transmission timing tolerance are combined.

3.4.3 Controller

A mobile station includes the memory device to save the mobile identification number, system parameters, etc..

3.4.4 Repeater Antenna

When installed, it is the basic that the vertical gain characteristic of the base antenna is to be at least 10 dB attenuation from the main beam gain at the direction 3° or more below the horizontal. However, the vertical gain characteristic of the base antenna may be determined depending on the geographical feature of individual systems. The adjacent channel coupled power and carrier-off leakage power of mobile stations must be considered.

Chapter 4 Communication Control System

4.1 Outline

First, Section 4.2 "Basic Interface Requirements" of this chapter defines the physical radio channels and the functional channels in the TDM/TDMA system. The relationship between the two is clarified, and the coding procedure (for the control information transmitted on these channels) is specified.

Second, Section 4.3 "Transmission Control and Radio Link Control" defines the radio link interface of Layer 2 between basestation and mobile station.

Section 4.4 "Layer 3 Control Procedures" defines the protocol for the kinds of communication link like the establishment and release of the communication link.

Section 4.5 "Definition of Message Functions and Contents" defines the messages for radio link management, mobility management and connection management to be used in Layer 3 entity.

In this chapter, group call, individual call and fleetwide call are generically called "dispatch call" and it is used except for PSTN interconnect service. The terms except for "dispatch communication" used in this chapter are explained according to necessity. The expression for numerical values defines as below.

Hexadecimal (base 16) numbers---------- indicated by the prefix "$" : i.e. $FFFF
Binary (base 2) numbers---------- indicated by the prefix "%": i.e. %0110
Decimal (base 10) numbers ---------- no prefix

In this chapter, "a mobile station" includes both a mobile station and a control station.

4.2 Basic Interface Requirements

4.2.1 Radio Carriers

One or more radio carrier(s), from those allocated to the digital JSMR system, are assigned to each system depending on its scale. From these assigned carriers, one or more radio carrier(s) can be used as control carrier(s), and the rest as communication carriers.

(1) Control Carrier

Random access slots are those slots on the radio carrier that can be commonly accessed by all users in a system for communication control (such as communication link establishment). Among the radio carriers assigned to the system, those which include random access slots are called control carriers. For each system, one or more radio carrier(s) can be assigned as control carriers.

(2) Communication Carrier

Following the communication link establishment, a slot is assigned to a user for exclusive use. This slot is called reserved access slot that is individually assigned. Radio carriers that consist of individually assigned slots only are called communication carriers.

4.2.2 Frame Structure

The time section which is the minimum communication unit on the time axis is called "slot" and the repetition of slot which consists of the plural slots on the radio carrier is called "frame". The frame prescribes the multiplexing and principally consists of radio channel with a set of slots in each frame.

In this chapter, the details of frame structure, slot and radio channel is defined.

4.2.2.1 Detailed Frame Structure

Fig. 4.2.2.1-1 shows the frame structure of both inbound and outbound. Each frame consists of 30,240 slots, the length is 15 ms and the duration of the frame is 453.6 seconds.

A hyperframe structure is also defined, in addition to the frame structure shown in Fig. 4.2.2.1-1. The hyperframe comprises 256 frames; thus, it contains a total of 7,741,440 slots and has a duration of 116, 121.6 seconds.

In this section, the terms of such as RS, SS, symbol are more frequently used. These definitions are shown as below.

RS (Real Symbol) ---------- One of 4 values produced in a subchannel modulator. Each real symbol transmits 2 bits of information. This is the minimum element of information in the Quad-QAM modulation scheme.

SS (Subchannel Symbol) --------Refers to a complex symbol in one of the four Quad-QAM subchannels. One SS comprises two RS and transmits 4 bits of information.

Symbol ----------A single point in signal space. In this document, refers to the composite signal emitted by the modulator at a 4kHz rate. Each symbol comprises four SS or eight RS and transfers 16 bits of information.

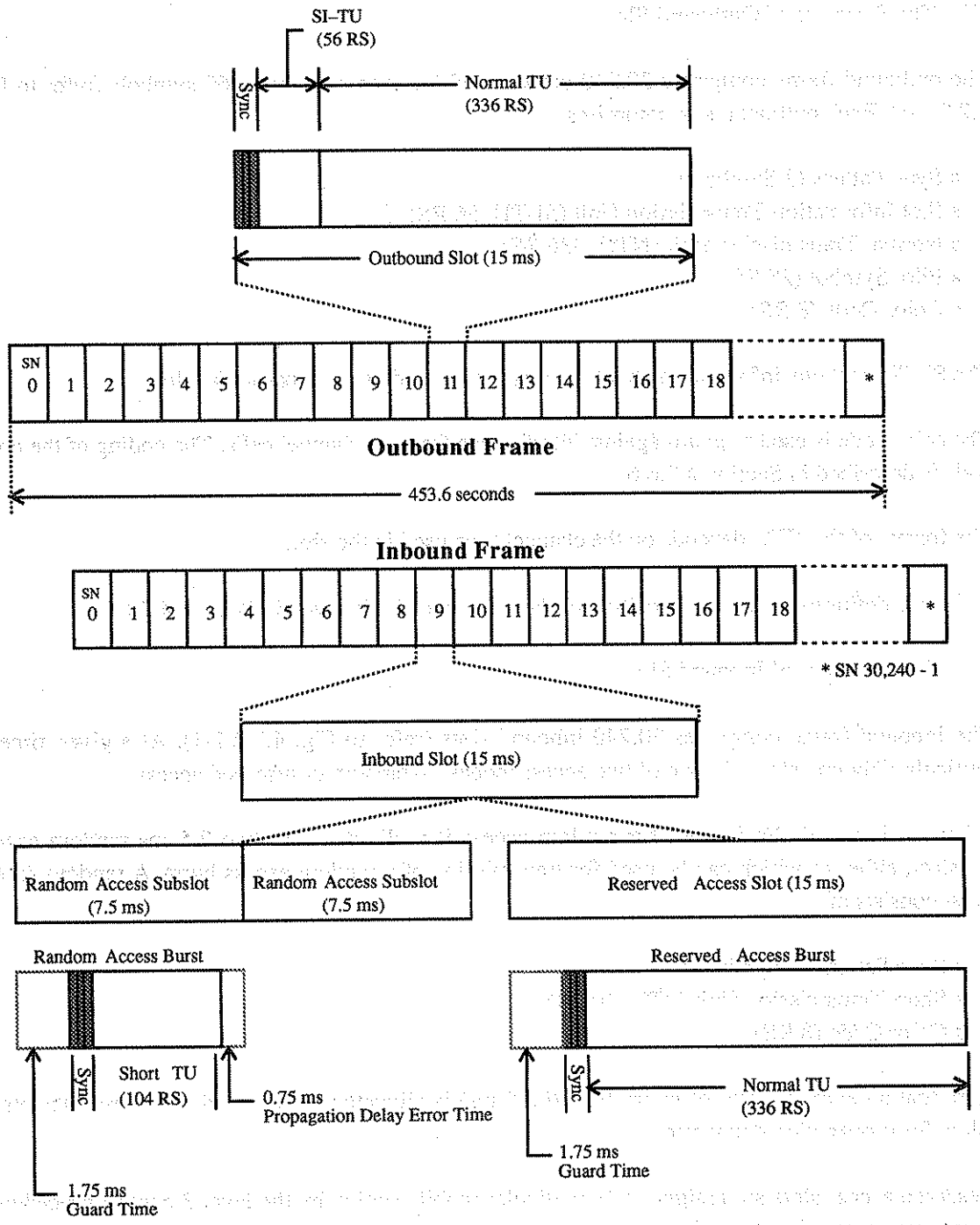


Fig. 4.2.2.1-1 RF Frame Structure

(1) The Structure of Outbound Slot

The outbound frame comprises 30,240 outbound slots, each containing 60 symbols (refer to Fig. 4.2.2.1-1). Each outbound slot comprises:

- a Sync Pattern (3 Symbols)
- a Slot Information Transmission Unit (SI-TU, 56 RS)
- a Normal Transmission Unit (NTU, 336 RS)
- a Pilot Symbol (28 SS)
- a Color Code (8 RS)

The SI-TU contains information about the assignment and use of a particular slot.

The color code is used to guard against interference from co-channel cells. The coding of the color code is described in Section 4.2.6.6.

The format of the NTU depends on the channel type used in the slot.

A precise definition of the composition of the outbound slot is given in Section 4.2.6.7.

(2) The Structure of Inbound Slot

The inbound frame comprises 30,240 inbound slots (refer to Fig. 4.2.2.1-1). At a given time, a particular inbound slot is in one of two access modes — random or reserved access.

When an inbound slot is used for random access it is divided into two 7.5 ms random access subslots, either of which can be used for transmission of a random access burst. A random access burst consists of:

- a Sync Pattern (3 Symbols)
- a Short Transmission Unit (STU, 104 RS)
- a Color Code (8 RS)

Note that an extra amount of guard time (0.75 ms) is allocated within random access subslots to allow for propagation delay error.

Reserved access slots are assigned to a particular mobile station by the layer 3 control procedures. A reserved access burst consists of:

- a Sync Pattern (3 Symbols)
- an NTU (336 RS)
- a Pilot Symbol (28 SS)
- a Color Code (8 RS)

A mobile station using a reserved access slot removes its propagation delay error by advancing its transmissions by the correct amount; thus, no allocation for propagation delay error is required in a reserved access slot. The time alignment value is controlled by a field contained within the SI-TU.

The color code is used to guard against interference from co-channel cells. The coding of the color code is described in Section 4.2.6.6.

The format of the STU and NTU depends on the channel type and LLC protocol being used in the Slot.

A precise definition of the composition of the reserved and random access bursts is given in Table 4.2.6.7-2 and Table 4.2.6.7-3 respectively.

4.2.2.2 Slot Structure

(1) Slot Numbering

Table 4.2.2.2-1 shows the numbering of slots. The operator "div", shows the quotient omitting the figures below the decimal place and "mod" shows the remainder of division. Further , [A..B] expresses the range of between A and B including A and B and "*" shows the multiplication.

Table 4.2.2.2-1 Slot Numbering

Quantity	Usage	Range	Relations
Slot Number (SN)	Numbers slots within each frame	[0..30,239]	SN = xSN mod 30,240
Frame Number (FN)	Numbers frames within each hyperframe	[0..255]	FN = xSN div 30,240
Extended Slot Number (xSN)	Numbers slots within each hyperframe	[0..7,741,439]	xSN = 30,240*FN + SN

The explanation for the frame size (30,240 Slots) is as follows. The factors of 30,240 are

30,240 = (2*2*2*2*3*3*5*7)*(2*3) = 5,040*6. ---------- (Expression 4.2.2.2-1)

The first term (equalling 5,040) is the least common multiple of all of the channel interleaves in Table 4.2.2.3-1. The extra factor of 6 is introduced to permit certain fields to be distributed over several slot descriptor blocks (see, for example, Section 4.2.5).

(2) Frame Offset

Slots are always assigned in pairs. A slot in the outbound frame is corresponding in the inbound frame. Corresponding slots have the same Extended Slot Number (xSN). Fig. 4.2.2.2-1 defines the frame offset precisely.

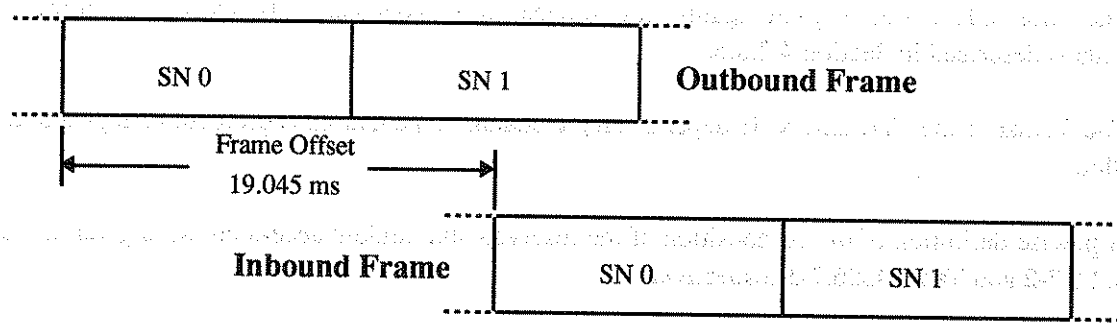


FIg. 4.2.2.2-1 Frame Offset

The reference point at which Fig. 4.2.2.2-1 applies is the FNE base site radio antenna port.

(3) Slot Synchronization

Among the all carriers used by a particular cell, the outbound slot positions are synchronized.

4.2.2.3 The Structure of Channels

(1) Channel Definition

A channel is defined as a collection of slots in a particular frame which are dedicated to a particular use (i.e., a traffic channel or a primary control channel).

For example, suppose we want to set up a 6/1 voice call. This requires allocating a channel made up of, for example, the slots numbered 1, 7, 13, 19, etc.. A channel is uniquely specified by two parameters:

- Interleave ---------- The increment in SN between adjacent channel slots.
- Offset---------- Gives the SN of the first slot in the channel (e.g. that slot which has the lowest SN). The offset is a value in the range [0..Interleave - 1].

Continuing the above example, the channel consisting of slots 1, 7, 13, 19, etc. has an interleave of 6 and an offset of 1. In general, the slots which make up a particular channel may be found by applying the following equation:

SN mod interleave = Offset ---------- (Expression 4.2.2.3-1)

(3) Channel Specifier

A channel specifier is an 8-bit field which precisely identifies the slots which compose channel by giving the interleave and offset. The coding of a channel specifier is shown in Table 4.2.2.3-1.

Table 4.2.2.3-1 Coding of Channel Specifier

Channel Specifier Bits								Channel Interleave	Interleave Code
8(MS)	7	6	5	4	3	2	1(LS)		
0	0	0	1	0	0	0	0	1	$0
0	0	0	1	0	1	n	n	2	$1
0	0	0	1	1	0	n	n	3	$2
0	0	0	1	1	1	n	n	4	$3
0	0	1	0	0	n	n	n	5	$4
0	0	1	0	1	n	n	n	6	$5
0	0	1	1	0	n	n	n	7	$6
0	0	1	1	1	n	n	n	8	$7
0	1	0	0	n	n	n	n	9	$8
0	1	0	1	n	n	n	n	10	$9
0	1	1	0	n	n	n	n	12	$A
0	1	1	1	n	n	n	n	14	$B
1	0	0	0	n	n	n	n	16	$C
1	0	1	n	n	n	n	n	18	$D
1	1	0	n	n	n	n	n	20	$E
1	1	1	n	n	n	n	n	24	$F

4.2.3 The Definition and the Structure of Channel Types

This section describes the various kinds of channels used in the digital JSMR system gives details about their definition and structure. The material discussed in this section summarized in Table 4.2.3-1.

Table 4.2.3-1 JSMR Channel

Channel Type			Inbound Access
Control Channel	Slot Information Channel (SICH)		-
	Primary Control Channel (PCCH)	Broadcast Control Channel (BCCH)	-
		Common Control Channel (CCCH)	Random
		Random Access Channel (RACH)	Random
	Temporary Control Channel (TCCH)		
	Dedicated Control Channel (DCCH)		Reserved
	Associated Control Channel (ACCH)		
Communication Channel	Traffic Channel (TCH)		
	Packet Channel (PCH)		Random / Reserved (R-ALOHA)

4.2.3.1 Slot Information Channel (SICH)

The SICH is an outbound-only broadcast channel used for transmission of slot control information.

4.2.3.2 Primary Control Channel (PCCH)

The PCCH is a multiple-access channel used for layer 3 control signaling between the FNE and mobile stations. Each cell has one PCCH.

The outbound PCCH is subdivided into the Broadcast Control Channel (BCCH) and the Common Control Channel (CCCH). The inbound PCCH is called the Random Access Channel (RACH). All slots of the RACH are random access mode.

The following parameters specify the configuration of the PCCH on a Cell:

PCCH_Interleave ---------- The channel interleave of the PCCH.

PCCH_Offset ---------- The channel offset of the PCCH.

BCCH_Interleave ---------- The increment in the quantity between adjacent BCCH slots on the PCCH.

PA_NSUB ---------- The number of distinct paging subchannels supported on the PCCH.

The parameter BCCH_Interleave creates a subframe structure on the outbound PCCH according the following equations:

PCCH_Subframe = (SN div PCCH_Interleave) div BCCH_Interleave --------- (Expression 4.2.3.2-1)

PCCH_SN = (SN div PCCH_Interleave) mod BCCH_Interleave ---------- (Expression 4.2.3.2-2)

Fig. 4.2.3.2-1 shows an example of the PCCH subframe structure for PCCH_Interleave = 6, PCCH_Offset = 0, and BCCH_Interleave = 8. Only those slots comprising the PCCH are shown in the figure.

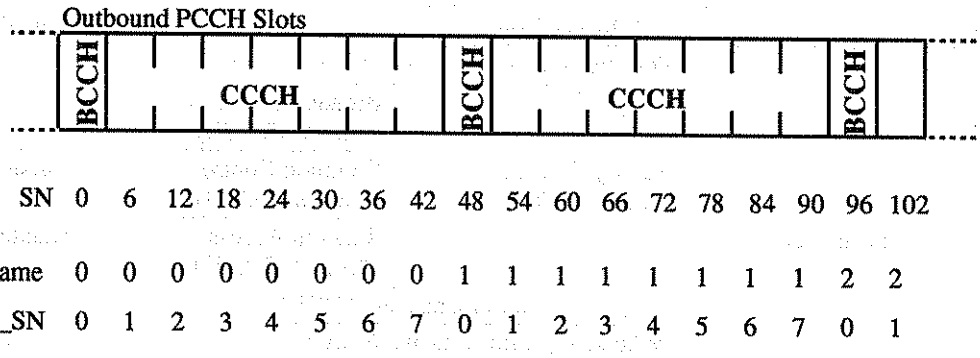


Fig. 4.2.3.2-1 An Example of the PCCH Subframe Structure

(1) Broadcast Control Channel (BCCH)

The BCCH is reserved for messages containing general system information and parameters. Data messages directed to particular mobile stations or groups of mobile stations do not appear on the BCCH.

Considering only those slots belonging to the PCCH, a BCCH slot occurs when PCCH_SN = 0.

(2) Common Control Channel (CCCH)

The CCCH is reserved for data messages directed to particular mobile stations or groups of mobile stations (i.e. channel assignments, paging, etc.).

Considering only those slots belonging to the PCCH, a CCCH slot occurs when PCCH_SN != 0 (Where, "!" denotes "not equal").

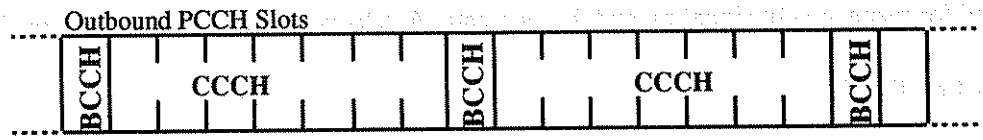
A paging message is a message directed to an individual mobile station to initiate a base-to-mobile call. To reduce the battery drain of idle mobile stations the concept of paging subchannels is introduced. A mobile station calculates which paging subchannel to monitor from the equation:

Paging_Subchannel = (IMSI mod 1000) mod PA_NSUB ----------(Expression 4.2.3.2-3)

The paging subchannel associated with a particular CCCH Slot is

Paging_Subchannel = [PCCH_Subframe*(BCCH_Interleave - 1) + PCCH_SN - 1] mod PA_NSUB. ----------(Expression 4.2.3.2-4)

Fig. 4.2.3.2-2 illustrates the position of paging subchannel slots with PCCH_Interleave = 6, PCCH_Offset = 0, and BCCH_Interleave = 8, and PA_NSUB = 14. Those slots including the PCCH are shown in the Fig. 4.2.3.2-2.



SN	0	6	12	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102
PCCH_Subframe	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	2	2
PCCH_SN	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7	0	1
Paging Subchannel		0	1	2	3	4	5	6		7	8	9	10	11	12	13		0

Fig. 4.2.3.2-2 Illustration of Paging Subchannels

Note that paging subchannel slots are not reserved exclusively for paging messages; these slots may contain data messages which are not paging. The FNE guarantees only that a paging, if and when it appears, appears in a CCCH slot which belongs to the correct paging subchannel.

4.2.3.3 Temporary Control Channel (TCCH)

The TCCH is a multiple-access channel used for layer 3 control signaling. A TCCH is temporarily allocated by layer 3 control to provide a means for inbound random access on a channel which is normally reserved access. Examples of the use of the TCCH include:

During the repeater hang time of a message-trunked dispatch call. During the hang-time interval, the channel type is changed to TCCH and any member of the dispatch group may attempt to gain the right to transmit on the channel by transmitting random access bursts on the TCCH.

When handover is being performed, the target cell allocates a channel to accept the handed-over mobile station. While waiting for the mobile station to appear, the channel type is initially set to TCCH. Then, when the mobile station arrives, it transmits random access bursts on the TCCH to signal its appearance.

Note that the TCCH always appears "in place of" a TCH or DCCH.

4.2.3.4 Dedicated Control Channel (DCCH)

The DCCH is allocated (by means of layer 3 control signaling) for signaling between the FNE and an individual mobile station. The main application of the DCCH is to support the more extended layer 3 control procedures. It can also be used for user data.

4.2.3.5 Associated Control Channel (ACCH)

The ACCH provides a signaling path on a traffic channel. The main application of the ACCH is to support whatever layer 3 control signaling is required for traffic channel supervision. It can also be used for management signaling and for user data. ACCH is assigned dynamically on the TCH.

4.2.3.6 Traffic Channel (TCH)

A TCH is allocated (by means of layer 3 control signaling) for transport of users' circuit-mode voice and data traffic. Either the Voice Channel Procedure (VCP) or Data Channel Procedure (DCP) are used on TCHs.

There are two slightly different applications of the TCH:

The multiple-user TCH is used for dispatch communications. In dispatch, it is common to have a group of mobile stations assigned to the same TCH. One of the mobile stations in the group is designated to transmit on the channel, and the remainder listens on the channel.

The single-user TCH is used for all other types of communications, i.e. telephone and data. A single user TCH is assigned to a particular mobile station for the lifetime of the channel.

4.2.3.7 Packet Channel (PCH)

4.2.4 Mapping of Protocol Transmission Units into the Frame

A Protocol Transmission Unit (PTU) is a fixed-size block of RS, with error correction and detection coding already applied. The size of a PTU and the coding used depends on the particular Logical Link Control (LLC) procedure. The various LLC procedures and the particulars of each PTU are defined in later sections of this specification.

The purpose of this section is to define precisely how the PTUs produced by the various LLC-sublayer procedures are mapped onto the Normal Transmission Units (NTU) and Short Transmission Units (STU) transmitted within the frame. This mapping is a function of the channel type as well as the particular LLC procedure operating on the channel.

4.2.4.1 Structure of MAC Transmission Units

There are three types of Media Access Control Transmission Units (MAC TUs):

- Slot Information Transmission Unit (SI-TU), which consists of 56 RS
- Normal Transmission Unit (NTU), which consists of 336 RS
- Short Transmission Unit (STU), comprising 104 RS

As discussed previously in Section 2.1, the SI-TU appears only in outbound slots; the NTU appears in both outbound slots and inbound reserved access bursts; the STU appears only in inbound random access bursts.

4.2.4.2 Mapping of PTUs into MAC TUs

The following sections describe how the PTUs produced by the various LLC-sublayer procedures are mapped into NTUs and STUs. Table 4.2.4.2-1 provides a "road map" to the various mapping procedures defined below.

Table 4.2.4.2-1 Mapping of PTUs into MAC TUs

Channel Type	Direction of Transmission	MAC TU Used	Mapping Defined in
SICH	Outbound	SI-TU	This section (1)
PCCH & TCCH	Inbound	NTU	This section (2)
	Outbound	STU	This section (3)
DCCH	both	NTU	This section (4)
ACCH	both	NTU	This section (5)
TCH	both	NTU	This section (6)
TCH	both	NTU	This section (7)
PCH	Outbound	NTU	This section (8)
	Inbound	STU	This section (9)
		NTU	This section (10)

The following notation is used throughout the sections below:

- i --- An index into the RS contained within an input PTU.
- p -- An index designating one of the set of PTUs.
- k -- An index into the RS within an NTU or STU. It takes on values [0..335] for NTUs and [0..103] for STUs.
- n -- An index designating one of the set of NTUs into which the input PTUs map. The value n0 designates the first NTU.

(1) Block Interleave on SICH

This produces 56-RS per slot. This is block-interleaved into the SI-TU as follows.

for i = [0..55]
nn = i mod 4 ; kk = i div 4
k = kk + 14*nn

(2) Block Interleave on Outbound PCCH & TCCH

This produces three PTUs, each containing 112 RS per slot. These are concatenated into a single NTU as follows.

for i = [0..111] and p = [0, 1, 2]
nn = i mod 4 ; kk = i div 4
k = 112*p + kk + 28*nn

(3) Block Interleave on Inbound PCCH & TCCH

This produces at most one PTU, containing 104 RS per random access subslot. This is block-interleaved into a single STU as follows.

for i = [0..103]
nn = i mod 4 ; kk = i div 4
k = kk + 26*nn

(4) Block Interleave on DCCH

This produces 332-RS PTU every slot when operating on a DCCH. This is block-interleaved into a single NTU as follows.

for i = [0..331]
nn = i mod 4 ; kk = i div 4
k = 2 + kk + 83*nn

The four RS given by k = {0, 1, 334, 335} are not used and should be set to -1.

(5) Block Interleave on ACCH

This produces at most one PTU every m slots when operating on an ACCH (where m is an integer [1..6]). The length of the PTU is m*83 RS. The PTU is block-interleaved into m consecutive NTUs.

for i = [0 .. m*83 - 1]
nn = i mod m ; kk = i div m
n = n0 + nn
k = 2 + kk

Each PTU steals 83 RS from each of the m NTUs [n0, ... , n0+m-1]. The presence and alignment of an PTU is indicated by the Steal Code (Table 4.2.4.2-2)

Table 4.2.4.2-2 Coding of Steal Code RS

Steal Code Bits		Steal Code RS				Meaning
Bit 1	Bit 2	SC0	SC1	SC2	SC3	
0	0	-3	-3	-3	-3	no steal
0	1	-3	+3	+3	-3	83 RS stolen; NTU n0,...,n0+m-2(not last NTU)
1	0	+3	-3	-3	+3	83 RS stolen; NTU n0+m-1(last NTU)

The four RS SCi are placed into the NTU in the positions indicated in Table 4.2.4.2-3.

Table 4.2.4.2-3 Replacement of Steal Code RS into the NTU

SC RS	k
SC0	0
SC1	1
SC2	334
SC3	335

(6) Block Interleave on TCH (Voice)

This produces one PTU, containing 332 RS per slot. It is mapped into a single NTU as follows.

for i = [0..331]
k = 2 + i

The steal code is used to provide bandwidth for the ACCH on the TCH.

(7) Block Interleave on TCH (Data)

This produces one PTU, containing 332 RS per slot. The PTU is block-interleaved into a single NTU as follows.

for i = [0..331]
nn = i mod 4 ; kk = i div 4
k = 2 + kk + 83*nn

The steal code is used to provide bandwidth for the ACCH on the TCH.

4.2.4.3 Mapping of MAC TUs into the Frame

NTUs appear in both outbound slots and inbound reserved access bursts. The particulars of the placement of the NTUs are defined by Table 4.2.6.7-1 and Table 4.2.6.7-2 respectively.

STUs appear only in inbound random access bursts. An STU is placed into the burst as defined in Table 4.2.6.7-3.

4.2.5 Definition and Structure of SDB

SDB is the outbound element and provides the information about the allocation and use of the channel which contains the corresponding slot to SICH(Slot Information Channel) associated with each outbound slot.

4.2.5.1 Correspondence between Slot and Slot Descriptor Block

The slot descriptor block residing in an outbound slot numbered xSN describes the allocation of outbound slot xSN and inbound slot xSN.

4.2.5.2 General Slot Descriptor Block Format

Fig. 4.2.5.2-1 shows the most general format of the slot descriptor block

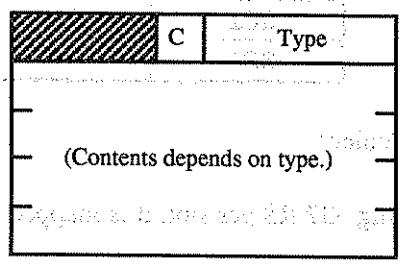


Fig. 4.2.5.2-1 The General Format of the Slot Descriptor Block

Note : Slanting line shows the area including no bits.

- C (1 bit)-------- It is equal to 1 if the outbound frame containing the SDB also contains any primary control channels; otherwise, it is equal to 0.

- Type (4 bits)--- Specifies the allocation of the slot (See Table 4.2.5.2-1)

Table 4.2.5.2-1 Values of the Type Field

Value	Usage	Inbound Access Mode
$0	Unassigned Channel	Not Allowed
$1	BCCH, (a Portion of PCCH)	
$2	CCCH, (a Portion of PCCH)	
$3	TCCH	Random
$4	DCCH	Reserved
$5..$7	Reserved	
$8	TCH+ACCH Multiple User Format	Reserved
$9	TCH+ACCH Single User Format	Reserved
$A	PCH	Random
$B		Reserved
$C..$E	Reserved	
$F	Reserved for testing	

4.2.5.3 Unassigned Channel (Type $0)

This slot descriptor block identifies unassigned slots. It contains information which directs mobile stations to a PCCH.

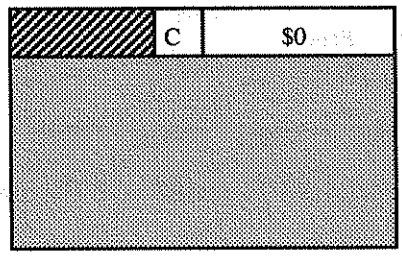


Fig. 4.2.5.3-1 Type $0 SDB Format

4.2.5.4 Broadcast Control Channel (BCCH:Type $1)

This slot descriptor block identifies slots comprising the BCCH portion of a PCCH.

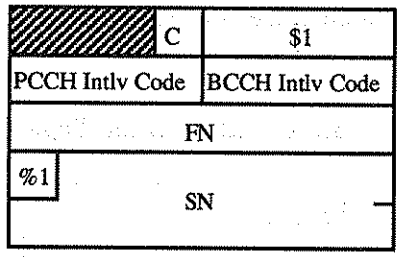


Fig. 4.2.5.4-1 Type $1 SDB Format

- PCCH Intlv Code (4 bits) ------ Gives the value of PCCH_Interleave (refer to Section 4.2.3.2) using the coding defined in Table 4.2.2.3-1.
- BCCH Intlv Code(4 bits)-------- Gives the value of BCCH_Interleave (refer to Section 4.2.3.2) using the coding defined in Table 4.2.2.3-1.
- FN (1 byte) and SN (15 bits)----- Define the position of the associated slot within the hyperframe.

4.2.5.5 Common Control Channel (CCCH: Type $2)

This slot descriptor block identifies slots which comprise the CCCH portion of a PCCH.

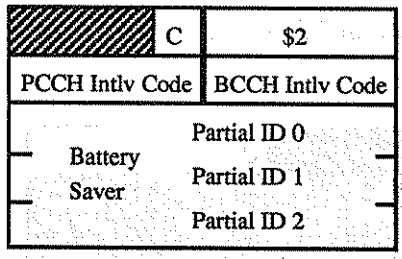


Fig. 4.2.5.5-1 Type $2 SDB Format

- PCCH Intlv Code (4 bits) and BCCH Intlv Code (4 bits)
  ---------- Coded in the same manner as in the type $1 SDB.
- Battery Saver (3 bytes)-------- Contains three 1-byte "partial" identifiers, Partial ID 0 through Partial ID 2.

A mobile station examines each Partial ID to determine if it needs to decode the corresponding Protocol Data Unit (PDU). The algorithm for calculating and evaluating Partial IDs is used in Layer 3.

4.2.5.6 Temporary Control Channel (TCCH : Type $3)

This slot descriptor block identifies the slots which comprise a TCCH. A TCCH is created when it is necessary to support random access on a channel which is normally reserved access. The random access procedure is used in a TCCH.

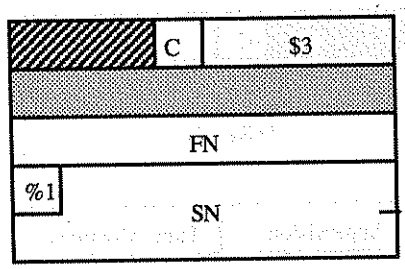


Fig. 4.2.5.6-1 Type $3 SDB Format

4.2.5.7 Dedicated Control Channel (DCCH : Type $4)

This slot descriptor block identifies the slots comprising a DCCH. A DCCH is assigned to an individual mobile station and is used for extended layer 3 control signaling.

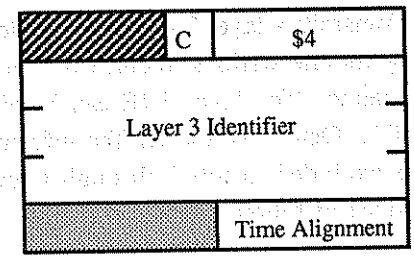


Fig. 4.2.5.7-1 Type $4 SDB Format

- Layer 3 Identifier (3 bytes)---Designates the individual mobile station which is assigned to transmit on the channel. The mobile station is identified using octets 2 through 4 of random reference information element. Octet 1 of the IE, the information element identifier (IEI), is excluded.

- Time Alignment (4 bits) ------Controls the transmitting mobile stations time alignment value. This field allows the FNE to remove propagation delay error from the inbound bursts. This field is interpreted as an unsigned number in the range [0..15]. The amount of time alignment is specified absolutely and is equal to (Time alignment value)*62.5μs.

4.2.5.8 Traffic Channel (TCH:Type $8) and Associated Control Channel (ACCH:Type $9)

Both of these slot descriptor block are used to identify the slots which comprise a TCH together with its ACCH.

The type $8 SDB designates the multiple user format TCH. It is used for TCHs in which a group of mobile stations listen on the channel with one of the mobile stations in the group assigned to transmit on the channel. This situation is typical of dispatch communications

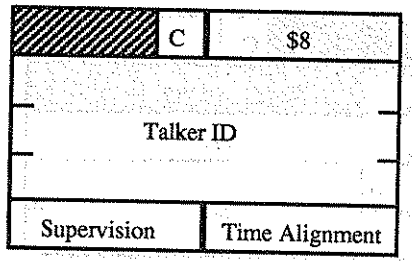


Fig. 4.2.5.8-1 Type $8 SDB Format

- Talker ID (3 octets)---------- Identifies the mobile station which is permitted to transmit on the channel. It contains octets 2 through 4 of the layer 3 "Individual ID" information element. The information element identifier (octet 1) is excluded.

- Supervision (4 bits)---------- Transmits a layer 3 information element (IE) which can be checked by mobile stations to confirm that they are allowed to monitor the channel. The layer 3 IE can be either "Individual ID" or "Group ID". Octet 1 of the IE (the information element identifier, or IEI) is excluded; octets 2 through 4 are packed into a sequence of six SDBs as follows.

Given a TCH of a particular interleave and a particular slot in the channel, let

SV_INDEX = (SN div Interleave) mod 6.---------- (Expression 4.2.5.8-1)

Then, Table 4.2.5.8-1 defines which bits of the IE occupy the supervision field as a function of SV_INDEX

Table 4.2.5.8-1 Placement of ID into Supervision Field

SV_INDEX	IE Octet	IE Bits			
0	2	8	7	6	5
1	2	4	3	2	1
2	3	8	7	6	5
3	3	4	3	2	1
4	4	8	7	6	5
5	4	4	3	2	1

- Time Alignment (4 bits)-------- Coded in the same manner as in the type $4 SDB .

The type $9 SDB is the single user format, used for TCHs which are dedicated to a single mobile station. This situation is typical for telephone and data communications.

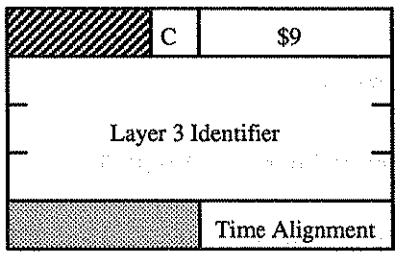


Fig 4.2.5.8-2 Type $9 SDB Format

- Layer 3 Identifier (3 octets) and Time Alignment (4 bits)
  ---------- Coded in the same way as in the type $4 SDB.

4.2.5.9 Packet Channel (PCH:Type $A)

Not prescribed.

4.2.6 Channel Coding

4.2.6.1 The Principle of Channel Coding

Channel coding procedure is shown as below.

(1) Serialization Procedure

(2) Scrambling

(3) CRC Calculation Procedure

(4) Forward Error Correction Procedure

The following sections give a detailed description.

4.2.6.2 PDU Serialization Procedure

Let n be the number of bits in the PDU. The bit string p[ ] = p[0], p[1], ... , p[n-1] is obtained by scanning the bits of the PDU in row order, from upper left to lower right (Fig. 4.2.6.2-1).

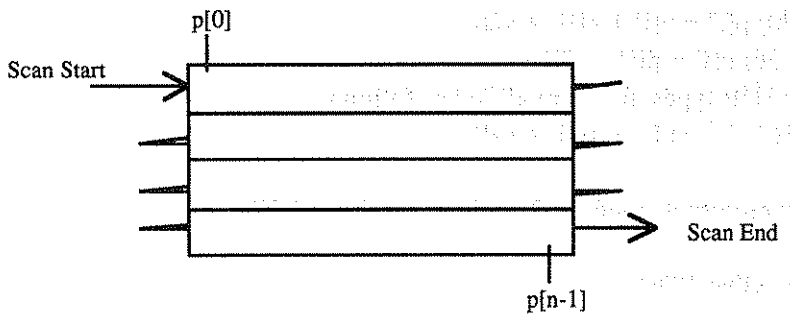


Fig. 4.2.6.2-1 Generation of Bit String p[ ] from PDU

4.2.6.3 Scrambling Procedures

(1) Scrambling Slot Descriptor Blocks

The input to the scrambler is the bit string p[ ] of length 37.

Scrambling of the SDB uses two scrambling strings, s1[ ] and s2[ ].

(A) Generating s1[ ]

Let x be a 16-bit unsigned integer, s1[ ] be a bit string which is initially empty, and the Slot Number (SN) of the slot in which the SDB is to be transmitted.

Step 1 : Let x = 2*SN + 1
Step 2 : Repeat steps 3 and 4 until the length of s1[ ] is equal to 48.
Step 3 : Let x = (x*21851) mod 65536
Step 4 : Append the 16 bits of x to s1[ ], beginning with MSB of x and ending with LSB of x

This procedure produces a bit string s1[ ] of length 48.

(B) Generating s2[ ]

Let x be a 16-bit unsigned integer, s2[ ] be a bit string which is initially empty, and CC the color code used on the carrier.

Step 1 : Let x = 2*CC + 1
Step 2 : Repeat steps 3 and 4 until the length of s2[ ] is equal to 48.
Step 3 : Let x = (x*21851) mod 65536
Step 4 : Append the 16 bits of x to s2[ ], beginning with MSB of x and ending with LSB of x

This procedure produces a bit string s2[ ] of length 48.

(C) Scrambling p[ ]

For BCCH (type 1) and TCCH (type 3) SDBs, the bits of p[ ] are modified as follows:

for i = [5 .. 20] p[i] = p[i] + s1[i] + s2[i]
for i = [22 .. 36] p[i] = p[i] + s2[i]
For all other SDB types, p[ ] is modified as follows:
for i = [5 .. 36] p[i] = p[i] + s1[i] + s2[i]

The "+" sign represents modulo-2 addition (exclusive-OR).

(2) Scrambling other PDUs

The input to the scrambler is the bit string p[ ] of length n.

(A) Generating s[ ]

Let x be a 16-bit unsigned integer, s[ ] be a bit string which is initially empty, and the Slot Number (SN) of the last slot in which any bit of p[ ] is to be transmitted. The procedure for generating the scrambling pattern s[ ] is:

Step 1 : Let x = 2*SN + 1
Step 2 : Repeat steps 3 and 4 until the length of s[ ] is greater than or equal to n.
Step 3 : Let x = (x*21851) mod 65536
Step 4 : Append the 16 bits of x to s[ ], beginning with MSB of x and ending with LSB of x

This procedure produces a bit string s[ ] of length greater than or equal to n.

(B) Scrambling p[ ]

The scrambled output string p[ ] is then obtained by exclusive-OR operation corresponding elements in s[ ] and p[ ], i.e.

for i = [0 .. n -1]
if(S_LOWER <= i < S_UPPER) p[i] = p[i] + s[i]

4.2.6.4 CRC Calculation Procedures

(1) General

This section describes the details of CRC calculation. The steps involved are:

Step 1 : Form the polynomial M(x) from the input string p[ ].
Step 2 : Calculate the CRC polynomial C(x) using polynomial division.
Step 3 : Form the output bit string.

The generator polynomials used in CRC calculation are summarized in Table 4.2.6.4-1.

(2) Form PDU Polynomial P(x)

Let p[ ] be the input string of length n. Form the polynomial M(x) of order n-1 in which p[0] is the coefficient of x^{n-1} and p[n-1] is the coefficient of x0:

$M(x) = p[0]x^{n-1} + p[1]x^{n-2} + ... + p[n-2]x^{1} + p[n-1]$. ----------(Expression 4.2.6-1)

(3) Calculate CRC Polynomial C(x)

Let I(x) be a polynomial of order r-1 with all coefficients equal to one, i.e.

$I(x) = x^{r-1} + x^{r-2} + ... + x^{1} + 1$. ----------(Expression 4.2.6-2)

The CRC polynomial C(x) of order r-1 is calculated by polynomial division:

$C(x)=c_{r-1}x^{r-1}+c_{r-2}x^{r-2}+...+c_1x^1+c_0=\text{Remainder}[\ x^r M(x)/G(x)\ ]+I(x)$. ---------(Expression 4.2.6-3)

(4) Form Output Bit String

The CRC is then appended to the PDU to form B(x):

$B(x)=x^r M(x)+C(x)=p[0]x^{n+r-1}+p[1]x^{n+r-2}+...+p[n-2]x^{r+1}+p[n-1]x^r+c_{r-1}x^{r-1}+c_{r-2}x^{r-2}+...+c_1x^1+c_0$ ---------- (Expression 4.2.6.4-4)

The output bit string b[ ] of length n+r is obtained by reading out the coefficients of B(x) from left to right:

$b[\ ]=b[0], b[1], ..., b[n+r-1]=p[0], p[1], ..., p[n-2], p[n-1], c_{r-1}, c_{r-2}, ..., c_1, c_0$

.---------- (Expression 4.2.6-5)

The length n+r of b[ ] is referred to by the name N_BITS in following sections.

(5) Generator Polynomials

The length of the CRC, and hence the particular generator polynomial used, is protocol specific. The polynomials used are tabulated in Table 4.2.6.4-1.

Table 4.2.6.4-1

CRC Length r	G(x)
16	$X^{16}+X^{12}+X^5+1$
19	$X^{19}+X^5+X^2+X^1+1$
21	$X^{21}+X^{14}+X^7+X^2+1$
29	$X^{29}+X^{23}+X^{10}+X^9+X^5+X^4+X^3+X^2+1$

4.2.6.5 Forward Error Correction Procedures

(1) Rate 1/2 Code

(A) General

The input to the rate 1/2 FEC is the scrambled bit string b[ ] of length N_BITS. The steps used to obtain the PTU are:

Step 1 : N_FLUSH zero bits are appended to the end of b[ ].
Step 2 : Each bit in the resulting string is sequentially trellis coded into an RS, forming an RS string.
Step 3 : N_PUNC RS are eliminated (punctured).

The remaining RS form the PTU.

Table 4.2.6.5-1 shows the protocol-specific parameters required to completely specify a rate 1/2 FEC

Table 4.2.6.5-1 Parameters Used to Specify Rate 1/2 FEC

Parameter	Description
N_BITS	Number of bits in PDU+CRC
N_FLUSH	Number of flush-outs (must be>=3)
N_PUNC	Number of RS to puncture

In addition, if N_PUNC is not zero, the location (indices) of the punctured RS must be specified.

The following sections give a detailed description of the steps listed above.

(B) Append Flush-Outs

Let c[ ] be a bit string of length N_BITS + N_FLUSH, initialized to all zero bit values. Copy b[ ] into c[ ] as follows:

for n = [0 .. N_BITS - 1] c[n] = b[n]. ----------(Expression 4.2.6.5-1)

(C) Rate 1/2 Trellis Code

The trellis coder is modelled as a finite state machine. The initial state is zero. The coder operates on the input bit string one bit at a time beginning with c[0] and ending with c[N_BITS + N_FLUSH-1].

For each bit in the input string, the coder changes state as specified in Table 4.2.6.5-2 and emits one RS as specified in Table 4.2.6.5-3.

Table 4.2.6.5-2 Rate 1/2 Trellis Coder Next State Table

Current State	Input Bit Value	
	0	1
0	0	1
1	2	3
2	4	5
3	6	7
4	0	1
5	2	3
6	4	5
7	6	7

Table 4.2.6.5-3 Rate 1/2 Trellis Coder Output Symbol Table

Current State	Input Bit Value	
	0	1
0	+1	-3
1	+3	-1
2	-3	+1
3	-1	+3
4	-3	+1
5	-1	+3
6	+1	-3
7	+3	-1

As each RS is output by the coder it is appended to the previously output RS, eventually forming an output RS string rs[ ] of length N_BITS+N_FLUSH.

(D) Puncture

N_PUNC RS are then eliminated (punctured) from the RS string rs[ ] produced by the trellis coder. The number of RS punctured, and the locations (indices) of these RS, depends on the particular FEC application. The remaining (unpunctured) RS are gathered into the RS string t[ ] (without otherwise changing the order) and these RS comprise the PTU. The length of t[ ] is

N_PTU = N_BITS+N_FLUSH ---------- (Expression 4.2.6.5-2)

(2) Rate 3/4 Code

(A) General

The input to the FEC procedure is the string b[ ] of length N_BITS. The steps used to obtain the PTU are:

Step 1 : N_FLUSH zero bits are appended to the bit string.
Step 2 : Bits in the resulting string are grouped three at a time to form a tri-bit string.
Step 3 : Each tri-bit is sequentially trellis coded into two RS, forming an RS string.
Step 4 : N_PUNC RS are punctured.

The remaining RS form the NTU.

Table 4.2.6.5-4 shows the application-specific parameters required to specify the rate 3/4 FEC.

Table 4.2.6.5-4 Parameters Used to Specify Rate 3/4 FEC

Parameter	Description
N_BITS	Number of bits in PDU+CRC
N_FLUSH	Number of flush-outs (must be>=9)
N_PUNC	Number of RS to puncture

Note that N_BITS + N_FLUSH must be an integer multiple of 3.

(B) Append Flush-Outs

N_BITS + N_FLUSH must be an integer multiple of 3.

Let c[ ] be a bit string of length N_BITS+N_FLUSH, initialized to all zero bit values. Copy b[ ] into c[ ] as follows:

for n = [0 .. N_BITS - 1] c[n] = b[n].

(C) Group into Tri-Bits

Define the tri-bit string t[ ] of length N_TRI_BIT = (N_BITS+N_FLUSH)/3. The kth element t[k] comprises the three bits t[k][0], t[k][1], t[k][2].

The bit string c[ ] is assigned into the tri-bit string t[ ] in accordance with the equations:

for n = [0 .. N_BITS+N_FLUSH-1]
t[n/3][n%3] = c[n].

(D) Trellis Code

The trellis coder is modelled as a finite state machine. The initial state is zero. The coder operates on the input tri-bit string one element at a time beginning with t[0] and ending with t[N_TRI_BIT-1].

For each element in the input string, the coder changes state as specified in Table 4.2.6.5-5 outputs two RS as specified in Table 4.2.6.5-6 and Table 4.2.6.5-7.

Each entry of Table 4.2.6.5-6 contains an symbol index which specifies the particular 2RS sequence defined in Table 4.2.6.5-7.

Table 4.2.6.5-5 Rate 3/4 Trellis Coder Next State Table

Current State	Input tri-bit t [ ] [0], t [ ] [1], t [ ] [2]							
	000	001	010	011	100	101	110	111
0	0	1	2	3	0	1	2	3
1	4	5	6	7	4	5	6	7
2	0	1	2	3	0	1	2	3
3	4	5	6	7	4	5	6	7
4	0	1	2	3	0	1	2	3
5	4	5	6	7	4	5	6	7
6	0	1	2	3	0	1	2	3
7	4	5	6	7	4	5	6	7

Table 4.2.6.5-6 Rate 3/4 Trellis Coder Output Symbol Table

Current State	Input tri-bit t [ ] [0], t [ ] [1], t [ ] [2]							
	000	001	010	011	100	101	110	111
0	0	2	4	6	8	10	12	14
1	1	3	5	7	9	11	13	15
2	2	0	6	4	10	8	14	12
3	3	1	7	5	11	9	15	13
4	4	6	0	2	12	14	8	10
5	5	7	1	3	13	15	9	11
6	6	4	2	0	14	12	10	8
7	7	5	3	1	15	13	11	9

As each RS pair (x, y) is output by the coder, first RSx and then RSy are appended to the previously output RS.

Table 4.2.6.5-7 Rate 3/4 Trellis Coder Real Symbol Values

Symbol Index	RSx	RSy
0	+1	-1
1	–1	–1
2	+3	–3
3	–3	–3
4	–3	–1
5	+3	–1
6	–1	–3
7	+1	–3
8	–3	+3
9	+3	+3
10	–1	+1
11	+1	+1
12	+1	+3
13	–1	+3
14	+3	+1
15	–3	+1

(E) Puncture

N_PUNC RS are then eliminated (punctured) from the RS string rs[ ] produced by the trellis coder. The number of RS punctured, and the locations (indices) of these RS, depends on the particular FEC application. The remaining (unpunctured) RS are gathered into the RS string t[ ] (without otherwise changing the order) and these RS comprise the PTU. The length of t[ ] is

N_PTU = 2*N_TRI_BIT = 2*(N_BITS+N_FLUSH)/3. ---------- (Expression 4.2.6.5-3)

4.2.6.6 Definition of Color Code

There are 16 color codes. These are coded into 8 RS according to Table 4.2.6.6-1.

Table 4.2.6.6-1 Coding of Color Code RS

Color Code No.	Color Code RS							
	CC0	CC1	CC2	CC3	CC4	CC5	CC6	CC7
0	–3	–3	–3	–3	–3	–3	–3	–3
1	–3	–3	–3	+3	–3	–3	–3	+3
2	–3	–3	+3	–3	–3	–3	+3	–3
3	–3	–3	+3	+3	–3	–3	+3	+3
4	–3	+3	–3	–3	–3	+3	–3	–3
5	–3	+3	–3	+3	–3	+3	–3	+3
6	–3	+3	+3	–3	–3	+3	+3	–3
7	–3	+3	+3	+3	–3	+3	+3	+3
8	+3	–3	–3	–3	+3	–3	–3	–3
9	+3	–3	–3	+3	+3	–3	–3	+3
10	+3	–3	+3	–3	+3	–3	+3	–3
11	+3	–3	+3	+3	+3	–3	+3	+3
12	+3	+3	–3	–3	+3	+3	–3	–3
13	+3	+3	–3	+3	+3	+3	–3	+3
14	+3	+3	+3	–3	+3	+3	+3	–3
15	+3	+3	+3	+3	+3	+3	+3	+3

The 8 RS CCi are placed into the outbound slot, inbound random access burst, and inbound reserved access burst in the positions indicated in Table 4.2.6.7-1–Table 4.2.6.7-3.

4.2.6.7 Symbol Mappings

The tables which appear in this section define precisely the placement of RS within the outbound slot, inbound reserved access burst, and inbound random access burst. The notation used in the tables is:

- SSi : Sync SS
- Di : SI-TU RS
- Pi : Pilot SS
- CCi : Color Code RS
- Ti : NTU or STU RS

(1) Outbound Slot

Table 4.2.6.7-1 Mapping onto Symbols of an Outbound Slot

Sym-bol	Subchannel 0		Subchannel 1		Subchannel 2		Subchannel 3		Usage
	X	Y	X	Y	X	Y	X	Y	
0	SS0		SS1		SS2		SS3		Sync Pattern
1	SS4		SS5		SS6		SS7		
2	SS8		SS9		SS10		SS11		
3	D0	D1	D2	D3	D4	D5	D6	D7	SI-TU (index k)
4	D8	D9	D10	D11	D12	D13	D14	D15	
5	P0		D18	D19	D20	D21	P1		
6	D16	D17	D26	D27	D28	D29	D30	D31	
7	D25	D25	D34	D35	D36	D37	D30	D31	
8	D32	D33	D42	D43	D44	D45	D38	D39	
9	D40	D41	P2		P3		D46	D47	
10	D48	D49	D50	D51	D52	D53	D54	D55	
11	CC0	CC1	CC2	CC3	T0	T1	T2	T3	NTU (index k)
12	T4	T5	T6	T7	T8	T9	T10	T11	
13	P4		T14	T15	T16	T17	P5		
14	T12	T13	T22	T23	T24	T25	T18	T19	
15	T20	T21	T30	T31	T32	T33	T26	T27	
16	T28	T29	T38	T39	T40	T41	T34	T35	
17	T36	T37	P6		P7		T42	T43	
18	T44	T45	T46	T47	T48	T49	T50	T51	
19	T52	T53	T54	T55	T56	T57	T58	T59	
20	T60	T61	T62	T63	T64	T65	T66	T67	
21	P8		T70	T71	T72	T73	P9		
22	T68	T69	T78	T79	T80	T81	T74	T75	
23	T76	T77	T86	T87	T88	T89	T82	T83	
24	T84	T85	T94	T95	T96	T97	T90	T91	
25	T92	T93	P10		P11		T98	T99	
26	T100	T101	T102	T103	T104	T105	T106	T107	
27	T108	T109	T110	T111	T112	T113	T114	T115	
28	T116	T117	T118	T119	T120	T121	T122	T123	
29	P12		T126	T127	T128	T129	P13		

Table 4.2.6.7-1 Mapping onto Symbols of an Outbound Slot (Continued)

Sym-bol	Subchannel 0		Subchannel 1		Subchannel 2		Subchannel 3		Usage
	X	Y	X	Y	X	Y	X	Y	
30	T124	T125	T134	T135	T136	T137	T130	T131	
31	T132	T133	T142	T143	T144	T145	T138	T139	
32	T140	T141	T150	T151	T152	T153	T146	T147	
33	T148	T149	P14		P15		T154	T155	
34	T156	T157	T158	T159	T160	T161	T162	T163	
35	T164	T165	T166	T167	T168	T169	T170	T171	
36	T172	T173	T174	T175	T176	T177	T178	T179	
37	P16		T182	T183	T184	T185	P17		
38	T180	T181	T190	T191	T191	T192	T186	T187	
39	T188	T189	T198	T199	T200	T201	T194	T195	
40	T196	T197	T206	T207	T208	T209	T202	T203	
41	T204	T205	P18		P19		T210	T211	
42	T212	T213	T214	T215	T216	T217	T218	T219	
43	T220	T221	T222	T223	T224	T225	T226	T227	
44	T228	T229	T230	T231	T232	T233	T234	T235	NTU (index k)
45	P20		T238	T239	T240	T241	P21		
46	T236	T237	T246	T247	T248	T249	T242	T243	
47	T244	T245	T254	T255	T256	T257	T250	T251	
48	T252	T253	T262	T263	T264	T265	T258	T259	
49	T260	T261	P22		P23		T266	T267	
50	T268	T269	T270	T271	T272	T273	T274	T275	
51	T276	T277	T278	T279	T280	T281	T282	T283	
52	T284	T285	T286	T287	T288	T289	T290	T291	
53	P24		T294	T295	T296	T297	P25		
54	T292	T293	T302	T303	T304	T305	T298	T299	
55	T300	T301	T310	T311	T312	T313	T306	T307	
56	T308	T309	T318	T319	T320	T321	T314	T315	
57	T316	T317	P26		P27		T322	T323	
58	T324	T325	T326	T327	T328	T329	T330	T331	
59	T332	T333	T334	T335	CC4	CC5	CC6	CC7	

(2) Reserved Access Burst

Table 4.2.6.7-2 Mapping onto Symbols of a Reserved Access Burst

Sym-bol	Subchannel 0		Subchannel 1		Subchannel 2		Subchannel 3		Usage
	X	Y	X	Y	X	Y	X	Y	
0	SS0		SS1		SS2		SS3		Sync Pattern
1	SS4		SS5		SS6		SS7		
2	SS8		SS9		SS10		SS11		
3	CC0	CC1	CC2	CC3	T0	T1	T2	T3	NTU (index k)
4	T4	T5	T6	T7	T8	T9	T10	T11	
5	P0		T14	T15	T16	T17	P1		
6	T12	T13	T22	T23	T24	T25	T18	T19	
7	T20	T21	T30	T31	T32	T33	T26	T27	
8	T28	T29	T38	T39	T40	T41	T34	T35	
9	T36	T37	P2		P3		D42	D43	
10	T44	T45	T46	T47	T48	T49	T50	T51	
11	T52	T53	T54	T55	T56	T57	T58	T59	
12	T60	T61	T62	T63	T64	T65	T66	T67	
13	P4		T70	T71	T72	T73	P5		
14	T68	T69	T78	T79	T80	T81	T74	T75	
15	T76	T77	T86	T87	T88	T89	T82	T83	
16	T84	T85	T94	T95	T96	T97	T90	T91	
17	T92	T93	P6		P7		T98	T99	
18	T100	T101	T102	T103	T104	T105	T106	T107	
19	T108	T109	T110	T111	T112	T113	T114	T115	
20	T116	T117	T118	T119	T120	T121	T122	T123	
21	P8		T126	T127	T128	T129	P9		
22	T124	T125	T134	T135	T136	T137	T130	T131	
23	T132	T133	T142	T143	T144	T145	T138	T139	
24	T140	T141	T150	T151	T152	T153	T146	T147	
25	T148	T149	P10		P11		T154	T155	
26	T156	T157	T158	T159	T160	T161	T162	T163	
27	T164	T165	T166	T167	T168	T169	T170	T171	
28	T172	T173	T174	T175	T176	T177	T178	T179	
29	P12		T182	T183	T184	T185	P13		

Table 4.2.6.7-2 Mapping onto Symbols of a Reserved Access Burst (Continued)

Sym-bol	Subchannel 0		Subchannel 1		Subchannel 2		Subchannel 3		Usage
	X	Y	X	Y	X	Y	X	Y	
30	T180	T181	T190	T191	T192	T193	T186	T187	NTU (index k)
31	T188	T189	T198	T199	T200	T201	T194	T195	
32	T196	T197	T206	T207	T208	T209	T202	T203	
33	T204	T205	P14		P15		T210	T211	
34	T212	T213	T214	T215	T216	T217	T218	T219	
35	T220	T221	T222	T223	T224	T225	T226	T227	
36	T228	T229	T230	T231	T232	T233	T234	T235	
37	P26		T238	T239	T240	T241	P17		
38	T236	T237	T246	T247	T248	T249	T242	T243	
39	T244	T245	T254	T255	T256	T257	T250	T251	
40	T252	T253	T262	T263	T264	T265	T258	T259	
41	T260	T261	P18		P19		T266	T267	
42	T268	T269	T270	T271	T272	T273	T274	T275	
43	T276	T277	T278	T279	T280	T281	T282	T283	
44	T284	T285	T286	T287	T288	T289	T290	T291	
45	P20		T294	T295	T296	T297	P21		
46	T292	T293	T302	T303	T304	T305	T298	T299	
47	T300	T301	T310	T311	T312	T313	T306	T307	
48	T308	T309	T318	T319	T320	T321	T314	T315	
49	T316	T317	P22		P23		T322	T323	
50	T324	T325	T326	T327	T328	T329	T330	T331	
51	T332	T333	T334	T335	CC4	CC5	CC6	CC7	
52	P24		P25		P26		P27		

(3) Random Access Burst

Table 4.2.6.7-3 Mapping onto Symbols of a Random Access Burst

Sym-bol	Subchannel 0		Subchannel 1		Subchannel 2		Subchannel 3		Usage
	X	Y	X	Y	X	Y	X	Y	
0	SS0		SS1		SS2		SS3		Sync Pattern
1	SS4		SS5		SS6		SS7		
2	SS8		SS9		SS10		SS11		
3	CC0	CC1	CC2	CC3	T0	T1	T2	T3	STU (index k)
4	T4	T5	T6	T7	T8	T9	T10	T11	
5	P0		T14	T15	T16	T17	P1		
6	T12	T13	T22	T23	T24	T25	T18	T19	
7	T20	T21	T30	T31	T32	T33	T26	T27	
8	T28	T29	T38	T39	T40	T41	T34	T35	
9	T36	T37	P2		P3		D42	D43	
10	T44	T45	T46	T47	T48	T49	T50	T51	
11	T52	T53	T54	T55	T56	T57	T58	T59	
12	T60	T61	T62	T63	T64	T65	T66	T67	
13	P4		T70	T71	T72	T73	P5		
14	T68	T69	T78	T79	T80	T81	T74	T75	
15	T76	T77	T86	T87	T88	T89	T82	T83	
16	T84	T85	P6		P7		T90	T91	
17	T92	T93	T94	T95	T96	T97	T98	T99	
18	T100	T101	T102	T103	CC4	CC5	CC6	CC7	
19	P8		P9		P10		P11		

4.2.6.8 Coding of Each Channel

In this section, channel coding methods of each functional channel are described , in accordance to the procedure above mentioned. Table 4.2.6.8-1 to Table 4.2.6.8-4 show the procedures and their parameters of each functional parameters.

Table 4.2.6.8-1 SICH Coding

Procedure	Procedure Reference	Parameter	Parameter Value
Serialize	4.2.6.2	n	37
Scramble	4.2.6.3		
CRC	4.2.6.4	r	16
FEC	4.2.6.5	Rate	1/2
		N_BITS	53
		N_FLUSH	3
		N_PUNC	0
		N_PTU	56

Table 4.2.6.8-2 PCCH & TCCH Coding

Procedure	Procedure Reference	Parameter	Value for Inbound PDU	Value for Outbound PDU
Serialize	4.2.6.2	n	88	88
Scramble	4.2.6.3			
CRC	4.2.6.4	r	19	21
FEC	4.2.6.5	Rate	1/2	1/2
		N_BITS	107	109
		N_FLUSH	3	3
		N_PUNC	6 index 13,27,41,55,69,83	0
		N_PTU	104	112

Table 4.2.6.8-3 DCCH & ACCH Coding

Procedure	Procedure Reference	Parameter	Parameter Value m					
			1	2	3	4	5	6
Serialize	4.2.6.2	n	51	131	211	291	371	451
Scramble	4.2.6.3	S_LOWER						
CRC	4.2.6.4	r	29					
FEC	4.2.6.5	Rate	1/2					
		N_BITS	80	160	240	320	400	480
		N_FLUSH	3	6	9	12	15	18
		N_PUNC	0					
		N_PTU	83	166	249	332	415	498

Table 4.2.6.8-4 TCH (Data) Coding

Procedure	Procedure Reference	Parameter	Parameter Value
Serialize	4.2.6.2	n	488
Scramble	4.2.6.3		
CRC	4.2.6.4	r	r =0 (no CRC)
FEC	4.2.6.5	Rate	3/4
		N_BITS	488
		N_FLUSH	10
		N_PUNC	0
		N_PTU	332

4.3 Transmission Control and Radio Link Control

In this section, the transmission control and radio link control between a base station and mobile station are described.

4.3.1 Radio Carrier Transmission Conditions at the Base Station

(1) Frame Synchronization between Radio Carriers

Outbound frames in the radio carriers transmitted from base stations must be synchronized with each other. In the multi-zone structure system, every carriers at the base stations should be transmitted with frame synchronization.

(2) Control Carrier Transmission

The control carrier is continuously transmitted.

(3) Communication Carrier Transmission

The communication carrier is continuously transmitted when at least one communication channel in the carrier is used. It can stop transmitting when all channels are not used.

4.3.2 Access Modes at Inbound Radio Channel

Two access modes, random access and reserved access, exist in the inbound radio channel.

(1) Random Access Mode

This is the access mode for permitting the transmission from plural mobile stations and randomly accessed.

Random access mode is used when the call connection request etc. are transmitted from mobile stations. There are RACH and TCCH in the random channel.

(2) Reserved Access Mode

This is the access mode for permitting only transmission from the individual mobile station and the base station is assigned reserved access slot to the mobile station when necessary. There are DCCH, ACCH, TCH and PCH in reserved access channel.

4.3.3 Transmission Conditions of the Slot at the Mobile Station

The transmission from mobile stations is based on the slot information including the system information type message in BCCH broadcasted from the base station when the mobile station transmits the slot.

(1) Basic Principle of Transmission Condition of the Slot

The mobile station receives BCCH and must confirm that the base station is not in the access prohibition state from system information type 0 message.

(2) Transmission Condition at Random Access Slot

The mobile station can use only subslot format when the inbound random access slot is used. The TCCH transmission condition by the mobile station is to be confirmed that the channel used is TCCH by the outbound SDB. When the mobile station detects channel disconnect by the base station, it immediately must stop transmitting. The channel disconnect is prescribed in Section 4.3.8 "Channel Disconnect".

(3) Transmission Condition at Reserved Access Slot

The basic slot format is used in inbound reserved access slot. The transmission condition of reserved access slot by mobile station is to confirmed that the IDs is included in the outbound SDB.

The mobile station must immediately stop when it detects the channel disconnect by the base station.

(4) Access Prohibition

The base station can inform Cell Availability Parameters and Cell Access Parameters of the system information type 1 message on BCCH and prohibit the mobile station from accessing to the serving cell.

The Cell Availability Parameters transmit the information whether it is possible for the mobile station to access to the base station or not.

The mobile station is classified into 16 access class. The base station can set up the access grant/non-grant and inform Access Parameters of System Information Type 1 message on BCCH.

4.3.4 Random Access Transmission Control

The transmission control method is shown as below.

4.3.4.1 Random Access Transmission

Random Access Transmission control is the procedure included in layer 2. The operation for random access by mobile station is started by the transmission request from the upper layer. The operation is stopped when the transmission of resend transmission

4.3.4.2 Operation of Random Access Transmission Control

(1) Transmission Control at the Mobile Station

The transmission of signaling on random access channel by the mobile station is accompanied with random delay resend control.

When the mobile station transmitted the inbound signal on random access slot, the mobile station can execute the random access control for re-transmitting the same signal after the random time delay. However, it can not resend more than the maximum random resending number (MAX_RTX).

MAX_RTX can be calculated from _MAX_RTX of Cell Access Parameter in the System Information Type 1 message on BCCH from the base station.

(2) Conditions for Random Delay Value

The mobile station adds the random delay value n for resending after the transmission of the inbound signal and passing of the time prescribed (random resending basic wait time, FIXED_WAIT_TIME) .

The random delay value n is randomly selected in the range of 0 to random resending delay n.

The range of random resending delay is set up to the initial value of random resending delay (INITIAL_RTX_TIME) when the first burst is transmitted and after that, it is changed according to (random resending delay time of k+1)=2*(the range of random resending delay of k) each resending. The range of random resending delay is within the maximum random resending time (MAX_RTX_TIME).

The random resending basic wait time, the random resending delay initial value and the maximum random resending time is respectively calculated from _FIXED_WAIT_TIME, INITIAL_RTX_TIME and _MAX_RTX_TIME, which are in Cell Access parameters of the System Information Type 1 message on BCCH broadcasted by the base station.

4.3.5 Reserved Access Transmission Control

In this section, the transmission control method at reserved access is prescribed. The random access transmission control is the transmission control procedure existing in layer 2.

(1) Control Operation at Base Station

The base station indicates the ID of mobile station with the right for access to the channel on the layer 3 specifier of SDB (DCCH) or the talker ID (TCH or ACCH) and stimulates the mobile station to inbound signal transmission.

(2) Control Operation at Mobile Station

When the mobile station transmits the signal by the reserved access, the mobile station receives the outbound SDB and must confirm that the channel is the reserved access channel and the itself individual ID is indicated.

4.3.6 Cell Selection

The cell selection is the operation for fetching of control channel by the mobile station.

The cell selection is executed to find the optimum serving cell from the multiple cells by the mobile station. When the serving cell is determined by the cell selection, the mobile station must start receiving the single or the plural slot and fetching the control channel. When the fetching of control channel, the slot timing of receiving carrier and the frame timing must be stored.

While the mobile station is in the fetching of control channel, the mobile station is receiving SDBs and color codes in every CCCHs. The mobile station must store the version number broadcasted on BCCH at least once per 10 seconds. If the mobile station detects the different version number from the former version number, the mobile station has to receive BCCH again.

The state, which the mobile station does not communicate though the serving cell of the mobile station is determined, is named as the Idle Mode

4.3.6.1 Initiation Condition of Cell Selection

The mobile station initiates the Cell Selection in the case shown as follows.

(A) When powered on.

(B) While monitoring PCCH, if disconnect or failure of the PCCH is detected or the serving cell becomes barred, and there are no unconditional foreground cells (see 4.3.10 (5)).

(C) When the usage of serving cell is prohibited and the foreground cell, which is the candidate for the next serving cell, is not recorded.

(D) If an attempt to connect to a PCCH fails and there are no unconditional foreground cells.

Foreground cell is prescribed in Section 4.3.10 "Quality supervision".

4.3.6.2 Procedure of Cell Selection

(1) Sync Symbol Detection

The mobile station starts receiving a radio control channel in the control channel candidates and detects the sync symbol in outbound slot with 15ms cycle. The mobile station stores the frequencies of plural control carriers in advance.

(2) SDB Reception

When it is possible for the mobile station to detect the sync symbol, the mobile station must receive SDBs on voluntary slots.

(3) Tracking Condition of the Control Channel

The mobile station confirms that the carrier is a control carrier including PCCH from C bit of SDB.

(4) Communication Quality Measurement for the Control Channel

The mobile station measures the communication quality of the control channel fetched.

(5) Each procedure of (1) to (4) is executed for every control carriers.

(6) Determination of the Serving Cell

The service provider specifies the conditions for determination of the serving cell.

4.3.7 Fetching the Communication Channels

The mobile station executes the operation for fetching of the communication channel when the communication channel is assigned by the base station.

4.3.7.1 Fetching Procedures for Communication Channels

(1) Sync Symbol Detection

The mobile station switches to the carrier directed by the base station and detects the sync symbol of slot's location appointed on the base of the standard point of slot timing stored at the control channel.

If the mobile station detects channel failure on this communication channel, it returns to the control channel and then to an idle mode.

(2) SDB Reception

The mobile station receives the SDB of the slot when the sync symbol is detected.

(3) Fetching the communication channel

The conditions for fetching the communication channel are shown as below. If the conditions are not satisfied with, the mobile station returns to the control channel and then to an idle mode.

(A) When the channel assigned is TCCH

The mobile station must confirm that the channel is assigned to its mobile station from FN and SN field of SDB.

(B) When the channel assigned is TCH, ACCH and DCCH

When the mobile station transmits, the mobile station must confirm that the channel includes its individual ID in SDB. When the mobile station does not transmit, the mobile station confirms that monitoring is permitted to its mobile station by the supervision field of SDB.

4.3.7.2 Conditions of Keeping Synchronization of Communication Channel

The conditions for keeping synchronization of the communication channel are shown as below. If the condition is not satisfied with, the mobile station returns to the control channel and then to an idle mode.

(A) When the channel is TCCH

The mobile station confirms that the channel is the communication channel assigned to its mobile station from FN and SN field of SDB.

(B) When the channel is TCH, ACCH or DCCH

The mobile station, which try to transmit, confirms that SDB includes its mobile station's individual ID. The mobile station, which does not try to transmit, confirms that monitoring is permitted to its mobile station from supervision field of SDB.

If the mobile station detects channel failure on this communication channel, it returns to the control channel and then to an idle mode.

4.3.8 Channel Disconnect

Channel disconnect is always initiated by the base station. The base station informs the channel disconnect to the mobile station by four times or more transmitting SDB which includes the channel type of the unassigned channel.

The mobile station recognizes the channel type and the content of the SDB and detects to be disconnected the channel.

The recognition is executed in the only case that the color code is correct and the SDB's CRC checks.

Table 4.3.8-1 shows the detection standard of the channel disconnect each mobile station's situation.

Table 4.3.8-1 The Detection Standard of the Channel Disconnect

The State of the Mobile Station	The Detection Standard of the Channel Disconnect
Any	Reception of SDB type "Unassigned"
Monitoring PCCH	SDB type not BCCH or CCCH
Assigned to multi-user TCH	SDB type not multi-user TCH or TCCH
	Supervision field of SDB does not check.
Assigned to single-user TCH	SDB type not single-user TCH
	Layer 3 identifier field of SDB does not check.
Assigned to DCCH	SDB type not DCCH
	Layer 3 identifier field of SDB does not check.
RR connection transfer(assignment or handover)	Any SDB besides TCCH observed.

4.3.9 Channel Failure

The channel failure is the failure of the radio channel detected by the mobile station and the failure of input signal to the mobile station caused by RF channel error.

(1) Detection of Channel Failure by Mobile Station

The mobile station detects the channel failure by receiving SDB.

The mobile station stores the receiving number of SDB checked by CRC from receiving slots (the number for recognizing failure reception : _MS_fail_window)

If this number is less than the specified number (Threshold value for checking channel failure : MS_fail_threshold), the channel is detected as the channel failure.

The number for recognizing failure reception and the threshold value for checking channel failure are calculated by _MS_fail_threshold broadcasted on BCCH from the base station.

4.3.10 Quality Supervision at Mobile Stations

The mobile station executed the quality supervision for the serving cell and the neighbor cell at idle mode and communication mode.

The result of quality supervision is used as the information for re-selection, handover and cell re-connection.

(1) The mobile station measures the items below for the quality supervision of the serving cell.

(A) Serving Cell C/I+N (serving_CINRo)

The mobile station measures C/I+N of the serving base station. The serving cell C/I+N is obtained by averaging the most recent C/I+N (the serving cell measurement number : serving_window) result of the serving base station measured with the number of times prescribed.

(B) Serving Cell RSSI (serving_RSSI)

The mobile station has to measure the RSSI (Received Signal Strength Indicator) of the serving base station. The serving cell RSSI is obtained by averaging the most recent RSSI of the serving base station measured with the number of times prescribed.

The serving cell measurement number is calculated from _serving_window broadcasted on BCCH by the base station.

(2) Neighbor Cell Quality Measurement

The mobile station can obtain the information on the neighbor cell from BCCH broadcasted by the serving base station. The mobile station periodically measures the communication quality of the neighbor cells and classifies their neighbor cells into two categories, foreground cell and back ground cell.

(3) Foreground Cell Quality Measurement

The mobile station measures the items of foreground cells shown as below classified from the neighbor cells.

(A) Neighbor Cell C/I+N (neighbor_CINRo)

The mobile station measures C/I+N of each foreground cell. The neighbor cell C/I+N is obtained by averaging the most recent measured C/I+N (the foreground cell measurement number: foreground_window)result of each foreground cell with the number of times prescribed.

(B) Neighbor Cell RSSI (neighbor_RSSI)

The mobile station measures RSSI of each foregorund cell. The neighbor cell RSSI is obtained by averaging the most recent measured RSSI result of each foreground cell with the number of times prescribed(foreground cell measurement number).

The measurement number of times is broadcasted on BCCH from the base station.

(4) Quality Measurement of Background Cell

The mobile station measures the items of foreground cells shown as below classified from the neighbor cells.

(A) Neighbor Cell C/I+N (neighbor_CINRo)

The mobile station measures C/I+N of each background cell. The neighbor cell C/I+N is obtained by averaging the most recent measured C/I+N result of each background cell with the number of times prescribed.

(B) Neighbor Cell RSSI (neighbor_RSSI)

The mobile station measures RSSI of each backgorund cell. The neighbor cell RSSI is obtained by averaging the most recent measured RSSI result of each background cell with the number of times prescribed.

(5) Neighbor Cell Classification

The neighbor cell is classified in two categories, foreground cell and background cell, by the measurement result of communication quality.

The mobile station classifies the neighbor cells exceeding the neighbor cell C/I+N prescribed (foreground cell C/I+N threshold value : foreground_CINRo_threshold) into the foregorund cell. In this time, the number of foreground cells can not exceed the prescribed number(maximum foreground cell number : foreground_max). The neighbor cells, which is not selected as the foregorund cell, are classified as the background cell. The foreground cell C/I+N threshold value is calculated by _foregroud_CINRo_threshold broadcasted by the base station and the maximum foreground cell number is informed on BCCH by the base station.

4.3.11 Cell Re-selection

The mobile station in idle mode changes the serving cell according to radio link quality. Cell re-selection is defined as the transition to the neighbor cell executed by the mobile station which determined the serving cell.

4.3.11.1 Quality Measurement for Cell Re-selection

The mobile station measures C/I+N and RSSI of the serving base station and measures the serving cell C/I+N and the serving cell RSSI.

The mobile station measures and records the neighbor cell C/I+N and the neighbor cell RSSI, which is described in the neighbor list IE of System Information Type 5 message broadcasted on BCCH.

4.3.11.2 Initiation Conditions for Cell Re-selection

The mobile station starts transiting to the neighbor cell according to cell re-selection procedure in the cases shown as below.

(A) The serving cell is prohibited to access to the base station.
(B) The serving cell is detected channel disconnect or channel failure.
(C) The mobile station fails to connect to PCCH.

If there is no target neighbor cell, the mobile station starts the cell selection procedure.

4.3.11.3 Cell Re-selection Class

The cell re-selection class shows the priority of the neighbor cell as the target neighbor cell. Higher values indicate more desirable candidates and the priority goes down in descending order.

%00 : Re-selection impossible
%01 : Re-selection Class 1
%10 : Re-selection Class 2
%11 : Re-selection Class 3

4.3.12 Handover

The mobile station assigned to either DCCH or Single TCH changes the serving cell in accordance to the communication quality and continues the communication at the new cell. Either the mobile station or FNE can initiate handover. Handover is the serving cell change by the mobile station in the Radio Management Link.

In this section, the condition to initiate handover is described (Handover Procedure is referred to Section 4.4.2.4(3).).

4.3.12.1 Quality Measurement at the Mobile Station for Handover

The mobile station measures Outbound serving cell C/I+N and serving RSSI of serving cell.

The mobile station measures the neighbor cell C/I+N and the neighbor cell RSSI of neighbor cell which is informed by BCCH. The handover class, which is in the neighbor cell list included in the neighbor cell IE of System Information Type 5 message, is broadcasted.

4.3.12.2 Communication Quality Measurement at the Base Station

The base station measures and records C/I+N of inbound signal of the channel assigned.

4.3.12.3 Handover Initiation

(1) Initiation of Handover by Mobile Station

The mobile station initiates the handover in the cases as shown below.

(A) When the cell shown as below, which is foreground cells with handover class %01, is found

(serving_CINRo < hdvr_CINRo_threshold) &&
(neighbor_CINRo >= serving_CINRo + hdvr_CINRo_hysteresis)

where "A&&B" means the logical product of A and B.

(B) When the cell shown as below, which is foreground cells with handover class %10, is found

((neighbor_RSSI>= serving_RSSI + hdvr_CINRo_hysteresis) &&
(neighbor_CINRo >= MIN(serving_CINRo, hdvr_CINRo_threshold +
hdvr_CINRo_hysteresis))
or

((neighbor_RSSI< serving_RSSI + hdvr_CINRo_hysteresis) &&
(serving_CINRo < hdvr_CINRo_threshold) &&
(neighbor_CINRo >= serving_CINRo + hdvr_CINRo_hysteresis))

(C) When the cell shown as below, which is foreground cells with handover class %11, is found

(neighbor_CINRo >= MIN(serving_CINRo, hdvr_CINRo_threshold + hdvr_CINRo_hysteresis))

Handover C/I+N threshold value (hdvr_CINRo_threshold) is calculated by _hdvr_CINRo_threshold broadcasted on BCCH and Handover C/I+N hysteresis(hdvr_CINRo_hysteresis) is broadcasted on BCCH by the base station.

(2) Handover Initiated by the Base Station

The base station initiates handover when the Inbound signal quality is the condition shown as below.

mobile station C/I+N<handover mobile station C/I+N threshold

The mobile station uses the cell with the conditions shown as below as the candidate of the target cell.

C/I+N of candidate cell >= MIN (serving cell C/I+N, handover C/I+N threshold)

4.3.12.4 Handover Class

Handover class indicates the desirability of each neighbor cell for handover. Higher values indicate more desirable candidates and the priority goes down in descending order.

%00 : Handover impossible
%01 : Handover Class 1
%10 : Handover Class 2
%11 : Handover Class 3

4.3.13 Re-connection

When the mobile station detects the deterioration of communication quality while involved in a dispatch call or a individual call, the change of the serving cell is executed and the communication is continued in a new cell. Re-connection is the change of serving cell while involved in the communication at multi-user TCH.

In this section, the conditions for initiating re-connection is described.

4.3.13.1 Communication Quality Measurement at the Mobile Station

The mobile station while in communication measures C/I+N and RSSI of the serving cell on PCCH or TCH and records the serving cell C/I+N and the serving cell RSSI.

The mobile station measures C/I+N and RSSI on each neighbor cell and records of the neighbor cell C/I+N. Re-connection class is broadcasted on BCCH by the base station.

4.3.13.2 Conditions of the Mobile Station during the Call Set-up Phase

The mobile station initiates the re-connection when the conditions shown below is filled while involved in a communication.

(1) The mobile station detects disconnect or failure of the serving cell PCCH.

In this case the mobile station changes to the highest-ranked foreground cell.

(2) The mobile station detects the conditions below.

serving C/I+N < Re-connection C/I+N

Then the mobile station selects the most desirable foreground cell with the conditions shown as below.

neighbor_CINRo >= serving_CINRo + rcon_CINRo_hysteresis

The re-connection C/I+N threshold (rcon_CINRo_threshold) is calculated by _rcon_CINRo_threshold informed on BCCH and the re-connection C/I+N hysteresis (rcon_CINRo_hysteresis) is broadcasted on BCCH.

4.3.13.3 Re-connection Conditions during the Talk Phase of a Call

The mobile station during the talk phase of a call, that is , while on the TCH, initiates re-connection if the conditions shown as below are filled.

(1) The mobile station detects channel failure of TCH.

In this case the mobile station changes to the highest-ranked foreground cell with conditions below. If there is no target cell, the mobile station terminates the call and returns to PCCH of the serving cell. If the mobile station fails to connect to PCCH, the mobile station initiates cell selection.

(2) The communication quality fills the conditions below.

serving C/I+N < Re-connection C/I+N

In this case the mobile station selects the highest-ranked foreground cell with conditions below and initiates re-connection.

neighbor cell C/I+N>= serving cell C/I+N

4.3.13.4 Re-connection Conditions of the Mobile Station while on TCCH

The mobile station while on the TCH initiates re-connection if the conditions shown as below are filled.

(1) Channel failure of TCCH is detected.

In this case the mobile station changes to the highest-ranked foreground cell with conditions below. If there is no target cell, the mobile station terminates the call and returns to PCCH of the serving cell. If the mobile station fails to connect to PCCH, the mobile station initiates cell selection.

(2) The communication quality fills the conditions below.

serving_CINRo < rcon_CINRo_threshold

In this case the mobile station selects the highest-ranked foreground cell with conditions below and initiates re-connection.

neighbor cell C/I+N>= serving cell C/I+N+re-connection C/I+N hysteresis

4.3.13.5 Re-connection Class

Re-connection class shows the properties of the neighbor cell as the target cell. Re-connection class is broadcasted on BCCH by the base station.

%00	:	Re-connection impossible
%01	:	Re-connection possible
%10	:	Option
%11	:	Option

4.3.14 Time Alignment Control

The following time alignment control is executed for the inbound channel reserved accessed.

(1) Outline of Time Alignment Control

Inbound reserved access channel formats are not provided with propagation delay absorbing guard times at their back ends. For this reason, when transmitting an inbound "burst" in this format (DCCH, ACCH and TCH), it is possible that adjacent slots interfere with each other as result of propagation delays in the radio channels.

In this system, the base station has a time alignment control function whereby it measures the propagation delay of the inbound burst. To prevent interference, it sends a transmit timing parameter to the mobile station that transmitted the burst, and the mobile station in turn adjusts its transmit timing based on this parameter.

(2) Timing Reference

At the base station, the reference point for measuring each slot timing is specified as at the terminal of the repeater station transmit / receive antenna.

(3) Time Alignment Control Value and Control Reference

The time alignment value of the outbound DCCH, TCH and ACCH is prescribed at the equation below.

time alignment value (μs)=time alignment value *62.5 ---------- (Expression 4.3.14-1)

Where, the time alignment value is equal to the value specified on the SDB.

The reference on which the control value is based to adjust the time alignment at the mobile station is the transmit timing of the reference burst signal described below. Before transmitting, the mobile station permitted individual access adjusts its timing according to the indicated control value, based on the transmit timing of the reference burst signal.

(A) Reference Burst Signal in Requesting Channel Assignment with Individual Access Permission

Either the calling mobile station which transmitted the call request signal or the called mobile station which sent the call response in individual call can make the reserved access after the channel assigned.

In this case, the calling mobile station uses the inbound burst signal (RACH) for making the call request as the reference burst signal. On the other hand, when individual access permission is granted to the called mobile station in an individual call, the inbound burst signal (RACH) for sending the call response is used as the reference burst signal.

(B) Reference Burst Signal during Transition from Multi-Channel Access State to Reserved Access State after Channel Assignment

A mobile station can alter to the state of reserved access mode in the state of multi access mode by sending an Group Call Update Request message or an Individual Call Update Request message (TCCH). In such a case, this inbound burst signal (TCCH) is used as the reference burst signal.

(4) Time Alignment Control Operation

The base station measures the receive timing of the reference burst. The base station indicates the ID of the mobile station which send the reference burst on inbound DCCH, ACCH and TCH indicating the reserved access grant and designate the time alignment control value according to the timing measured. When the mobile station send the inbound burst signal on the reserved access state, it has to be sent according to the time alignment control value designated of the outbound SDB. In this case, the mobile station has to confirm that its IMSI by the individual ID included in the SDB is indicated and the slot type is correct.

The time alignment control operations at the base station and the mobile station are described next.

(A) Operation in Requesting Channel Assignment with Reserved Access Mode

The base station has the capability to perform timing measurement of the inbound RACH and TCCH on random accessed channel.

The base station measures the receive timing of the reference burst signal (call request signal or call response signal) designate the time alignment control value measured to the SDB assigned of DCCH,ACCH and TCH.

When the mobile station transmits after the channel assigned, it has to use the transmission timing of the reference burst signal of the inbound RACH. When the mobile station transmits the inbound signal after the transition to the channel reserved accessed, it has to transmit according to the time alignment control value designated by the SDB of the outbound DCCH, ACCH and TCH.

(B) Operation during Transition from Random Access Mode to Reserved Access Mode

The base station measures the receive timing of the reference burst signal (Inbound TCCH) . The base station permits the reserved access on the outbound DCCH, ACCH and TCH indicating the transition to the reserved access state and designate the time alignment control value measured.

The mobile station uses the transmission timing of the inbound TCCH as the standard timing. When the mobile station transmits the inbound signal after the transition to the channel reserved accessed, it has to transmit according to the time alignment control value designated by the SDB of the outbound DCCH, ACCH and TCH.

(C) Operation during Individual Access State

The base station measures the receive timing of DCCH / ACCH/ TCH inbound basic slots even in reserved access permitted state. As the need arises, the base station is able to indicate the time alignment control vale (a change in the control value or the same control value) through the SDB of DCCH/ACCH/TCH.

The mobile station maintains the transmit timing after transition to reserved access permitted state and continually receive the SDB and check if there is no change in the time alignment control value.

The mobile station in reserved access permitted state receives a time alignment control indication in the SDB. When the mobile station confirms that the time alignment control value is changed, the mobile station adjusts according to the indication from the next inbound signal. If the mobile station can not receive correctly, it has to transmit at the same timing of the last transmission slot

Fig. 4.3.14-1A and Fig.4.3.14-1B show examples of time alignment control operations.

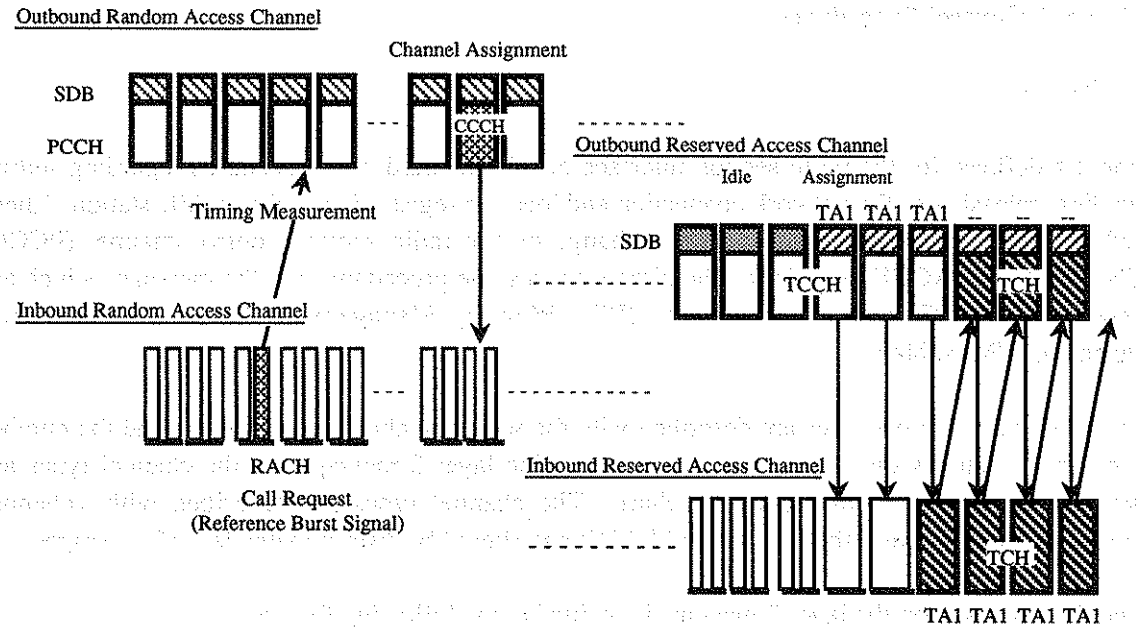
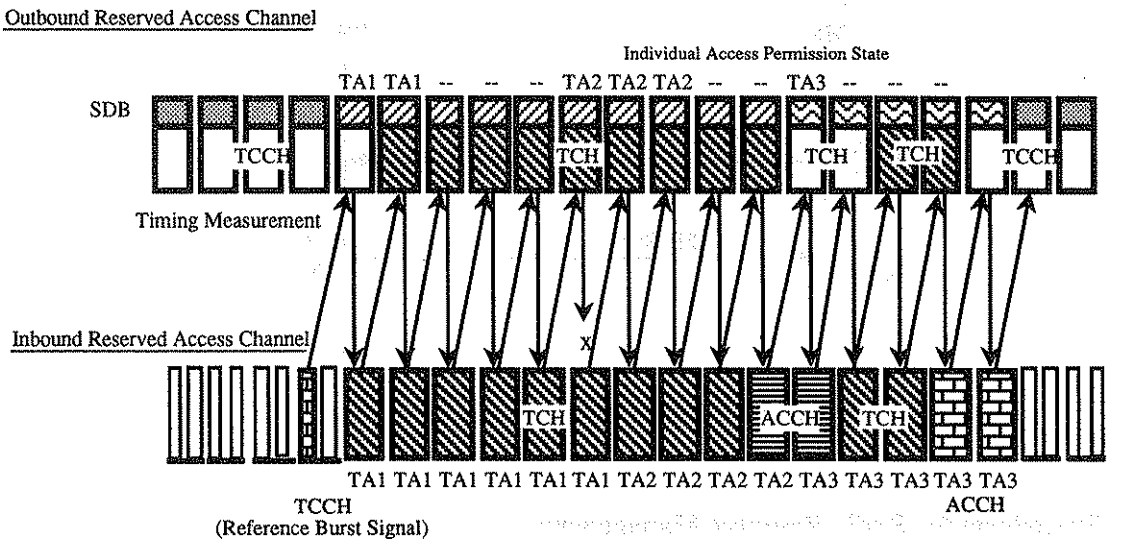


Fig. 4.3.14-1A Time Alignment Control Operation Example 1



*TA1 to TA3 indicates the time alignment control value and adjustment value. "--" indicates no control indication.

Fig. 4.3.14-1B Time Alignment Control Operation Example 2

4.3.15 Transmit Power Control

In this section, power control at a mobile station is stipulated.

(1) Autonomous Transmit Power Control Function

This function enables every unspecific mobile station to autonomously control its transmit power according to the received signal strength of the outbound carrier from the base station, and applies to all radio carriers. Autonomous transmit power control is prescribed in Section 3.4.1 (8) "Transmit Power Control".

4.4 Layer 3 Control Procedures

4.4.1 General

Section 4.4 defines, for the radio section interface of this standard, the procedures regarding setting up, holding, releasing of the network connection and location registration of the mobile station. These procedures apply to the messages which exchange on the radio section control channel (PCCH, DCCH, TCCH and ACCH) and define the circumstances, the procedures and the messages which are necessary to Radio Resource management (RR), Mobility Management (MM) and Connection Management (CM) sublayer.

The protocol control procedures are described with the sequence chart in this section and the number from one to ten shows the control procedure step. The layer 3 messages or the channel types are showed on the arrows in the sequence chart. The channel types are described with <channel type>SDB notation because they are sent with SDB and should be discriminated layer 3 messages.

The word of message on the layer 3 message is omitted at the following figures.

The example of control sequence chart is shown in Fig. 4.4.1-1.

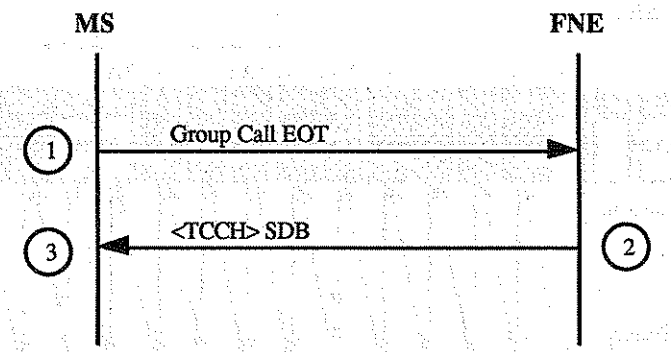


Fig. 4.4.1-1 Control Sequence Example

4.4.2 Procedures for Radio Resource Management

4.4.2.1 General

The RR sublayer has the function of RR connection management including, establishment, transfer, release of RR connections and system information report. RR connection is utilized to send the information between the mobile station and the FNE (point-to-point). Equipment on network side is called FNE in Digital JSMR system.

The RR sublayer includes the connection control function for group call and individual call in this standard.

4.4.2.2 Idle Mode Procedures

The RR sublayer while in an idle mode performs cell re-selection. Cell re-selection is defined in the 4.3.11.

4.4.2.3 RR Connection Establishment

RR connection is established by the requirement of MM sublayer. RR connection establishment may be initiated by either the mobile station or the FNE.

(1) RR Connection Establishment Initiated by the Mobile Station

(A) Procedure

Step 1 : The mobile station initiates the procedure by sending a Channel Request message on the RACH. The Channel Request message includes a random reference value selected by the mobile station. The mobile station retains the random reference value for transmission and a request reference value which includes a slot number sent the Channel Request message.

Step 2 : When the FNE receives the Channel Request message, it allocates an appropriate signaling channel, responds on the CCCH with an Immediate Assignment message and starts T3101.

Step 3 : The mobile station received the Immediate Assignment message confirms the random reference value and the request reference value. If these values correspond with retained values, the mobile station cancels inbound transmission of the Channel Request message, moves to the assigned channel and establishes RR connection.

(B) Abnormal Case

(a) The FNE cannot assign a Channel.

The FNE send the Immediate Assignment Reject message on the CCCH and repeats N3101 times. The mobile station received the Immediate Assignment Reject message cancels the transmission of the Channel Request message and returns to an idle mode.

(b) T3101 Timed out

The FNE cancels the transmission of the Immediate Assignment message and terminates the procedure. The channel does not assigned.

(c) Failure of a Immediate Assignment message receiving

If the mobile station doesn't receive the Immediate Assignment message before ending of maximum channel request message re-sending number which is defined at random access transmission control, the mobile station returns to an idle mode.

(2) RR Connection Establishment Initiated by the FNE

(A) Procedure

Step 1 : The FNE begins the procedure by sending a Paging Request 2 message on the CCCH and starts T3113.

Step 2 : The mobile station received the Paging Request 2 message starts T3120.

Step 3 : The FNE sends the Immediate Assignment message on the CCCH and reports the assigned channel to the mobile station. The FNE starts T3101.

Step 4 : The mobile station received the Immediate Assignment message, stops T3120 and moves to the assigned signaling channel.

Step 5 : The mobile station sends a Paging Response 2 message and establishes the signaling link for control.

Step 6 : The FNE received the Paging Response 2 message stops T3101 and T3113. It terminates RR connection establishment.

(3) RR Connection Establishment for PSTN Connection Initiated by the FNE

The procedure is the same as (2) "RR Connection Establishment Initiated by the FNE", except that uses the Paging Request message for a Paging Request 2 message, and a Paging Response message for a Paging Response 2 message.

4.4.2.4 RR Connection Transfer

RR connection transfer refers to inter-cell change of channel and inter-cell handover.

(1) Start of RR Connection Transfer

While RR connection is in progress, the mobile station and the FNE is monitoring the signaling quality which is defined at 4.3.12.

If the measured quality on the mobile station satisfies the handover conditions which defines at 4.3.12, the mobile station sends a Measurement Report message each slot in hdvr_report_interval number, the mobile station urges the FNE to transfer the RR connection.

When the measured signaling quality on the FNE side satisfies handover starting conditions defined at 4.1.12, the FNE inquires Measurement Report message at the mobile station side by sending the Measurement Request message.

A Measurement Report message includes a list of cells for handover selected by the mobile station referring to measured signaling quality. A cell is registered in order of priority for handover and in order of RSSI magnitude at the same priorities. The number of registered cells doesn't exceed the number of max_candidates.

When the FNE decides to transfer RR connection link referring to measurement report, it start the RR connection transfer procedure. The hdvr_report_interval is calculated from the _hdvr_report_interval on the BCCH and max_candidates is sent on the BCCH.

The conditions for RR connection transfer at the FNE side depends on the system providers.

(2) Channel Re-assign in Inter-cell

This procedure is always initiated by the FNE.

(A) Procedure

Step 1 : The FNE sets up a target channel on the TCCH and starts channel transfer by sending an Assignment Command message to the mobile station RR connection of the old channel. The FNE starts T3107.

Step 2 : The mobile station received the Assignment Command message releases the old channel, changes to the new channel, and sends the Assignment Access message on the TCCH.

Step 3 : The FNE received the Assignment Access message responds to the mobile station by changing the channel type to the DCCH or the TCH. The FNE stops T3107.

(B) Abnormal Case

(a) Channel Failure on the New Channel

The mobile station returns to the old channel and sends the Assign Failure message to the FNE. The FNE received the Assign Failure message stops T3107 and returns to the state before transfer procedure.

(3) Handover

Handover procedures are initiated when RR connection transfer from the serving cell to the target cell is executing during the call on the DCCH or on a single user TCH.

(A) Procedure

Step 1 : The FNE sets up the assigned channel on the TCCH in the target cell and sends a Handover Command message to the mobile station on the main signaling link of the old channel. The FNE starts T3103.

Step 2 : The mobile station received a Handover Command message releases the old channel, switches to the new channel. The mobile station sends the Handover Access message on the TCCH and informs the moving to the FNE.

Step 3 : The FNE received the Handover Access message stops T3103 and responds by changing the channel to the DCCH or the TCH.

(B) Abnormal Cases

(a) The mobile station can not send a Handover Access message.

(b) Channel Failure on the new channel.

In the case of (a) or (b), the mobile station returns to the old channel and sends a Handover Failure message to the FNE. The FNE received the Handover Failure message returns to the state before the handover procedure.

(c) T3103 Timed out

The FNE releases the old channel and newly assigned channel and terminates the call.

4.4.2.5 RR Connection Release

RR connection release is always initiated by the FNE.

(1) Procedure

Step 1 : The FNE releases and deactivates all data links of the designated channel and sets the channel type to unassigned.

Step 2 : When the mobile station notes that the channel is unassigned, it immediately releases RR connection and returns to an idle mode.

4.4.2.6 Group Call Procedures

In order to participate in a group call, it is necessary to register an individual or group IDs. These parameters are obtained and maintained through MM sublayer procedures.

(1) Initiation of a Group Call

(A) Initial Situation

Members of the group are idle, monitoring the PCCH.

(B) Triggering Event

A mobile station wants to set up a group call (this mobile station is called the "initiating mobile station").

(C) Procedure

See Fig. 4.4.2.6-1.

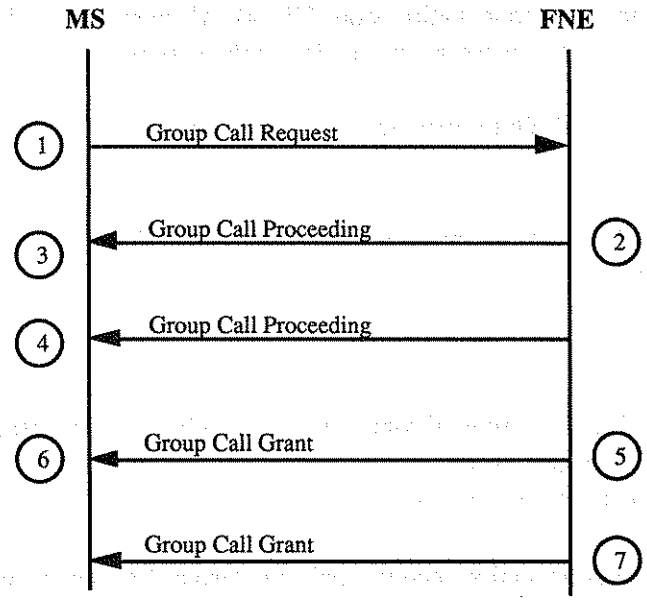


Fig. 4.4.2.6-1 Group Call Initiation Elementary Procedure

Step 1 : The initiating mobile station sends a Group Call Request message on the RACH.

Step 2 : The FNE sends a Group Call Proceeding message on the CCCH.

Note : The ID fields in the Group Call Proceeding message are set as follows: the group ID identifies the talkgroup, and the individual ID identifies the initiating mobile station.

Step 3 : The initiating mobile station receives a Group Call Proceeding message. It cancels inbound transmission and starts T3130.

Note : The initiating mobile station can not cancel inbound transmission until it receives a Group Call Proceeding message containing the correct group ID and its own individual ID.

Step 4 : The Group Call Proceeding message is repeated on the CCCH while the FNE continues to process the call. Each time the mobile station receives a Group Call Proceeding message containing the correct group ID, it starts T3130 again.

Note : Once the T3130 is running, the mobile station checks only the group ID and ignores the individual ID.

Step 5 : The FNE allocates a multi-user TCH for the call, terminates to send the Group Call Proceeding, message and starts to send the Group Call Grant message on the CCCH.

Note : The Group ID of the talkgroup is used in the supervision field of the SDB, in all cells throughout the duration of the call.

Step 6 : The initiating mobile station stops T3130. All members of the group respond to the Group Call Grant message by moving to the assigned TCH.

Step 7 : The Group Call Grant message is repeated on the CCCH throughout the duration of the call.

Finally, members of the group are on a multi-user TCH. The initiating mobile station is the talking mobile station.

(D) Abnormal Cases

(a) The FNE does not send Group Call Proceeding message(e.g. if the call can be immediately set up), or the mobile station can not receive the Group Call Proceeding message due to channel errors.

In that case, the mobile station receives only the Group Call Grant message. It responds as described in step 6 (also, if the mobile station is transmitting a Group Call Request message, it cancels that transmission).

(b) Failure of Inbound Transmission

The procedure is terminated.

(c) Cell Re-selection during Inbound Transmission

The target mobile station can not change cells while inbound transmission on the RACH is in progress.

(d) Cell Re-selection While T3130 is running.

While T3130 is running, the mobile station performs cell re-selection (Section 4.3.11) in an idle mode.

If the mobile station changes cells while T3130 is running, it initiate the reconnect procedure.

(e) T3130 Timed out

The FNE terminates the call. The initiating mobile station reports failure of the call to the user, and returns to an idle mode.

(f) Call Reject or Failure

The FNE may be unable to handle the call request. The FNE rejects the request by sending a Group Call Complete message.

Note 1 : The Group Call Complete message includes the mobile ID in the individual ID field identifies. The RR cause IE gives the reason for the reject.

The reasons for call rejection are given by the RR cause IE in the Group Call Complete message and may be one of:

Not authorized to initiate call ----The requesting mobile station is not allowed to request the call.

Unrecognized Individual ID ------ The individual ID used by the mobile station is not known by the FNE. The mobile station should start the registration procedure to obtain correct information (Individual ID, etc.).

Incorrect Group ID ----------The Group ID used by the mobile station does not agree with the one recorded by the FNE. The mobile station should start the registration procedure to obtain correct information (Group ID, etc.).

Call target not responding ---------No other members of the initiator's talkgroup responded when paged. The mobile station can try the call again and the call may succeed if other group members become available.

Temporary call failure ----------The FNE could not set up the call temporarily. The mobile station can try the call again and it will likely succeed.

Network out of order ---------- The FNE could not set up the call. The mobile station may try again but the call is unlikely to succeed until the condition is corrected.

(2) Paging

(A) Initial Situation

Members of the group are idle, monitoring the PCCH.

(B) Triggering Event

The FNE is setting up a group call, and needs to locate members of the group.

(C) Procedure

The procedure below describes the message activity from the point of view of a single member of the group (There may be any number of mobile stations in a particular cell).

See Fig. 4.4.2.6-2.

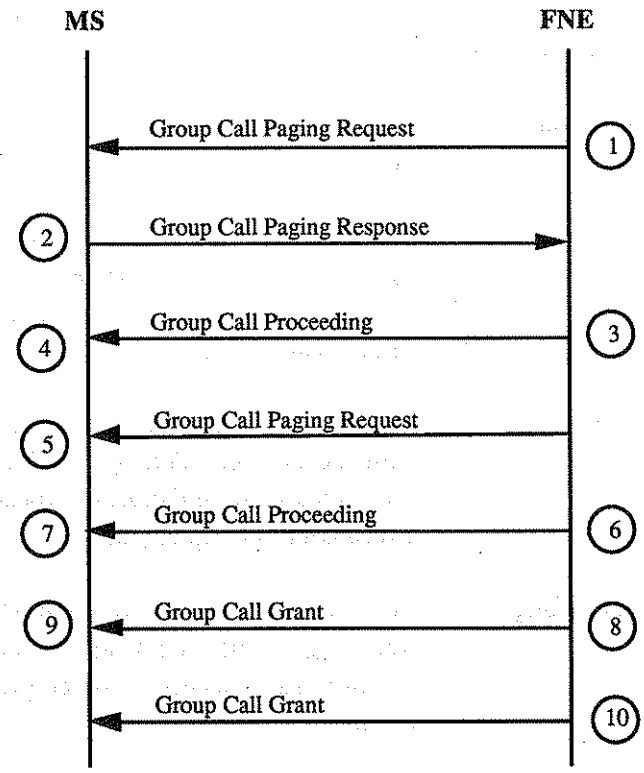


Fig. 4.4.2.6-2 Group Call Paging Elementary Procedure

Step 1 : The FNE broadcasts the Group Call Paging Request message on the CCCH. The message is repeated for a time interval T3150.

Step 2 : The target mobile station sends the Group Call Paging Response message on the RACH.

Step 3 : The FNE starts to send the Group Call Proceeding message on the CCCH.

Step 4 : The target mobile station receives a Group Call Proceeding message containing the correct group ID and an individual ID IE equal to the reserved value 0. The mobile station cancels inbound transmission and starts T3130.

Step 5 : Repeats of the Group Call Paging Request message may appear on the CCCH. If the target mobile station receives this message while T3130 is running, it does not respond with the Group Call Paging Response message.

Step 6 : The Group Call Proceeding message is repeated while the FNE continues to process the call.

Step 7 : Each time the target mobile station receives the Group Call Proceeding message with the correct group ID, it starts T3130.

Step 8 : The FNE allocates a multi-user TCH for the call, terminates to send the Group Call Proceeding, message and starts to send the Group Call Grant message on the CCCH.

Step 9 : The target mobile station stops T3130. All members of the group respond to the Group Call Grant message by moving to the assigned TCH. Target mobile stations becomes listeners on the channel.

Step 10 : The Group Call Grant message is repeated on the CCCH throughout the duration of the call.

Finally, the target members on the group are listening on the multi-user TCH.

(D) Abnormal Cases

(a) The FNE does not send Group Call Proceeding message (e.g. if the call can be immediately set up), or the mobile station can not receive the Group Call Proceeding message due to channel errors.

In that case, the target mobile station receives only the Group Call Grant. It responds as described in step 9. If the mobile station is transmitting a Group Call Paging Response message, it cancels that transmission.

(b) The FNE does not need to send the Group Call Paging Request message.

In that case the mobile station does not send a Group Call Paging Response message, and the procedure begins with either the Group Call Proceeding message (as in step 6) or the Group Call Grant message (as in step 8). The mobile station responds to these as described in step 7 or step 9, respectively.

(c) Failure of Inbound Transmission

In this case, the mobile station terminates the procedure.

(d) Cell Re-selection during Inbound Transmission

The target mobile station can not change cells while inbound transmission on the RACH is in progress.

(e) Cell Re-selection while T3130 is running.

While T3130 is running, the mobile station performs normal cell re-selection in an idle mode (see 4.3.11). If the mobile station changes cells while T3130 is running, it initiate the re-connect procedure.

(f) T3130 Timed out

The FNE terminates the call. The mobile station returns to an idle mode.

(3) Reconnect

(A) Initial Situation

There are two cases to consider

(a) A mobile station is in the setup phase of the Group Call (i.e. monitor the PCCH with T3130 running).

(b) A mobile station is assigned to a TCH and communicating in a Group Call.

In either of these cases the mobile station normally monitors the quality of the outbound link on its serving cell, and measures the quality of service available from the neighbor cells.

(B) Triggering Event

Applying the re-connection conditions of radio channel control, an mobile station determines that it changes cells.

(C) Procedure

See Fig. 4.4.2.6-3

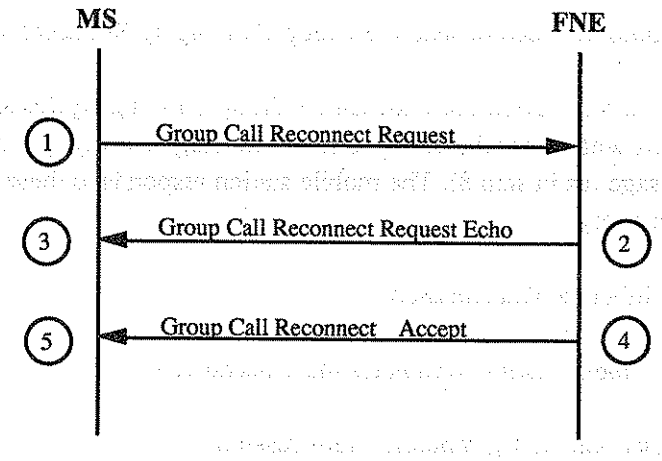


Fig. 4.4.2.6-3 Group Call Reconnect Procedure

Step 1 : The mobile station stops T3130, if running, and sends a Group Call Reconnect Request message on the RACH.

Step 2 : The FNE responds immediately with a Group Call Reconnect Request Echo message on the CCCH. This message is sent N3156 times in response to each Group Call Reconnect Request message received by the FNE.

Step 3 : The mobile station cancels inbound transmission, starts T3132, and waits for a Group Call Reconnect Accept message on the CCCH.

Step 4 : The FNE sends a Group Call Reconnect Accept message on the CCCH. This message is repeated N3154 times.

Step 5 : The mobile station stops T3132, starts T3130, and waits for appropriate a Group Call Grant message or Group Call Proceeding messages. In the mobile station, Cell Re-selection is inhibited for the duration of the procedure while T3132 is running.

(D) Abnormal Cases

(a) Due to RF channel errors, a mobile station receives a Group Call Reconnect Accept message without ever having seen the Group Call Reconnect Request Echo message.

In this case, it responds as described in step 5.

(b) FNE can not permit the Reconnect.

The FNE responds with (N3154 repeats of) the Group Call Reconnect Reject message, stops T3132, terminates the call, and returns to an idle mode.

(c) Failure of the RACH Access

In this case the mobile station terminates the call and returns to an idle mode.

(d) Cell Re-selection during Inbound Transmission

The target mobile station can not change cells while inbound transmission on the RACH is in progress.

(e) Cell Re-selection while T3132 is running.

While T3132 is running, the mobile station continues to monitor the neighbor cells but does not change cells.

(f) T3132 or T3130 Timed out

The mobile station terminates the call and returns to an idle mode.

(4) End of Transmission

(A) Initial Situation

Members of the group are on the TCH. One of the members is talking.

(B) Triggering Event

The talking user releases the PTT.

(C) Procedure

See Fig. 4.4.2.6-4.

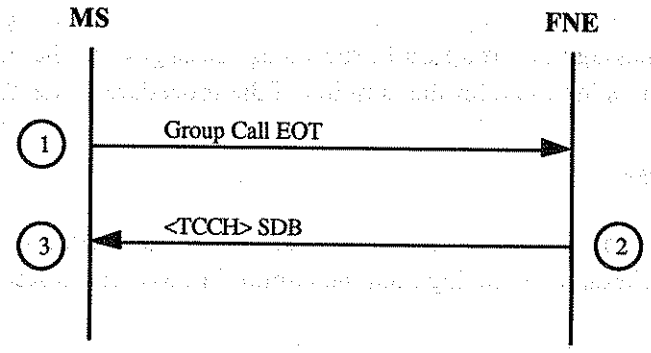


Fig. 4.4.2.6-4 Group Call End of Transmission Elementary Procedure

Step 1 : The mobile station sends Group Call End of Transmission (EOT) message on the ACCH.

Step 2 : The FNE receives the Group Call EOT message and changes the channel type to the TCCH.

Step 3 : The mobile station sees the channel type change to the TCCH, and stops repeating the Group Call EOT message. Members of the group are monitoring the TCCH.

(D) Abnormal Cases

(a) The FNE cannot receive the Group Call EOT message due to channel errors.

The FNE detect a channel failure, and will then set the channel to the TCCH.

(b) A Group Call EOT message received by the FNE, but channel re-assigned to another mobile station before <TCCH>SDB successfully received.

The mobile station behaves exactly as if it had observed a <TCCH>SDB, i.e., stop sending the Group Call EOT message and start the listening of channel.

(5) Re-assignment

(A) Initial Situation

Members of the group are monitoring the channel, which is TCCH.

(B) Triggering Event

A group member pushes the PTT switch.

(C) Procedure

See Fig. 4.4.2.6-5.

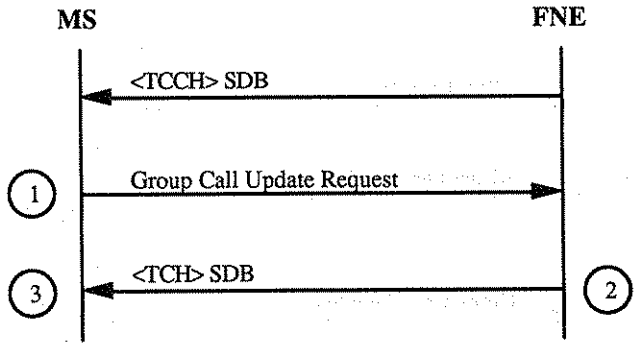


Fig. 4.4.2.6-5 Group Call Re-assignment Elementary Procedure

Step 1 : The mobile station sends a Group Call Update Request message on the inbound TCCH.

Step 2 : The FNE responds by changing the channel type to the TCH. The new talker is identified in the talker ID field of the SDB.

Step 3 : The mobile station observes the change to the TCH and cancels inbound transmission. The mobile station checks the SDB to see if it has won the right to transmit.

(D) Abnormal Cases

(a) The response of <TCH> SDB from the FNE is not observed.

In this case the mobile station indicates to the upper layer that his attempt to become the talker was not successful.

(b) Channel Failure detected by the FNE

The FNE sets the channel to a TCCH.

(6) Call Termination

(A) Initial Situation

Members of the group are monitoring the channel, which is TCCH.

(B) Triggering Event

The FNE hang timer expires without anyone in the group attempting to require a call.

(C) Procedure

See Fig. 4.4.2.6-6.

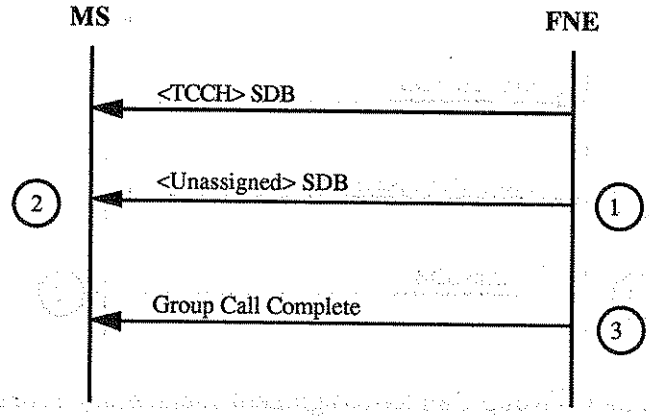


Fig. 4.4.2.6-6 Group Call Channel Release Elementary Procedure

Step 1 : The FNE stops the Group Call Grant messages on the CCCH and changes the channel type to unassigned.

Step 2 : When the mobile station receives the unassigned SDB, all mobile stations immediately release the TCH and return to the serving cell PCCH.

Step 3 : The FNE sends a Group Call Complete message on the CCCH. This message is repeated N3150 times. The RR cause value in the message indicates "Normal end of call".

Finally all members of the group return to an idle mode, monitoring the outbound PCCH.

(D) Abnormal Case

(a) Termination of the Call

A group call may terminate before the normal end of call. For example, the FNE wishes to reject the Group Call Request message made by the initiating unit or the mobile station requests the FNE to abort the call.

If the call is terminated before allocation of a TCH, the FNE stops the Group Call Proceeding message on the CCCH and sends the Group Call Complete message on the CCCH N3150 times.

If the call is terminated after allocation of the TCH, the FNE releases the TCH and sends the Group Call Complete message on the CCCH N3150 times.

When the mobile station recognizes that the call is terminated, it stops T3130 (if running), returns to the PCCH, and returns to an idle mode.

(7) Abort

This procedure provides a means for the initiating mobile station to prematurely abort the group call.

Note : An use of the abort procedure is to allow the initiating user to kill a call. It may also be used to prematurely terminate a call after setup.

(A) Initial Situation

A group call is in the process of being set up phase (i.e. Group Call Proceeding messages are being sent on the CCCH).

(B) Triggering Event

A member of the group wishes to abort the call.

(C) Procedure

See Fig. 4.4.2.6-7.

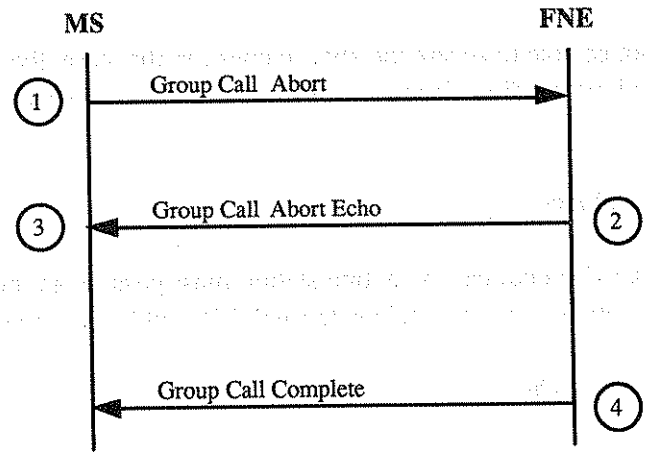


Fig. 4.4.2.6-7 Group Call Abort Elementary Procedure

Step 1 : The mobile station sends a Group Call Abort message on the RACH.

Step 2 : The FNE responds immediately with a Group Call Abort Echo message on the CCCH. This message is sent N3156 times in response to each Group Call Abort message received by the FNE.

Step 3 : The mobile station cancels inbound transmission.

Step 4 : If the FNE is able to abort the call, it terminates the call by sending of the Group Call Complete message on the CCCH N3150 times. The RR cause IE in the message indicates "Call aborted at user request".

Finally the call is over, and the mobile station starts monitoring the CCCH in an idle mode.

(D) Abnormal Cases

(a) The mobile station to receive a Group Call Complete message without ever having received a Group Call Abort Echo message because of RF channel errors.

In this event the mobile station reacts as though it had received a Group Call Abort Echo message followed by a Group Call Complete message.

(b) Failure of Inbound Transmission

In this case, the mobile station simply continues with the call. The abort attempt is not repeated.

(c) Cell Re-selection during Inbound Transmission

The target mobile station can not change cells while inbound transmission on the RACH is in progress.

(d) Call State does not allow abort at the FNE.

The FNE may not be able to accept the abort request. In that case, the FNE will proceed with the call (i.e. continue sending Group Call Proceeding messages and eventually Group Call Grant messages).

4.4.2.7 Private Call Procedures

In order to participate in a individual call, a mobile station must possess an individual ID or a group ID. These parameters are obtained and maintained through MM sublayer procedures.

(1) Initiation for Individual Call

(A) Initial Situation

The originating mobile station is an idle mode, monitoring the PCCH.

(B) Triggering Event

The user wants to set up a individual call.

(C) Procedure

See Fig. 4.4.2.7-1.

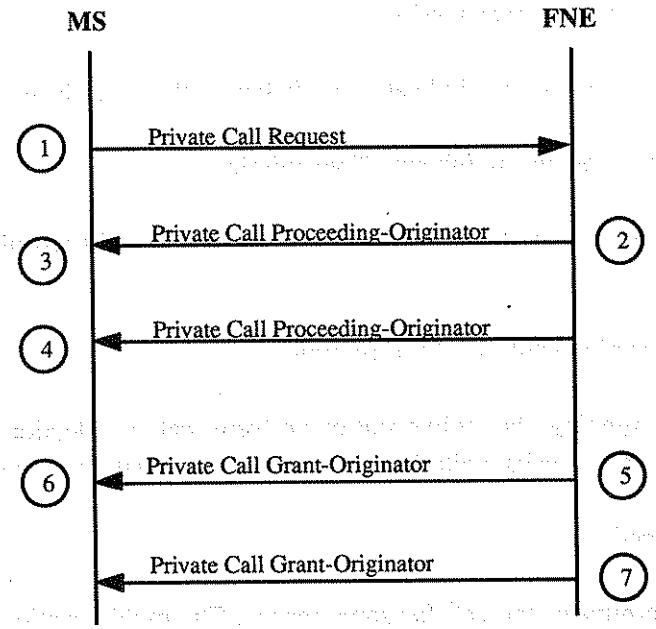


Fig. 4.4.2.7-1 Private Call Initiation Elementary Procedure

Step 1 : The originating mobile station sends a Private Call Request message on the RACH.

Step 2 : The FNE starts to send a Private Call Proceeding-Originator message on the CCCH.

Step 3 : The originating mobile station terminates inbound transmission and starts T3130.

Step 4 : The Private Call Proceeding-Originator message is repeated on the CCCH while the FNE continues to process the call. Each time the mobile station receives a this message, it re-starts T3130.

Step 5 : The FNE allocates a multi-user TCH for the call, terminates the Private Call Proceeding-Originator message, and starts the Private Call Grant-Originator message on the CCCH.

Step 6 : The originating mobile station stops T3130, moves to the assigned TCH, and becomes the talker.

Step 7 : The Private Call Grant-Originator message is repeated periodically on the CCCH throughout the duration of the call.

(D) Abnormal Cases

(a) The FNE does not send the Private Call Proceeding-Originator message or the mobile station can not receive the message due to channel errors.

In that case, the mobile station receives only the Private Call Grant-Originator message. It responds as described in step 6 (also, if the mobile station is transmitting a Private Call Request message, it cancels that transmission).

(b) Failure of Inbound Transmission

In this case, the mobile station indicates call failure to the upper layer.

(c) Cell Re-selection during Inbound Transmission

The target mobile station can not change cells while inbound transmission on the RACH is in progress.

(d) Cell Re-selection while T3130 is running.

While T3130 is running, the mobile station performs cell re-selection in an idle mode. The mobile station changes cells while T3130 is running, it initiate the reconnect procedure.

(e) T3130 Timed out

The FNE has terminates the call for some reason. The mobile station reports failure of the call to the user, and returns to an idle mode.

(f) Call Reject and Failure

When the FNE may be unable to handle the call request, the FNE rejects the request by sending a Private Call Complete-Originator message.

The reason for call rejection is given by the RR cause IE in the Private Call Complete-Originator message, and may be one of:

Not authorized to initiate call --- The requesting mobile station is not allowed to request the call.

Unrecognized Individual ID----- The Individual ID used by the mobile station is not known by the FNE. The mobile station starts the Registration procedure to obtain correct individual ID.

Call target non-existent---------- The target mobile station specified for the private call does not exist.

Call target not responding ------- The target mobile station does not respond.

Call target busy ---------- The target mobile station is currently involved in another call.

Call target not authorized -------- The target mobile station is not authorized to accept the call.

Temporary call failure ---------- The FNE could not set up the call due to a transient condition. The mobile station can try the call again.

Network out of order ---------- The FNE could not set up the call. The call is unlikely to succeed until the condition is corrected.

(2) Paging

(A) Initial Situation

The target mobile station is an idle mode, monitoring the PCCH.

(B) Triggering Event

The FNE is setting up a private call, and needs to locate the target mobile station.

(C) Procedure

See Fig. 4.4.2.7-2.

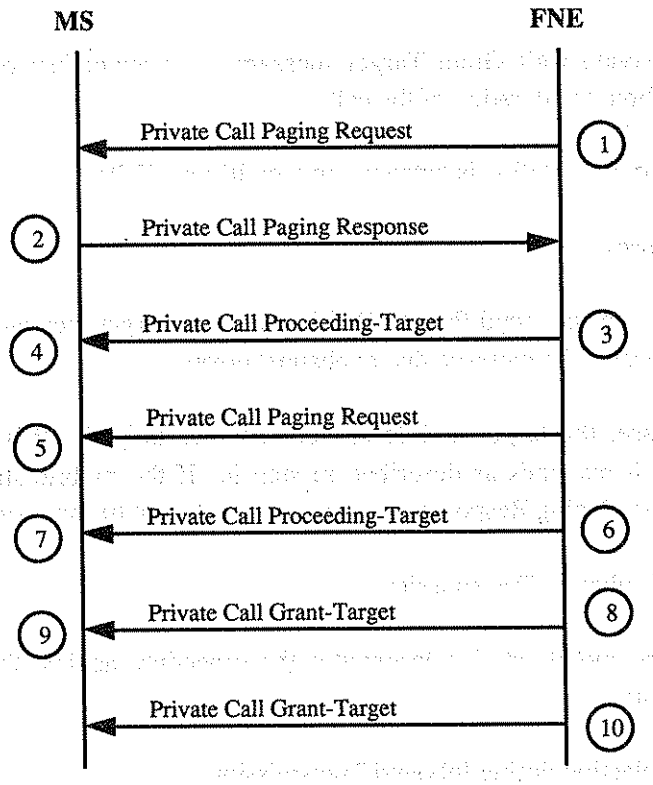


Fig. 4.4.2.7-2 Private Call Paging Elementary Procedure

Step 1 : The FNE broadcasts the Private Call Paging Request message on the CCCH. The message is repeated for a time interval T3151.

Step 2 : The target mobile station sends the Private Call Paging Response message on the RACH.

Step 3 : The FNE starts the Private Call Proceeding-Target message on the CCCH.

Step 4 : The mobile station cancels inbound transmission and starts T3130.

Step 5 : The Private Call Paging Request message is repeated on the CCCH. If an mobile station receives this message while T3130 is running, it does not respond.

Step 6 : The Private Call Proceeding-Target message is repeated while the FNE continues to process the call.

Step 7 : Each time the target mobile station receives the Private Call Proceeding-Target message, it re-starts T3130.

Step 8 : The FNE allocates a multi-user TCH for the call, terminates the Private Call Proceeding-Target message, and starts the Private Call Grant-Target message on the CCCH.

Step 9 : The target mobile station stops T3130, moves to the assigned TCH, and listens to the TCH.

Step 10 : The Private Call Grant-Target message is repeated periodically on the CCCH throughout the duration of the call.

Finally the target mobile station is listening on a multi-user TCH.

(D) Abnormal Cases

(a) The FNE does not send Private Call Proceeding-Target message or the mobile station can not receive the message due to channel errors.

In that case, the target mobile station receives only the Private Call Grant-Target message. It responds as described in step 9. If the mobile station is transmitting a Private Call Paging Response message, it cancels that transmission.

(b) Failure of Inbound Transmission

In this case, the mobile station terminates the procedure against the Private Call Paging Response message.

(c) Cell Re-selection during Inbound Transmission

The target mobile station can not change cells while inbound transmission on the RACH is in progress.

(d) Cell Re-selection while T3130 is running.

While T3130 is running, the mobile station performs normal cell re-selection in an idle mode. When the mobile station changes cells while T3130 is running, it initiate the reconnect procedure.

(e) T3130 Timed out

The FNE has terminated the call and returns to an idle mode.

(3) Reconnect

(A) Initial Situation

There are two cases to consider

(a) The mobile station may be in the setup phase of a private call (i.e. on the PCCH with T3130 running).

(b) The mobile station may be assigned to a TCH and communicating in a private call.

In either of these cases the mobile station normally monitors the quality of the outbound link on its serving cell, and measures the quality of service available from the neighbor cells.

(B) Triggering Event

Applying the criteria described in Section 4.3, a mobile station determines that it changes to one of the neighbor cells.

(C) Procedure

See Fig. 4.4.2.7-3.

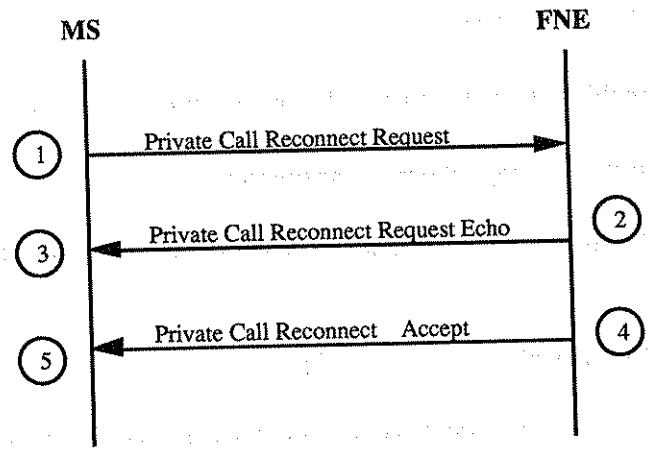


Fig. 4.4.2.7-3 Private Call Reconnect Procedure

Step 1 : The mobile station stops T3130, if running, and sends a Private Call Reconnect Request message on the RACH.

Step 2 : The FNE responds immediately with a Private Call Reconnect Request Echo message on the CCCH. This message is sent N3156 times in response to each request message received by the FNE.

Step 3 : The mobile station cancels inbound transmission, starts T3132, and waits for a Private Call Reconnect Accept message on the CCCH.

Step 4 : The FNE sends a Private Call Reconnect Accept message on the CCCH. This message is repeated N3154 times.

Step 5 : The mobile station stops T3132, starts T3130, and waits for Private Call Grant message or Private Call Reconnect Accept messages.

When the mobile station doesn't receive the system information from the BCCH of the new cell before being assigned to a new channel, the mobile station proceed with the call using the system information from the old cell.

(D) Abnormal Cases

(a) Due to RF channel errors it is possible for the mobile station to receive a Private Call Reconnect Accept message without ever having seen the Private Call Reconnect Request Echo message.

In this event the mobile station proceeds as though it had received the echo followed by the accept.

(b) FNE can not allow the Reconnect.

The FNE responds with N3154 repeats of the Private Call Reconnect Reject message rather than the Accept. RR stops T3132, terminates the call, and returns to an idle mode.

(c) Failure of the RACH Access

In this case the mobile station terminates the call and returns to an idle mode.

(d) Cell Re-selection during Inbound Transmission

The target mobile station can not change cells while inbound transmission on the RACH is in progress.

(e) Cell Re-selection while T3132 is running.

While T3132 is running, the mobile station continues to monitor the neighbor cells but does not change cells.

(f) T3132 or T3130 Timed out

The mobile station terminates the call and returns to an idle mode.

(4) End of Transmission

(A) Initial Situation

Two mobile stations are involved in a private call. One of the mobile stations is talking.

(B) Triggering Event

The talking user releases the PTT.

(C) Procedure

See Fig.4.4.2.7-4.

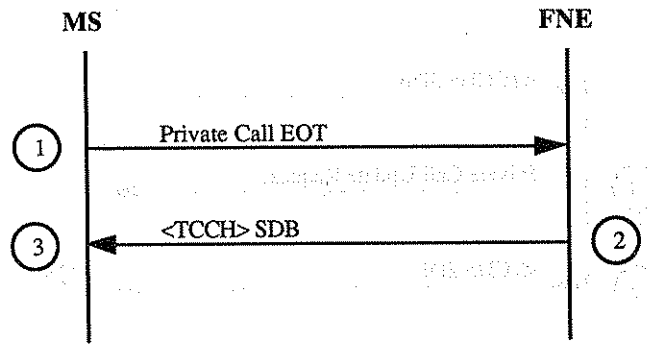


Fig. 4.4.2.7-4 Private Call End of Transmission (EOT) Elementary Procedure

Step 1 : The mobile station sends a Private Call End of Transmission on the ACCH.

Step 2 : The FNE receives the Private Call EOT message and changes the channel type to a TCCH.

Step 3 : The mobile station sees the channel type change to the TCCH, and stops repeating the Private Call EOT message.

Finally the mobile stations are monitoring the TCCH. Neither mobile station is talking.

(D) Abnormal Cases

(a) The FNE can not detect the Private Call EOT message due to RF channel errors.

The FNE recognizes a channel failure, and will then enter the re-assignment phase.

(b) The Private Call EOT message received by the FNE, but channel re-assigned to another mobile station before <TCCH>SDB successfully received.

The mobile station behaves exactly as if it had observed <TCCH> SDB – i.e., cease sending the EOT and become a listening mobile station.

(5) Re-assignment

(A) Initial Situation

The initiating and target mobile stations are monitoring the channel, which is TCCH.

(B) Triggering Event

One of the users pushes the PTT.

(C) Procedure

See Fig. 4.4.2.7-5.

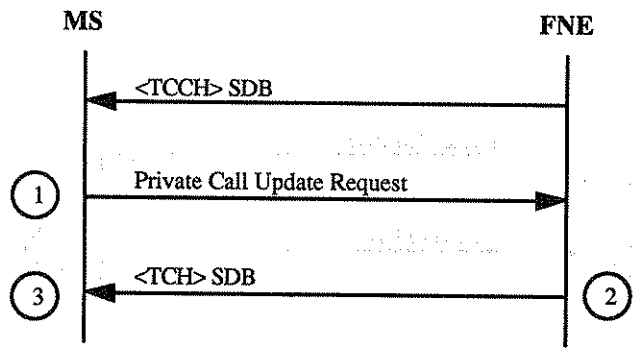


Fig. 4.4.2.7-5 Private Call Re-assignment Elementary Procedure

Step 1 : The mobile station sends the Private Call Update Request message on the inbound TCCH.

Step 2 : The FNE responds by changing the channel type to the TCH. The new talker is identified in the SDB.

Step 3 : The mobile station observes the change to TCH and cancels inbound transmission. The mobile station checks the SDB to see if it has won the right to transmit.

Finally Only mobile station is talking, which is TCH.

(D) Abnormal Cases

(a) No mobile station wishes to become the talker.

The FNE eventually times out and terminates the call.

(b) <TCH> SDB is not observed.

In this case the mobile station indicates to the upper layer that the re-assignment was not successful.

(c) Channel Failure detected by the FNE

The FNE sets the channel to a TCCH.

(6) Call Termination

(A) Initial Situation

The two mobile stations involved in a private call are monitoring the channel, which is TCCH.

(B) Triggering Event

The FNE hang timer timed out without either mobile station attempting to become the talker.

(C) Procedure

See Fig. 4.4.2.7-6.

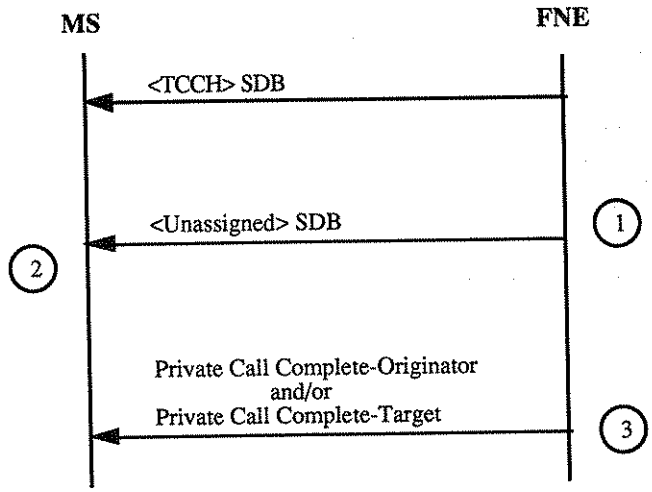


Fig. 4.4.2.7-6 Private Call Channel Release Elementary Procedure

Step 1 : The FNE stops the Private Call Grant message on the CCCH, and changes the type of the assigned TCH to unassigned.

Step 2 : Reception of the unassigned SDB causes a channel disconnect to be signaled. The mobile stations immediately leave the TCH and return to the serving cell's PCCH.

Step 3 : The FNE may send Private Call Complete-Originator messages or Private Call Complete-Target messages on the CCCH. Each of these messages are repeated N3150 times.

Finally mobile stations are idle, monitoring the outbound PCCH.

(D) Abnormal Cases

(a) Termination of the Call

A private call terminates prematurely. For example, the FNE wishes to reject the request by the initiating mobile station or the mobile station requests the FNE to abort the call.

If the call is terminated abnormally before allocation of a TCH for the call, the FNE stops the Private Call Proceeding messages on the CCCH and sends Private Call Complete messages on the CCCH N3150 times.

If the call is terminated abnormally after allocation of the TCH, FNE releases the TCH and sends Private Call Complete messages on the CCCH.

In either case, when the mobile station recognizes that the call is terminated, it stops T3130 and returns to an idle mode.

(7) Abort

This elementary procedure provides a means for either mobile station to prematurely abort the private call.

(A) Initial Situation

A private call is in progress.

(B) Triggering Event

One of the users wishes to abort the call.

(C) Procedure

See Fig. 4.4.2.7-7.

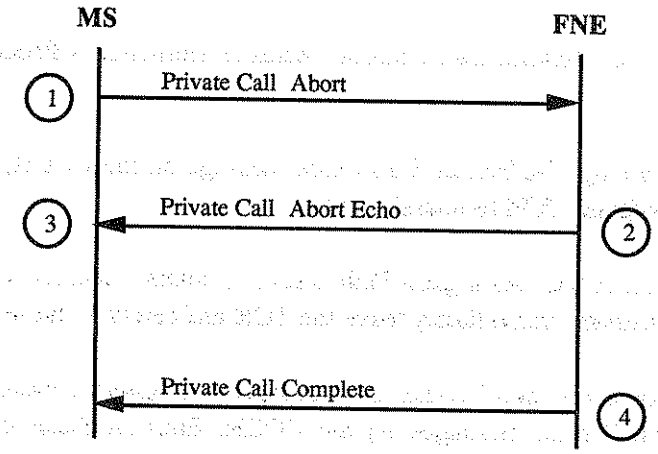


Fig. 4.4.2.7-7 Private Call Abort Elementary Procedure

Step 1 : The mobile station sends a Private Call Abort message on the RACH.

Step 2 : The FNE responds immediately with a Private Call Abort Echo message on the CCCH. This message is sent N3156 times in response to each Private Call Abort message received by the FNE.

Step 3 : The mobile station cancels inbound transmission.

Step 4 : If the FNE is able to abort the call, it terminates the call including the sending of the Group Call Complete message on the CCCH N3150 times. The RR cause IE in the message indicates "Call aborted at user request".

Finally the call is over, and the mobile station returns to an idle mode, monitoring the CCCH.

(D) Abnormal Cases

(a) Due to RF channel errors it is possible for the mobile station to receive a Private Call Complete message without ever having received a Private Call Abort Echo message.

In this event the mobile station reacts as though it had received both a Private Call Abort Echo followed by a Private Call Complete message.

(b) Failure of Inbound Transmission

In this case, the mobile station simply continues with the call. The abort attempt is not repeated.

(c) Cell Re-selection during Inbound Transmission

The target mobile station can not change cells while inbound transmission on the RACH is in progress.

(d) Call State does not allow abort at the FNE.

The FNE isn't able to honor the abort request. In that case, the FNE will proceed with the call (i.e. continue sending Private Call Proceeding message and Private Call Grant message.)

4.4.3 Mobility Management Procedures

4.4.3.1 General

The Mobility Management (MM) sublayer has the resposibilities for the location register and the authentication.

4.4.3.2 DLAI and RNC

(1) DLAI: Dispatch Location Area ID

Each cell in a system belongs to exactly one dispatch location area. The location area consists of many cells, and is a minimum unit for registration to the FNE. The dispatch location area ID identifies the location area. A cell may support one or more other dispatch location areas. DLAIs are given in the cell's BCCH from the FNE.

When a registration or registration renewal takes place, the mobile station stores the associated DLAI in which it last updated the FNE's location registers. The information (Individual ID, etc) which are obtained via the registration or registration renewal, are valid only within the particular dispatch location area in which they were assigned. When the mobile station moves into a new dispatch location area, it tries to renew the IDs by using the registration renewal procedure.

(2) Home RNC (Regional Network Code)

Home RNC indicates a system RNC where a mobile station locates. The mobile station stores Home RNC after obtaining Home RNC with registration.

4.4.3.3 Parameters Maintained by the MM sublayer

The followings are the parameters maintained by MM sublayer.

(a) Mobile Station
(b) Home RNC
(c) Individual ID
(d) Group ID
(e) Serving Dispatch Location Area

4.4.3.4 Registration

Registration is to register the serving location area to the FNE, and to obtain individual ID and group ID.

(1) Registration Initiated by the Mobile Station

(A) Initial Situation

The mobile station may be either idle or RR connected, with no other MM procedure active.

(B) Beginning of Registration

The reasons for the mobile station to initiate registration include:

(a) The mobile station is not registered.
(b) The user changes the groups.
(c) The mobile station switches on.
(d) A Registration Renewal attempt fails.

(C) Procedure

Registration takes place on the RR connection. If no RR connection exists, the mobile station causes an RR connection to be established by using RR connection sublayer module.

See Fig. 4.4.3.4-1.

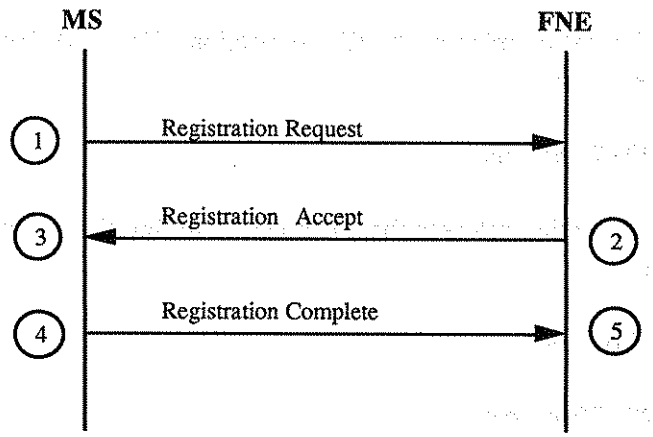


Fig. 4.4.3.4-1 Registration Initiated by the Mobile Station

Step 1 : The mobile station sends a Registration Request message on a DCCH and starts T3201.

Step 2 : The FNE updates its database, responds with a Registration Accept message on the DCCH and starts T3291.

Step 3 : The mobile station received the Registration Accept message stores the information (group ID,etc.) contained in this message, sends a Registration Complete message, stops T3201 and starts T3204.

Step 4 : The FNE received the Registration Complete message stops T3291 and initiates the release of the RR connection.

Step 5 : The mobile station observes the RR connection release, stops T3204, and terminates a registration procedure.

(D) Abnormal Cases

(a) On the Mobile Station Side

(i) RR Connection Establishment Failure

This is defined on Table 4.4.3.7-1 (J) "RR Connection Failure".

(ii) RR Connection fails before Reception of the Registration Accept Message.

This is defined on Table 4.4.3.7-1 (J) "RR Connection Failure".

(iii) The FNE Rejects the Registration Request.

This is defined on Table 4.4.3.7-1 (G)~(I) "Registration Reject 1~3".

(iv) T3201 Timed out

The mobile station releases the RR connection. This is defined on Table 4.4.3.7-1 "(K) T3201 Timed out".

(v) T3204 Timed out

The mobile station releases the RR connection, but the registration is considered to be successful.

(b) On the FNE Side

(i) T3291 Timed out

(ii) RR Connection fails before reception of the Registration Complete message.

In both cases, the FNE releases the RR connection, stops T3291 (if still running) and it considers the registration to be valid.

(2) Registration Initiated by the FNE

(A) Initial Situation

The mobile station may be either idle or RR connected, with no other MM procedure active.

(B) Beginning of Registration

The FNE initiate registration because of changing of the group ID.

(C) Procedure

Registration takes place on the RR connection. If no RR connection exists between target mobile station and the FNE, the FNE causes an RR connection to be established by using RR connection sublayer module.

See Fig. 4.4.3.4-2.

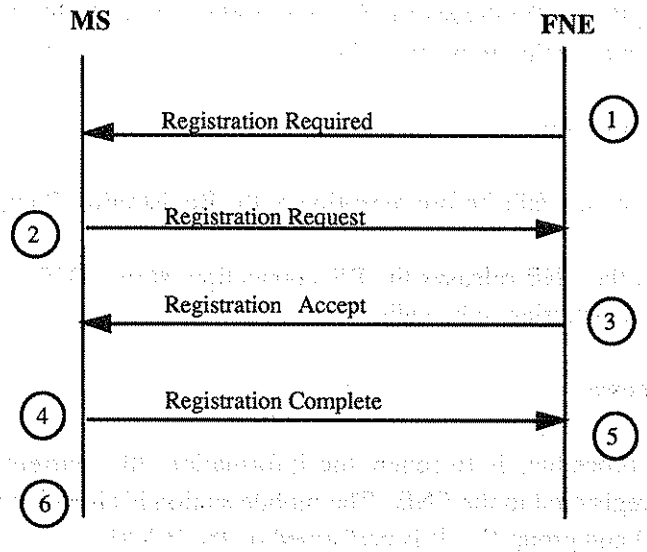


Fig. 4.4.3.4-2 Registration Initiated by the FNE Elementary Procedure

Step 1 : The FNE sends Registration Required message to the mobile station and starts T3292.

Step 2 : The mobile station sends a Registration Request message and starts T3201.

Step 3 : The FNE received the Registration Request message stops T3292, updates mobile station's database, responds with a Registration Accept message, and starts T3291.

Step 4 : The mobile station received the Registration Accept message stops T3201, stores the information contained in the message, sends a Registration Complete message, starts T3204.

Step 5 : The FNE received the Registration Complete message stops T3291 and initiates the release of the RR connection.

Step 6 : The mobile station detected the RR connection release stops T3204 and terminates the registration procedure.

(D) Abnormal Cases

(a) On the Mobile Station Side

Same as 4.4.3.4 (1) (D).

(b) On the FNE Side

(i) T3292 Timed out

(ii) RR Connection fails before Reception of the Registration Request message.

In both cases, the FNE releases the RR connection, stops T3292 (if still running), and it considers the registration to be not valid.

(iii) T3291 Timed out

(iv) RR Connection fails before reception of the Registration Complete message.

In both cases, the FNE releases the RR connection, stops T3291 (if still running) and it considers the registration to be valid.

4.4.3.5 Registration Renewal

The registration renewal procedure is to renew the information, like current location area, of the mobile station which has registered to the FNE. The mobile station is allowed to operate continuously with a stored individual ID and group ID. It is performed on the PCCH.

The mobile station does not perform cell re-selection during a registration renewal procedure. This procedure is a function of MM, but it is included in RR submodule.

(A) Initial Situation

The mobile station is in an idle mode, stores IMSI, individual ID and current location area.

(B) Beginning of Registration Renewal

When the mobile station changes, caused by cell re-selection, the current cell and the location area number which it obtained via a previous registration. Registration renewal procedure begins.

(C) Procedure

See Fig. 4.4.3.5-1.

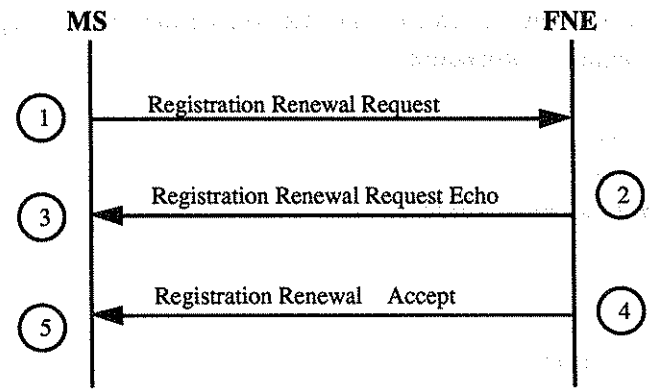


Fig. 4.4.3.5-1 Registration Renewal Elementary Procedure

Step 1 : The mobile station sends a Registration Renewal Request message on the RACH.

Step 2 : The FNE received the Registration Renewal Request message responds immediately with a Registration Renewal Request Echo message on the CCCH. The Registration Renewal Request Echo message is sent N3156 times in response to each request message received by the FNE.

Step 3 : The mobile station received the Registration Renewal Request Echo message cancels inbound transmission, starts T3132.

Step 4 : The FNE registered new registration sends the Registration Renewal Accept message on the CCCH. This message is repeated N3153 times.

Step 5 : The mobile station received the Registration Renewal Accept message stops T3132 and returns to an idle mode.

(D) Abnormal Cases

(a) Fail to receive the Registration Renewal Request Echo Message

The mobile station can receive a Registration Renewal Accept message without ever having seen the Registration Renewal Request Echo message. In this event the mobile station proceeds as though it had received a Registration Renewal Request Echo message.

(b) Access to the cell is prohibited.

The mobile station does not send the Registration Renewal Request message. The registration renewal is considered to be failed.

(c) FNE can not process the renewal.

The FNE responds with the Registration Renewal Reject message. The mobile station received the Registration Renewal Reject message stops T3132. It is defined on Table 4.4.3.7-1 (L) "Renewal Reject".

(d) Cell Re-selection during Inbound Transmission

The target mobile station does not change cells while inbound transmission on the RACH is in progress.

(e) Cell Re-selection while T3132 is running.

The target mobile station does not change cells while inbound transmission on the RACH is in progress.

(f) T3132 Timed out

The Registration Renewal is cosidered to be failed. It is defined on Table 4.4.3.7-1 (M) "Renewal Failure".

4.4.3.6 De-activation

(A) Initial Situation

The mobile station is registered, at initial situation, to the FNE and stores the valid IMSI, individual ID and current location area in the registers.

(B) Triggering Event

The de-activation procedure may be performed when the mobile station is switched off.

(C) Procedure

See Fig. 4.4.3.6-1

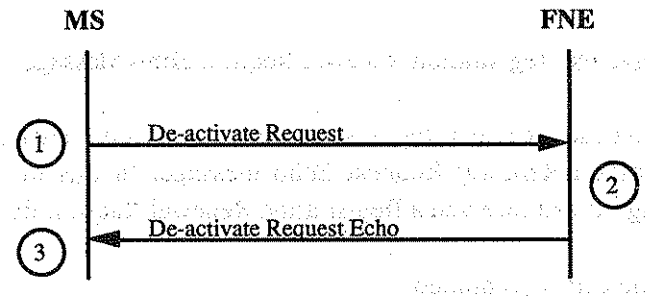


Fig. 4.4.3.6-1 De-activation Elementary Procedure

Step 1 : The mobile station sends the De-activate Request message on the RACH.

Step 2 : The FNE received De-activate Request message responds with a De-activate Request Echo message. This message is sent N3156 times in response to each request message.

Step 3 : The mobile station received the De-activate Request Echo message cancels inbound transmission, switches off and become inactive.

(D) Abnormal Cases

(a) Cell Re-selection during Inbound Transmission

The target mobile station can not change cells while inbound transmission is in progress.

(b) Fail to Receive the De-activate Request Echo Message

The mobile station switches off and become inactive.

4.4.3.7 State Transitions in Mobility Management (MM)

(1) Status of MM

Description of states on a mobile station side

(A) No IMSI

The mobile station has only an IMEI; it has no other IDs. The states No. is ST1.

(B) Registering IMEI

The mobile station is performing the registration procedure to the FNE using its IMEI. The states No. is ST2.

(C) Registered

The mobile station has completed a registration. It receives a valid individual ID and a group ID and stored these IDs and the current location area. The states No. is ST3.

(D) Renewing

The mobile station is performing the registration renewal to the FNE with registration renewal procedure . The states No. is ST4.

(E) Registering

The mobile station is performing the registration to the FNE with registration procedure using its IMSI. The states No. is ST5.

(F) Not Registered

The mobile station has IMSI, but doesn't register to the FNE. In this state the mobile station does not have an individual ID, group ID, or the current location area. The states No. is ST6.

(G) No Dispatch Service

The mobile station does not allow to access to the FNE. In this state the mobile station does not have an individual ID, group ID, or the current location area. The states No. is ST7.

(H) Not Permitted Mobile Station

The mobile station is not permitted an individual call and a group call. In this state the mobile station does not have a valid individual ID, group ID, or a current location area. The states No. is ST8.

(2) Cause of State Transitions in MM

(A) Switch on

The mobile station is turned on a switch.

(B) Cell Selection

Selection of a cell with cell selection or cell re-selection

(C) Successful Registration

(D) Successful Renewal

(E) Group Change

The user has changed the group.

(F) Switch off

The mobile station is turned off a switch

(G) Registration Reject 1

Receiving the Registration Rejection from the FNE using cause value "IMSI unknown".

(H) Registration Reject 2

Receiving the Registration Rejection from the FNE using cause value "IMEI not accepted".

(I) Registration Reject 3

Registration Reject message from the FNE using a cause value other than those specifically mentioned G and H.

(J) RR Connection Failure

(K) T3201 Timed out.

(L) Renewal Reject

Receiving the Registration Renewal Reject message.

(M) Renewal Failure

The Registration Renewal failure caused by any reason besides FNE reject.

(N) T3202 Timed out

(O) T3206 Timed out

(P) User Initiates a Transmission Call

Initiates a group call or a private call from a mobile station.

(Q) FNE Initiates a Transmission Call

Call of a group call or a private call from a FNE.

(R) Paging Request 2-1

Receiving Paging Request 2 message including IMSI in a mobile station.

(S) Paging Request 2-2

Receiving Paging Request 2 message including a mobile station's individual ID.

(3) Transition State/Procedure Table

State transitions and procedures are defined on Table 4.4.3.7-1. The state STx in the table shows the following state in MM. The trial numbers are parameters for storing numbers of times of attempted registration or registration renewal. A camped cell indicates the mobile station is in the cell not prohibited from camping. The negative RNC list is for the list that the mobile station stores the FNE prohibited from access. Stored DLAI shows DLAI stored in a mobile station. The trial number ++ shows adding one each trial number.

Table 4.4.3.7-1 MM State / Event Description (Part 1)

Events	States			
	ST1: No IMSI	ST2: Registering IMEI	ST3: Registered	ST4: Renewing
(A) Switch on	1. Delete DLAI 2. Delete ID except for IMEI 3. Delete home RNC			
(B) Cell Selection	1. stop T3202 2. initiate registration 3. ST2		1. if DLAI not=stored DLAI, 1-1 stop T3202,T3206 1-2 initiate renewal Renewing 1-3 ST4	
(C) Successful Registration		1. attempt = 0 2. store home RNC 3. store Service Provider. 4. if no Individual ID assigned, ST8 5. except for 4, ST3		
(D) Successful Renewal				1. attempt=0 2. store DLAI 3. start T3206 4. ST3
(E) Group Change	reject group change	reject group change	1.if camped, 1-1 stop T3202, stop T3206 1-2 initiate registration 1-3 ST5 2.1 else, reject group change	postpone group change

Table 4.4.3.7-1 MM State / Event Description (Part 2)

Events	States			
	ST1: No IMSI	ST2:Registrating IMEI	ST3: Registered	ST4: Renewing
(F) Switch Off	stop T3202	ST1	1. stop T3202, T3206 2. if camped & Access permitted, start SW off procedure. 3. delete group and individual ID & stored DLAI 4. ST6	1. delete group and individual ID & stored DLAI 2. ST6
(G) Registration Reject 1				
(H) Registration Reject 2		1. add this RNC to negative RNC list 2. start cell selection 3. ST1		
(I) Registration Reject 3		1. start T3202 2. ST1		
(J) RR Connection Failure		1. start T3202 2. ST1		
(K) T3201 Timed Out		1. start T3202 2. ST1		
(L) Renewal Reject				1. attempt = 0 2. delete group and individual ID & stored DLAI 3. initiate Registration Registering 4. ST2

Table 4.4.3.7-1 MM State / Event Description (Part 3)

Events	States			
	ST1: No IMSI	ST2: Resistrating IMEI	ST3: Resistrated	ST4: Renewing
(M) Renewal Failure				1. attempt++ 2. if DLAI = stored DLAI && attempt <= 4) 2-1 start T3202 2-2 ST3 3. Except for 2 3-1 delete group and individual ID & stored DLAI 3-2 start T3202 3-3 ST6
(N) T3202 Timed Out	1. if camped cell 1-1 start registration Registering 1-2 ST2		1. if camped cell initiate renewal Renewing 2. except for 1 2-1 delete group and individual ID & stored DLAI 2-2 ST6	
(O) T3206 Timed Out				
(P) User Initiates a Transmission Call	reject call	reject call	1. if camped cell start call 2. else reject call	postpone call
(Q) FNE Initiates a Transmission Call			1. if camped cell start call 2. else reject call	
(R) Paging Request 2–1			respond to page	
(S) Paging Request 2–2			respond to page	

Table 4.4.3.7-1 MM State / Event Description (Part 4)

Events	States			
	ST5: Registrating	ST6: Not Registered	ST7: No Service	ST8:Not permitted MS
(A) Switch on		attempt=0		
(B) Cell Selection		1. stop T3202 2. start registration registering 3. ST5		
(C) Successful Registration	1. attempt=0 2. no Individual ID assignedST8 3. except for 2 3-1 start T3206 3-2 ST3			
(D) Successful Renewal				
(E) Group Change	defer group change	1. if camped cell 1-1 stop T3202 1-2 start registration registering 1-3 ST5 2. except for 1 2-1 reject group change	not permit group change	not permit group change
(F) Switch off	ST6	stop T3202	ST6	
(G) Registration Reject 1	attempt=0 ST7			
(H) Registration Reject 2				

Table 4.4.3.7-1 MM State / Event Description (Part 5)

Events	States			
	ST5: Registering	ST6: Not Registering	ST7: No Service	ST8:Not permitted MS
(I)Reject Registration 3	1. attempt++ 2. if attempt is less than 4 2-1 startT3202 3. ST6			
(J) RR Connection Failure	same as above			
(K) T3201 Time Out	same as above			
(L) Renewal Reject				
(M) Renewal Failure				
(N) T3202 Timed Out		1. if camped cell 1-1 start registration Registering 1-2 ST5		
(O) T3206 Timed Out				
(P) User Initiates a Transmission Call	defer call	reject call	reject call	reject call
(Q) FNE Initiates a Transmission Call		ignore	ignore	ignore
(R) Paging Request 2–1		respond to page	respond to page	respond to page
(S) Paging Request 2–2		ignore	ignore	ignore

4.4.4 Procedure for Connection Management

CM connection submodule consists of many protocol entities. The followings are protocol entities.

(1) Call control for PSTN connection
(2) Supplementary service control
(3) Short message service control
(4) Supplementary control for group call and individual call

The message exchanged by the entities are sent through RR link which set up with RR connection sublayer. The control procedure sequence for the entities is determined by service providers.

4.4.5 List of Layer 3 Parameters

In this Section , values or operations in blanks are specified by the service providers.

4.4.5.1 Radio Resource Management sublayer Parameters

(1) Timers on the Mobile Station Side

Table 4.4.5.1-1 RR sublayer Timers on the Mobile Station Side

Timer	Value	Cause for Start	Normal Stop	On Expiration
T3120		receives paging request 2	receives immediate assignment	
T3130	sent on BCCH (20 sec.)	receives call proceeding	receives grant	resumes normal idle mode operation
T3132	sent on BCCH (12 sec.)	sends request to FNE	procedure completes	depends on particular request

(2) Timers on the FNE side

Table 4.4.5.1-2 RR sublayer Timers on the FNE Side

Time	Value	Cause for Start	Normal Stop	On Expiration
T3101		sends immediate assignment	moves to the mobile station's new channel	aborts RR link procedure
T3103		sends handover command	receives handover access	terminates a call
T3107		sends assigning command	receives assign access	terminates a call
T3113		sends paging request	receives paging response	re-starts sending paging requests
T3150	1 sec.	starts sending message		ends sending message
T3151	1 sec.	starts sending message		ends sending message
T3152	option			

(3) Other Parameters on the FNE Side

Table 4.4.5.1-3 Other RR Parameters on the FNE Side

Parameter	Value	Purpose
N3101		sending number of immediate assignment message
N3150	4	number of repeats of Group Call Complete, Private Call Complete message
N3151		option
N3152		option
N3153	2	number of repeats of Registration Renewal Accept/Reject message
N3154	4	number of repeats of Reconnect Accept/Reject message
N3155		option
N3156	1	number of repeats of echo in response various inbound messages

4.4.5.2 Mobility Management sublayer Parameters

(1) Timers on the Mobile Station Side

Table 4.4.5.2-1 MM sublayer Timers on the Mobile Station Side

Timer	Value	Cause for Start	Normal Stop	On Expiration
T3201	10sec.	sends Registration Request	receives Registration Accept	fails registration
T3202	10sec.	fails registration	successes registration	re-starts registration procedure
T3204	10sec.	receives normal end of procedure	releases RR link	aborts RR connection
T3206	sent on the BCCH	registration succeeds or registration renewal		initiates periodic registration renewal

(2) Timers on the FNE Side

Table 4.4.5.2-2 MM sublayer Timers on the FNE Side

Timer	Value	Cause for Start	Normal Stop	On Expiration
T3291	10sec.	sends Registration Accept	receives Registration Complete	aborts RR connection
T3292	10sec.	sends Registration Required	receives Registration Request	aborts RR connection

4.4.5.3 Connection Management sublayer Parameters

(1) Timers on the Mobile Station Side

None currently defined.

(2) Timers on the FNE Side

Table 4.4.5.3-1 MM sublayer Timers on the FNE Side

Timer	Value	Cause for Start	Normal Stop	On Expiration
T3300		Option		
T3301		Option		

(3) Other Parameters on the FNE Side

Table 4.4.5.3-2 Other RR Parameters on the FNE Side

Parameter	Value	Purpose
N3300		Option
N3301		Option

4.5 Definition of Message Functions and Contents

4.5.1 Outline

In this Section 4.5, first, in 4.5.2 "Message Definition", the messages for the radio resource management, the mobile management and the connection management used at layer 3 entity are defined.

Each message, the methods and the Information Elements (IE) consisting messages are described. There are the next four type's IEs shown in the Table 4.5.1-1. Hereinafter, these symbols are used in the table.

Table 4.5.1-1 Symbols Used in IE

	Mandatory	Optional
Fixed length	MF	OF
Variable Length	MV	OV

In 4.5.3 "Message Structure and the definition of Information Element", message structure and each identifier, message type and the detail of IEs which consist of message are described.

The messages which are not prescribed for this standard are optional.

4.5.2 Message Definition

4.5.2.1 Messages for Radio Resource Management

In this section, messages for radio resource management are described. Table 4.5.2.1-1 shows a set of these messages and the details of these messages are shown in Item (1)~(56).

Table 4.5.2.1-1 Table 1 Message for Radio Resource Management

Message Category	Message Name	Channel Used	Direction	Reference
Paging	Paging Request	CCCH	outbound	4.5.2.1 (28)
	Paging Response	Dm(Note 1)	inbound	4.5.2.1 (30)
	Paging Request - 2	CCCH	outbound	4.5.2.1 (29)
	Paging Response - 2	Dm	inbound	4.5.2.1 (31)
Control channel establishment	Channel Request	RACH	inbound	4.5.2.1 (4)
	Immediate Assingment	CCCH	outbound	4.5.2.1 (24)
	Immediate Assingment Reject	CCCH	outbound	4.5.2.1 (25)
Handover	Assignment Access	TCCH	inbound	4.5.2.1 (1)
	Assignment Command	Dm	outbound	4.5.2.1 (2)
	Assignment Failure	Dm	inbound	4.5.2.1 (3)
	Handover Access	TCCH	inbound	4.5.2.1 (21)
	Handover Command	Dm	outbound	4.5.2.1 (22)
	Handover Failure	Dm	inbound	4.5.2.1 (23)
	Measurement Inquire	Dm	outbound	4.5.2.1 (26)
	Measurement Report	Dm	inbound	4.5.2.1 (27)
Direct MM support	Registration Renewal Request	RACH	inbound	4.5.2.1 (51)
	Registration Renewal Request Echo	CCCH	outbound	4.5.2.1 (52)
	Registration Renewal Accept	CCCH	outbound	4.5.2.1 (49)
	Registration Renewal Reject	CCCH	outbound	4.5.2.1 (50)
	De-activate Request	RACH	inbound	4.5.2.1 (5)
	De-activate Request Echo	CCCH	outound	4.5.2.1 (6)
System information	System Information type 0	BCCH	outbound	4.5.2.1 (54)
	System Information type 1	BCCH	outbound	4.5.2.1 (55)
	System Information type 5	Dm	outbound	4.5.2.1 (56)
Other	RR-Status	Dm	both	4.5.2.1 (53)

Note 1 : Dm shows either ACCH or DCCH.

Table 4.5.2.1-1 Table 1 Message for Radio Resource Management (Continued)

Message Category	Message Name	Channel Used	Direction	Reference
Group Call	Group Call Request	RACH	inbound	4.5.2.1 (19)
	Group Call Paging Request	CCCH	outbound	4.5.2.1 (12)
	Group Call Paging Response	RACH	inbound	4.5.2.1 (13)
	Group Call Proceeding	CCCH	outbound	4.5.2.1 (14)
	Group Call Grant	CCCH	outbound	4.5.2.1 (11)
	Group Call End of Transmission	Dm	inbound	4.5.2.1 (10)
	Group Call Update Request	TCCH	inbound	4.5.2.1 (20)
	Group Call Complete	CCCH	outbound	4.5.2.1 (9)
	Group Call Abort	RACH	inbound	4.5.2.1 (7)
	Group Call Abort Echo	CCCH	outbound	4.5.2.1 (8)
	Group Call Reconnect Request	RACH	inbound	4.5.2.1 (17)
	Group Call Reconnect Request Echo	CCCH	outbound	4.5.2.1 (18)
	Group Call Reconnect Accept	CCCH	outbound	4.5.2.1 (15)
	Group Call Reconnect Reject	CCCH	outbound	4.5.2.1 (16)
Individual Call	Private Call Request	RACH	inbound	4.5.2.1 (47)
	Private Call Proceeding - Originator	CCCH	outbound	4.5.2.1 (41)
	Private Call Grant - Originator	CCCH	outbound	4.5.2.1 (37)
	Private Call Paging Request	CCCH	outbound	4.5.2.1 (39)
	Private Call Paging Response	RACH	inbound	4.5.2.1 (40)
	Private Call Proceeding - Target	CCCH	outbound	4.5.2.1 (42)
	Private Call Grant - Target	CCCH	outbound	4.5.2.1 (38)
	Private Call End of Transmission	Dm	inbound	4.5.2.1 (36)
	Private Call Update Request	TCCH	inbound	4.5.2.1 (48)
	Private Call Complete - Originator	CCCH	outbound	4.5.2.1 (34)
	Private Call Complete - Target	CCCH	outbound	4.5.2.1 (35)
	Private Call Abort	RACH	inbound	4.5.2.1 (32)
	Private Call Abort Echo	CCCH	outbound	4.5.2.1 (33)
	Private Call Reconnect Request	RACH	inbound	4.5.2.1 (45)
	Private Call Reconnect Request Echo	CCCH	outbound	4.5.2.1 (46)
	Private Call Reconnect Accept	CCCH	outbound	4.5.2.1 (43)
	Private Call Reconnect Reject	CCCH	outbound	4.5.2.1 (44)

(1) Assignment Access

This message is sent from the mobile station to the FNE on the TCCH which is newly assigned to trigger the activation of the channel.

Table 4.5.2.1-2 Assignment Access

Information Element	Reference	Type	Length (octet)	Notes
Protocal discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Random reference	4.5.3.6 (3) (S)	MF	3	1

Note 1 : The mobile station sends the Random reference value that is was previously using on the old channel.

(2) Assignment Command

This message is sent on the Dm from the FNE to the mobile station to change the channel.

Table 4.5.2.1-3 Assignment Command

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Channel description	4.5.3.6 (3) (I)	MF	3	
Option	–	–	2	

(3) Assignment Failure

This message is sent from the mobile station to the FNE on the last used Dm to indicate that the mobile station has failed to seize the new channel assigned in an assignment command

Table 4.5.2.1-4 Assignment Failure

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
RF cause	4.5.3.6 (3) (V)	MF	1	

(4) Channel Request

This message is sent from the mobile station to the FNE on the RACH to initiate RR-connection.

Table 4.5.2.1-5 Channel Request

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Establishment cause	4.5.3.6 (3) (K)	MF	1	
Random reference	4.5.3.6 (3) (S)	MF	3	1

Note 1: The mobile station chooses a "random value" for the random reference IE, and uses this value to match up the subsequent Immediate Assignment message.

(5) De-activate Request

This message is sent on the RACH from the mobile station to the FNE to indicate that the mobile station is being de-activated.

Table 4.5.2.1-6 De-activate Request

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Individual ID	4.5.3.6 (2) (D)	MF	3	

(6) De-activate Request Echo

The De-activate Request Echo message is sent on the CCCH from the FNE to the mobile station in reply to a De-activate Request.

Table 4.5.2.1-7 De-activate Request Echo

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Individual ID	4.5.3.6 (2) (D)	MF	3	

(7) Group Call Abort

This message is sent on the RACH from an mobile station to the FNE to abort a Group Call.

Table 4.5.2.1-8 Group Call Abort

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Individual ID	4.5.3.6 (2) (D)	MF	3	
Group ID	4.5.3.6 (2) (C)	MF	3	
Group call modifier	4.5.3.6 (3) (L)	MF	1	

(8) Group Call Abort Accept

This message is sent on the CCCH from the FNE to an mobile station to indicate reception of a Group Call Abort message.

Table 4.5.2.1-9 Group Call Abort Echo

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Individual ID	4.5.3.6 (2) (D)	MF	3	
Group call modifier	4.5.3.6 (3) (L)	MF	1	

(9) Group Call Complete

This message is sent on the CCCH from the FNE to the mobile station to indicate that a Group Call has terminated.

Table 4.5.2.1-10 Group Call Complete

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Individual ID	4.5.3.6 (2) (D)	MF	3	
Group ID	4.5.3.6 (2) (C)	MF	3	
RR cause	4.5.3.6 (3) (V)	MF	1	
Group call modifier	4.5.3.6 (3) (L)	MF	1	

(10) Group Call End of Transmission

This message is sent on Dm from the talking mobile station to the FNE. To indicate that the mobile station has ended of transmission.

Table 4.5.2.1-11 Group Call End of Transmission

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	

(11) Group Call Grant

This message is sent on the CCCH from the FNE to the mobile station to assign a channel for a Group Call.

Table 4.5.2.1-12 Group Call Grant

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Group call modifier	4.5.3.6 (3) (L)	MF	1	
Individual ID fragment	4.5.3.6 (3) (M)	MF	2	
Group ID	4.5.3.6 (2) (C)	MF	3	
Channel assignment	4.5.3.6 (3) (H)	MF	3	

(12) Group Call Paging Request

This message is sent on the CCCH from the FNE to the mobile station to locate members of groups. Targeted mobile station responds to the Group Call Paging Response.

Table 4.5.2.1-13 Group Call Paging Request

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Group ID	4.5.3.6 (2) (C)	MF	3	
Group ID	4.5.3.6 (2) (C)	MF	3	1
Group call modifier	4.5.3.6 (3) (L)	MF	1	2
Group call modifier	4.5.3.6 (3) (L)	MF	1	3

Notes 1: This ID may be set to 0 if only one Group ID is being paged.
2: Applies to the first Group ID.
3: Applies to the second Group ID.

(13) Group Call Paging Response

This message is sent on the RACH from a targeted mobile station to the FNE in response to a Group Call Paging Request.

Table 4.5.2.1-14 Group Call Paging Response

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Individual ID	4.5.3.6 (2) (D)	MF	3	
Group ID	4.5.3.6 (2) (C)	MF	3	
Group call modifier	4.5.3.6 (3) (L)	MF	1	

(14) Group Call Proceeding

This message is sent on the CCCH from the FNE to the mobile station in response to a Group Call Request to indicate that a Group Call is being processed.

Table 4.5.2.1-15 Group Call Proceeding

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Individual ID	4.5.3.6 (2) (D)	MF	3	
Group ID	4.5.3.6 (2) (C)	MF	3	
Group call modifier	4.5.3.6 (3) (L)	MF	1	

(15) Group Call Reconnect Accept

This message is sent on the CCCH from the FNE to the mobile station to indicate that a reconnect attempt is successful.

Table 4.5.2.1-16 Group Call Reconnect Accept

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Location area ID	4.5.3.6 (2) (E)	MF	5	1
Individual ID	4.5.3.6 (2) (D)	MF	3	1

Note 1 : LAI (Location Area ID) & Individual ID are used in the Reconnect Request.

(16) Group Call Reconnect Reject

This message is sent on the CCCH from the FNE to a mobile station to indicate that a reconnect attempt is unsuccessful.

Table 4.5.2.1-17 Group Call Reconnect Reject

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Location area ID	4.5.3.6 (2) (E)	MF	5	1
Individual ID	4.5.3.6 (2) (D)	MF	3	1

Note 1: LAI & Individual ID are used in the Group Call Reconnect Request.

(17) Group Call Reconnect Request

This message is sent on the RACH from the mobile station to the FNE to reconnect a group call when the mobile station changes cells.

Table 4.5.2.1-18 Group Call Reconnect Request

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Location area ID	4.5.3.6 (2) (E)	MF	5	1
Individual ID	4.5.3.6 (2) (D)	MF	3	
Talk-group index	4.5.3.6 (3) (X)	MF	1	

Note 1: This IE contains the location area in which the Individual ID was last registered.

(18) Group Call Reconnect Request Accept

This message is sent on the CCCH from the FNE to an mobile station to indicate that the FNE received, a Group Call Reconnect Request.

Table 4.5.2.1-19 Group Call Reconnect Request Accept

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Location area ID	4.5.3.6 (2) (E)	MF	5	1
Individual ID	4.5.3.6 (2) (D)	MF	3	1

Note 1: LAI & Individual ID are used in the Group Call Reconnect Request.

(19) Group Call Request

This message is sent on the RACH from an mobile station to the FNE to initiate a Group Call.

Table 4.5.2.1-20 Group Call Request

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Individual ID	4.5.3.6 (2) (D)	MF	3	
Group ID	4.5.3.6 (2) (C)	MF	3	
Service area ID	4.5.3.6 (3) (W)	MF	1	1
Group call modifier	4.5.3.6 (3) (L)	MF	1	

Note 1: The value "$00"(no service area) indicates a local service area call; the value "$FF"(all service areas) indicates a wide area call.

(20) Group Call Update Request

This message is sent on the TCCH from the mobile station to the FNE by an mobile station which wishes to become the talker.

Table 4.5.2.1-21 Group Call Update Request

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	OF	1	
Transaction identifier	4.5.3.4	OF		
Message type	4.5.3.5	OF	1	
Individual ID	4.5.3.6 (2) (D)	OF	3	
Group call modifier	4.5.3.6 (3) (L)	OF	2	

(21) Handover Access

This message is sent from the mobile station to the FNE on the TCCH to trigger the activation of the new channel.

Table 4.5.2.1-22 Handover Access

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Random reference	4.5.3.6 (3) (S)	MF	3	1

Note 1: The value used is equal to the random reference transmitted in the previous Handover Command.

(22) Handover Command

This message is sent on the Dm from the FNE to the mobile station to change the dedicated channel configuration.

Table 4.5.2.1-23 Handover Command

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Cahnnel description	4.5.3.6 (3) (I)	MF	3	
Random reference	4.5.3.6 (3) (S)	MF	3	1
Cell basic parameters	4.5.3.6 (3) (D)	MF	6	2

Notes 1: The Random reference value is chosen by the FNE, and is returned by the mobile station in the subsequent Handover Access message.

2: This IE gives the basic parameters of the target cell.

(23) Handover Failure

This message is sent from the mobile station to the FNE on the old Dm before Handover to indicate that the mobile station failed to seize the new channel.

Table 4.5.2.1-24 Handover Failure

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
RR cause	4.5.3.6 (3) (V)	MF	1	

(24) Immediate Assignment

This message is sent on the CCCH from the FNE to the mobile station in response to a Channel Request to assign a dedicated control channel.

Table 4.5.2.1-25 Immediate Assignment

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Cahnnel description	4.5.3.6 (3) (I)	MF	3	1
Random reference	4.5.3.6 (3) (S)	MF	3	2
Request reference	4.5.3.6 (3) (U)	MF	2	2
Timing Alignment	4.5.3.6 (3) (Y)	MF	1	

Notes 1: Equal to the Random reference value contained in the original Channel Request.

2: Indicates the SN and subslot in which the original Channel Request was received.

(25) Immediate Assignment Reject

This message is sent on the CCCH from the FNE to the mobile station to reject a Channel Request.

Table 4.5.2.1-26 Immediate Assignment Reject

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Random reference	4.5.3.6 (3) (S)	MF	3	
Request reference	4.5.3.6 (3) (U)	MF	2	

(26) Measurement Inquire

This message is sent on the Dm from the FNE to a mobile station to request transmission of a Measurement Report.

Table 4.5.2.1-27 Measurement Inquire

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	

(27) Measurement Report

This message is sent from the mobile station to the FNE on the Dm to report measurements on the serving and neighbor cells.

Table 4.5.2.1-28 Measurement Report

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Measurement results	4.5.3.6 (3) (P)	MV	1+3n	

(28) Paging Request

This message is sent on the CCCH from the FNE to a mobile station. It causes the mobile station to access a control channel and establish an RR connection. The mobile station then responds on the control channel with a Paging Response.

Table 4.5.2.1-29 Paging Request

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Mobile ID	4.5.3.6 (2) (F)	MV	Max 9	

(29) Paging Request-2

This message is sent on the CCCH from the FNE to a mobile station. It causes the mobile station to access a control channel and establish an RR-connection. The mobile station then responds on the control channel with a Paging Response-2.

Table 4.5.2.1-30 Paging Request-2

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Mobile ID	4.5.3.6 (2) (F)	MV	Max 9	

(30) Paging Response

This message is sent on the Dm from the mobile station to the FNE to indicate a response to a Paging Request.

Table 4.5.2.1-31 Paging Response

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Option	–	MF	1/2	
Mobile station classmark 2	4.5.3.6 (2) (H)	MV	Max 4	
Mobile ID	4.5.3.6 (2) (F)	MV	Max 9	

(31) Paging Response-2

This message is sent on the Dm from the mobile station to the FNE to indicate a response to a Paging Request-2 message.

Table 4.5.2.1-32 Paging Response-2

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Mobile station classmark 2	4.5.3.6 (2) (H)	MV	Max 4	
Mobile ID	4.5.3.6 (2) (F)	MV	Max 9	

(32) Private Call Abort

This message is sent on the RACH from the mobile station to the FNE to abort a Private Call.

Table 4.5.2.1-33 Private Call Abort

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Individual ID	4.5.3.6 (2) (D)	MF	3	1

Note 1: denitrifies the mobile station which is requesting the abort.

(33) Private Call Abort Echo

This message is sent on the CCCH from the FNE to the mobile station to indicate that the FNE has received a Private Call Abort.

Table 4.5.2.1-34 Private Call Abort Echo

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Individual ID	4.5.3.6 (2) (D)	MF	3	

(34) Private Call Complete-Originator

This message is sent on the CCCH from the FNE to the originating mobile station to indicate that a Private Call has terminated.

Table 4.5.2.1-35 Private Call Complete-Originator

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Individual ID	4.5.3.6 (2) (D)	MF	3	1
RR cause	4.5.3.6 (3) (V)	MF	1	

Note 1: Identifies the originating mobile station.

(35) Private Call Complete-Target

This message is sent on the CCCH from the FNE to the target mobile station to indicate that a Private Call has terminated.

Table 4.5.2.1-36 Private Call Complete-Target

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Individual ID	4.5.3.6 (2) (D)	MF	3	1
RR cause	4.5.3.6 (3) (V)	MF	1	

Note 1: Identifies the target mobile station.

(36) Private Call End of Transmission

This message is sent on Dm from the talking mobile station to the FNE. It indicates that the mobile station has ended the transmission.

Table 4.5.2.1-37 Private Call End of Transmission

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	

(37) Private Call Grant-Originator

This message is sent on the CCCH from the FNE to the originating mobile station to assign a channel for the Private Call.

Table 4.5.2.1-38 Private Call Grant-Originator

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Individual ID	4.5.3.6 (2) (D)	MF	3	1
Channel Assignment	4.5.3.6 (3) (H)	MF	1	

Note 1: Identifies the originating mobile station.

(38) Private Call Grant-Target

This message is sent on the CCCH from the FNE to the target mobile station to assign a channel for the Private Call.

Table 4.5.2.1-39 Private Call Grant-Target

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Individual ID	4.5.3.6 (2) (D)	MF	3	1
Individual ID	4.5.3.6 (2) (D)	MF	3	2
Channel Assignment	4.5.3.6 (3) (H)	MF	1	

Notes 1: Identifies the target mobile station.

2: Identifies the originating mobile station.

(39) Private Call Paging Request

This message is sent on the CCCH from the FNE to the target mobile station to locate the target mobile station.

Table 4.5.2.1-40 Private Call Paging Request

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Individual ID	4.5.3.6 (2) (D)	MF	3	1
Fleet member ID	4.5.3.6 (2) (B)	MF	5	2

Notes 1: denitrifies the target mobile station.

2: Identifies the originating mobile station

(40) Private Call Paging Response

This message is sent on the RACH from the target mobile station to the FNE in reply to a Private Call Paging Request.

Table 4.5.2.1-41 Private Call Paging Response

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Individual ID	4.5.3.6 (2) (D)	MF	3	1
Fleet member ID	4.5.3.6 (2) (B)	MF	5	2

Notes 1: Identifies the target mobile station.

2: Identifies the originating mobile station

(41) Private Call Proceeding-Originator

This message is sent on the CCCH from the FNE towards the originating mobile station in response to a Private Call Request.

Table 4.5.2.1-42 Private Call Proceeding-Originator

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Individual ID	4.5.3.6 (2) (D)	MF	3	1

Note 1: Identifies the originating mobile station

(42) Private Call Proceeding-Target

This message is sent on the CCCH from the FNE towards the target mobile station in response to a Private Call Page Response.

Table 4.5.2.1-43 Private Call Proceeding-Target

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Individual ID	4.5.3.6 (2) (D)	MF	3	1

Note 1: Identifies the target mobile station

(43) Private Call Reconnect Accept

This message is sent on the CCCH from the FNE to the mobile station to indicate that a reconnect attempt is successful.

Table 4.5.2.1-44 Private Call Reconnect Accept

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Location area ID	4.5.3.6 (2) (E)	MF	5	1
Individual ID	4.5.3.6 (2) (D)	MF	3	1

Note 1: LAI & Individual ID are used in the Reconnect Request.

(44) Private Call Reconnect Reject

This message is sent on the CCCH from the FNE to the mobile station to indicate that a reconnect attempt is unsuccessful.

Table 4.5.2.1-45 Private Call Reconnect Reject

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Location area ID	4.5.3.6 (2) (E)	MF	5	1
Individual ID	4.5.3.6 (2) (D)	MF	3	1

Note 1: LAI & Individual ID are used in the Private Call Reconnect Request.

(45) Private Call Reconnect Request

This message is sent on the RACH from the mobile station to the FNE to reconnect a private call when the mobile station changes cells.

Table 4.5.2.1-46 Private Call Reconnect Request

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Location area ID	4.5.3.6 (2) (E)	MF	5	1
Individual ID	4.5.3.6 (2) (D)	MF	3	

Note 1: This IE shows the location area in which the Individual ID was last registered.

(46) Private Call Reconnect Request Echo

This message is sent on the CCCH from the FNE to an mobile station to indicate that the FNE received, and is processing, a Private Call Reconnect Request.

Table 4.5.2.1-47 Private Call Reconnect Request Echo

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Location area ID	4.5.3.6 (2) (E)	MF	5	1
Individual ID	4.5.3.6 (2) (D)	MF	3	1

Note 1: LAI & Individual ID are used in the Reconnect Request.

(47) Private Call Request

This message is sent on the RACH from the originating mobile station to the FNE to initiate a Private Call.

Table 4.5.2.1-48 Private Call Request

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Individual ID	4.5.3.6 (2) (D)	MF	3	1
Fleet member ID	4.5.3.6 (2) (B)	MF	5	2

Notes 1: Identifies the originating mobile station.

2: Identifies the target mobile station. A Fleet member ID "zero" is used to indicate that the target belongs to the same fleet as the originator.

(48) Private Call Update Request

This message is sent to the FNE on the TCCH during the channel hold time interval to by an mobile station which wishes to become the talker.

Table 4.5.2.1-49 Private Call Update Request

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Individual ID	4.5.3.6 (2) (D)	MF	3	

(49) Registration Renewal Accept

This message is sent on the CCCH from the FNE to an mobile station to indicate success of the registration renewal procedure.

Table 4.5.2.1-50 Registration Renewal Accept

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Location area ID	4.5.3.6 (2) (E)	MF	5	1
Individual ID	4.5.3.6 (2) (D)	MF	3	1

Note 1: LAI & Individual ID are used in the Registration Renewal Request.

(50) Registration Renewal Reject

This message is sent on the CCCH from the FNE to an mobile station to indicate failure of the registration renewal procedure.

Table 4.5.2.1-51 Registration Renewal Reject

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Location area ID	4.5.3.6 (2) (E)	MF	5	1
Individual ID	4.5.3.6 (2) (D)	MF	3	1

Note 1: LAI & Individual ID are used in the Registration Renewal Request.

(51) Registration Renewal Request

This message is sent on the RACH from the mobile station to the FNE to renew a previous registration

Table 4.5.2.1-52 Registration Renewal Request

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Location area ID	4.5.3.6 (2) (E)	MF	5	1
Individual ID	4.5.3.6 (2) (D)	MF	3	1

Note 1: This IE transmits the stored DLAI (Dispatch LAI), i.e. the location area in which the Individual ID was last registered.

(52) Registration Renewal Request Echo

This message is sent on the CCCH from the FNE to a mobile station to indicate that the FNE received an Registration Renewal Request.

Table 4.5.2.1-53 Registration Renewal Request Echo

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Location area ID	4.5.3.6 (2) (E)	MF	5	1
Individual ID	4.5.3.6 (2) (D)	MF	3	1

Note 1: LAI & Individual ID are those assigned in the old location area, as used in the Registration Renewal Request.

(53) RR-Status

This message is sent on Dm at any time by the mobile station or FNE to indicate error conditions.

Table 4.5.2.1-54 RR-Status

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
RR cause	4.5.3.6 (3) (V)	MF	1	
Option	–	–	–	

(54) System Information type 0

This message is sent on the BCCH from the FNE to all idle mobile stations within the cell to transmit system parameters and other information.

Table 4.5.2.1-55 System Information type 0

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Cell identity	4.5.3.6 (2) (A)	MF	7	
Cell availability	4.5.3.6 (3) (C)	MF	1	
Regional network information	4.5.3.6 (3) (T)	MV	1+3n	
Service provider identification	4.5.3.6 (2) (I)	MV	1+2n	

(55) System Information type 1

This message is sent on the BCCH from the FNE to all idle mobile stations within the cell to transmit system parameters and other information.

Table 4.5.2.1-56 System Information type 1

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Location area list (PSTN connect call)	4.5.3.6 (3) (O)	MV	1+2n	1
Location area list (dispatch call)	4.5.3.6 (3) (O)	MV	1+2n	2
Option	–	–	1+n	
Service area ID	4.5.3.6 (3) (W)	MF	1	
Cell basic parameters	4.5.3.6 (3) (D)	MF	6	
Cell access parameter	4.5.3.6 (3) (B)	MF	10	
Cell handover parameters	4.5.3.6 (3) (E)	OF	3	
Cell reselection parameters	4.5.3.6 (3) (G)	OF	3	
Cell reconnection parameters	4.5.3.6 (3) (F)	OF	3	
Neighbor cell list	4.5.3.6 (3) (R)	OV	4+3n	
Call timeout paramaters	4.5.3.6 (3) (A)	OF	3	
Local time	4.5.3.6 (3) (N)	OF	5	

Notes 1: Designates PSTN connect location areas, and contains at least one Local LAI.

2: Designates dispatch location areas, and contains at least one Local LAI.

(56) System Information type 5

This message includes the system parameter information and is sent on the Dm from the FNE to the mobile station immediately after a handover. It provides the mobile station with the information needed to continue operation on the new cell.

Table 4.5.2.1-57 System Information type 5

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Cell handover parameters	4.5.3.6 (3) (E)	MF	2	
Neighbor cell list	4.5.3.6 (3) (R)	MV	3+3n	

4.5.2.2 Message for Mobility Management

In this section, messages for Mobility Management are described. Table 4.5.2.2-1 shows the list for these messages and the details are described in (1) to (5).

Table 4.5.2.2-1 Message for Mobility Management

Category	Message name	Direction	Reference
Registration	Registration Request	inbound	4.5.2.2 (5)
	Registration Accept	outbound	4.5.2.2 (1)
	Registration Complete	inbound	4.5.2.2 (2)
	Registration Reject	outbound	4.5.2.2 (4)
	Registration Required	outbound	4.5.2.2 (3)

(1) Registration Accept

The Registration Accept message is sent on Dm from the FNE to the mobile station in response to a Registration Request. It contains the various identities to be used by the mobile station in accessing dispatch service.

Table 4.5.2.2-2 Registration Accept

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Location area ID	4.5.3.6 (2) (E)	MF	5	
Cell identity (Home Cell)	4.5.3.6 (2) (A)	OF	8	1
Group ID	4.5.3.6 (2) (C)	OF	4	2
Individual ID	4.5.3.6 (2) (D)	OF	4	3
Mobile identity	4.5.3.6 (2) (F)	OV	Max 10	4
Service provider identification	4.5.3.6 (2) (I)	OV	2+2n	5
Group ID list	4.5.3.6 (2) (D)	OV	2+5n	6

Notes 1: If present, assigns a Home cell to the mobile station.
2: As the case may be, consists of zero, one or two octets.
3: If present, assigns the mobile station an Individual ID for dispatch service. It is absent if the mobile station does not have dispatch service.
4: Used to assign the mobile station's IMSI in the case where the mobile station registers with IMEI.
5: If present, provides the mobile station with a list of preferential provider codes.
6: If present, overrides the information in the Group ID IE(s).

Notice that the information contained in the "Group ID" IE and the "Group ID list" IE is redundant. "The Group ID" IE and "Group ID list" IE are provided only for back-compatibility.

(2) Registration Complete

The Registration Complete message is sent on Dm from the mobile station to the FNE in response to a Registration Accept to conclude a successful registration.

Table 4.5.2.2-3 Registration Complete

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	

(3) Registration Required

The Registration Required message is sent on Dm from the FNE to the mobile station to cause the mobile station to initiate the registration procedure (i.e. respond with a Registration Request).

Table 4.5.2.2-4 Registration Required

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	

(4) Registration Reject

The Registration Reject is sent on Dm from the FNE to the mobile station in response to a Registration Request to indicate a failed registration.

Table 4.5.2.2-5 Registration Reject

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Reject cause	4.5.3.6 (4) (G)	MF	1	

(5) Registration Request

The Registration Request is sent on Dm from the mobile station to the FNE to initiate the registration procedure.

Table 4.5.2.2-6 Registration Request

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Mobile station classmark 1	4.5.3.6 (2) (H)	MF	1	
Mobile identity	4.5.3.6 (2) (G)	MV	Max 9	1
Option	–	–	1	

Note 1: The identifier used is (in order of reference) IMSI, IMEI.

4.5.2.3 Message for Dispatch Call Control

In this section, messages for dispatch call management are described. Table 4.5.2.3-1 shows the list for these messages and details are describes in (1) to (2).

Table 4.5.2.3-1 Message for Dispatch Call Control

Message name	Direction	Reference
Emergency Call Indication	outbound	4.5.2.3 (1)
Talker Identification	outbound	4.5.2.3 (2)

(1) Emergency Call Indication

This message is sent from the FNE to the mobile station to indicate that the call is an emergency call. It identifies the initiator of the emergency and the talking mobile stations.

Table 4.5.2.3-2 Emergency Call Identification

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Fleet member ID	4.5.2.3 (2) (B)	MF	5	1
Fleet member ID	4.5.2.3 (2) (B)	MF	5	2

Notes 1: Identifies the mobile station that initiated the emergency.

2: Identifies the talking mobile station.

(2) Talker ID

This message is sent from the FNE to the mobile station to identify the transmitting mobile stations

Table 4.5.2.3-3 Talker Identification

Information Element	Reference	Type	Length (octet)	Notes
Protocol discriminator	4.5.3.3	MF	1	
Transaction identifier	4.5.3.4	MF		
Message type	4.5.3.5	MF	1	
Fleet member ID	4.5.2.3 (2) (B)	MF	5	

4.5.3 Message Structure and the Definition of Information Elements

4.5.3.1 Outline of Message Structure

In this section, the structure of each layer 3 message and the information element, which is the element of these messages, are defined.

Each Layer 3 message consists of the following parts:

- Protocol Discriminator (PD)
- Transaction Identifier (TI)
- Message type
- Mandatory information elements

In addition, there may also be:

- Optional information elements, as required
- Pad bytes, as required

Table 4.5.3.1-1 shows the structure of a general message.

Table 4.5.3.1-1 General Message Structure

<table>
<tr><td colspan="8">Bit number</td><td rowspan="2">Octet number</td></tr>
<tr><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td></tr>
<tr><td colspan="4">Transaction identifier</td><td colspan="4" rowspan="2">Protocol discriminator</td><td rowspan="2">1</td></tr>
<tr><td>TI flag</td><td colspan="3">TI value</td></tr>
<tr><td colspan="8">Message type</td><td>2</td></tr>
<tr><td colspan="8">Mandatory information elements</td><td>etc.</td></tr>
<tr><td colspan="8">Optional information elements(as required)</td><td>etc.</td></tr>
<tr><td colspan="8">Pad bytes(as required) = $00 (as required)</td><td>etc.</td></tr>
</table>

4.5.3.2 Bit Ordering and Numbering

Bits within each octet are numbered 1 through 8. The higher-numbered bits are more significant. If a field spans more than one octet, then the MSB of the field is the highest-numbered bit of the lowest numbered octet, and the LSB is the lowest-numbered bit of the highest numbered octet.

Binary numbers are indicated by the prefix % and hexadecimal numbers are indicated by the prefix $.

4.5.3.3 Protocol Discriminator

The protocol discriminator is used to distinguish between the message sets used by the various Layer 3 protocol entities. The values of the PD are shown in Table 4.5.3.3-1.

Table 4.5.3.3-1 Values of the Protocol Discriminator

PD Value	Layer 3 Entity	TI Used (1)	N(S) Used (2)	Listing of Message Types	Listing of IEs
$0	Null (3)	no	no	–	–
$1	Option	–	–	–	–
$2	Option	–	–	–	–
$3	Call Control	yes	yes	4.5.3.5 (4)	–
$4	Option	–	–	–	–
$5	Mobility Management (MM)	no	yes	4.5.3.5 (3)	4.5.3.5 (4)
$6	Radio Resources Management (RR)	no	no	4.5.3.5 (2)	4.5.3.5 (3)
$7					
$8	Option	–	–	–	–
$9	Option	–	–	–	–
$A	Option	–	–	–	–
$B	Option	–	–	–	–
$C	Option	–	–	–	–
$D	Dispatch Call Control	no	no	4.5.3.5 (4)	–
$E	Dispatch Call Control	yes	yes	4.5.3.5 (4)	–
$F	Option				

Notes 1: The transaction identifier(TI) is used only with the PDs indicated.
If not used,it is set to $0 by the sender and ignored by the receiver. (see Section 4.5.3.4)
2: The sequence number N(S)is further described in section 4.5.3.5 (1). It is used only with the PDs in the outbound direction. If not used, it is set to %0 by the sender and ignored by the receiver.
3: PD $0 includes a null message. Since the TI is not used, the entire first octet of the null message is equal to $00.

4.5.3.4 Transaction Identifier

The transaction identifier (TI) is used by some protocol entities to distinguish between simultaneous activities within a single mobile station. It is equivalent to the call reference defined in CCITT Q.931. Table 4.5.3.3-1 shows the PDs for which the TI is actually used.

As shown in Table 4.5.3.1-1, the transaction identifier comprises the TI flag and the TI value.

TI values are chosen and assigned by the side of the interface initiating a transaction. At the beginning of a transaction, a free TI value is chosen and assigned to the transaction. It then remains fixed for the lifetime of the transaction. When the transaction ends, the associated TI value is freed and may be re-assigned to another transaction.

The TI flag is used to prevent ambiguities which would result if both sides of the interface should happen to choose the same TI value for different transactions. The TI flag identifies which side of the interface chose the TI value. Table 4.5.3.4-1 defines the use of the TI flag.

Table 4.5.3.4-1 TI Flag

TI flag	Description
%0	The message is sent by the entity which choses the TI value
%1	The message is received to the entity which choses the TI value

Table 4.5.3.4-2 defines the use of the TI Value.

Table 4.5.3.4-2 TI Value

TI value	Description
%000	Chosen by the entity to identify a transaction
%001	
%010	
%011	
%100	
%110	
%111	Option

4.5.3.5 Message Type

The message type, together with the PD, identifies the function of a particular message. It is coded as shown in Table 4.5.3.5-1.

Table 4.5.3.5-1 Message Type

Bit Number							
8	7	6	5	4	3	2	1
0	N(S)	Message type					

Bit 8 is set to 0.

Bit 7 is used by RR to transmit the one-bit sequence number N(S). The procedures to use are defined in Section 4.5.3.5(1).

(1) RR Sublayer Message Sequencing

Duplicate MM and CM sublayer messages can be received by the RR entity in the FNE as a result of release and establishment of the Layer 2 connection during handover.

During the lifetime of the RR connection, the RR sublayer uses sequence numbering of certain higher sublayer messages to eliminate these duplicates. The clients for which RR performs this function are shown in Table 4.5.3.3-1. The messages in which N(S) is used can thus be identified by PD value.

The RR entity in the mobile station keeps a send state variable V(S) which denotes the next sequence number of the MM or the sequence number of the CM sublayer message in which N(S) is valid. For each such message, N(S) is set equal to V(S) and then the value of V(S) is incremented by one (mod 2). V(S) is initialized to zero upon establishment of the RR connection.

The RR entity in the FNE keeps a receive state variable V(R) which denotes the next sequence number of the MM or the sequence number of the CM sublayer message in which N(S) is used. For each such message, if N(S) is equal to V(R), the message is transferred to the appropriate client, and V(R) is incremented by one (mod 2); if N(S) is not equal to V(R), the message is discarded and V(R) is not changed. V(R) is initialized to zero upon establishment of the RR connection.

For those messages in which N(S) is not used, N(S) is set to zero by the sending RR entity and is ignored by the receiving RR entity. Transmission of such a message does not affect the values of V(S) or V(R).

Note 1: N(S) is not used in the outbound (FNE to MS) direction.

From the above description, it is clear that messages using N(S) may only be sent while an RR connection is established. However, messages not using N(S) can in principle be sent at any time

(2) Message Types for Radio Resource Management

To increase the available set of RR messages, two PD ($6,$7) values have been allocated to RR (refer to Table 4.5.3.3-1). The message types listed in Table 4.5.3.5-2 are associated with PD $6.

Table 4.5.3.5-2 Message Types for Radio Resource Management(PD $6)

Message Type								Message
8	7	6	5	4	3	2	1	
0	0	0	1	0	0	0	0	Option
					1	1	1	Option
					1	1	0	Option
					1	0	0	Measurement Request
					1	0	1	Measurement Report
					0	1	0	RR Status
		0	1	1	0	0	0	System Information type 0
					0	0	1	System Information type 1
					1	0	1	System Information type 5
					1	1	0	Option
		1	0	0	0	0	1	Paging Request
					1	1	1	Paging Response
		1	0	1	0	0	0	Handover Failure
					0	0	1	Assignment Access
					0	1	0	Handover Access
					0	1	1	Handover Command
					1	1	0	Assignment Command
					1	1	1	Assignment Failure
		1	1	0	1	0	1	Option
					0	1	0	Option
		1	1	1	0	0	1	Channel Request
					0	1	0	Immidiate Assignment Reject
					1	1	1	Immidiate Assignment

The message types listed in Table 4.5.3.5-3 are associated with PD$7.

Table 4.5.3.5-3 Message Types for Radio Resource Management (PD $7)

Message type								Message
8	7	6	5	4	3	2	1	
0	0	0	0	0	0	0	0	Option
					0	0	1	Option
					0	1	0	Paging Request - 2
					0	1	1	Paging Response - 2
					1	0	0	Option
					1	0	1	Option
					1	1	0	Option
					1	1	1	Option
		0	0	1	0	0	0	Registration Renewal Request
					0	0	1	Registration Renewal Request Echo
					0	1	0	Registration Renewal Accept
					0	1	1	Registration Renewal Reject
					1	0	0	De-activate Request
					1	0	1	De-activate Request Echo
					1	1	0	Option
					1	1	1	Option
		0	1	0	0	0	0	Group Call Request
					0	0	1	Group Call Paging Request
					0	1	0	Group Call Paging Response
					0	1	1	Group Call Proceeding
					1	0	0	Group Call Grant
					1	0	1	Group Call End of Transmission
					1	1	0	Group Call Update Request
					1	1	1	Group Call Complete

Table 4.5.3.5-3 Message Types for Radio Resource Management (PD $7) (continued)

Message type								Message
8	7	6	5	4	3	2	1	
0	0	0	1	1	0	0	0	Private Call Request
					0	0	1	Private Call Proceeding - Originator
					0	1	0	Private Call Grant - Originator
					0	1	1	Private Call Paging Request
					1	0	0	Private Call Paging Response
					1	0	1	Private Call Proceeding - Target
					1	1	0	Private Call Grant - Target
					1	1	1	Private Call End of Transmission
		1	0	0	0	0	0	Private Call Update Request
					0	0	1	Private Call Complete - Originator
					0	1	0	Private Call Complete - Target
					0	1	1	Private Call Abort
					1	0	0	Private Call Abort Echo
					1	0	1	Private Call Reconnect Request
					1	1	0	Private Call Reconnect Request Echo
					1	1	1	Private Call Reconnect Accept
		1	0	1	1	1	1	Private Call Reconnect Reject

Table 4.5.3.5-3 Message Types for Radio Resource Management (PD $7) (continued)

Message type								Message
8	7	6	5	4	3	2	1	
0	0	1	1	0	0	0	0	Group Call Abort
					0	0	1	Group Call Abort Echo
					0	1	0	Group Call Reconnect Request
					0	1	1	Group Call Reconnect Request Echo
					1	0	0	Group Call Reconnect Accept
					1	0	1	Group Call Reconnect Reject

(3) Message Types for Mobility Management

The message types used for MM are listed in Table 4.5.3.5-4. These message types are associated with PD $5.

Table 4.5.3.5-4 Message Types for Radio Resource Management (PD $5)

Message type								Message
8	7	6	5	4	3	2	1	
0	0	1	1	0	0	0	0	Registaration Request
					0	0	1	Registaration Accept
					0	1	0	Registration Complete
					0	1	1	Registration Reject
					1	0	0	Registration Required

(4) Message types for Call Management

Table 4.5.3.5-5 shows the messages used for dispatch call. These messages is related to PD $D.

Table 4.5.3.5-5 Messages Types for Dispatch Call Control (PD$D)

Message type								Message
8	7	6	5	4	3	2	1	
0	0	0	1	0	0	0	0	Talker Identification
0	0	0	1	0	0	1	0	Emergency Call Indication

4.5.3.6 Information Elements

(1) General

As shown in Table 4.5.3.1-1, mandatory information elements (mandatory IEs) and optional information elements (optional IEs) usually follow the message type. Each IE comprises at least an Information Element Identifier (IEI) and possibly additional information.

(A) Types of Information Elements

There are four types of information elements (IEs) used:

type 1 : One byte fixed length, and have 1/2 byte IEI plus 1/2 byte of content.

type 2 : One byte fixed length, consisting only of a 1/2 byte IEI. This type of IE is always optional in a message, since it transmits information solely by its presence or absence.

type 3 : Fixed length, having a one byte IEI and a fixed number of bytes of content.

type 4 : Variable length, having a one byte IEI, a one byte length indicator, and a variable number of bytes of content.

The structure of these four types of IEs is further described below.

Table 4.5.3.6-1 shows the structure of the type 1 IE. The IEI for this type is identified by bit 8=%1; but the IEI is not equal to %1010 and this pattern marks a type 2 IE.

Table 4.5.3.6-1 Structure of Type 1 Information Element

Bit Number								Octet Number
8	7	6	5	4	3	2	1	
IEI				Content				1

The type 2 IE is shown in Table 4.5.3.6-2. It is identified by the pattern %1010 in bits 8 through 5. The IEI occupies the bits 4 through 1.

Table 4.5.3.6-2 Structure of Type 2 Information Element

Bit Number								Octet Number
8	7	6	5	4	3	2	1	
1	0	1	0	IEI				1

The type 3 IE is shown in Table 4.5.3.6-3. The IEI for this type has bit 8=%0. The length of the content is fixed, and is known from the definition of the particular IE.

Table 4.5.3.6-3 Structure of Type 3 Information Element

Bit Number								Octet Number
8	7	6	5	4	3	2	1	
IEI								1
fixed length contents								2 through n+1

The type 4 IE is shown in Table 4.5.3.6-4. The IEI for this type has bit 8=%0. The length of the content is given by the value of the length indicator (LI).

Table 4.5.3.6-4 Structure of Type 4 Information Element

Bit Number								Octet Number
8	7	6	5	4	3	2	1	
IEI								1
length indicator (LI)								2
variable length contents								3 through LI+2

Some of the IEs defined in the sections which follow have spare bits (indicated by gray). These bits are set to %0 by the transmitter and ignored by the receiver.

(B) Assignment of Information Element Identifier (IEI) Values

Common IEs can appear in any Layer 3 message. The IEIs for the common IEs are listed in Section 4.5.3.6(2)

Sublayer-specific IEs are used only within messages belonging to a particular sublayer. The protocol discriminator in conjunction with the IEI uniquely identifies these IEs.

The sublayer-specific IEs are listed in sections 4.5.3.6(3), 4.5.3.6(4).

(C) Organization of Information Element in Messages

Mandatory IEs and Optional IEs are included in messages.

Mandatory IEs

The order of appearance for the mandatory IEs within a message is as defined for each message in Section 4.5.2. When an IE is mandatory in a message, the IEI is omitted. This saves space in the message and is permissible since the presence and order of the mandatory IEs are determined unambiguously for each message, by the message definition itself.

The messages are generally defined so that mandatory type 1 IEs, if present, go together in succession. In that case, the first type 1 IE occupies bits 4 through 1 of byte N, the second bits 8 through 5 of byte N, the third bits 4 through 1 of byte N+1, and so on. If the number of type 1 IEs is odd then bits 8 through 5 of the last byte are set to %0.

As mentioned previously, type 2 IEs cannot be mandatory.

Optional IEs

Optional IEs, if any, are added to the message after the mandatory IEs (refer to Table 4.5.3.1-1).

The optional type 3 and 4 IEs are placed into the message in ascending IEI order. This allows the receiving equipment to detect the presence or absence of a particular optional IE without scanning the entire message.

Optional type 1 and 2 IEs can appear anywhere in the message.

Unrecognized IEIs are assumed to indicate a type 4 IE, which allows the receiver to skip over the IE, and parse the remainder of the message, by using the length indicator.

(D) Construction of Information Elements

This Section describes an octet-extension convention used for construction of certain variable-length IEs.

Certain of the octets (say, octet 'N') in an IE may be an "octet group". The octets in the group are labeled 'Na', 'Nb', 'Nc', etc.. All octets in the group, except the first, are optional.

The actual length of an octet group is indicated by using bit 8 as an extension bit. Bit 8 is set to %0 in an octet if the group extends to the next octet, and to %1 in an octet if it is the last in the group.

In the information element definitions, the extension bit is marked '0/1 ext' if extension is possible; it is marked '1 ext' in the last octet in the group.

Table 4.5.3.6-5 Illustration of Octet Extension

Bit Number								Octet Number
8	7	6	5	4	3	2	1	
IEI								1
Length indicator								2
0/1 ext	1st octet of octet group (mandatory)							3
0/1 ext	2nd octet of octet group							3a
1 ext	3rd octet of octet group							3b

In Table 4.5.3.6-5, the octets numbered 3, 3a, and 3b form an octet group. Octet 3 is always present, octet 3a is present only if bit 8 of octet 3 is set to %0, and octet 3b is present only if bit 8 of octet 3a is set to %0. Octet 3b is the last octet of the group so bit 8 of that octet is always %1.

(2) Common Information Elements

The common IEs (Table 4.5.3.6-6) appears in any layer 3 message.

Table 4.5.3.6-6 Common Information Elements

8	7	6	5	4	3	2	1	Information Element	Reference	Length
0	0	0	1	0	0	0	0	Option	–	–
				0	0	0	1	Cell identity	4.5.3.6(2) (A)	F1+7
				0	0	1	0	Fleet member ID	4.5.3.6(2) (B)	F1+5
				0	0	1	1	Location area ID	4.5.3.6(2) (E)	F1+5
				0	1	0	0	Option	–	–
				0	1	0	1	Group ID	4.5.3.6(2) (C)	F1+3
				0	1	1	0	Individual ID	4.5.3.6(2) (D)	F1+3
				0	1	1	1	Mobile station ID	4.5.3.6(2) (F)	V1+9
				1	0	0	0	Mobile station classmark 1	4.5.3.6(2) (G)	F1+1
				1	0	0	1	Service provider ID	4.5.3.6(2) (I)	V1+1+2n
				1	0	1	0	Option	–	–
				1	0	1	1	Option	–	–
				1	1	0	0	Option	–	–
				1	1	0	1	Option	–	–
				1	1	1	0	Option	–	–
				1	1	1	1	Mobile station classmark 2	4.5.3.6(2) (H)	V1+3

Note : F1 shows fixed length 1 octet. V1 shows variable length 1 octet.

(A) Cell Identity

This IE provides a global identification of a cell

Table 4.5.3.6-7 Cell Identity IE

Bit Number								Octet Number
8	7	6	5	4	3	2	1	
IEI								1
MCC digit 2				MCC digit 1				2
$F				MCC digit 3				3
NDC digit 2				NDC digit 1				4
Local location area identifier								5
								6
Cell identifier								7
								8

- MCC (Mobile Country Code) ----The digits of the MCC are BCD coded in the order shown.
- NDC (National Domain Code) ---The digits of the NDC are BCD coded in the order shown. If the NDC comprises only one digit, then digit 2 is set to $F.
- Local location area identifier ----- Unsigned binary.
- Cell identifier ---------- Unsigned binary.

(B) Fleet Member ID

This IE is used to identify a particular member of a Fleet, using the Fleet member and ID extension.

Table 4.5.3.6-8 Fleet Member ID IE

Bit Number								Octet Number
8	7	6	5	4	3	2	1	
IEI								1
Fleet member ID								2
								3
								4
Fleet member ID extension								5
								6

- Fleet member ID ----------An all-zeros value is used to indicate that fleet to which the sending mobile station belongs.
- Fleet member ID extension---------An all-zeros value may be used to indicate a predefined default member of the fleet.

(C) Group ID

This IE is used to transmit a 3 octets dispatch Group ID.

Table 4.5.3.6-9 Group ID IE

Bit Number								Octet Number
8	7	6	5	4	3	2	1	
IEI								1
Group ID								2
								3
								4

(D) Individual ID

This IE is used to transmit a 3 octets dispatch Individual ID.

Table 4.5.3.6-10 Individual ID IE

Bit Number								Octet Number
8	7	6	5	4	3	2	1	
IEI								1
Individual ID								2
								3
								4

(E) Location Area ID

This IE provides an identification of a location area.

Table 4.5.3.6-11 Location Area ID IE

Bit Number								Octet Number
8	7	6	5	4	3	2	1	
IEI								1
MCC digit 2				MCC digit 1				2
$F				MCC digit 3				3
NDC digit 2				NDC digit 1				4
Local location area identifier								5
								6

- MCC (Mobile Country Code) --- The digits of the MCC are BCD coded in the order shown.

- NDC (National Domain Code) -- The digits of the NDC are BCD coded in the order shown.
  If the NDC comprises only one digit, then digit 2 is set to $F.

- Local location area identifier----- Unsigned binary. The field may be set to all 0% to indicate no location area.

(F) Mobile Station ID

This IE is used to transmit various types of mobile station ID. Table 4.5.3.6-12 shows the form of the mobile station ID IE when used to transmit an IMEI or IMSI.

Table 4.5.3.6-12 Mobile Station ID IE (IMEI or IMSI)

Bit Number								Octet Number
8	7	6	5	4	3	2	1	
IEI								1
Length indicator								2
Digit 1				Odd/ Even	Type of ID			3
Digit 3				Digit 2				4
etc.								...

- Type of ID---------- See Table 4.5.3.6-13.

Table 4.5.3.6-13 Type of ID

Value	Description
%000	No ID
%001	IMSI
%010	IMEI
%100	TMSI
%101	Individual ID

- Odd/Even indicator ---------- Set to %0 to indicate an even number of digits; set to %1 to indicate an odd number.

- Digit 1, 2, 3, etc. ----------The BCD-coded ID digits are placed as shown in Table 4.5.3.6-12. If the number of digits is even then bit 8 through 5 of the last octet are filled with %1.

Table 4.5.3.6-14 shows the form of the IE when used to transmit a TMSI.

Table 4.5.3.6-14 Mobile Station ID IE(TMSI)

Bit Number								Octet Number
8	7	6	5	4	3	2	1	
IEI								1
Length indicator								2
				0	Type=%100			3
TMSI								4
								5
								6
								7

TMSI ---------- Unsigned binary, 4 octets maximum length. If the TMSI is shorter than 4 octets, it is padded with %0 on the most significant end to make it an integer number of octets and the TMSI field is then sized accordingly.

Table 4.5.3.6-15 shows the form of the IE when used to transmit an Individual ID.

Table 4.5.3.6-15 Mobile Station ID IE (Individual ID)

Bit Number								Octet Number
8	7	6	5	4	3	2	1	
IEI								1
Length indicator = 4								2
				0	Type= %101			3
Individual ID								4
								5
								6

- Individual ID ---- Unsigned binary, 3 octets length.

(G) Mobile Station Classmark 1

This IE gives information about the mobile station.

Table 4.5.3.6-16 Mobile Station Classmark 1 IE

Bit Number								Octet Number
8	7	6	5	4	3	2	1	
IEI								1
Revision level			0	0	RF power capability			2

- Revision level ---------- See Table 4.5.3.6-17.

Table 4.5.3.6-17 Revision Level

Value	Description
%000	Revision 0
All others	Option

- RF power capability----------Indicates the maximum power capability of the mobile station. See Table 4.5.3.6-18.

Table 4.5.3.6-18 RF Power Capability

Value	Description
%000	20 Watts (43 dBm)
%001	10 Watts (40 dBm)
%010	5 Watts (37 dBm)
%011	2 Watts (33 dBm)
%100	1 Watt (30 dBm)
%101	0.5 Watt (27 dBm)
%110	Option
%111	Option

(H) Mobile Station Classmark 2

This IE gives information about the mobile station.

Table 4.5.3.6-19 Mobile Station Classmark 2 IE

Bit Number								Octet Number
8	7	6	5	4	3	2	1	
IEI								1
Length indicator								2
Revision level			0	0	RF power capability			3
				Option				4

- Revision level ---------- Coded as shown for the Classmark 1 (refer to Section 4.5.3.6 (2) (G)).
- RF power capability ---------- Coded as shown for the Classmark 1 (refer to Section 4.5.3.6 (2) (G)).

(I) Service provider ID

This IE provides a list of service providers.

Table 4.5.3.6- 20 Service Provider ID IE

Bit Number								Octet Number
8	7	6	5	4	3	2	1	
IEI								1
LI + 2n								2
Service provider code 1								3
								4
...								...
Service provider code n								LI + 1
								LI + 2

- Service provider code n ---------- Each service provider code is a 2-byte value.

(3) RR Sublayer Information Elements

The RR sublayer IEs may appear only in messages belonging to the RR sublayer message set (i.e. PD $6 or $7).

Table 4.5.3.6-21 RR Sublayer Information Elements

8	7	6	5	4	3	2	1	Information Element	Reference	Length (octet)
1	0	0	1	Option				Option	–	F1
	0	1	1	Option				Option	–	F1
0	1	0	1	0	0	0	0	Channel assignment	4.5.3.6(3)(H)	F1+3
				0	0	0	1	Option	–	–
				0	0	1	0	Option	–	–
				0	0	1	1	Cell availability parameters	4.5.3.6(3)(C)	F1+1
				0	1	0	0	Talkgroup index	4.5.3.6(3)(X)	F1+1
				0	1	0	1	Group call modifier	4.5.3.6(3)(L)	F1+1
				0	1	1	0	Option	–	–
				0	1	1	1	Individual ID fragment	4.5.3.6(3)(M)	F1+2
0	1	1	0	0	0	0	0	Cell access parameters	4.5.3.6(3)(B)	F1+10
				0	0	0	1	Cell basic parameters	4.5.3.6(3)(D)	F1+6
				0	0	1	0	Cell handover parameters	4.5.3.6(3)(E)	F1+2
				0	0	1	1	Cell re-selection parameters	4.5.3.6(3)(G)	F1+2
				0	1	0	0	Channel discription	4.5.3.6(3)(I)	F1+3
				0	1	0	1	Channel discription list	4.5.3.6(3)(J)	V1+1+3n
				0	1	1	0	Option	–	F1+1
				0	1	1	1	Channel re-conection parameters	4.5.3.6(3)(F)	F1+2
				1	0	0	0	Establishement cause	4.5.3.6(3)(K)	F1+1
				1	0	0	1	Location area list	4.5.3.6(3)(O)	V1+1+2n
				1	0	1	0	Measurement resaults	4.5.3.6(3)(P)	V1+1+3n
				1	0	1	1	Neighbor cell list	4.5.3.6(3)(R)	V1+3+3n
				1	1	0	0	Call timeout parameters	4.5.3.6(3)(A)	F1+2
				1	1	0	1	Local time	4.5.3.6(3)(N)	F1+4
				1	1	1	0	Regional network information	4.5.3.6(3)(T)	V1+1+3n
				1	1	1	1	Random reference	4.5.3.6(3)(S)	F1+2

Table 4.5.3.6-21 RR Sublayer Information Elements (continued)

8	7	6	5	4	3	2	1	Information Element	Reference	Length (octet)
0	1	1	1	0	0	0	0	Request reference	4.5.3.6(3)(U)	F1+9
				0	0	0	1	RR cause	4.5.3.6(3)(V)	F1+1
				0	0	1	0	Service area ID	4.5.3.6(3)(W)	F1+1
				0	0	1	1	Option	–	–
				0	1	0	0	Timing alignment	4.5.3.6(3)(Y)	F1+1
				0	1	0	1	MS status code	4.5.3.6(3)(Q)	F1+1

(A) Call Timeout Parameters

This IE provides the mobile station with call timeout values.

Table 4.5.3.6-22 Call Timeout Parameters IE

Bit Number								Octet Number
8	7	6	5	4	3	2	1	
IEI								1
interconnect_timeout								2
dispatch_timeout								3

- interconnect_timeout ---------- Unsigned value, range [0..255]. If non-zero, the timeout for interconnect calls is given by interconnect_timeout * 10 seconds. A value of 0 indicates that no interconnect timeout applies.

- dispatch_timeout ---------- Unsigned value, range [0..255]. If non-zero, the timeout for dispatch calls is given by dispatch_timeout * 10 seconds. A value of 0 indicates that no dispatch timeout applies.

(B) Cell Access Parameters

This IE provides miscellaneous information about access privileges, procedures, etc..

Table 4.5.3.6-23 Cell Access Parameters IE

Bit Number								Octet Number
8	7	6	5	4	3	2	1	
IEI								1
_MAX_TX				_FIXED_WAIT_TIME				2
				_INITIAL_RTX_TIME				3
								4
_MAX_RTX_TIME								5
PA_NSUB				ACT	ATT	Option	RE	6
AC15	AC14	AC13	AC12	AC11	Option	AC09	AC08	7
AC07	AC06	AC05	AC04	AC03	AC02	AC01	AC00	8
_T3206								9
_T3212								10
_T3130				_T3132				11

- _MAX_TX ---------- Unsigned value, range [0..15]. The parameter_MAX_TX is given by_(MAX_TX = _MAX_TX + 1).
- _FIXED_WAIT_TIME---------- Unsigned value, range [1..15]. The parameter _FIXED _WAIT_TIME is given by (_FIXED_WAIT_TIME = _FIXED_WAIT_TIME*2*15 msecs).
- _INITIAL_RTX_TIME ---------- Unsigned value, range [1..15]. The parameter _INITIAL _RTX_TIME is given by (_INITIAL_RTX_TIME = _INITIAL_RTX_TIME*2*15 msecs).
- _MAX_RTX_TIME ---------- Unsigned value, range [1..255]. The parameter _MAX _RTX_TIME is given by (_MAX_RTX_TIME = _MAX_RTX_TIME*2*15 msecs).
- PA_NSUB---------- Unsigned value, range [1..15]. The number of Paging Subchannels supported on the PCCH.

- ACT ---------- Flag indicating if power-on registration and de-activation is used (see Table 4.5.3.6-24).

Table 4.5.3.6-24 ACT Flag

Value	Description
%0	MS in the cell does not register on power-up and de-activate on power off
%1	MS in the cell registers on power-up and de-activate on power off

- ATT---------- Flag indicating if IMSI attach/detach is used (see Table 4.5.3.6-25).

Table 4.5.3.6-25 ATT Flag

Value	Description
%0	MS in the cell is not allowed to apply IMSI attach/detach
%1	MS in the cell applies IMSI attach/detach

- RE---------- Flag indicating if call re-establishment is allowed in the cell (see Table 4.5.3.6-26).

Table 4.5.3.6-26 RE Flag

Value	Description
%0	Call re-establishment is not allowed in the cell.
%1	Call re-establishment is allowed in the cell.

- ACn---------- A bit field used to control mobile station access by Access Class. For a mobile station with Access Class (=n), access is barred if the ACn bit is coded with a 1; otherwise, access is not barred.

- _T3206 ---------- Unsigned value, range [0..255]. The timeout value used for periodic registration renewal, T3206, is given by _T3206 = _T3206*1 hour.

- _T3212 ---------- Unsigned value, range [0..255]. The timeout value used for periodic location updating, T3212, is given by _T3212 = _T3212*10 hours.

- _T3130 ---------- Unsigned value, range [0..15]. The RR sublayer parameter _T3130 is given by (_T3130 = (1 + _T3130)*4 seconds).

- _T3132 ---------- Unsigned value, range [0..15]. The RR sublayer parameter _T3132 is given by (_T3132 = (1 + _T3132)*4 seconds).

(C) Cell Availability Parameters

This IE is sent on the BCCH to indicate the availability of the cell for cell selection

Table 4.5.3.6-27 Cell Availability Parameters

Bit Number								Octet Number
8	7	6	5	4	3	2	1	
IEI								1
					Cell status		Option	2

- Cell status---------- Field indicating the operational status of the cell (See Table 4.5.3.6-28).

Table 4.5.3.6-28 Cell Status

Value	Description
%00	Cell is fully operational.
%01	Cell is barried (MS should not camp on this cell).
%10	Not used.
%11	Cell is isolated (not connected to network).

(D) Cell Basic Parameters

This IE contains various parameters needed to successfully communicate with the cell.

Table 4.5.3.6-29 Cell Basic Parameters IE

Bit Number								Octet Number
8	7	6	5	4	3	2	1	
IEI								1
Option								2
	cell_Pti_max			DTX_period				3
_MS_fail_window				_MS_fail_threshold				4
_serving_window								5
color_code				carrier number(Hi bits)				6
carrier number(Lo bits)								7

- cell_Pti_max ---------- This value is coded the same as the RF power capability field in the Mobile Station Classmark IE.
- DTX_period ---------- Unsigned value in the range [0..15].
- _MS_fail_window ---------- Unsigned value in the range [0..15]. The parameter MS_fail_window is given by (MS_fail_window = _MS_fail_window * 2).
- _MS_fail_threshold ---------- Unsigned value in the range [0..15]. The parameter MS_fail_threshold is given by (MS_fail_threshold = _MS_fail_threshold * 2).
- _serving_window ---------- Unsigned value, range [0..15]. The parameter serving_window is given by (serving_window = 4*_serving_window).
- color_code ---------- Unsigned value in the range [0..15]. Specifies the color code used on this cell.
- carrier number ---------- Specifies the frequency of the cell's PCCH.

(E) Cell Handover Parameters

This IE contains various parameters needed by the mobile station to perform the handover procedures during an assignment to a single-user TCH or DCCH.

Table 4.5.3.6-30 Cell Handover Parameters IE

Bit Number								Octet Number
8	7	6	5	4	3	2	1	
IEI								1
max_candidates				_hdvr_report_interval				2
_hdvr_CINRo_threshold				hdvr_CINRo_hysteresis				3

- max_candidates ---------- Unsigned value, range [0..5].
- _hdvr_report_interval ---------- Unsigned value, range [0..15]. The parameter hdvr_report_interval is given by (hdvr_report_interval = 24*_hdvr_report_interval).
- _hdvr_CINRo_threshold ---------- Unsigned value, range [0..15]. The parameter hdvr_CINRo_threshold is given by (hdvr_CINRo_threshold = _hdvr_CINRo_threshold + 14 dB).

- hdvr_CINRo_hysteresis ---------- Unsigned value, range [0..15]. Units are dB.

(F) Cell Re-connection Parameters

This IE contains various parameters needed to perform the re-connection procedures during dispatch calls.

Table 4.5.3.6-31 Cell Re-connection Parameters IE

Bit Number								Octet Number
8	7	6	5	4	3	2	1	
IEI								1
_rcon_CINRo_low								2
_rcon_CINRo_threshold				rcon_CINRo_hysteresis				3

- _rcon_CINRo_low ---------- Unsigned value, range [0..15]. The parameter rcon_CINRo_low is given by (rcon_CINRo_low = _rcon_CINRo_low + 14 dB).

- _rcon_CINRo_threshold ---------- Unsigned value, range [0..15]. The parameter rcon_CINRo_threshold is given by (rcon_CINRo_threshold = _rcon_CINRo_threshold + 14 dB).

- rcon_CINRo_hysteresis ---------- Unsigned value, range [0..15].

(G) Cell Re-selection Parameters

This IE contains various parameters needed by the mobile station to perform the cell re-selection procedures while in idle mode.

Table 4.5.3.6-32 Cell Re-selection Parameters IE

Bit Number								Octet Number
8	7	6	5	4	3	2	1	
IEI								1
rsel_measurement_period								2
_rsel_CINRo_threshold				rsel_CINRo_hysteresis				3

- rsel_measurement_period ---------- Unsigned value, range [0..15].

- rsel_CINRo_hysteresis---------- Unsigned value, range [0..15]. Units are dB.

- _rsel_CINRo_threshold---------- Unsigned value, range [0..15]. The parameter rsel_CINRo_threshold is given by (rsel_CINRo_threshold = _rsel_CINRo_threshold + 14 dB).

(H) Channel Assignment

This IE is used to describe a multi-user TCH for a dispatch call.

Table 4.5.3.6-33 Channel Assignment IE

Bit Number								Octet Number
8	7	6	5	4	3	2	1	
IEI								1
Time alignment				Carrier number(Hi bits)				2
Carrier number(Lo bits)								3
Channel specifier								4

- Time alignment value---------- Unsigned value, range [0..15]. The time alignment to be used by the talking mobile station is equal to the contents of this field times 62.5 μs.

(I) Channel Description

This IE provides information necessary to allow a mobile station to locate a channel.

Table 4.5.3.6-34 Channel Description IE

Bit Number								Octet Number
8	7	6	5	4	3	2	1	
IEI								1
Channel type				Carrier number(Hi bits)				2
Carrier number(Lo bits)								3
Channel specifier								4

- Channel type---------- See Table 4.5.3.6-35.

Table 4.5.3.6-35 Channel Type

Bit Number				Channel Type
8	7	6	5	
0	0	0	1	PCCH
0	1	0	0	DCCH
1	0	0	0	TCH(single user format) + ACCH
1	0	0	1	TCH(multiple user format) + ACCH
All others				Option

(J) Channel Description List

This IE provides a list of n channels.

Table 4.5.3.6-36 Channel Description List IE

Bit Number								Octet Number
8	7	6	5	4	3	2	1	
IEI								1
Length indicator = 3n								2
Channel type				Carrier number(Hi bits)				3
Carrier number(Lo bits)								4
Channel specifier								5
...								...
Channel type				Carrier number(Hi bits)				LI
Carrier number(Lo bits)								LI+1
Channel specifier								LI+2

The following three fields are repeated n times.

- Channel type ---------- This field describes the type of channel specified by the next two fields.
- Carrier number
- Channel specifier

(K) Establishment Cause

This IE is used in the Channel Request message to indicate the reason for request.

Table 4.5.3.6-37 Establishment Cause IE

Bit Number								Octet Number
8	7	6	5	4	3	2	1	
IEI								1
Establishment cause								2

- Establishment cause ---------- See Table 4.5.3.6-38.

Table 4.5.3.6-38 Establishment Cause

Value	Description
$00	Location updating
$04	Answer to paging(Paging Request)
$05	Emergency call
$06	Call re-establishment
$07	Mobile originated circuit-switched telephone or data call.
$80	Registration
$84	Answer to paging(Paging Request-2)
$87	Option

(L) Group Call Modifier

The purpose of this IE is to modify the operation of group calls.

Table 4.5.3.6-39 Group Call Modifier IE

Bit Number								Octet Number
8	7	6	5	4	3	2	1	
IEI								1
Modifier								2

- Modifier ---------- Indicates modifications, to the group call. (See Table 4.5.3.6-40).

Table 4.5.3.6-40 Modifier

Value	Description
%0000 0000	Ordinary group call
%0000 0001	Emergency group call
All others	Option

(M) Individual ID Fragment

This IE contains part of an Individual ID.

Table 4.5.3.6-41 Individual ID Fragment

Bit Number								Octet Number
8	7	6	5	4	3	2	1	
IEI								1
ID fragment								2
								3

- ID fragment ---------- The last two bytes of the Individual ID (octet 3 and 4 of the Individual ID IE, Section 4.5.3.6 (2) (D)).

(N) Local Time

This IE can be sent in system information to allow the mobile station to display the local time.

Table 4.5.3.6-42 Local Time IE

Bit Number								Octet Number
8	7	6	5	4	3	2	1	
IEI								1
Month				Day of week				2
Day of month								3
Hours digit 2				Hours digit 1				4
Minutes digit 2				Minutes digit 1				5

- Month---------- Unsigned binary, value [1..12]. Indicates the month, where January is numbered 1 and December numbered 12.
- Day of week----- Unsigned binary, value [1..7]. Indicates the day of week, where Sunday is numbered 1 and Saturday is numbered 7.
- Day of month ---- Unsigned binary, value [1..31]. Gives the day of month.
- Hours, minutes-- Encodes the time HH:MM in four BCD digits. The time is encoded in 24-hour format, leading zeros are not suppressed.

For example, Thursday, December 3, 6:51 AM appears as follows:

Table 4.5.3.6-43 Local Time Example

Bit Number								Octet Number
8	7	6	5	4	3	2	1	
IEI								1
$C				$5				2
$03								3
$6				$0				4
$1				$5				5

(O) Location Area List

This IE provides a list of n location area codes.

Table 4.5.3.6-44 Location Area List IE

Bit Number								Octet Number
8	7	6	5	4	3	2	1	
IEI								1
Length indicator = 2n								2
Local location area identifier 1								3
								4
...								...
Local location area identifier n								LI+1
								LI+2

- Local location area identifier---- Identifies a location area within the domain of a particular MCC and NDC.

(P) Measurement Results

This IE summarizes the mobile station's measurements on the n best candidate cells.

Table 4.5.3.6-45 Measurement Results IE

Bit Number								Octet Number
8	7	6	5	4	3	2	1	
IEI								1
Length indicator = 3n								2
color_code				carrier number(Hi bits)				3
carrier number(Lo bits)								4
Pro								5
...								...
color_code				carrier number(Hi bits)				LI
carrier number(Lo bits)								LI+1
Pro								LI+2

The following 3 fields are repeated n times, once for each cell in the list. The maximum number of cells which can appear in the list is limited to max_candidates (see Section 4.5.3.6(3)(E)). Note that the serving cell can be a candidate.

- color_code ---------Unsigned value, range [0..15]. Gives the candidate cell's color code number.
- carrier number-----Gives the carrier frequency of the candidate cell's PCCH.
- Pro ----------2s-complement value, range [-128..127]. Gives the measured received power of the candidate cell in dBm.

The cells in the list are arranged in order of decreasing measured C/I+N.

(Q) Mobile Station Status Code

This IE is included in the Call Alert Request and Call Alert Paging Request message to transfer a status byte from one mobile station to another.

Table 4.5.3.6-46 Mobile Station Status Code IE

Bit Number								Octet Number
8	7	6	5	4	3	2	1	
IEI								1
Status								2

- status----------Unsigned value, [0..255]. The value 0 is used to indicate that no status is being sent. Any non-zero value indicates that status is being sent.

(R) Neighbor Cell List

This IE gives the list of n neighbor cells to be monitored and measured by the mobile station for cell re-selection and handover.

Table 4.5.3.6-47 Neighbor Cell List IE

Bit Number								Octet Number
8	7	6	5	4	3	2	1	
IEI								1
Length indicator = 2+3n								2
foreground_max				foreground_window				
foreground_fail_threshold				_foreground_CINRo_threshold				
re-selection class		handover class		re-connection class				4
color_code				carrier number(Hi bits)				5
carrier number(Lo bits)								6
...								...
re-selection class		hanover class		re-connection class				LI
color_code				carrier number(Hi bits)				LI+1
carrier number(Lo bits)								LI+2

- foreground_max ---------- Unsigned value, range [0..15].
- foreground_window ---------- Unsigned value, range [0..15].
- foreground_fail_threshold---------- Unsigned value, range [0..15].
- _foreground_CINRo_threshold --- Unsigned value, range [0..15]. The parameter foreground_CINRo_threshold is given by (foreground_CINRo_threshold=_foreground_CINRo_threshold + 14dB).

The remaining fields are repeated n times, once for each neighbor cell in the list.

- re-selection class ----------Value indicating how the cell is considered for re-selection .
- handover class ---------- Value indicating how the cell is considered for handover.
- re-connection class ----------Value indicating how the cell is considered for re-connection .
- color_code ---------- Unsigned value, range [0..15]. Gives the neighbor cell's color code number.

- carrier number ---------- Gives the carrier frequency of the neighbor cell's PCCH.

(S) Random Reference

This IE is used to provide a reference for the Channel Request/Immediate Assignment and Handover Command/Handover Access transactions. It also appears in the SDB of DCCHs and single-user TCHs.

Table 4.5.3.6-48 Random Reference IE

Bit Number								Octet Number
8	7	6	5	4	3	2	1	
IEI								1
Reference value								2
								3
								4

- Reference value ---------- An unformatted 24-bit field used as a transaction reference.

(T) Regional Network Information

This IE is sent in system information on the cell's BCCH to provide information about the regional network to which the cell belongs.

Table 4.5.3.6-49 Regional Network Information IE

Bit Number								Octet Numbe
8	7	6	5	4	3	2	1	
IEI								1
Length indicator = 3n								2
Regional network code 1								3
								4
								5
...								...
Regional network code n								LI
								LI+1
								LI+2

- regional network code n ------- Each of these values identifies a regional network. Normally, only a single RNC appears in this IE.

(U) Request Reference

This IE gives the slot number and random access subslot of a RACH access.

Table 4.5.3.6-50 Request Reference IE

Bit Number								Ocetet Number
8	7	6	5	4	3	2	1	
IEI								1
S	Slot Number (Hi 7 bits)							2
Slot Number (Lo 8 bits)								3

- S ---------- Flag indicating in which Random Access Subslot the access was made (See Table 4.5.3.6-51).

Table 4.5.3.6-51 S Flag

Value	Description
%0	Access made in first (earlier) Random Access Subslot
%1	Access made in second (later) Random Access Subslot

- Slot number ---------- Unsigned binary, range [0..30239]. Gives the slot number (SN) of the access.

(V) RR Cause

This IE is used to report various error conditions.

Table 4.5.3.6-52 RR Cause IE

Bit Number								Octet Number
8	7	6	5	4	3	2	1	
IEI								1
RR cause value								2

There is the call reject cause etc.. used in Section 4.4.2.6(1) in RR cause value. RR cause value is not described here.

(W) Service Area ID

This IE is used to identify a service area.

Table 4.5.3.6-53 Service Area ID IE

Bit Number								Octet Number
8	7	6	5	4	3	2	1	
IEI								1
Service area identification								2

- Service area ID ----------Unsigned value, range [$00..$FF]. The value $00 indicates "no service area"; the value $FF indicates "all service areas"; the values [1..99] are used to identify actual service areas within the system.

(X) Talkgroup Index

This IE transmits a talkgroup index (TGI). A TGI is a small number which identifies a talkgroup uniquely within the scope of a particular fleet.

Table 4.5.3.6-54 Talkgroup Index IE

Bit Number								Octet Number
8	7	6	5	4	3	2	1	
IEI								1
TGI value								2

- TGI value ---------- Unsigned value, range [1..255]. The value $00 is reserved.

(Y) Time Alignment

This IE provides the mobile station with a time advance value.

Table 4.5.3.6-55 Time Alignment IE

Bit Number								Octet Number
8	7	6	5	4	3	2	1	
IEI								1
				Timing Alignment Value				2

- Time alignment value ---------- Unsigned value, range [1..15]. The required time advance is equal to the contents of this field times 62.5 μs.

(4) MM Sublayer Information Elements

The MM sublayer IEs may appear only in messages belonging to the MM sublayer message set (i.e. PD $5).

Table 4.5.3.6-56 MM Sublayer Information Elements

8	7	6	5	4	3	2	1	Information Element	Reference	Length (octet)
1	0	0	1	Option				Option	–	F1
	1	0	0	Option				ID type	4.5.3.6(4) (B)	F1
	1	1	0	Option				Location updating type	4.5.3.6(4) (C)	F1
0	1	0	0	0	0	0	1	Option	–	F1+16
				0	0	1	0	Option	–	F1+4
				0	1	0	0	Reject cause	4.5.3.6(4) (D)	F1+1
0	1	1	0	0	0	0	1	Group ID list	4.5.3.6(4) (A)	V1+1+5n

(A) Group ID List

This IE is used to transmit a list of Group IDs.

Table 4.5.3.6-57 Group ID List IE

Bit Number								Octet Number
8	7	6	5	4	3	2	1	
IEI								1
LI=5n								2
Type indicator 1								3
Talkgroup index 1								4
Group ID 1								5
								6
								7
...								...
Type indicator n								LI-2
Talkgroup index n								LI-1
Group ID n								LI
								LI+1
								LI+2

- Type indicator n ----------Indicates the application of Group ID n (see Table 4.5.3.6-58).

Table 4.5.3.6-58 Type Indicator

Value	Description
$01	Selected (primary) ID. The ID used by the mobile station to indicate a Group Call. At most one may be present; if absent, the mobile station does not have dispatch service or an invalid mode was selected.
$2	Announcement (Issei) ID. The ID used by the mobile station to initiate an Announcement (Issei) Call. At most one may be present; if absent, the mobile station cannot initiate an Announcement Call.
$4	Associated (scan) ID. An ID that the mobile station responds to if activated another user. Zero to 3 (inclusive) may be present.
all others	Option

(B) ID Type

The ID type IE is used to indicate the type of ID being requested.

Table 4.5.3.6-59 ID Type IE

Bit Number								Octet Number
8	7	6	5	4	3	2	1	
IEI				0	Type of ID			1

- Type of ID---------- See Table 4.5.3.6-60

Table 4.5.3.6-60 ID Type

Value	Type of ID
%001	IMSI
%010	IMEI
%100	TMSI

(C) Location Updating Type

This IE indicates the type of the location updating type.

Table 4.5.3.6-61 Location Updating Type IE

Bit Number								Octet Number
8	7	6	5	4	3	2	1	
IEI						Location updating type		1

- Location updating type ---------- See Table 4.5.3.6-62.

Table 4.5.3.6-62 Location Updating Type

Value	Location Updating Type
%00	Normal location updating
%01	Periodic updating
%10	IMSI attach
%11	Reserved

(D) Reject Cause

The purpose of this IE is to indicate why a request is rejected by the FNE.

Table 4.5.3.6-63 Reject Cause IE

Bit Number								Octet Number
8	7	6	5	4	3	2	1	
IEI								1
Reject cause value								2

Chapter 5 Voice Coding System

In the digital JSMR system, the transmission rate of the coded voice signal is to be 7.467 kbps (672 bits per 90 ms) or less including error correcting codes. However, the voice coding system is not specified.

Chapter 6 Measuring Method

In the following measuring methods describing more than one method, any of them can be used as long as measurement accuracy is satisfied.

In this section, "mobile station" includes both mobile station and control station.

6.1 Measuring Methods for a Mobile Station

(1) The operating mode of a mobile station is as shown in the table below .

Operation for Transmitter Measurement		Operation for Receiver Measurement	
Transmit Mode	Synchronization Mode	Receive Mode	Synchronization Mode
Burst Transmission Continuous Transmission (Frequency measurement)	Asynchronous Transmission Synchronous Transmission (Time alignment measurement)	Continuous Signal Reception	Slave Mode Synchronization

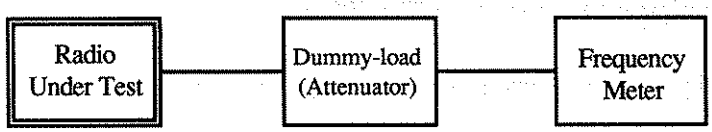
(2) A standard coded test signal used for modulation is to be the 511-bit Binary Pseudo Random Noise Sequence (CCITT V.52) and is to be sent on communication channels or all slots.

6.1.1 Transmitter

(1) Frequency Tolerance

I. Frequency Tolerance (Frequency Counter Method)

(A) Test Set-up



(B) Test Equipment Requirements/Conditions

(a) A frequency counter is to be used as a frequency meter.

(b) Using the pulse measurement function of the counter, set the gate time so that the entire burst period can be measured.

(c) The frequency counter has an accuracy to within one-tenth of the frequency tolerance specification. If it is necessary to increase resolution of short burst measurements, increase displayable digits by using averaging function, calibrate

with a known frequency, or input the signal at a lower frequency by mixing it down with a known frequency.

(C) State of Radio Under Test

(a) Set the radio under test in a test mode which outputs an unmodulated carrier (Center frequency).

(b) Or, set the radio under test in a test mode which outputs an unmodulated signal from only one of the four subcarriers. In this case, the subcarrier frequency (offset from the main carrier) is added to the measured value.

(c) Set the radio under test for transmission at the test frequency.

(D) Measurement Procedures

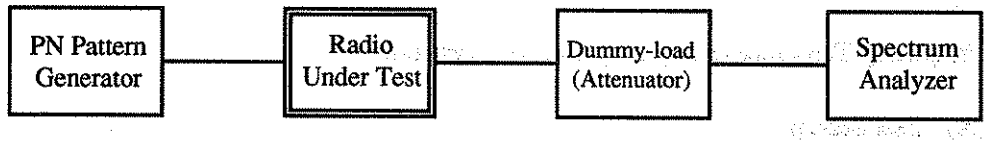
Measure the frequency of 10 or more (100 for example) bursts, then average all measurements for the result.

(E) Other Methods

The frequency of a reference oscillator output can be measured directly, as long as the radio under test is designed accordingly. The frequency accuracy of the reference oscillator must be equal to the frequency accuracy of the transmitter output.

II. Frequency Tolerance (Spectrum Analyzer Method)

(A) Test Set-up



(B) Test Equipment Requirements/Conditions

(a) A digital storage type spectrum analyzer is to be used.

(b) Setting of spectrum analyzer is as follows:

• Center frequency	Carrier frequency
• Sweep frequency bandwidth	2 ~ 20 kHz
• Resolution bandwidth	Approx. 100 Hz
• Video bandwidth	Same as resolution bandwidth
• Y-axis scale	1 dB/div.
• Input level	At least 50dB higher than internal noise of spectrum analyzer
• Sampling points	400 points or more (e.g. 1001 points)

- Sweep time — Every sample covers the whole slot under measurement (AGC preamble + M16QAM burst). (90 sec or longer for 1001 points, for example)
- Sampling mode — Positive peak
- Sweep mode — Single sweep

(C) State of Radio Under Test

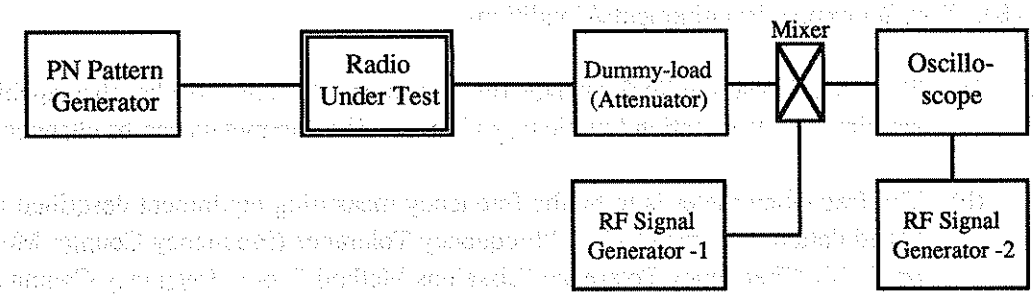
Set the radio under test for transmission at the test frequency.

(D) Measurement Procedures

Measure the frequency at the deepest point of the central dip of spectrum of the four subchannels. If a peak (caused by carrier feedthrough) appears at the dip, measure the frequency at the peak.

III. Frequency Tolerance (Lissajous Method)

(A) Test Set-up



(B) Test Equipment Requirements/Conditions

(a) The RF signal generator-1 can output a stable unmodulated signal at the frequency around 1MHz lower than the test frequency.

(b) The RF signal generator-2 can output a stable unmodulated signal around 1MHz.

(C) State of Radio Under Test

Set the radio under test for transmission at the test frequency.

(D) Measurement Procedures

(a) Generate the standard coded test signal or the code signal with fixed pattern with the pattern generator.

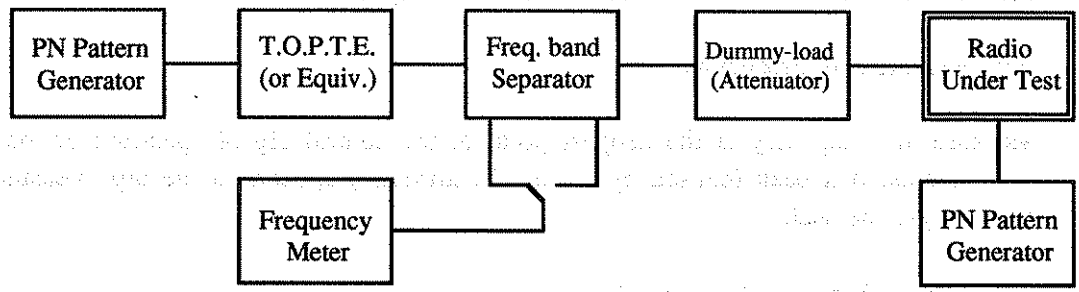
(b) Adjust the frequency of the RF signal generator-2 to stop Lissajous Figure (on the oscilloscope screen) which formed by the mixed-down signal and output signal of the RF signal generator-2.

(c) Measure the frequencies of the RF signal generator-1 and -2, F1 and F2, by the frequency counter , then compute the test frequency F by the following formula:

$F = F1 + F2$

IV. Frequency Tolerance (Frequency Tracking Accuracy)

(A) Test Set-up



T.O.P.T.E. : Total Operating Performance Test Equipment

(B) Test Equipment Requirements/Conditions

(a) The Total Operating Performance Test Equipment (T.O.P.T.E.) has the capability to simulate the base station functions, and its specific parameters can be changed.

(b) The frequency meter is to be the frequency measuring equipment described in (10) "Modulation Accuracy", (1) I. "Frequency Tolerance (Frequency Counter Method)" or (1) III. "Frequency Tolerance (Lissajous Method)", or a Frequency Counter.

(C) State of Radio Under Test

If necessary for the frequency measurement, set the radio under test in an appropriate test mode.

(D) Measurement Procedures

(a) The T.O.P.T.E. is adjusted so that the frequency equals to the test frequency, and the output level equals to 9 dBμ at the input of the radio under test.

(b) Confirm that the output frequency of the radio under test tracks as varying the T.O.P.T.E. output frequency.

(c) Measure the output frequency of the radio under test by the frequency meter (F1).

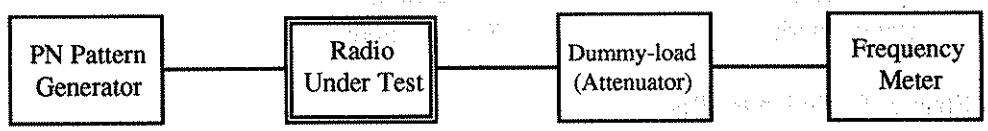
(d) Measure the output frequency of the T.O.P.T.E. by the frequency meter (F2).

(e) Compute the Frequency Tracking Accuracy (ΔF) by the following formula ;

$\Delta F = (| F1 - F2 | - (Fs))/(Ft)$
Where : Fs = Nominal Tx/Rx Frequency Separation
Ft : Nominal Transmit Frequency

V. Frequency Tolerance (Phase Locus Method)

(A) Test Set-up



(B) Test Equipment Requirements/Conditions

The frequency meter is to be the frequency measuring equipment described in (10) "Modulation Accuracy".

(C) State of Radio Under Test

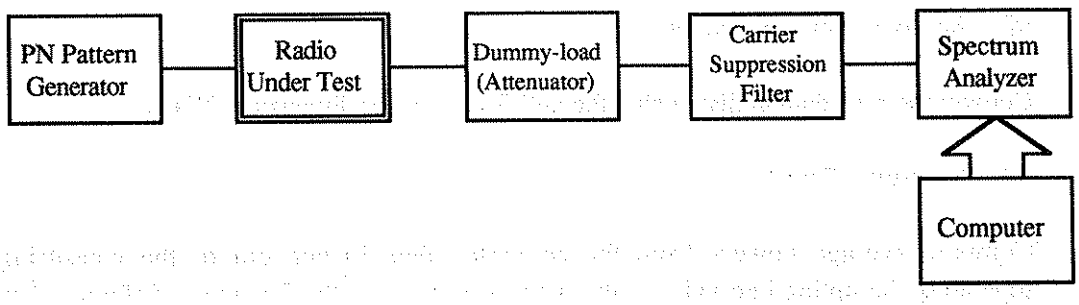
Set the radio under test for transmission at the test frequency.

(D) Measurement Procedures

Measure the output frequency of the radio under test by the frequency meter.

(2) Strength of Spurious Emission

(A) Test Set-up



(B) Test Equipment Requirements/Conditions

(a) Use the carrier suppression filter as required. Attenuation at the carrier frequency is to be 30 dB or more.

(b) A digital storage type spectrum analyzer is to be used.

(c) Setting of spectrum analyzer is as follows:

- Center frequency — Spurious frequency
- Sweep frequency bandwidth — 0 Hz

- Resolution bandwidth — 30 kHz
- Video bandwidth — Same as resolution bandwidth
- Y-axis scale — 10 dB/div.
- Input level — 70 ~ 90% of full scale for the maximum amplitude
- Sweep mode — Single sweep
- Trigger mode — Free-run or video-trigger (Adjustment may be needed though generally positive voltage)
- Sweep time — 27 ms or less
- Detect mode — Sample mode

(C) State of Radio Under Test

Set the radio under test for transmission at the test frequency.

(D) Measurement Procedures

(a) Center Frequency Setting

Set the center frequency of the spectrum analyzer at the spurious frequency.

(b) Measurement of Power Distribution

Measure the power distribution by the spectrum analyzer with single sweep.

(c) Data Reading

When sweep completes, read the sampled data in and out of the measuring slot into the array valuable in the computer.

(d) Antilogarithm Conversion

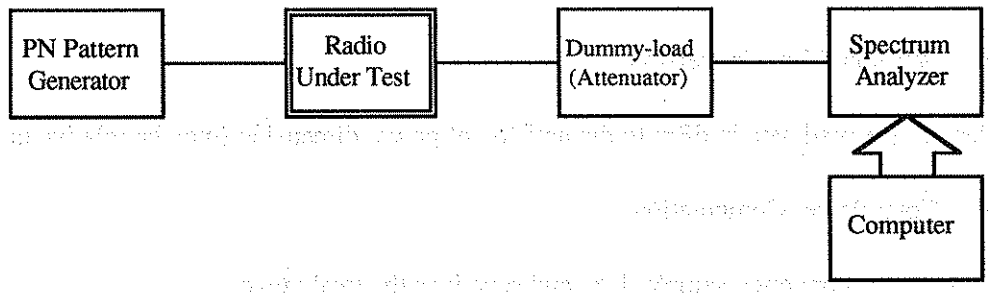
Convert the read data in dBm using the anti-log to power dimension (Watt)

(e) Averaging Power

Compute average powers from the converted data in and out of the measuring slot separately. Sampling intervals are the reciprocal of twice the frequency difference between outer subcarriers (36 kHz), or less.

(3) Occupied Bandwidth

(A) Test Set-up



(B) Test Equipment Requirements/Conditions

(a) A digital storage type spectrum analyzer is to be used.

(b) Setting of spectrum analyzer is as follows:

• Center frequency	Carrier frequency
• Sweep frequency bandwidth	Approx. 75 kHz
• Resolution bandwidth	Approx. 100 Hz
• Video bandwidth	Same as resolution bandwidth
• Y-axis scale	10 dB/div.
• Input level	Carrier signal level to be at least 50dB higher than internal noise of spectrum analyzer
• Sampling points	400 points or more.(e.g. 1001 points)
• Sweep time	Every sample covers the whole slot under measurement (AGC preamble + M16QAM burst). (90 sec or longer for 1001 points, for example)
• Detect mode	Positive peak
• Sweep mode	Single sweep

(c) The computer internal or external to the spectrum analyzer is to process the data measured by the spectrum analyzer.

(d) Data transmission rate is adjusted to the specification of the radio under test.

(C) State of Radio Under Test

Set the radio under test for transmission at the test frequency.

(D) Measurement Procedures

(a) Measurement

Measure the power distribution by the spectrum analyzer with single sweep.

(b) Data Reading

When sweep completes, read the sampled data in and out the measuring slot into the array valuable in the computer.

(c) Antilogarithm Conversion

Convert the read data in dBm to the anti-log of power dimension (may be relative numbers).

(d) Total Power Computation

Total all the converted sample data, and save it as the total power.

(e) Compute the Lower Limit Frequency

Add the converted sample data successively upwards from the lowest frequency point, and find the sample point where the sum reaches 0.5% of the total power. Convert the sample point to the frequency and save it as the lower limit frequency.

(f) Compute the Upper Limit Frequency

Total the converted sample data successively downwards from the highest frequency point, and find the sample point where the sum reaches 0.5% of the total power. Convert the sample point to the frequency and save it as the upper limit frequency.

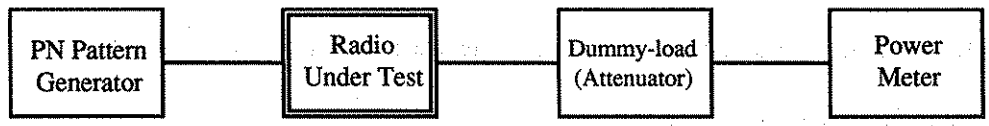
(g) Compute the Occupied Bandwidth

Compute the Occupied Bandwidth as "Upper Limit Frequency" - "Lower Limit Frequency".

(4) Antenna Power Tolerance

I. Antenna Power Tolerance (I)

(A) Test Set-up



(B) Test Equipment Requirements/Conditions

A power meter whose time constant is much larger than the burst interval is to be used.

(C) State of Radio Under Test

Set the radio under test for transmission at the test frequency. The radio is to transmit one burst per frame.

(D) Measurement Procedures

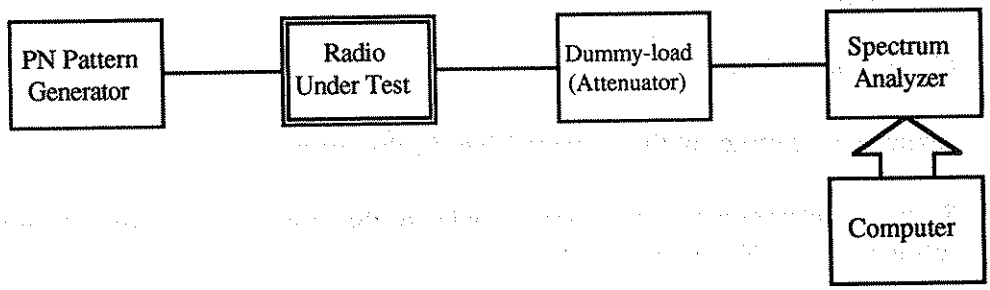
(a) Measure the power (Pm) by the power meter for sufficiently long time.

(b) Compute the average power within a slot (P) using correcting factor of the AGC preamble to the slot length (B = 16.1 ms for the basic slot. However, it is to be modified depending on the waveform of the AGC preamble) and the slot length (T = 15 ms for the basic slot.).

$P = Pm \times (T/B) \times 6$

II. Antenna Power Tolerance (II)

(A) Test Set-up



(B) Test Equipment Requirements/Conditions

(a) A digital storage type spectrum analyzer is to be used.

(b) Setting of spectrum analyzer is as follows:

• Center frequency	Carrier frequency
• Sweep frequency bandwidth	0 Hz
• Resolution bandwidth	Approx. 100 kHz
• Video bandwidth	Same as resolution bandwidth
• Y-axis scale	10 dB/div.
• Input level	70 ~ 90% of full scale for the maximum amplitude
• Sweep mode	Single sweep
• Trigger mode	Free-run or video-trigger (Adjustment may be needed though generally positive voltage)
• Sweep time	27 ms or less
• Detect mode	Sample mode

(C) State of Radio Under Test

Set the radio under test for transmission at the test frequency.

(D) Measurement Procedures

(a) Measurement

Measure the power distribution by the spectrum analyzer with single sweep.

(b) Data Reading

When sweep completes, read the sampled data in and out the measuring slot into the array valuable in the computer.

(c) Antilogarithm Conversion

Convert the read data in dBm to the anti-log of power dimension (may be relative numbers).

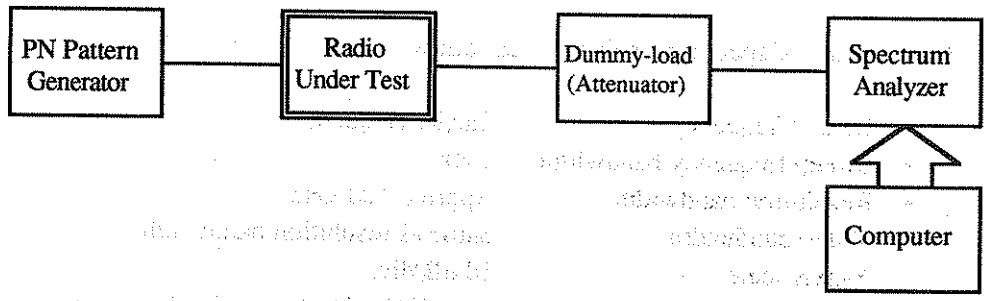
(d) Compute Power

Compute the average of the converted data for the average power.

Sampling interval is the reciprocal of twice of the frequency difference between outer subcarriers (36 kHz) or less.

(5) Adjacent Channel Coupled Power

(A) Test Set-up



(B) Test Equipment Requirements/Conditions

(a) A digital storage type spectrum analyzer is to be used.

(b) Setting of spectrum analyzer is as follows:

- Center frequency — Carrier frequency
- Sweep frequency bandwidth — Approx. 100 kHz
- Resolution bandwidth — Less than approx. 1 kHz
- Video bandwidth — About 3 times of resolution bandwidth
- Y-axis scale — 10 dB/div.
- Sampling points — 400 points or more (e.g. 1001 points)

• Sweep time	Every sample covers the whole slot under measurement (AGC preamble + M16QAM burst) (90 sec or longer for 1001 points, for example)
• Input level	Around the max. linear region of the mixer internal to the spectrum analyzer. (e.g. –10 dBm~ –30 dBm)
• Display mode	Max. hold
• Detect mode	Positive peak
• Sweep mode	Single sweep

(c) The computer internal or external to the spectrum analyzer is to process the data measured by the spectrum analyzer.

(C) State of Radio Under Test

Set the radio under test for transmission at the test frequency.

(D) Measurement Procedures

(a) After sweep completes, read all of the sampled data into the array variable in the computer.

(b) Convert all of the data in dBm to the anti-log of power dimension (may be relative numbers).

(c) Sum up all of the converted data, and save it as the total power (Pc).

(d) Compute the Upper Adjacent Channel Coupled Power (Pu)

- Read all of the sampled data, which fall into the specified bandwidth (18 kHz) centering at +25 kHz (channel spacing) away from the carrier, into the array variable in the computer.
- Convert all of the data in dBm to the anti-log of power dimension, then sum them up (Pu) .

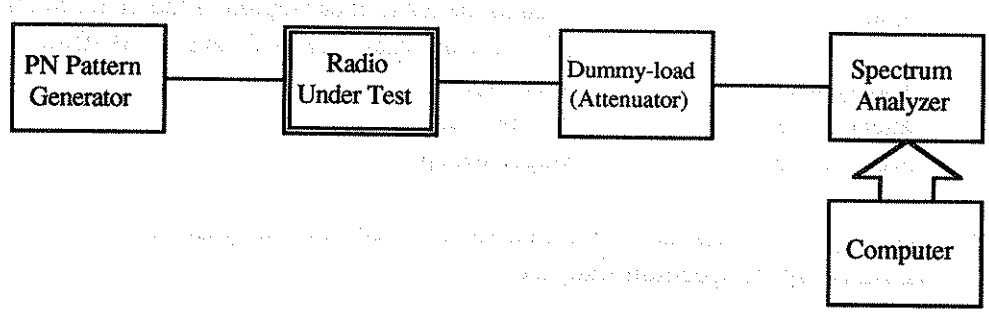
(e) Compute the Lower Adjacent Channel Coupled Power (Pl)

- Read all of the sampled data, which fall into the specified bandwidth (18 kHz) centering at -25 kHz (channel spacing) away from the carrier, into the array variable in the computer.
- Convert all of the data in dBm to the anti-log of power dimension, then add them up (Pl) .

(f) Get the measurement results by the following formulas ;
Upper Adjacent Channel Coupled Power Ratio = 10 log (Pc/Pu)
Lower Adjacent Channel Coupled Power Ratio = 10 log (Pc/Pl)
The results are expressed in dB.

(6) Carrier-off Leakage Power

(A) Test Set-up



(B) Test Equipment Requirements/Conditions

(a) A digital storage type spectrum analyzer is to be used.

(b) Setting of spectrum analyzer is as follows:

- Center frequency — Carrier frequency
- Sweep frequency bandwidth — 0 Hz
- Resolution bandwidth — 30 kHz
- Video bandwidth — Same as resolution bandwidth
- Y-axis scale — 10 dB/div.
- Input level — Below the max input level, and average noise level of the spectrum analyzer is to be -10 dB or lower than the Carrier-off leakage power specification
- Sweep mode — Single sweep
- Trigger mode — Free-run or video-trigger (Adjustment may be needed though generally positive voltage)
- Sweep time — 27 ms or less
- Detect mode — Sample mode

(C) State of Radio Under Test

Set the radio under test for transmission at the test frequency.

(D) Measurement Procedures

(a) Measurement

Measure the power distribution by the spectrum analyzer with single sweep.

(b) Data Reading

When sweep completes, read the sampled data during carrier-off into the array value in the computer.

(c) Antilogarithm Conversion

Convert the read data in dBm to the anti-log of power dimension (Watt).

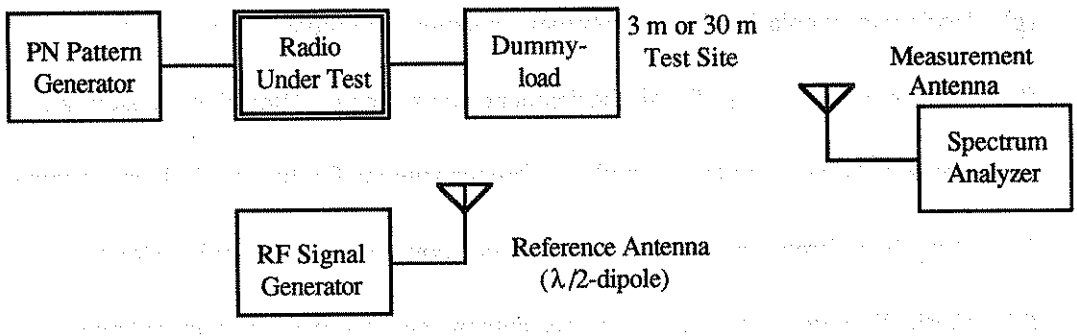
(d) Compute Power

Compute the average of the converted data for the average power.

Sampling interval is the reciprocal of twice of the frequency difference between outer subcarriers (36 kHz), or less.

(7) Radiated Spurious Emission

(A) Test Set-up



(B) Test Equipment Requirements/Conditions

(a) Terminate antenna terminal of the radio under test with dummy load.

(b) Take measurements at an open test site in accordance with IEC Pub. 489-6 Appendix K if one edge of the radio housing exceeds 60 cm or if the measurement frequency is less than 100 MHz. Otherwise, take measurements at an open test site in accordance with Appendix K or L.

(c) At frequencies 300 MHz or higher, it is best to suppress any ground reflected waves in order to avoid trouble caused by increased complexity of the height pattern. For this, the measurement antenna is of high directivity. The radio under test is as high as possible. If ground reflected waves cannot be suppressed adequately, arrange a shielding curtain around the center, or deploy a radio wave absorber.

(C) State of Radio Under Test

Set the radio under test for transmission at the test frequency.

(D) Measurement Procedures

(a) Set the radio under test on a rotating stand and check its any spectrum within a specified frequency range.

(b) Tune the spectrum analyzer with one given frequency component from the spectrum ascertained in (a).

(c) Vertically polarize the measurement antenna.

(d) Rotate the stand and obtain the maximum reading of the spurious power (average power within a burst).

(e) Vary the measurement antenna height between 1 - 4 meters above the ground for the maximum reading of the spurious power .

(f) Repeat steps (d) and (e) until the maximum reading does not increase any more. Record the frequency, the maximum reading of the spurious power, and antenna height measurement at this point.

(g) Horizontally polarize the measurement antenna, and repeat steps (d) - (f).

(h) Perform steps (b) - (g) for all the frequency components determined in step (a).

(i) Replace the radio under test with a reference antenna fed by an RF signal generator.

(j) Tune the reference antenna to the frequency component measured in step (f).

(k) Vertically polarize both the reference antenna and the measurement antenna.

(l) Vary the measurement antenna height between 1 meter and 4 meters above the ground. Adjust the output level of the RF signal generator so that the maximum reading of the spectrum analyzer obtained during this antenna adjustment matches the maximum value obtained in step (f). Record the output level of the RF signal generator and the height of the measurement antenna at this point.

(m) Horizontally polarize both the reference antenna and the measurement antenna and repeat step (g).

(n) Repeat steps (j) - (m) for all frequency components measured up to step (m).

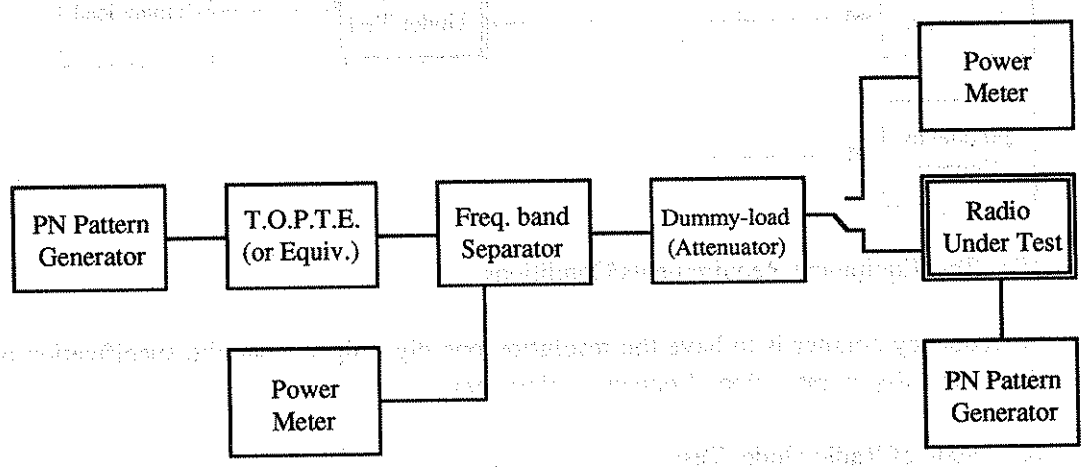
(E) Computation of Results

Radiated spurious emission is the sum of the output levels of the RF signal generator as obtained in procedure (d), the gain of the reference antenna, and the correction for the cable loss (between the RF signal generator and the reference antenna).

(8) Transmission Power Control

I. Autonomous Transmission Power Control

(A) Test Set-up



T.O.P.T.E. : Total Operating Performance Test Equipment

(B) Test Equipment Requirements/Conditions

(a) The Total Operating Performance Test Equipment (T.O.P.T.E.) can simulate the base station functions, and its specific parameters can be changed.

(b) The power meter is to be a power measuring equipment described in (4) "Antenna Power Tolerance".

(c) The test set-up must be calibrated prior to the measurements.

(C) State of Radio Under Test

Set the radio under test in an appropriate test mode for the measurements.

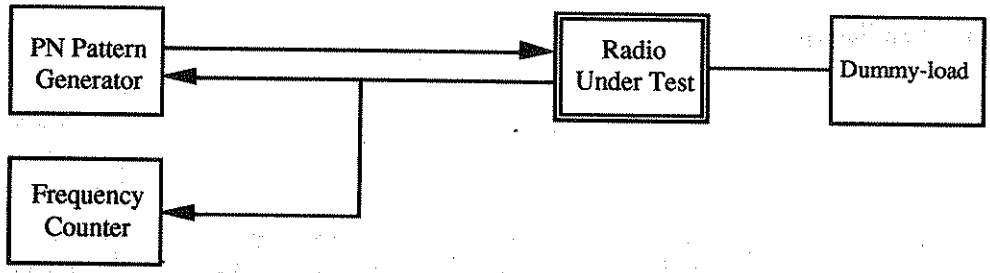
(D) Measurement Procedures

(a) The T.O.P.T.E. is tuned to the test frequency.

(b) Feed the specified signal level to the radio under test, then measure the output power of the radio.

(9) Accuracy of Data Transmission Rate

(A) Test Set-up



(B) Test Equipment Requirements/Conditions

A frequency counter is to have the resolution one digit higher than the specification of the data transmission rate (clock frequency tolerance).

(C) State of Radio Under Test

Set the radio under test for transmission at the test frequency.

(D) Measurement Procedures

Measure the clock frequency of the radio under test.

(E) Computation of Results

Compute the deviation of the measurement in procedure (D) to the nominal value.

(10) Modulation Accuracy

(A) Definition of the Modulation Accuracy

If the ideal transmitter output signal is passed through the ideal receive root roll-off filter, then each symbol of the signal is sampled at ideal timing (i.e., there is no symbol interference among symbols). However, in an actual transmitter output signal, symbol interference occurs because the transmission path deviates from the ideal characteristics. The modulation accuracy can be obtained by measuring symbol errors caused by symbol interference. Fig. 6.1-1 illustrates such symbol errors.

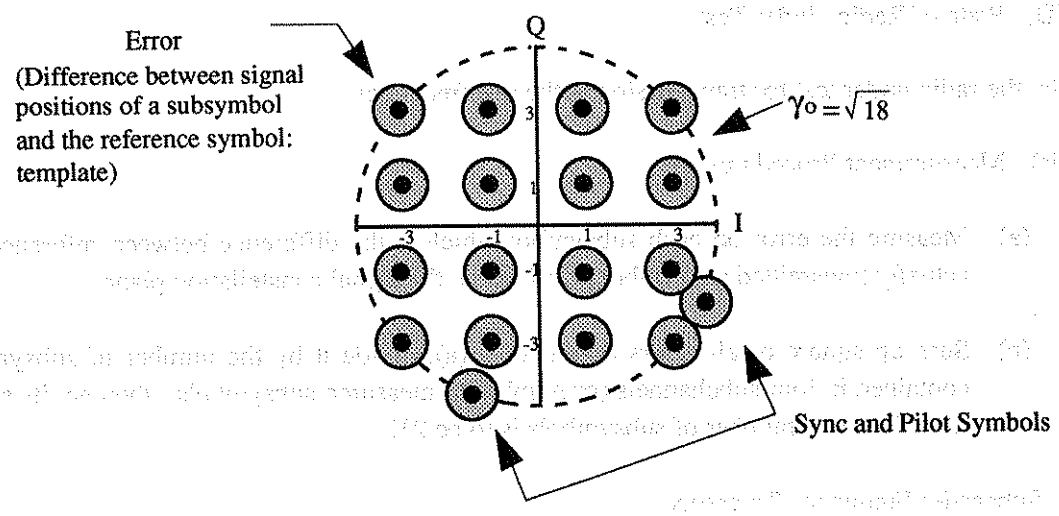


Fig. 6.1-1 Signal Constellation Diagram

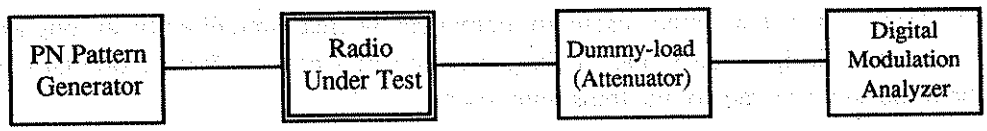
The formula defining the modulation accuracy is shown below:

$$\varepsilon = \frac{\sqrt{\frac{1}{N}\sum_{i=1}^{N}\left|V_{mi}\,\alpha\exp(j\phi) - V_i - V_0\right|^2}}{\gamma_0} \times 100\%$$

where ; i : Subsymbol number
N : Total number of subsymbols for the measurement
V_{mi} : Vector of i-th subsymbol
Vi : Reference symbol vector determined by the i-th subsymbol
V_o : Origin offset level
α : Gain parameter (scalar value)
ϕ : Phase parameter (scalar value)
γ_o : Maximum magnitude of the Signal Constellation Diagram($\sqrt{18}$).

Unknown parameters V_o, α, and ϕ are chosen for the minimum value of the modulation accuracy ε given by the above formula.

(B) Test set-up



(C) Test Equipment Requirements/Conditions

The digital modulation analyzer is to have a function of the receive root roll-off filter, and have capability to measure the root mean square of the difference between actually transmitted signal and the reference symbols.

(D) State of Radio Under Test

Set the radio under test for transmission at the test frequency.

(E) Measurement Procedures

(a) Measure the error on each subsymbol which is the difference between reference and actually transmitted subsymbol positions on the signal constellation plane.

(b) Sum up square of all errors obtained in (a), divide it by the number of subsymbols contained in four subchannels (or number of measured subsymbols), then get its square root. The total number of subsymbols is to be 212.

(11) Subcarrier Frequency Tolerance

I. Frequency Tolerance (Frequency Counter Method)

(A) Test Set-up

Same as (1) I. "Frequency Tolerance (Frequency Counter Method)".

(B) Test Equipment Requirements/Conditions

Same as (1) I. "Frequency Tolerance (Frequency Counter Method)".

(C) State of Radio Under Test

(a) Set the radio in a test mode which outputs an unmodulated signal from one of the four subcarriers at a time. Any of the four subcarriers can be selected.

(b) Set the radio under test for transmission at the test frequency.

(D) Measurement Procedures

Measure the frequency of 10 or more (100 for example) bursts, then average all measurements for the result.

(E) Other Methods

The frequency of a reference oscillator output can be measured directly, as long as the radio under test is designed such that the frequency accuracy of the reference oscillator is equal to the frequency accuracy of the transmitter output.

II. Frequency Tolerance(Phase Locus Method)

(A) Test Set-up

Same as (1) V. "Frequency Tolerance (Phase Locus Method)".

(B) Test Equipment Requirements/Conditions

Same as (1) V. "Frequency Tolerance (Phase Locus Method)".

(C) State of Radio Under Test

Set the radio under test for transmission at the test frequency.

(D) Measurement Procedures

Measure the four subcarrier frequencies of the output of the radio under test by the frequency meter.

(12) Subsymbol Timing Synchronization

(A) Test Set-up

Same as (10) "Modulation Accuracy".

(B) Test Equipment Requirements/Conditions

The digital modulation analyzer is to detect the best symbol synchronization timing of four subcarriers independently, in addition to the functions for the modulation accuracy measurement.

(C) State of Radio Under Test

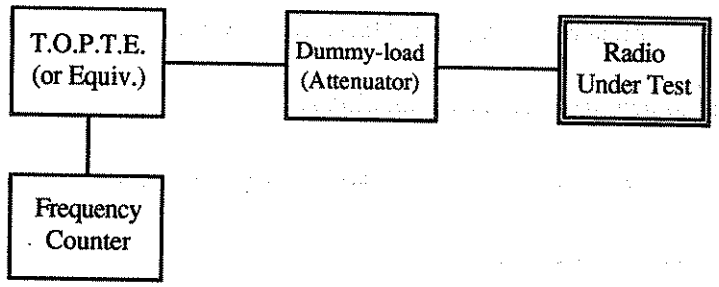
Set the radio under test for transmission at the test frequency.

(D) Measurement Procedures

Compute the timing differences among the symbol synchronization timings detected on each subcarrier independently.

(13) Time Alignment Control

(A) Test Set-up



T.O.P.T.E. : Total Operating Performance Test Equipment

(B) Test Equipment Requirements/Conditions

(a) The Total Operating Performance Test Equipment (T.O.P.T.E.) has a capability to simulate the base station functions, and its specific parameters can be changed.

(b) The T.O.P.T.E. is to have the function to output the timing difference between its own transmission and the transmission of the radio under test. The accuracy of the timing difference to be output is to be10 times of the specification, or better.

(c) The Frequency counter can measure the time intervals. The accuracy of the time interval measurement is to be10 times of the specification, or better.

(d) The combined accuracy of (b) and (c) is to be 10 times of the specification, or better.

(e) The measurement described above is the rated output power with no fading condition.

(C) State of Radio Under Test

Set the radio under test in normal operation mode.

(D) Measurement Procedures

(a) The T.O.P.T.E. activates a communication channel for the radio under test, then sends time alignment control command with normal timing (no time advance).

(b) The T.O.P.T.E. outputs the timing difference between its own transmission and the transmission of the radio under test.

(c) Measure the timing difference by the frequency counter with the time interval mode.

(d) Change the time alignment value to 1/4 symbol time and 3 symbol time, then repeat steps (a) to (b) on each time alignment value.

(14) Burst Transmission Timing

(A) Test Set-up

Same as (13) "Time Alignment Control".

(B) Test Equipment Requirements/Conditions

Same as (13) "Time Alignment Control".

(C) State of Radio Under Test

Set the radio under test in normal operation mode.

(D) Measurement Procedures

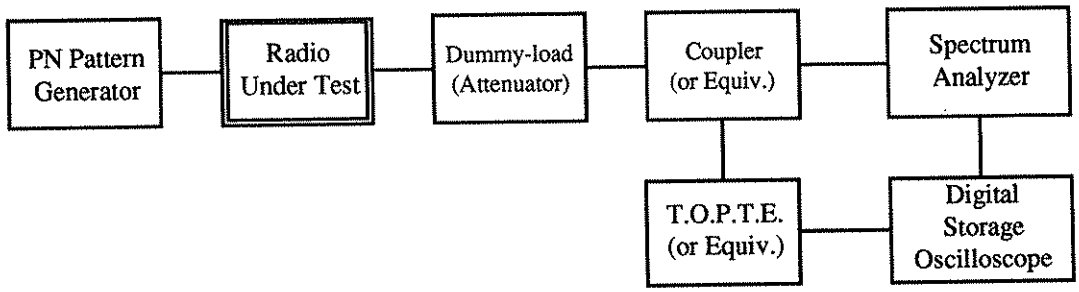
(a) The T.O.P.T.E. activates a communication channel for the radio under test, then sends time alignment control command with normal timing (no time advance).

(b) The T.O.P.T.E. outputs the timing difference between its own transmission and the transmission of the radio under test.

(c) Measure the timing difference by the frequency counter with the time interval mode.

(15) Transition Response Characteristics of the Burst Transmission and AGC Preamble

(A) Test Set-up



(B) Test Equipment Requirements/Conditions

(a) The Total Operating Performance Test Equipment (T.O.P.T.E.) is to be capable to output the trigger signal corresponding to the burst timing of the radio under test.

(b) The spectrum analyzer is to equip with the video output terminal, Vertical axis of the oscilloscope must be calibrated by the power meter as the system in conjunction with the spectrum analyzer.

(c) Setting of spectrum analyzer is as follows:

- Center frequency Carrier frequency

• Sweep frequency bandwidth	0 Hz
• Resolution bandwidth	Approx. 100 kHz
• Y-axis scale	10 dB/div.
• Input level	Below the max input level, and average noise level of the spectrum analyzer is to be 10 or more dB less than the specification of Carrier-off Leakage Power

(d) Video output signal is fed to the digital storage oscilloscope.

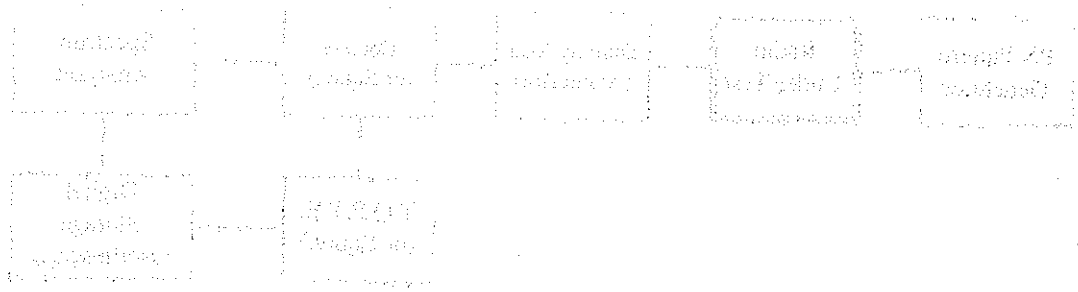
• Sweep trigger	External trigger
• Sweep time	Approx. 200 μs

(C) State of Radio Under Test

Set the radio under test for transmission at the test frequency.

(D) Measurement Procedures

Measure the video output signal from the spectrum analyzer on the oscilloscope.

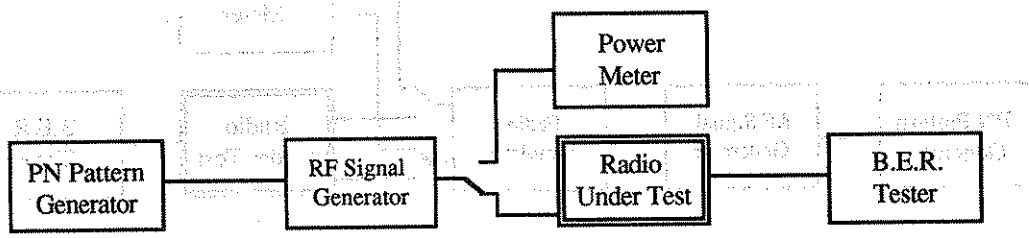


6.1.2 Receiver

(1) Receiver Sensitivity

I. Receiver Sensitivity (Static)

(A) Test Set-up



(B) Test Equipment Requirements/Conditions

(a) RF Signal Generator.

• Frequency	Specified frequency range
• Stability	Within $\pm 5 \times 10^{-8}$
• Modulation accuracy	Within 3% of RMS. vector error (recommended value)
• Modulation Rate	4 kbaud

(b) Pattern Generator

• Clock accuracy	Within $\pm 1 \times 10^{-6}$
• Generated pattern	To continuously generate the standard coded test signals (511-bit Binary Pseudo Random Noise Sequence based on CCITT V.52) communication channels. As well, must generate specified patterns as required for communication in other channels.

(C) State of Radio Under Test

(a) Set the radio under test for reception at the test frequency.

(b) Demodulation data is to be user specific channel portions (the standard coded test signal portions).

(D) Measurement Procedures

(a) Set the frequency of the RF signal generator at the test frequency.

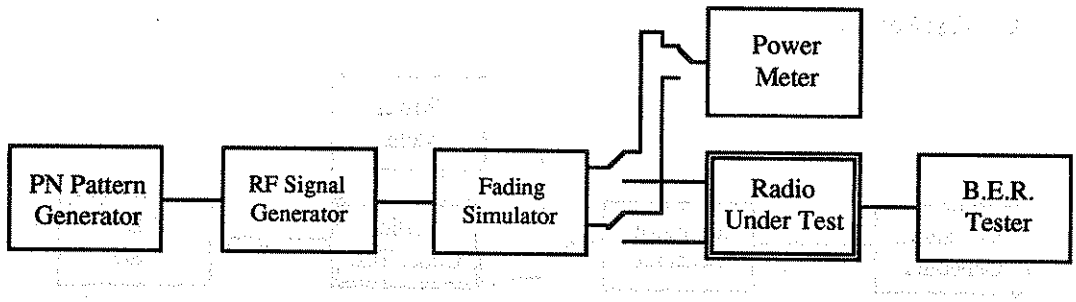
(b) RF signal generator is to transmit continuously . With the power meter, adjust the RF signal generator output to obtain a signal level equal to the standard sensitivity level (static). Then, change switches and apply the signal to the radio under test.

(c) With the BER (bit error rate) tester, accumulate the bit stream in the communication channels and measure the bit error rate for at least 2556 bits.

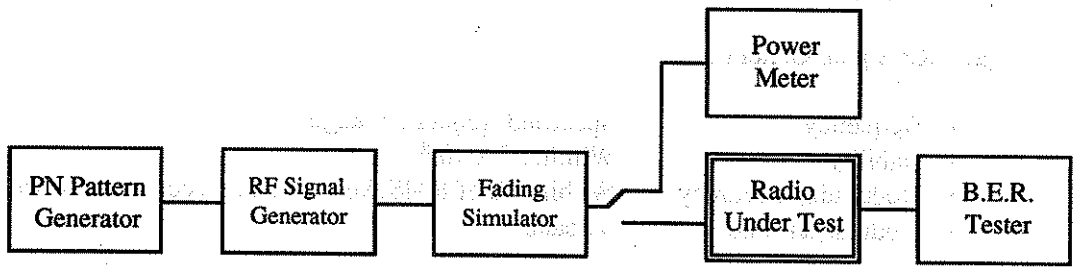
II. Receiver Sensitivity (Faded)

(A) Test Set-up

(a) With Diversity.



(b) Without Diversity



(B) Test Equipment Requirements/Conditions

(a) RF Signal Generator.

- Frequency — Specified frequency range
- Stability — Within $\pm 5 \times 10^{-8}$
- Modulation accuracy — Within 3% of RMS. vector error (recommended value)
- Modulation rate — 4 kbaud

(b) Pattern Generator.

- Clock accuracy — Within $\pm 1 \times 10^{-6}$
- Generated pattern — To continuously generate the standard coded test signals (511-bit Binary Pseudo Random Noise Sequence based on CCITT V.52) in communication channels. As well, must generate specified patterns as required for communication in other channels.

(c) Fading Simulator

In accordance with IEC Pub. 489-6 Appendix C. Maximum doppler frequency is to be 40 Hz (800 MHz band) and 70 Hz (1.5 GHz band) of Rayleigh fading

(C) State of Radio Under Test

(a) Set the radio under test for reception at the test frequency.

(b) Demodulation data is to be communication channel portions (the standard coded test signal portions).

(D) Measurement Procedures

(a) Set the frequency of the RF signal generator to the test frequency.

(b) The RF signal generator is to transmit continuously. With the power meter, adjust the RF signal generator output to obtain a signal level equal to the standard sensitivity level (mean value with fading). Then, change switches and apply the signal to the radio under test.

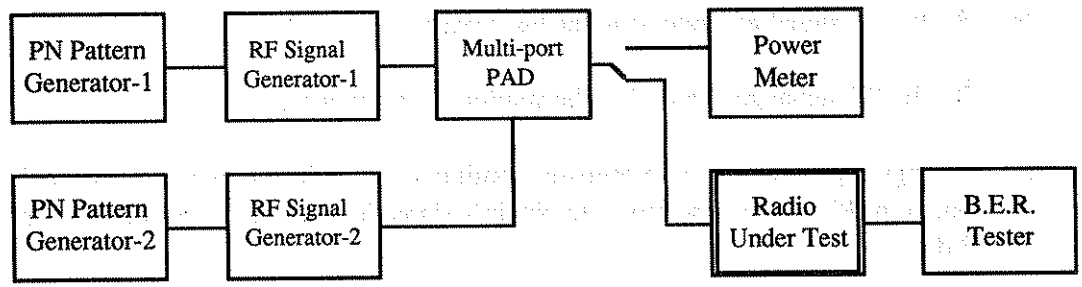
(c) With the BER (bit error rate) tester, accumulate the bit strings in the communication channels and measure the bit error rate at minimum for the larger of 2556 bits or :

$$\frac{43{,}200 \times \text{Bit Rate (bps)}}{\text{Vehicle Speed (km/h)} \times \text{Test Frequency (MHz)}}$$

Bit Rate (bps) : 64,000

(2) Spurious Response

(A) Test Set-up



(B) Test Equipment Requirements/Conditions

(a) RF Signal Generator-1 and -2

• Frequency	Specified frequency range
• Stability	Within $\pm 5 \times 10^{-8}$
• Modulation accuracy	Within 3% of RMS. vector error (recommended value)
• Modulation rate	4 kbaud
• Adjacent channel coupled power	86 dB or greater at ± 50 kHz off (recommended value) 87 dB or greater at ± 100 kHz off (recommended value)

(b) Pattern Generator-1

• Clock accuracy	Within $\pm 1 \times 10^{-6}$
• Generated pattern	To continuously generate the standard coded test signals (511-bit Binary Pseudo Random Noise Sequence based on CCITT V.52) in communication channels. As well, must generate specified patterns as required for communication in other channels.

(c) Pattern Generator-2

• Clock accuracy	Within $\pm 1 \times 10^{-6}$
• Generated pattern	To continuously generate digital signals (32,767-bit Binary Pseudo Random Noise Sequence based on CCITT O.151).

(C) State of Radio Under Test

(a) Set the radio under test for reception at the test frequency.

(b) Demodulation data is to be communication channel portions (standard coded test signal portions).

(D) Measurement Procedures

(a) Set the RF signal generator-1 to the test frequency.

(b) Set the RF signal generator-2 to the spurious frequency(*).

(c) RF signal generator-1 is to transmit continuously. With the power meter, adjust the output of RF signal generator-1 to obtain a signal level equal to [standard sensitivity + 3 dB].

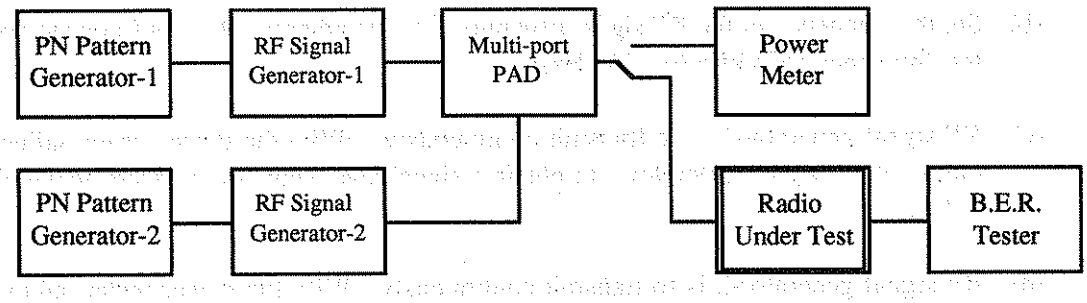
(d) RF signal generator-2 is to transmit continuously. With the power meter, adjust the output of RF signal generator-2 to obtain a signal level equal to (standard sensitivity + 3 dB) + (spurious response specification) [dBμ] . Then, change switches and apply the signal to the radio under test.

(e) With the BER(bit error rate) tester, accumulate the bit strings in the communication channels and measure the bit error rate for at least 2556 bits.

(*) Spurious frequency is the frequency of undesired signals which degrade a bit error rate and must be ascertained. As one method of measuring this, use a receiver capable of receiving IF frequencies and specify the spurious frequency from the IF level of the radio under test.

(3) Adjacent Channel Selectivity

(A) Test Set-up



(B) Test Equipment Requirements/Conditions

(a) RF Signal Generator-1 and -2

• Frequency	Specified frequency range
• Stability	Within $\pm 5 \times 10^{-8}$
• Modulation accuracy	Within 3% of RMS. vector error (recommended value)
• Modulation rate	4 kbaud
• Adjacent channel coupled power	75 dB or greater at ± 25 kHz off (recommended value)

(b) Pattern Generator-1

• Clock accuracy	Within $\pm 1 \times 10^{-6}$
• Generated pattern	To continuously generate the standard coded test signals (511-bit Binary Pseudo Random Noise Sequence based on CCITT V.52) in communication channels. As well, must generate specified patterns as required for communication in other channels.

(c) Pattern Generator-2

• Clock accuracy	Within $\pm 1 \times 10^{-6}$
• Generated pattern	To continuously generate digital signals (32,767 -bit Binary Pseudo Random Noise Sequence based on CCITT O.151).

(C) State of Radio Under Test

(a) Set the radio under test for reception at the test frequency.

(b) Demodulation data is to be communication channel portions (standard coded test signal portions).

(D) Measurement Procedures

(a) Set the frequency of the RF signal generator-1 to the test frequency.

(b) Set the frequency of the RF signal generator-2 to the adjacent channel frequency of the test frequency [+25 kHz (or -25 kHz)].

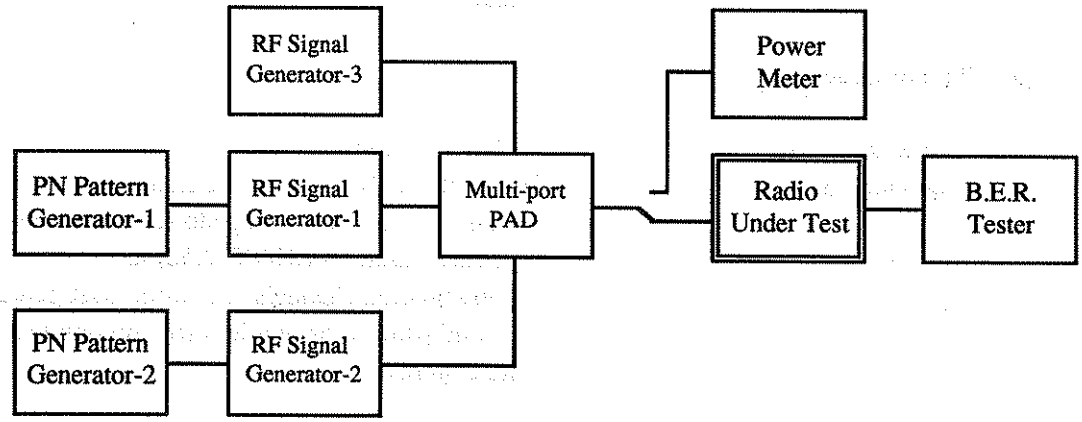
(c) RF signal generator-1 is to transmit continuously . With the power meter, adjust the output of RF signal generator-1 to obtain a signal level equal to [standard sensitivity + 3 dB].

(d) RF signal generator-2 is to transmit continuously. With the power meter, adjust the output of RF signal generator-2 to obtain a signal level equal to (standard sensitivity + 3 dB) + (adjacent channel selectivity specification) [dBμ] . Then, change switches and apply the signal to the radio under test.

(e) With the BER (bit error rate) tester, accumulate the bit strings in the communication channels and measure the bit error rate for at least 2556 bits.

(4) Intermodulation Characteristics

(A) Test Set-up



(B) Test Equipment Requirements/Conditions

(a) RF Signal Generator-1 and -2

• Frequency	Specified frequency range
• Stability	Within ±5 x 10^{-8}
• Modulation accuracy	Within 3% of RMS. vector error (recommended value)
• Modulation rate	4 kbaud
• Adjacent channel coupled power	87 dB or greater at ±100 kHz off (recommended value)

(b) RF Signal Generator-3

• Frequency	Specified frequency range
• Stability	Within $\pm 5 \times 10^{-8}$
• Adjacent channel coupled power	93 dB or greater at ±50 kHz off (recommended value)

(c) Pattern Generator-1

• Clock accuracy	Within $\pm 1 \times 10^{-6}$
• Generated pattern	To continuously generate the standard coded test signals (511-bit Binary Pseudo Random Noise Sequence based on CCITT V.52) in communication channels. As well, must generate specified patterns as required for communication in other channels.

(d) Pattern Generator-2

• Clock accuracy	Within $\pm 1 \times 10^{-6}$
• Generated pattern	To continuously generate digital signals (32,767 -bit Binary Pseudo Random Noise Sequence based on CCITT O.151).

(C) State of Radio Under Test

(a) Set the radio under test for reception at the test frequency.

(b) Demodulation data is to be communication channel portions (standard coded test signal portions).

(D) Measurement Procedures

(a) Set the frequency of the RF signal generator-1 to the test frequency.

(b) Set the frequency of the RF signal generator-3 to the test frequency +50 kHz (or -50 kHz), and that of the RF signal generator-2 to the test frequency +100 kHz (or -100 kHz).

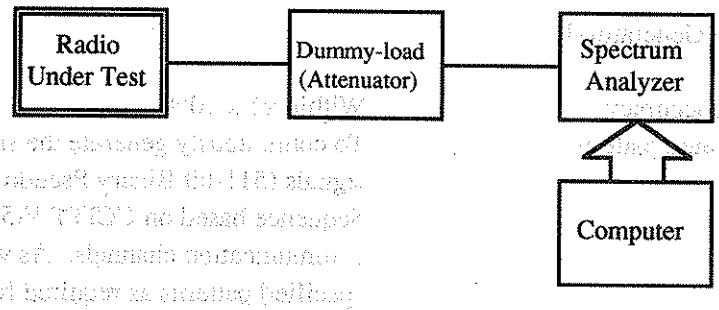
(c) RF signal generator-1 is to transmit continuously . With the power meter, adjust the output of RF signal generator-1 to obtain a signal level equal to [standard sensitivity + 3 dB].

(d) RF signal generator-3 is to transmit unmodulated signal continuously and RF signal generator-2 is to transmit continuously. With the power meter, adjust the outputs of RF signal generator-2 and -3 to obtain a signal level equal to (standard sensitivity + 3 dB) + (intermodulation characteristic specification) [dBμ] . Then, change switches and apply the signal to the radio under test.

(e) With the BER(bit error rate) tester, accumulate the bit strings in the communication channels and measure the bit error rate for at least 2556 bits.

(5) Conducted Spurious Emission

(A) Test Set-up



(B) Test Equipment Requirements/Conditions

(a) Attenuation of the dummy load (attenuator) is to be approx. 20 dB.

(b) Setting of spectrum analyzer is as follows:

• Center frequency	Conducted spurious frequency
• Sweep frequency bandwidth	0 Hz
• Resolution bandwidth	Approx. 100 kHz
• Video bandwidth	Same as resolution bandwidth
• Y-axis scale	10 dB/div.
• Input level	70 ~ 90 % of full scale for the maximum amplitude; or as large as possible if the amplitude is small.
• Sweep mode	Single sweep
• Sweep time	27 ms or less
• Detect mode	Sample mode

(C) State of Radio Under Test

Set the radio under test in reception mode and able to receive at the test frequency.

(D) Measurement Procedures

(a) Set the center frequency of the spectrum analyzer to the spurious frequency.

(b) Measure the power distribution by the spectrum analyzer with single sweep.

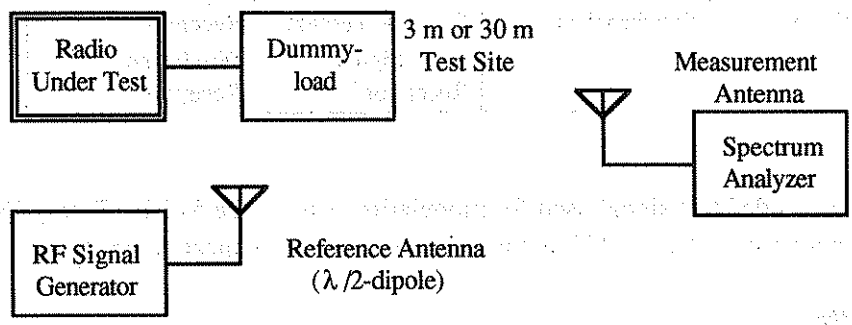
(c) After the sweep is finished, read the sampled data into the array variables of the computer. For burst emission, include all sampled data within a burst segment; for a continuous emission, include all sampled data within the sweep segment.

(d) Convert the read data in dBm to the anti-log of power dimension (Watt).

(e) Average the converted anti-log data to obtain average power values. For burst emission, data within bursts are averaged. For a continuous emission, data within sweep segments are averaged. Sampling intervals are the reciprocal of twice of the frequency difference between outer subcarriers (36 kHz), or less.

(6) Radiated Spurious Emission

(A) Test Set-up



(B) Test Equipment Requirements/Conditions

Same as "6.1.1 (7) Radiated Spurious Emission (Transmitter) (B)"

(C) State of Radio Under Test

Set the radio under test for reception at the test frequency.

(D) Measurement Procedures

Same as "6.1.1 (7) Radiated Spurious Emission (Transmitter) (D)"

6.2 Measuring Methods for a Base Station

(1) The operating mode of a base station is as shown in the table below .

Operation for Transmitter Measurement		Operation for Receiver Measurement	
Transmit Mode	Synchronization Mode	Receive Mode	Synchronization Mode
Continuous Transmission	Master Mode Synchronization	Continuous Signal Reception Burst Signal Reception	Asynchronous Reception Windowed Reception

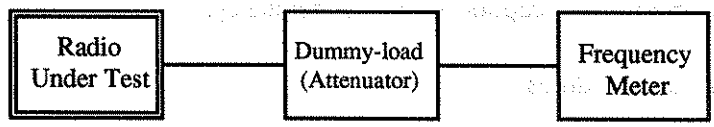
(2) A standard coded test signal used for modulation is to be the 511-bit Binary Pseudo Random Noise Sequence (CCITT V.52) and is to be sent on communication channels or all slots.

6.2.1 Transmitter

(1) Frequency Tolerance

I. Frequency Tolerance (Frequency Counter Method)

(A) Test Set-up



(B) Test Equipment Requirements/Conditions

(a) A frequency counter is to be used as a frequency meter.

(b) The frequency counter has an accuracy to within one-tenth of the frequency tolerance specification by calibrating with a known frequency, or by mixing down the input signal with a known frequency.

(C) State of Radio Under Test

(a) Set the radio under test in a test mode which outputs an unmodulated carrier (Center frequency).

(b) Or, set the radio under test in a test mode which outputs an unmodulated signal from only one of the four subcarriers. In this case, the subcarrier frequency (offset from the main carrier) is added to the measured value.

(c) Set the radio under test for transmission at the test frequency.

(D) Measurement Procedures

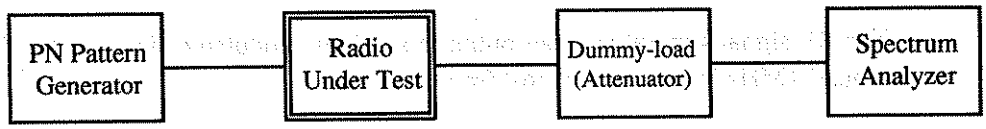
Measure the frequency after warm-up time elapsed.

(E) Other Methods

The frequency of a reference oscillator output can be measured directly if a radio under test is designed such that the frequency accuracy of the reference oscillator is equal to the frequency accuracy of the transmitter output.

II. Frequency Tolerance (Spectrum Analyzer Method)

(A) Test Set-up



(B) Test Equipment Requirements/Conditions

(a) A digital storage type spectrum analyzer is to be used.

(b) Setting of spectrum analyzer is as follows:

• Center frequency	Carrier frequency
• Sweep frequency bandwidth	2 ~ 20 kHz
• Resolution bandwidth	Approx. 100 Hz
• Video bandwidth	Same as resolution bandwidth
• Y-axis scale	1 dB/div.
• Input level	At least 50dB higher than internal noise of spectrum analyzer
• Sampling points	400 points or more (e.g. 1001 points)
• Sweep time	Every sample covers the whole slot under measurement (AGC preamble + M16QAM burst). (90 sec or longer for 1001 points, for example)
• Sampling mode	Positive peak
• Sweep mode	Single sweep

(C) State of Radio Under Test

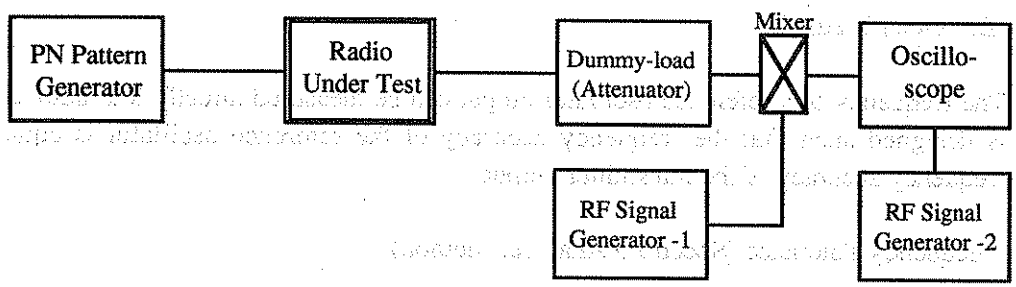
Set the radio under test for transmission at the test frequency.

(D) Measurement Procedures

Measure the frequency at the deepest point of the central dip of spectrum of the four subchannels.

III. Frequency Tolerance (Lissajous Method)

(A) Test Set-up



(B) Test Equipment Requirements/Conditions

(a) The RF signal generator-1 can output a stable unmodulated signal at the frequency around 1MHz lower than the test frequency.

(b) The RF signal generator-2 can output a stable unmodulated signal around 1MHz.

(C) State of Radio Under Test

Set the radio under test for transmission at the test frequency.

(D) Measurement Procedures

(a) Generate the standard coded test signal or the code signal with fixed pattern with the pattern generator.

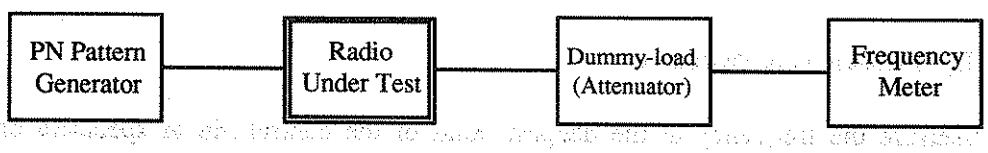
(b) Adjust the frequency of the RF signal generator-2 to stop Lissajous Figure (on the oscilloscope screen) which formed by the mixed-down signal and output signal of the RF signal generator-2.

(c) Measure the frequencies of the RF signal generator-1 and -2, F1 and F2, by the frequency counter , then compute the test frequency F by the following formula ;

$F = F1 + F2$

IV. Frequency Tolerance (Phase Locus Method)

(A) Test Set-up



(B) Test Equipment Requirements/Conditions

The frequency meter is to be a frequency measuring equipment described in (8) "Modulation Accuracy".

(C) State of Radio Under Test

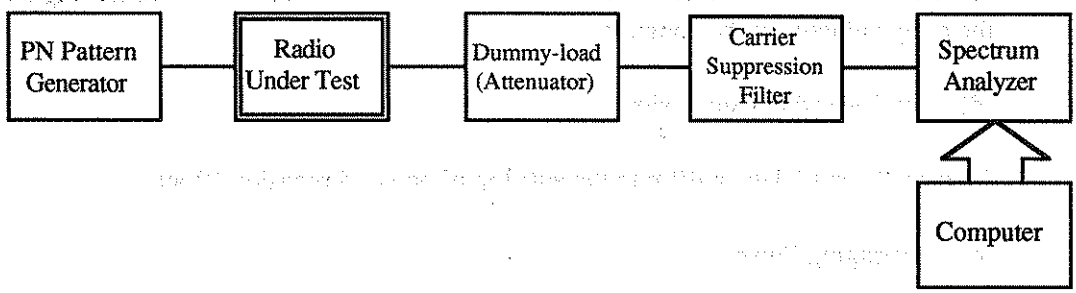
Set the radio under test for transmission at the test frequency.

(D) Measurement Procedures

Measure the output frequency of the radio under test by the frequency meter.

(2) Strength of Spurious Emission

(A) Test Set-up



(B) Test Equipment Requirements/Conditions

(a) Use the carrier suppression filter as required. Attenuation at the carrier frequency is to be 30 dB or more.

(b) A digital storage type spectrum analyzer is to be used.

(c) Setting of spectrum analyzer is as follows:

- Center frequency — Spurious frequency
- Sweep frequency bandwidth — 0 Hz
- Resolution bandwidth — 30 kHz
- Video bandwidth — Same as resolution bandwidth
- Y-axis scale — 10 dB/div.
- Input level — 70 ~ 90% of full scale for the maximum amplitude.
- Sweep mode — Single sweep
- Trigger mode — Free-run or Video-trigger (Adjustment may be needed though generally positive voltage)
- Sweep time — 27 ms or less
- Detect mode — Sample mode

(C) State of Radio Under Test

Set the radio under test for transmission at the test frequency.

(D) Measurement Procedures

(a) Center Frequency Setting

Set the center frequency of the spectrum analyzer at the spurious frequency.

(b) Measurement of Power Distribution

Measure the power distribution by the spectrum analyzer with single sweep.

(c) Data Reading

After the sweep is finished, read the sampled data in and out of the measuring slot into the array valuable in the computer.

(d) Antilogarithm Conversion

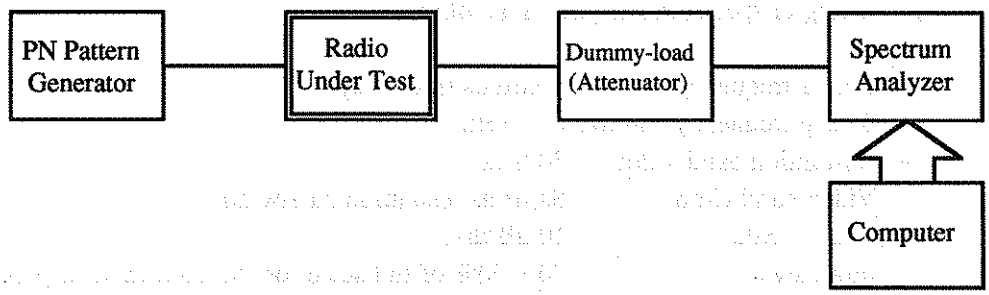
Convert the read data in dBm to the anti-log of power dimension (Watt)

(e) Averaging Power

Compute average powers from the converted data in and out of the measuring slot separately. Sampling intervals are the reciprocal of twice of the frequency difference between outer subcarriers (36 kHz), or less.

(3) Occupied Bandwidth

(A) Test Set-up



(B) Test Equipment Requirements/Conditions

(a) A digital storage type spectrum analyzer is to be used.

(b) Setting of spectrum analyzer is as follows:

- Center frequency Carrier frequency

- Sweep frequency bandwidth Approx. 75 kHz
- Resolution bandwidth Approx. 100 Hz
- Video bandwidth Same as resolution bandwidth
- Y-axis scale 10 dB/div.
- Input level Carrier signal level to be at least 50dB higher than internal noise of spectrum analyzer
- Sampling points 400 points or more.(e.g. 1001 points)
- Sweep time Smaller time as far as measurement error is negligible
- Detect mode Positive peak
- Sweep mode Single sweep

(c) The computer internal or external to the spectrum analyzer is to process the data measured by the spectrum analyzer.

(d) Data transmission rate is adjusted to the specification of the radio under test.

(C) State of Radio Under Test

Set the radio under test for transmission at the test frequency.

(D) Measurement Procedures

(a) Measurement

Measure the power distribution by the spectrum analyzer with single sweep.

(b) Data Reading

After the sweep is finished, read the sampled data in and out the measuring slot into the array valuable in the computer.

(c) Antilogarithm Conversion

Convert the read data in dBm to the anti-log of power dimension (may be relative numbers).

(d) Total Power Computation

Sum up all of the converted sample data, and save it as the total power.

(e) Compute the Lower Limit Frequency

Sum up the converted sample data successively upwards from the lowest frequency point, and find the sample point where the sum reaches 0.5% of the total power. Convert the sample point to the frequency and save it as the lower limit frequency.

(f) Compute the Upper Limit Frequency

Sum up the converted sample data successively downwards from the highest frequency point, and find the sample point where the sum reaches 0.5% of the total power. Convert the sample point to the frequency and save it as the upper limit frequency.

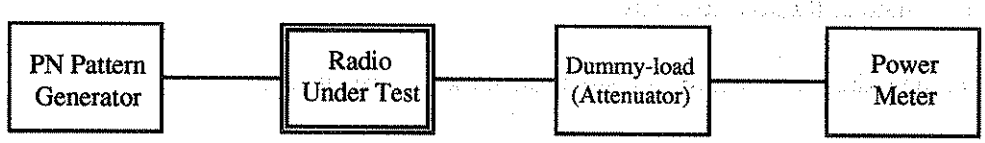
(g) Compute the Occupied Bandwidth

Compute the Occupied Bandwidth as "Upper Limit Frequency" - "Lower Limit Frequency".

(4) Antenna Power Tolerance

I. Antenna Power Tolerance (I)

(A) Test Set-up



(B) Test Equipment Requirements/Conditions

(C) State of Radio Under Test

Set the radio under test for transmission at the test frequency.

(D) Measurement Procedures

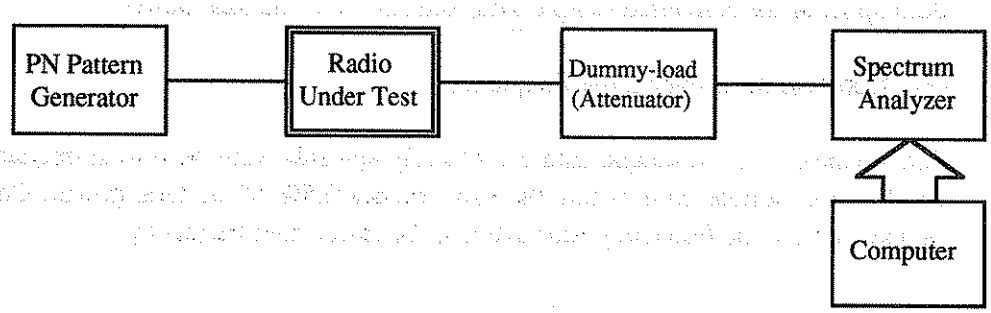
(a) Measure the power (Pm) by the power meter for sufficiently long time.

(b) The average power of the base station is :

P = Pm

II. Antenna Power Tolerance (II)

(A) Test Set-up



(B) Test Equipment Requirements/Conditions

(a) A digital storage type spectrum analyzer is to be used.

(b) Setting of spectrum analyzer is as follows:

- Center frequency Carrier frequency
- Sweep frequency bandwidth 0 Hz
- Resolution bandwidth Approx. 100 kHz
- Video bandwidth Same as resolution bandwidth
- Y-axis scale 10 dB/div.
- Input level 70 ~ 90% of full scale for the maximum amplitude
- Sweep mode Single sweep
- Trigger mode Free-run
- Sweep time 27 ms or less
- Detect mode Sample mode

(C) State of Radio Under Test

Set the radio under test for transmission at the test frequency.

(D) Measurement Procedures

(a) Measurement

Measure the power distribution by the spectrum analyzer with single sweep.

(b) Data Reading

After the sweep is finished, read the sampled data in the sweep segment into the array valuable in the computer.

(c) Antilogarithm Conversion

Convert the read data in dBm to the anti-log of power dimension (may be relative numbers).

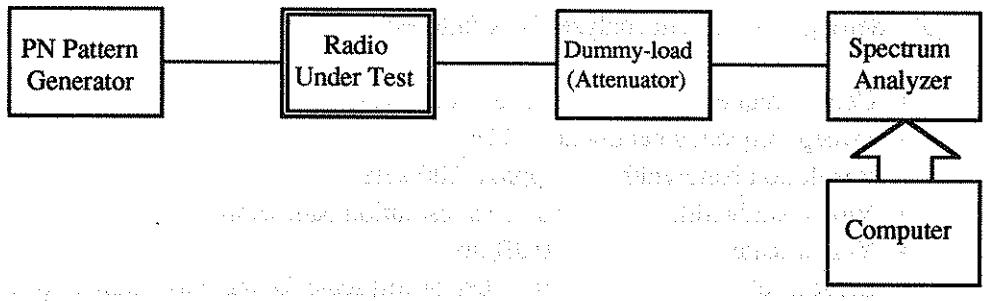
(d) Compute Power

Compute the average of the converted data for the average power.

Sampling interval is the reciprocal of twice of the frequency difference between outer subcarriers (36 kHz), or less.

(5) Adjacent Channel Coupled Power

(A) Test Set-up



(B) Test Equipment Requirements/Conditions

(a) A digital storage type spectrum analyzer is to be used.

(b) Setting of spectrum analyzer is as follows:

• Center frequency	Carrier frequency
• Sweep frequency bandwidth	Approx. 100 kHz
• Resolution bandwidth	Approx. 1 kHz
• Video bandwidth	3 times of resolution bandwidth
• Y-axis scale	10 dB/div.
• Sampling points	400 points or more (e.g. 1001 points)
• Sweep time	Smaller time as far as measurement error is negligible
• Input level	Around the max. linear region of the mixer internal to the spectrum analyzer. (e.g. -10 dBm ~ -30 dBm)
• Display mode	Max. Hold
• Detect mode	Positive peak
• Sweep mode	Single sweep

(c) The computer internal or external to the spectrum analyzer is to process the data measured by the spectrum analyzer.

(C) State of Radio Under Test

Set the radio under test for transmission at the test frequency.

(D) Measurement Procedures

(a) After the sweep is finished, read all of the sampled data into the array variable in the computer.

(b) Convert all of the data in dBm to the anti-log of power dimension (may be relative numbers).

(c) Sum up all of the converted data, and save it as the total power (Pc).

(d) Compute the Upper Adjacent Channel Coupled Power (Pu)

- Read all of the sampled data, which fall into the specified bandwidth (18 kHz) centering at +25 kHz (channel spacing) away from the carrier, into the array variable in the computer.
- Convert all of the data in dBm to the anti-log of power dimension, then sum them up (Pu) .

(e) Compute the Lower Adjacent Channel Coupled Power (Pl)

- Read all of the sampled data, which fall into the specified bandwidth (18 kHz) centering at -25 kHz (channel spacing) away from the carrier, into the array variable in the computer.
- Convert all of the data in dBm to the anti-log of power dimension, then sum them up (Pl) .

(f) Get the measurement results by the following formulas ;

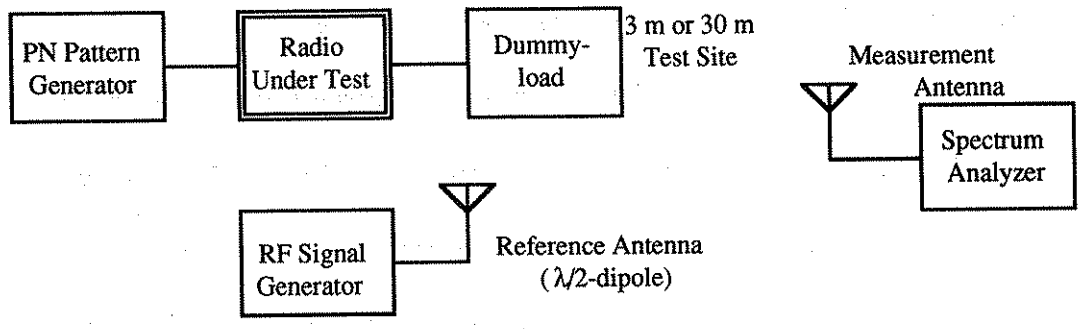
Upper Adjacent Channel Coupled Power Ratio = 10 log (Pc/Pu)

Lower Adjacent Channel Coupled Power Ratio = 10 log (Pc/Pl)

The results are expressed in dB.

(6) Radiated Spurious Emission

(A) Test Set-up



(B) Test Equipment Requirements/Conditions

(a) Terminate antenna terminal of the radio under test with dummy load.

(b) Take measurements at an open test site in accordance with IEC Pub. 489-6 Appendix K if one edge of the radio housing exceeds 60 cm or if the measurement frequency is less

than 100 MHz. Otherwise, take measurements at an open test site in accordance with Appendix K or L.

(c) At frequencies 300 MHz or higher, it is best to suppress any ground reflected waves in order to avoid any trouble caused by increased complexity of the height pattern. For this, the measurement antenna is of high directivity and the height of the radio under test is as high as possible. If ground reflected waves cannot be suppressed adequately, arrange a shielding curtain around the center, or deploy a radio wave absorber.

(C) State of Radio Under Test

Set the radio under test for transmission at the test frequency.

(D) Measurement Procedures

(a) Set the radio under test on a rotating stand and check if any spectrum within a specified frequency range.

(b) Tune the spectrum analyzer with one given frequency component from the spectrum ascertained in (a).

(c) Vertically polarize the measurement antenna.

(d) Rotate the stand and obtain the maximum reading of the spurious power.

(e) Vary the measurement antenna height between 1 meter to 4 meters above the ground for the maximum reading of the spurious power .

(f) Repeat Steps (d) and (e) until the maximum reading does not increase any more, and record the frequency, the maximum reading of the spurious power and measurement antenna height at this point.

(g) Horizontally polarize the measurement antenna, and repeat steps (d) - (f).

(h) Perform steps (b) - (g) for all the frequency components determined in step (a).

(i) Replace the radio under test with a reference antenna fed by an RF signal generator.

(j) Tune the reference antenna to the frequency component measured in step (f).

(k) Vertically polarize both the reference antenna and the measurement antenna.

(l) Vary the measurement antenna height between 1 meter and 4 meters above the ground and adjust the output level of the RF signal generator so that the maximum reading of the spectrum analyzer obtained during this antenna adjustment matches the maximum value obtained in step (f). Record the output level of the RF signal generator and the height of the measurement antenna at this point.

(m) Horizontally polarize both the reference antenna and the measurement antenna and repeat step (l).

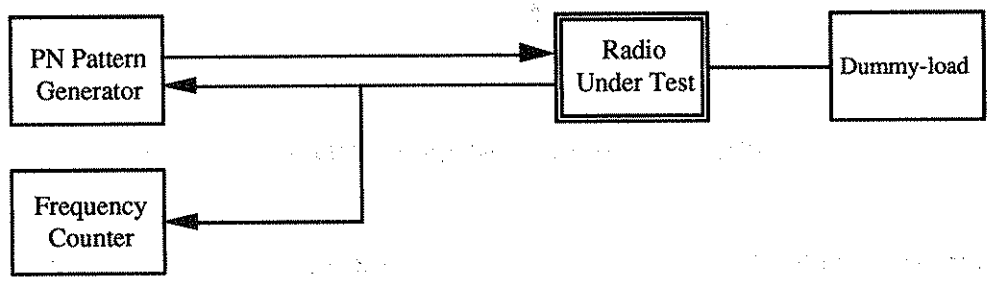
(n) Repeat steps (j) - (m) for all frequency components measured up to step (m).

(E) Computation of Results

The radiated spurious emission is the sum of the output levels of the RF signal generator as obtained in procedure (d), the gain of the reference antenna and the correction for the cable loss between the RF signal generator and the reference antenna.

(7) Accuracy of Data Transmission Rate

(A) Test Set-up



(B) Test Equipment Requirements/Conditions

A frequency counter is to have the resolution one digit higher than the specification of the data transmission rate (clock frequency tolerance).

(C) State of Radio Under Test

Set the radio under test for transmission at the test frequency.

(D) Measurement Procedures

Measure the clock frequency of the radio under test.

(E) Computation of Results

Compute the deviation of the measurement in procedure (D) to the nominal value.

(8) Modulation Accuracy

(A) Definition of the Modulation Accuracy

If the ideal transmitter output signal is passed through the ideal receive root roll-off filter, then each symbol of the signal is sampled at ideal timing, there is no symbol interference among symbols. However, in an actual transmitter output signal, symbol interference among symbols occurs because the transmission path deviates from the ideal characteristics. The modulation

accuracy can be obtained by measuring symbol errors caused by symbol interference. Fig. 6.2-1 illustrates such symbol errors.

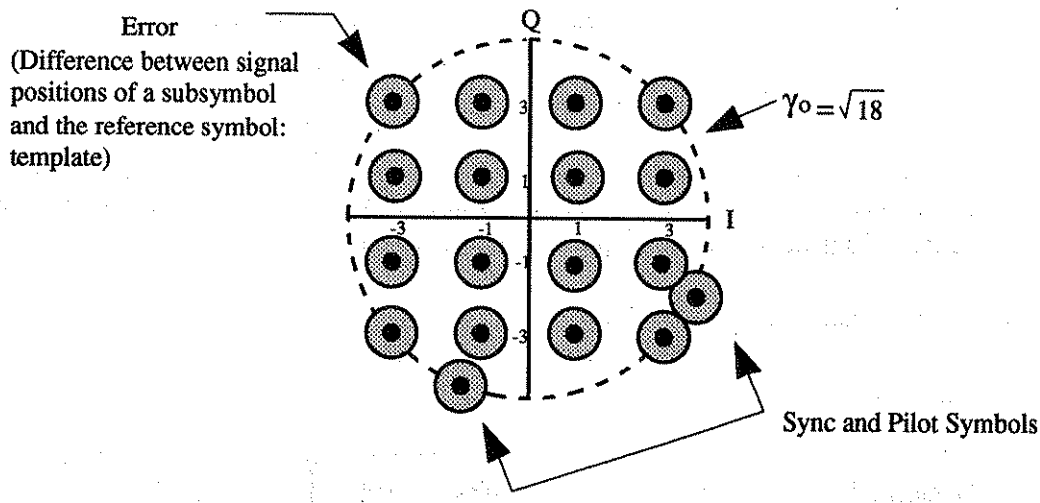


Fig. 6.2-1 Signal Constellation Diagram

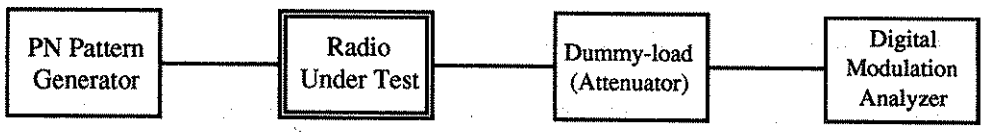
The formula defining the modulation accuracy is shown below ;

$$\varepsilon = \frac{\sqrt{\frac{1}{N}\sum_{i=1}^{N}\left|V_{mi}\,\alpha\exp(j\phi) - V_i - V_0\right|^2}}{\gamma_0} \times 100\%$$

where ; i : Subsymbol number
N : Total number of subsymbol for the measurement
V_{mi} : Vector of i-th subsymbol
Vi : Reference Symbol vector determined by the i-th subsymbol
V_o : Origin offset level
α : Gain parameter (scalar value)
ϕ : Phase parameter (scalar value)
γ_o : Maximum magnitude of the Signal Constellation Diagram ($\sqrt{18}$).

Unknown parameters V_o, α, and ϕ are chosen for the minimum value of the modulation accuracy ε given by the above formula.

(B) Test set-up



(C) Test Equipment Requirements/Conditions

The digital modulation analyzer is to have a function of the receive root roll-off filter, and have capability to measure the root mean square of the difference between actually transmitted signal and the reference symbols.

(D) State of Radio Under Test

Set the radio under test for transmission at the test frequency.

(E) Measurement Procedures

(a) Measure the error on each subsymbol which is the difference between reference and actually transmitted subsymbol positions on the signal constellation plane.

(b) Sum up square of all errors obtained in (a), divide it by the number of subsymbols contained in four subchannels (or number of measured subsymbols), then get its square root. The total number of subsymbols is to be 240.

(9) Subcarrier Frequency Tolerance

I. Frequency Tolerance (Frequency Counter Method)

(A) Test Set-up

Same as (1) I. "Frequency Tolerance (Frequency Counter Method)".

(B) Test Equipment Requirements/Conditions

(a) A frequency counter is to be used as a frequency meter.

(b) The frequency counter has an accuracy to within one-tenth of the frequency tolerance specification by calibrating with a known frequency, or by mixing down the input signal with a known frequency.

(C) State of Radio Under Test

(a) Set the radio under test in a test mode which outputs an unmodulated signal from only one of the four subcarriers at a time, but any of the four subcarriers can be selected.

(b) Set the radio under test for transmission at the test frequency.

(D) Measurement Procedures

Measure the frequency after warm-up time elapsed.

(E) Other Methods

The frequency of a reference oscillator output can be measured directly if a radio under test is designed such that the frequency accuracy of the reference oscillator is equal to the frequency accuracy of the transmitter output.

II. Frequency Tolerance (Phase Locus Method)

(A) Test Set-up

Same as (1) IV. "Frequency Tolerance (Phase Locus Method)".

(B) Test Equipment Requirements/Conditions

Same as (1) IV. "Frequency Tolerance (Phase Locus Method)".

(C) State of Radio Under Test

Set the radio under test for transmission at the test frequency.

(D) Measurement Procedures

Measure the four subcarrier frequencies of the output of the radio under test by the frequency meter.

(10) Subsymbol Timing Synchronization

(A) Test Set-up

Same as (8) "Modulation Accuracy".

(B) Test Equipment Requirements/Conditions

The digital modulation analyzer is to be have the function to detect the best symbol synchronization timing of four subcarriers independently, in addition to the functions for the modulation accuracy measurement.

(C) State of Radio Under Test

Set the radio under test for transmission at the test frequency.

(D) Measurement Procedures

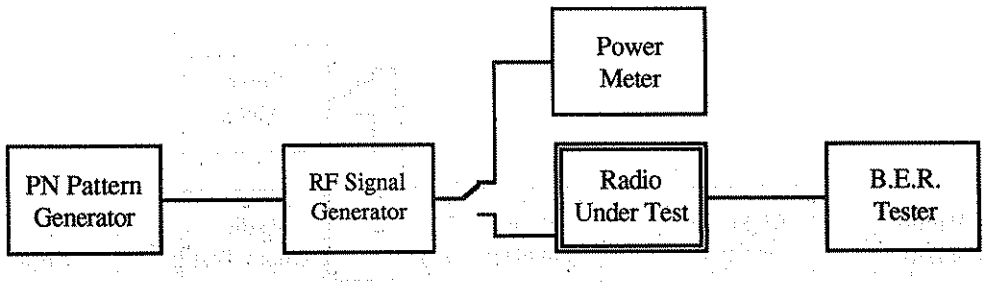
Compute the timing differences among the symbol synchronization timings detected on each subcarrier independently.

6.2.2 Receiver

(1) Receiver Sensitivity

I. Receiver Sensitivity (Static)

(A) Test Set-up



(B) Test Equipment Requirements/Conditions

(a) RF Signal Generator.

• Frequency	Specified frequency range
• Stability	Within $\pm 5 \times 10^{-8}$
• Modulation accuracy	Within 3% of RMS. vector error (recommended value)
• Modulation Rate	4 kbaud

(b) Pattern Generator

• Clock accuracy	Within $\pm 1 \times 10^{-6}$
• Generated pattern	To continuously generate the standard coded test signals (511-bit Binary Pseudo Random Noise Sequence based on CCITT V.52) in communication channels. As well, must generate specified patterns as required for communication in other channels.

(C) State of Radio Under Test

(a) Set the radio under test for reception at the test frequency.

(b) Demodulation data is to be communication channel portions (the standard coded test signal portions).

(D) Measurement Procedures

(a) Set the frequency of the RF signal generator to the test frequency.

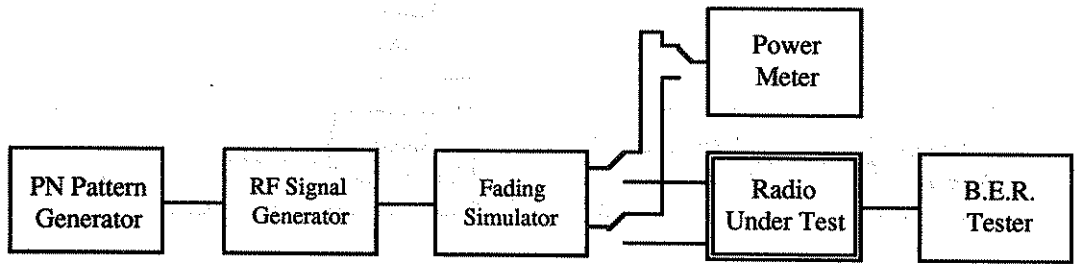
(b) RF signal generator is to transmit continuously or a burst. With the power meter, adjust the RF signal generator output to obtain a signal level equal to the standard sensitivity level (static). Then, change switches and apply the signal to the radio under test.

(c) With the BER(bit error rate) tester, accumulate the bit stream in the communication channels and measure the bit error rate for at least 2556 bits.

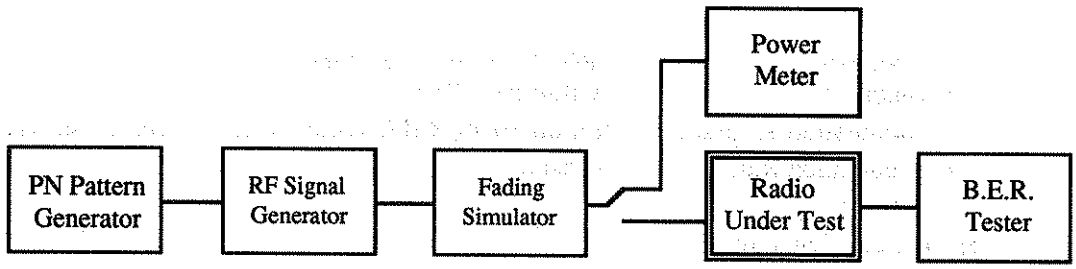
II. Receiver Sensitivity (Faded)

(A) Test Set-up

(a) With Diversity



(b) Without Diversity



(B) Test Equipment Requirements/Conditions

(a) RF Signal Generator.

• Frequency	Specified frequency range
• Stability	Within $\pm 5 \times 10^{-8}$
• Modulation accuracy	Within 3% of RMS. vector error (recommended value)
• Modulation rate	4 kbaud

(b) Pattern Generator.

• Clock accuracy	Within $\pm 1 \times 10^{-6}$
• Generated pattern	To continuously generate the standard coded test signals (511-bit Binary Pseudo Random Noise Sequence based on CCITT V.52) in communication channels. As well, must generate specified patterns as required for communication in other channels.

(c) Fading Simulator

In accordance with IEC Pub. 489-6 Appendix C. Maximum Doppler frequency is to be 40 Hz (800 MHz band) and 70 Hz (1.5 GHz band) of Rayleigh fading

(C) State of Radio Under Test

(a) Set the radio under test for reception at the test frequency.

(b) Demodulation data is to be user specific channel portions (the standard coded test signal portions).

(D) Measurement Procedures

(a) Set the frequency of the RF signal generator to the test frequency.

(b) RF signal generator is to transmit continuously or a burst. With the power meter, adjust the RF signal generator output to obtain a signal level equal to the standard sensitivity level (mean value with fading). Then, change switches and apply the signal to the radio under test.

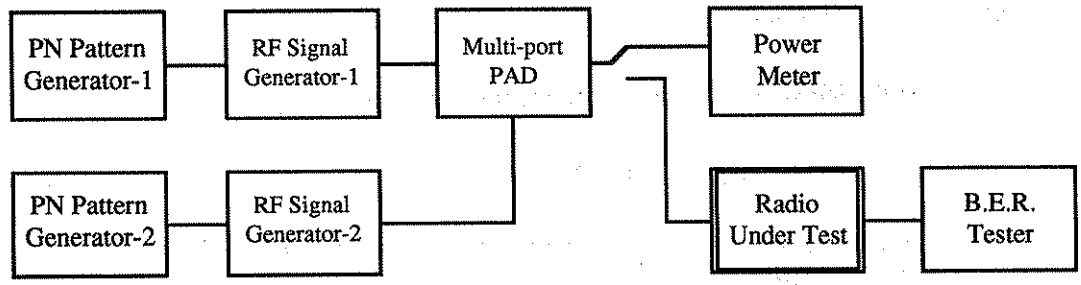
(c) With the BER (bit error rate) tester, accumulate the bit strings in the communication channels and measure the bit error rate at minimum for the larger of 2556 bits or :

$$\frac{43{,}200 \times \text{Bit Rate (bps)}}{\text{Vehicle Speed (km/h)} \times \text{Test Frequency (MHz)}}$$

Bit Rate (bps) : 64,000

(2) Spurious Response

(A) Test Set-up



(B) Test Equipment Requirements/Conditions

(a) RF Signal Generator-1 and -2

• Frequency	Specified frequency range
• Stability	Within $\pm 5 \times 10^{-8}$
• Modulation accuracy	Within 3% of RMS. vector error (recommended value)
• Modulation rate	4 kbaud

- Adjacent channel coupled power — 86 dB or greater at ± 50 kHz off (recommended value)
  87 dB or greater at ± 100 kHz off (recommended value)

(b) Pattern Generator-1

- Clock accuracy — Within $\pm 1 \times 10^{-6}$
- Generated pattern — To continuously generate the standard coded test signals (511-bit Binary Pseudo Random Noise Sequence based on CCITT V.52) in communication channels. As well, must generate specified patterns as required for communication in other channels.

(c) Pattern Generator-2

- Clock accuracy — Within $\pm 1 \times 10^{-6}$
- Generated pattern — To continuously generate digital signals (32,767-bit Binary Pseudo Random Noise Sequence based on CCITT O.151).

(C) State of Radio Under Test

(a) Set the radio under test for reception at the test frequency.

(b) Demodulation data is to be communication channel portions (standard coded test signal portions).

(D) Measurement Procedures

(a) Set the RF signal generator-1 to the test frequency.

(b) Set the RF signal generator-2 to the spurious frequency (*).

(c) RF signal generator-1 is to transmit continuously or a burst. With the power meter, adjust the output of RF signal generator-1 to obtain a signal level equal to [standard sensitivity + 3 dB].

(d) RF signal generator-2 is to transmit continuously or a burst. With the power meter, adjust the output of RF signal generator-2 to obtain a signal level equal to :

(standard sensitivity + 3 dB) + (spurious response specification) [dBμ]

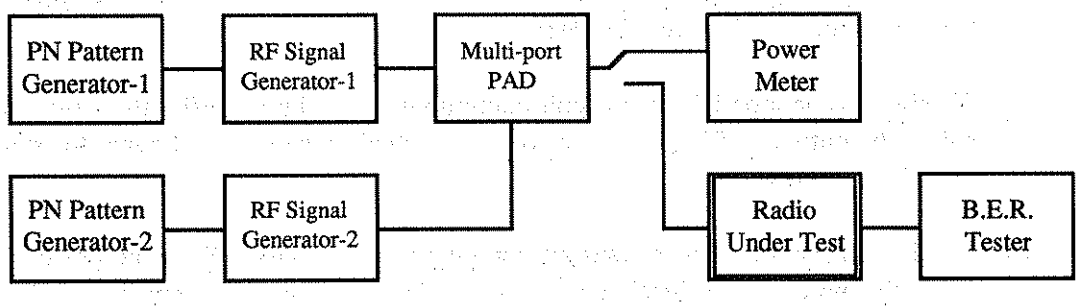
Then, change switches and apply the signal to the radio under test.

(e) With the BER(bit error rate) tester, accumulate the bit strings in the communication channels and measure the bit error rate for at least 2556 bits.

(*) Spurious frequency is the frequency of undesired signals which degrade a bit error rate and must be ascertained. As one method of measuring this, use a receiver capable of receiving IF frequencies and specify the spurious frequency from the IF level of the radio under test.

(3) Adjacent Channel Selectivity

(A) Test Set-up



(B) Test Equipment Requirements/Conditions

(a) RF Signal Generator-1 and -2

• Frequency	Specified frequency range
• Stability	Within $\pm 5 \times 10^{-8}$
• Modulation accuracy	Within 3% of RMS. vector error (recommended value)
• Modulation rate	4 kbaud
• Adjacent channel coupled power	75 dB or greater at $\pm$ 25 kHz off (recommended value)

(b) Pattern Generator-1

• Clock accuracy	Within $\pm 1 \times 10^{-6}$
• Generated pattern	To continuously generate the standard coded test signals (511-bit Binary Pseudo Random Noise Sequence based on CCITT V.52) in communication channels. As well, must generate specified patterns as required for communication in other channels.

(c) Pattern Generator-2

• Clock accuracy	Within $\pm 1 \times 10^{-6}$
• Generated pattern	To continuously generate digital signals (32,767 -bit Binary Pseudo Random Noise Sequence based on CCITT O.151).

(C) State of Radio Under Test

(a) Set the radio under test for reception at the test frequency.

(b) Demodulation data is to be communication channel portions (standard coded test signal portions).

(D) Measurement Procedures

(a) Set the frequency of the RF signal generator-1 to the test frequency.

(b) Set the frequency of the RF signal generator-2 to the adjacent channel frequency of the test frequency [+25 kHz (or -25 kHz)].

(c) RF signal generator-1 is to transmit continuously or a burst. With the power meter, adjust the output of RF signal generator-1 to obtain a signal level equal to [standard sensitivity + 3 dB].

(d) RF signal generator-2 is to transmit continuously or a burst. With the power meter, adjust the output of RF signal generator-2 to obtain a signal level equal to :

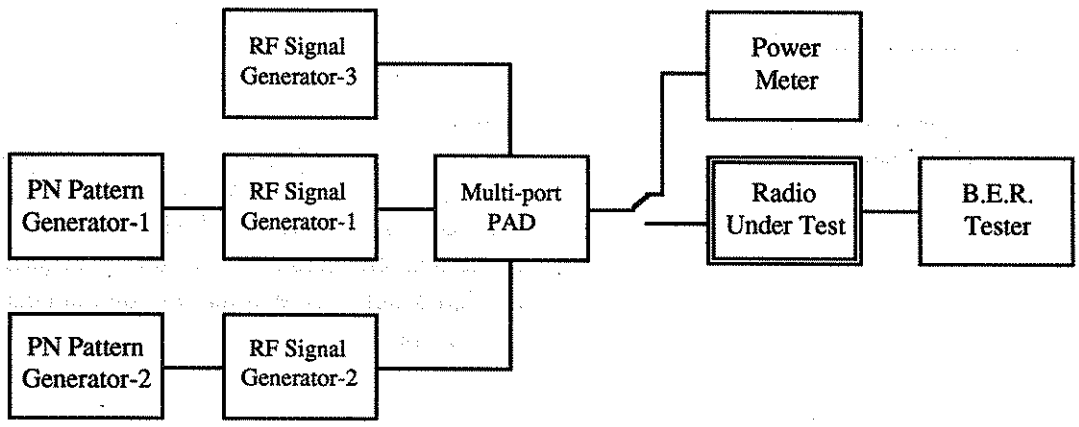
(standard sensitivity + 3 dB) + (adjacent channel selectivity specification) [dBμ]

Then, change switches and apply the signal to the radio under test.

(e) With the BER(bit error rate) tester, accumulate the bit strings in the communication channels and measure the bit error rate for at least 2556 bits.

(4) Intermodulation Characteristics

(A) Test Set-up



(B) Test Equipment Requirements/Conditions

(a) RF Signal Generator-1 and -2

• Frequency	Specified frequency range
• Stability	Within $\pm 5 \times 10^{-8}$
• Modulation accuracy	Within 3% of RMS. vector error (recommended value)
• Modulation rate	4 kbaud
• Adjacent channel coupled power	87 dB or greater at ±100 kHz off (recommended value)

(b) RF Signal Generator-3

• Frequency	Specified frequency range
• Stability	Within $\pm 5 \times 10^{-8}$
• Adjacent channel coupled power	93 dB or greater at ±50 kHz off (recommended value)

(c) Pattern Generator-1

• Clock accuracy	Within $\pm 1 \times 10^{-6}$
• Generated pattern	To continuously generate the standard coded test signals (511-bit Binary Pseudo Random Noise Sequence based on CCITT V.52) in communication channels. As well, must generate specified patterns as required for communication in other channels.

(d) Pattern Generator-2

• Clock accuracy	Within $\pm 1 \times 10^{-6}$
• Generated pattern	To continuously generate digital signals (32,767 -bit Binary Pseudo Random Noise Sequence based on CCITT O.151).

(C) State of Radio Under Test

(a) Set the radio under test for reception at the test frequency.

(b) Demodulation data is to be communication channel portions (standard coded test signal portions).

(D) Measurement Procedures

(a) Set the frequency of the RF signal generator-1 to the test frequency.

(b) Set the frequency of the RF signal generator-3 to the test frequency +50 kHz (or -50 kHz), and that of the RF signal generator-2 to the test frequency +100 kHz (or -100 kHz).

(c) RF signal generator-1 is to transmit continuously or a burst. With the power meter, adjust the output of RF signal generator-1 to the level equal to [standard sensitivity + 3 dB].

(d) RF signal generator-3 is to transmit continuously or a burst with unmodulated signal and RF signal generator-2 is to transmit continuously. With the power meter, adjust the outputs of RF signal generator-2 and -3 to the level equal to :

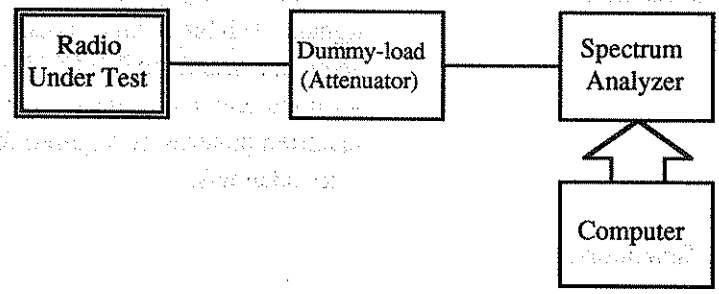
(standard sensitivity + 3 dB) + (intermodulation characteristic specification) [dBμ]

Then, change switches and apply the signal to the radio under test.

(e) With the BER(bit error rate) tester, accumulate the bit strings in the communication channels and measure the bit error rate for at least 2556 bits.

(5) Conducted Spurious Emission

(A) Test Set-up



(B) Test Equipment Requirements/Conditions

(a) Attenuation of the dummy load (attenuator) is to be approx. 20 dB.

(b) Setting of spectrum analyzer is as follows:

• Center frequency	Conducted spurious frequency
• Sweep frequency bandwidth	0 Hz
• Resolution bandwidth	Approx. 100 kHz
• Video bandwidth	Same as resolution bandwidth
• Y-axis scale	10 dB/div.
• Input level	70 ~ 90 % of full scale for the maximum amplitude; or as large as possible if the amplitude is small.
• Sweep mode	Single sweep
• Sweep time	27 ms or less
• Detect mode	Sample mode

(C) State of Radio Under Test

Set the radio under test in reception mode and able to receive at the test frequency.

(D) Measurement Procedures

(a) Conducted Spurious Search

Set up the spectrum analyzer for search operation, ascertain the conducted spurious components within the specified frequency band, then save them.

(b) Center Frequency Setting

Set up the spectrum analyzer for strength (power) measurement, then set the center frequency of the spectrum analyzer at the conducted spurious frequency.

(c) Measurement of Power Distribution

Measure the power distribution by the spectrum analyzer with single sweep.

(d) Data Reading

After sweep is finished, read the sampled data into the array variables of the computer. For burst emission, include all sampled data within a burst segment; for a continuous emission, include all sampled data within the sweep segment.

(e) Antilogarithm Conversion

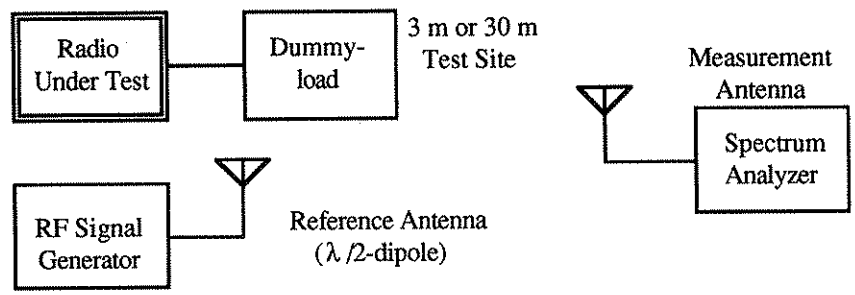
Convert the read data in dBm to the anti-log of power dimension (Watt)

(f) Averaging Power

Average the converted anti-log data to obtain average power values. For burst emission, data within bursts are averaged; for a continuous emission data within sweep segments are averaged. Sampling intervals are the reciprocal of twice of the frequency difference between outer subcarriers (36 kHz), or less.

(6) Radiated Spurious Emission

(A) Test Set-up



(B) Test Equipment Requirements/Conditions

Same as 6.2.1 (6) "Radiated Spurious Emission(Transmitter) (B)"

(C) State of Radio Under Test

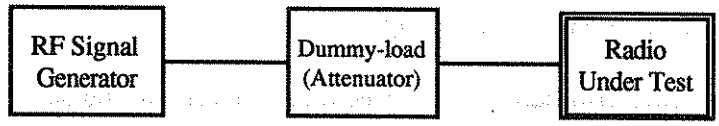
Set the radio under test for reception at the test frequency.

(D) Measurement Procedures

Same as 6.2.1 (6) "Radiated Spurious Emission(Transmitter) (D)"

(7) Burst Reception Timing

(A) Test Set-up



(B) Test Equipment Requirements/Conditions

The RF signal generator must be capable to simulate a mobile station to the radio under test. The RF signal generator is capable to generate a subslot burst signal and its timing can be changed with respect to the reference timing for the burst reception by changing particular parameters.

(C) State of Radio Under Test

Set the radio under test in normal operation.

(D) Measurement Procedures

The subslot burst signal generated with the RF signal generator is applied to the radio under test, then the burst timing is changed with respect to the reference timing for the burst reception. Ascertain the normal reception of the burst signal.

Chapter 7 Glossary

Associated Control Channel (ACCH)	A signaling path embedded in a traffic channel.
ARQ	Automatic Repeat Request. Commonly used to refer to any scheme which uses positive and/or negative acknowledgments to enhance transmission reliability.
C/I+N	It is the Carrier/ (Interference + Noise) and shows the quality of radio carrier.
Cell	An area of radio coverage, within which service is available.
Central Base Station	The base station with control equipments for FNE functions, such as handover.
Channel	A logically grouped set of slots allocated for a particular use.
Channel Specifier	An 8-bit field which identifies a channel by specifying its interleave and offset.
Client Message or Client Message Unit	The data transferred by a particular layer on behalf of its upper layer client.
CRC	Cyclic Redundancy Check. A type of error-detection coding.
Data Subchannel Symbol (DSS)	A complex symbol in one of the four M-QAM subchannels taken from the QAM constellation. One DSS is comprised of two RS and transmits four bits of information.
Dedicated Control Channel (DCCH)	A channel assigned by call control, used for call control, management, and user data signaling.
Extended Slot Number (xSN)	An integer in the range [0..7,741,440 - 1] which numbers slots within the hyperframe.
FEC	Forward Error Correction.
Frame	A structure which is imposed on the stream of symbols. It is associated with the MAC sublayer. It consists of 30,240 slots.
Frame Number	An integer in the range [0..255] which numbers frames within the hyperframe.
Inbound	From subscriber unit to FNE.

Inbound Frame	The frame structure in the inbound direction.
Inbound Slot	A slot in the inbound frame.
Interleave	A value which, together with offset, identifies a channel in the frame.
L3 Control	The Layer 3 entity which controls mobile station access to traffic channels and dedicated control channels.
Mobile Station (MS)	A mobile or portable radio. The RF interface connects MSs to the FNE.
Normal Transmission Unit (NTU)	A block of 342 RS which appears in outbound slots and inbound reserved access bursts.
Offset	A value which, together with Interleave, identifies a channel in the frame.
Outbound	From FNE to subscriber unit.
Outbound Frame	The frame structure in the outbound direction.
Outbound slot	A slot in the outbound frame.
Primary Control Channel (PCCH)	A channel used for call control signaling which provides for random access to the cell.
Pilot Sequence	A particular sequence of pilot subchannel symbols which is inserted into a transmitted stream to provide phase and amplitude reference.
Pilot Subchannel Symbol (PSS)	A single complex symbol in one of the four M-QAM subchannels used to measure channel amplitude and phase.
Protocol Data Unit (PDU)	A data packet exchanged by peer protocol entities.
Protocol Transmission Unit (PTU)	One or more PDUs with error detection and correction applied, ready for transmission over the channel.
QAM	Quadrature Amplitude Modulation. A modulation scheme that comprises two AM signals sent in quadrature.
Random Access Burst	An inbound transmission in a random access subslot.
Random Access Subslot	A 7.5 ms subslot in the inbound frame which provides access for mobile stations and control stations which are not time-synchronized.

Real Symbol (RS)	One of four values produced by the AM mapper in a subchannel modulator. Each real symbol has two bits of information. This is the minimal element of information in the M-QAM modulation scheme.
Reserved Access Burst	An inbound transmission in a reserved access subslot.
Reserved Access Slot	An inbound slot which is reserved for use by a particular mobile station which has been time synchronized.
Slot Descriptor Block (SDB)	An element of the outbound frame which provides information about the assignment and use of the associated slot.
Short Message Service (SMS)	A service for short messages transmission between users.
Short Transmission Unit (STU)	A block of 104 RS which appears in inbound random access bursts.
Slot	A logical pair of Inbound and outbound slots which forms a TDM-duplex path.
Slot Number (SN)	A value in the range [0..30,240 - 1] which numbers slots within a frame.
Subchannel Symbol (SS)	A complex symbol in one of the four M-QAM subchannels It is composed of two RSs and 4 bit-information.
Symbol	A single point in signal space. Each symbol comprises four subchannel symbols. It is composed of 4 SSs or 8 RSs and has 16 bits information.
Sync Pattern	A pattern of three symbols that is inserted into the transmitted stream to provide time reference.
Sync Subchannel Symbol (SSS)	A single complex symbol in one of the four M-QAM subchannels used to synthesize the sync pattern.
Talker	The mobile station assigned the channel and in the state available for communication.
Temporary Control Channel (TCCH)	A channel used for random access call control signaling on a channel which is normally reserved access.
Traffic Channel (TCH)	A channel assigned by call control for transfer of user data and voice.

Application of AGC Preamble Signal for Phase Control of a Linearizer

As the digital MCA system adopts the large zone configuration, the interference by a mobile station locating near the base station to a mobile station locating far from the base station becomes more significant. Coping with these problems, this standard specification specified the adjacent channel coupled power as -55 dB or less. To meet this, it is necessary to set the design goal of the radio equipment design around -60 dB, accordingly a linearizer is considered to be required.

To achieve -60 dB of the adjacent channel power with current technology level, the Cartesian loop may be the common method to realize. The linearizer needs to operate over all power control range since non-linear distortion is caused at both large and small amplitude when a power amplifier with class A or class AB is used for a power ampifier stage.

The problems to implement the Cartecian loop are distortion removal of the detection subsystem and phase control of the feedback subsystem. Especially when phase control of the feedback subsystem is imperfect, instability of the linearizer operation due to cross-coupling of I and Q channels and / or degradation of the linearizer performance due to gain reduction may be resulted even if 6 dB/oct of the correction factor is applied.

As a mobile station of the digital MCA system transmits a burst, the transmission starts under the condition phase relation is not controlled, and the transmission signal must meet the adjacent channel coupled power specification during a burst. One effective method to meet this requirement is to transmit non-modulated carrier signal at the beginning of the transmission. Once the feedback phase is aligned while the non-modulated carrier signal is being transmitted, further phase control is considered not to be required during the successive 15 ms burst transmission.

Consequently, the AGC preamble signal of the mobile station can be used for phase control of such linearizer.

Annex-2

Compensation Method of Fading Distortion

On the radio channels of the land mobile communications like the digital MCA system, the envelop of the received signals varies significantly due to the fading so that the compensation of the fading distortion is required when applying the high efficiency multi-level modulation system transmitting information on the envelop of the signal like the M16QAM to the land mobile communications.

It is the common method to compensate the fading distortion by the followings. At the transmitting end, the signal is transmitted inserting the known symbols (pilot symbols) to measure the fading distortion into the information symbols periodically. At the receiving end, the pilot symbols are extracted from the series of the received symbols, measured the fading distortion at pilot symbol positions, then estimated and compensated the fading distortion at the information symbols based on the measured fading distortion.

In this system, the pilot symbols are to be inserted periodically to recover the reference phase. The accuracy of the reference phase signal directly affects the bit error rate so that the reference phase must be recovered precisely even under the environment the thermal noise and dynamic phase variation of fading exist. The symbol rate is 4 ksps (kilo symbol per second) and the pilot symbols are inserted every 8 symbols, accordingly the frequency of the pilot symbols is 500 Hz. By the sampling theorem, the fading distortion up to 250 Hz can be reproduced precisely if the ideal filter is used and there is no thermal noise.

There may be the following technical choices in implementing the compensation of the fading distortion.

1 Processing Order of the Compensation of the Fading Channel and the Matched Filter

The demodulation of the received signal under the faded environment is composed of the following processes in order ; detecting the frequency offset and the time domain variation of the reference vector, removing them from the received signal, then applying the matched filter. However, this method increases the number of operations, and the following three simplified methods may be considered as alternatives.

(1) All the signals(data and pilot symbols) are matched filtered first, so that the reference vectors are detected from the pilot symbols, then the fading channel is compensated and the received signal is demodulated.

(2) The pilot symbols are matched filtered first to detect the reference vectors (estimation of the fading channel), the fading channel on which the data symbols are sent is compensated, then the received signal is matched filtered and demodulated.

(3) In the method (2), following processes on the pilot symbols are repeated ; matched filtering, reference vector estimation, and fading channel compensation. Then the received signal is demodulated.

The method (1) requires the smallest number of operations so that the sampled data can be compressed with the real time matched filtering, consequently required memory size gets small.

The method (2) has the processing order of the matched filtering on the data symbols after the fading channel compensation so that the better bit error rate is expected, compared to the method (1). However, it requires to store all sampled data within a burst(or slot), accordingly the larger memory size is required.

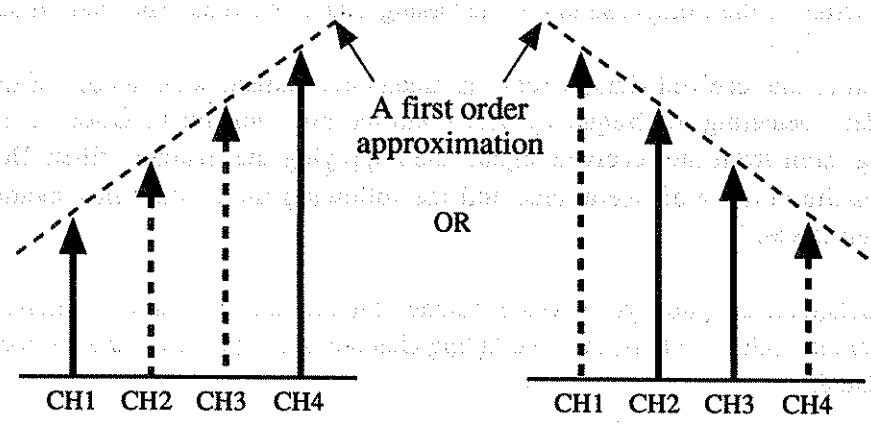
The method (3) requires the largest number of operations but the best performance can be obtained.

2 Pilot Signal Interpolation among Subcarriers

In case of the flat fading, the signal phase of each subcarrier is affected evenly. It is possible to obtain same effect as the pilot symbols are arranged with half of the interval, when transmitting the signal with the pilot symbols arranged as specified in Chapter 4 "Communication Control System" of this standard at the transmission end, and referring the pilot symbols on the adjacent subcarriers at the reception end. Consequently the demodulation performance under flat fading can be improved.

However, in case of the frequency selective fading, the phase correlation among subcarriers degrades from that of the flat fading. The demodulation performance (even at 2.5 μs of R.M.S. delay spread) deteriorates, when referring the pilot symbols on other subcarriers as it is.

One method avoiding this is to interpolate/extrapolate the other two subcarriers by the first order approximation using a pair of pilot symbols arranged on the outer or inner subcarriers of four subcarriers on the frequency domain. Consequently, the reference phase of the other two subcarriers can be presumed.



Pilot Signal Interpolation on the Frequency Domain

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