NXDN®

NXDN Technical Specifications

Part 1:
Air Interface

Sub-part E:
Common Air Interface (Type-D)

NXDN TS 1-E Version 1.1

June 2012

NXDN Forum

Contents

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Copyright © 2007-2012 Icom Incorporated and JVC KENWOOD Corporation

Copyright © 2007-2012 Icom Incorporated and JVC KENWOOD Corporation

Figures

Copyright © 2007-2012 Icom Incorporated and JVC KENWOOD Corporation

Tables

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1. General

1.1. Overview

Common Air Interface (CAI) specification specifies interface of Radio Frequency section of digital mobility. Radio Frequency communication system corresponding to demanding standards of 6.25kHz Spectrum efficiency mainly in 150MHz band and 450MHz band below 512MHz band specified in FCC Part 90.

This is the system for wide range land mobile radio market with feature rich set demanded for SMR and private system mainly for business & industry applications in trunked system by FDMA (Frequency Division Multiple Access) method.

Trunking method includes Dedicated Control Method with dedicated control channel and Distributed Control Method without dedicated control channel, the former of Type-C Trunked System is distinguished from the latter of Type-D Trunked System. And this CAI specification describes specifications of the latter of Type-D Trunked System .

1.2. Scope

NXDN™ Trunked System is made up of Trunking Repeater Site (TRS) and Subscriber Unit (SU).

This specification specifies Radio Frequency section interface in Reference Point – Um shown in Figure 1.2-1 as range of CAI.

The CAI specification does not describe network interface in inter-site connection and interface of Subscriber Unit and peripheral Equipment, etc.

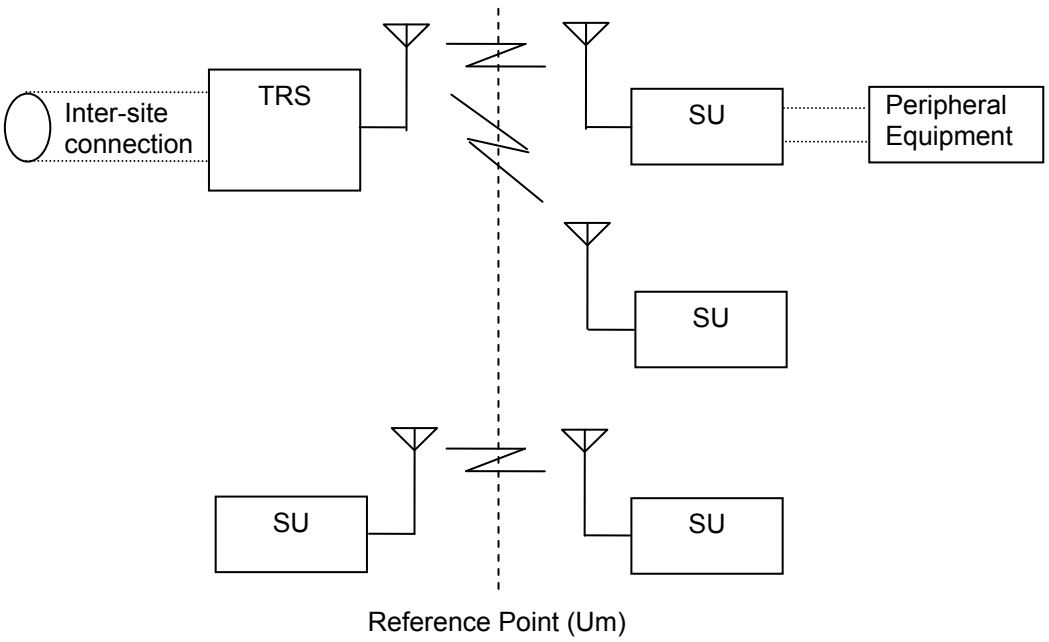

Figure 1.2-1 Reference Point of Radio Interface

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2. System Overview

2.1. System Structure

NXDN™ Trunked System is basically consists of TRS and SU and can perform communication between SU and SU via TRS and between TRS and SU and can directly communicate between SU and SU using Talk Around function of SU. Afterwards communication between SU and SU indicates communication structure via TRS and direct communication between SU and SU indicates communication structure without TRS.

Basic schematic diagram of NXDN™ Trunked System is shown in Figure 2.1-1 and structure elements, system type and line structure will be described after next section.

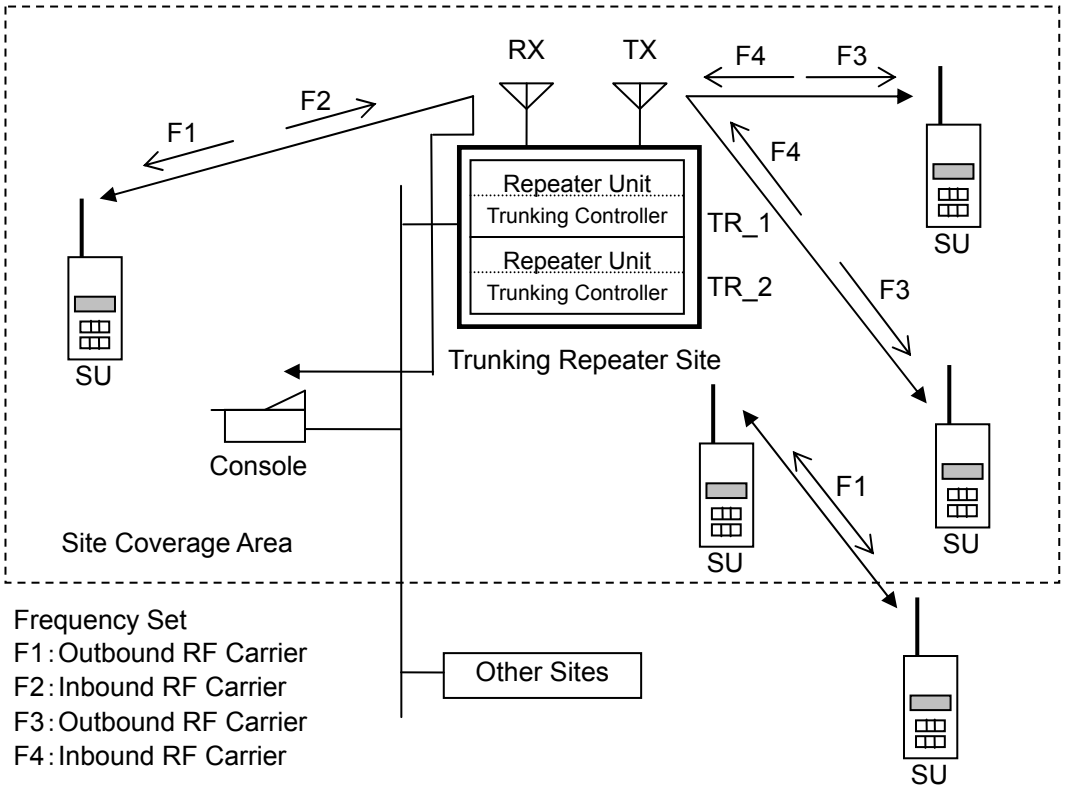

Figure 2.1-1 Basic Concept of NXDN™ Trunked System

A pair wave of Outbound RF Carrier and Inbound RF Carrier is assigned to TRS (F1/F2, F3/F4 of Figure 2.1-1), these pair waves are assigned to Traffic Channel with line control function. And Figure 2.1-1 shows example using frequency of Outbound RF Carrier of TRS (F1) in direct communication between SU and SU using Talk Around function when SU is outside of TRS.

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2.1.1. Elements of System Structure

Elements of NXDN™ Trunked System Structure are defined as below.

Repeater Unit (RU)

Repeater Unit (RU) is consists of receiver and sender that indicates device having function of relaying receiving signal as sending signal by Duplex operation.

Trunking Controller (TC)

Trunking Controller (TC) indicates device having function of managing line control of Radio Frequency communication.

Trunking Repeater (TR)

Trunking Repeater (TR) is consists of Repeater Unit and Trunking Controller and indicates device controlling line and operating communication relaying using two Radio Frequency carriers.

Trunking Repeater Site (TRS)

Trunking Repeater Site (TRS) indicates facility consists of one or more Trunking Repeater and having distributed control function, and performing Radio Frequency communication with SU within the area or relaying Radio Frequency between SU and SU using all Traffic Channels.

Subscriber Unit (SU)

Subscriber Unit (SU) is broadly divided into Mobile Station and Fixed Station as described below.

Mobile Station (MS)

Mobile Station (MS) indicates facility of performing Radio Frequency communication with other SU, which is mobile mainly on land. Mobile Station includes vehicle type Mobile Station and portable type Mobile Station.

Fixed Station (FS)

Fixed Station (FS) indicates fixed facility performing Radio Frequency communication with Mobile Station in order to transmit command to Mobile Station by dispatcher mainly.

Console

Console indicates position controlling system communication or performing system communication, which is connected to TRS. Or Console indicates position commanding communication by dispatcher, which is connected to Fixed Station.

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2.1.2. Structure of Trunked System

Communication of NXDN^{TM} Trunked System is based on Semi Duplex method in communication via TRS between SU and SU and based on Simplex method in direct communication between SU and SU.

Structure of Trunked System is shown in Figure 2.1-2. This TRS is consists of two channels (TR_1 to TR_2) and each of them is Traffic Channel having line control function. The TRS is employed when talking between SU and SU using Talk Around function of SU if SU is outside of area of TRS.

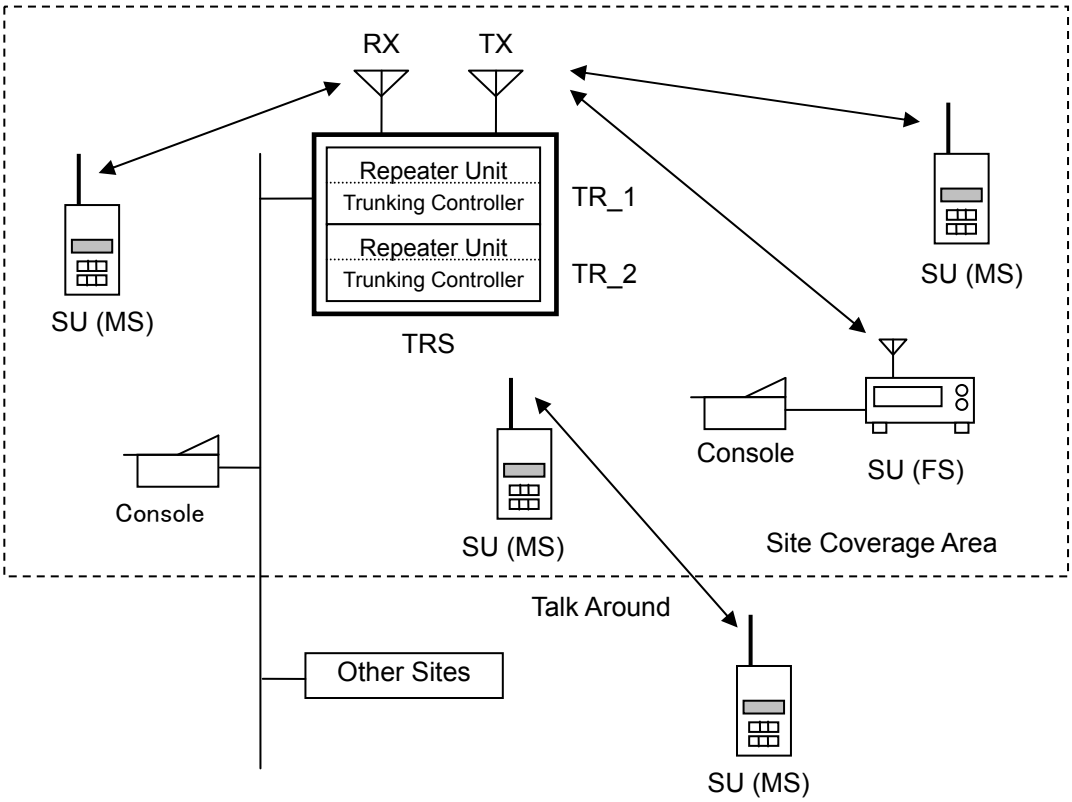

Figure 2.1-2 Structure of NXDN^{TM} Trunked System

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2.1.3. Structure of Lines

Line of NXDN™ Trunked System includes Radio Frequency line used for Radio Frequency communication and connected line to other networks.

Radio Frequency Line

Radio Frequency Channel used for communication is consists of Traffic Channel having control function.
Traffic Channel having one or more line control function is used in one Trunking Repeater Site and communicable channel is appointed by monitoring Traffic Channel set in advance.
Communication includes signal transmission of non-voice communication such as Data communication as well as voice communication.
Number of Traffic Channels differs from site to site.

Connected line to other networks

Connected line to other networks TRS can be connected to fixed network as below in TRS. However this specification does not describe other network connections.
. Independent communication network
. PSTN / PSDN
. IP network
And a plurality of TRSs can be connected by IP network, for instance.

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2.2. Functions Defined by CAI

List of service functions provided in Radio protocol of NXDN™ Trunked System is shown in Table 2.2-1, and the details will be described in next section.
Set of implemented service functions may differ according to system.
NXDN™ Trunked System includes two types of methods, single-site method and multi-site method, the former is defined as Single Trunked System and the latter is defined as Multi Trunked System.
Furthermore, classification of detailed service function is shown in Chapter 9.6.

Categories	Services	Multi Trunked System		Single Trunked System	
		Multi Site	Single Site	Single Site	Talk Around
Voice Service	Broadcast Group Call	✓	✓	✓	n/a
	Conference Group Call	✓	✓	✓	✓
	Individual Call	✓	✓	✓	✓
	Interconnect Call	✓	✓	n/a	n/a
Data Service	Data Call	✓	✓	✓	✓
	Broadcast Data Call	✓	✓	✓	✓
	Short Data Call	✓	✓	✓	✓
	Broadcast Short Data Call	✓	✓	✓	✓
	Simultaneous Data Call	✓	✓	✓	✓
Supplementary Service	Status Call	✓	✓	✓	✓
	Broadcast Status Call	✓	✓	✓	✓
	Paging	✓	✓	✓	✓
	Emergency Call	✓	✓	✓	✓
	Emergency Alert	✓	✓	✓	✓
	Remote Monitor	✓	✓	✓	✓
	Remote Stun	✓	✓	✓	✓
	Late Entry	✓	✓	✓	✓
System Service	Registration	✓	✓	n/a	n/a
	Group Registration	✓	✓	n/a	n/a
	Site Roaming	✓	n/a	n/a	n/a
	System Roaming	✓	n/a	n/a	n/a
	Restriction Control	✓	✓	n/a	n/a
	Over the Air Update	✓	✓	n/a	n/a
	Off the Air Call Processing	✓	✓	n/a	n/a
	Intermittent Operation	✓	✓	n/a	n/a
	Secondary Home Repeater	✓	✓	✓	n/a
	Priority Monitor	✓	✓	✓	n/a
Security	ID Validation	✓	✓	✓	n/a
	Authentication	✓	✓	✓	n/a
	Encryption	✓	✓	✓	✓

Table 2.2-1 List of Services

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2.2.1. Group Voice Call

Group Voice Call Communication can be performed for a plurality of SUs from SU or Console. Conference Call to perform bi-directional voice communication between selected groups and Broadcast Call to perform unidirectional voice communication between selected groups can be performed.

2.2.2. Individual Voice Call

Individual Voice Call Communication can be performed for one specified SU from SU or Console.

2.2.3. Interconnect Voice Call

TRS can be connected to PSTN, Individual Voice Call or Group Voice Communication can be performed between SU and line facility through TRS.

2.2.4. Data Call

Transmission of data such as image and AVL can be performed for individual or group from SU or Console. Data Call can select Data Call of manner targeting one specified SU and Broadcast Data Call of manner targeting groups.

2.2.5. Short Data Call

Transmission of small-capacity data can be performed for individual or group from SU or Console. Short Data Call can select Short Data Call of manner targeting one specified SU and Broadcast Short Data Call of manner targeting groups.

2.2.6. Simultaneous Data Call

Low speed transmission of data can be performed from SU or Console at the same time with voice communication during Individual Voice Call Communication or Group Voice Call communication.

2.2.7. Status Call

Transmission of simple fixed message can be performed for individual or group from SU or Console. Status Call includes special Status Message specified in advance and usable Status Message which is usable freely for every user. Status Call can select Status Call of manner targeting one specified SU and Broadcast Status Call of manner targeting groups can be selected.

2.2.8. Paging

SU or Console can inform specified SU of call occurring through alert sound or indicator. Paging is a part of Status Call and is performed using special status message specified in advance.

2.2.9. Emergency Call & Alert

When SU is in emergent status, SU can perform emergent voice communication towards individuals or groups, or inform the emergent status.

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2.2.10. Remote Monitor

SU or Console can confirm situation of specified SU whereby the SU launches sending operation remotely.

2.2.11. Remote Stun

SU or Console can make specified SU inoperative status remotely. The status has three kinds of Stun, Revival and Kill, which can be used separately depending on situation.

2.2.12. Late Entry

Late Entry is function of involving SU (SU which has moved from out-of-service area to service area or SU powered after starting group communication, etc.) which has become to be able to join group communication after starting the communication into group communication which has already started automatically.

2.2.13. Registration

In Trunked System, when SU is powered or receiving electric field strength which SU is waiting for is lowered, if TRS whose line quality is good is selected by searching other appointed Traffic Channel, position of SU can be registered to TRS.

2.2.14. Group Registration

In Trunked System, group to which SU belongs can be registered to TRS.

2.2.15. Site Roaming

When SU mobiles between sites in Trunked System constituted a plurality of Trunking Repeater Sites, TRS updates position registered record of the SU and traces the SU, and TRS provides information of site adjacent to SU so that the SU can transit properly between sites.

2.2.16. System Roaming

In the case that Trunked System is consists of a plurality of different Trunked Systems, when SU moves between different Systems, the Trunked System updates position registered record of the SU and traces the SU between Trunked System, and make communication between different systems possible by assigning temporal ID for SU.

2.2.17. Restriction Control

In Trunked System, TRS can perform communication regulation such as call control of SU, when communication is congested, for instance.

2.2.18. Over the Air Update

In Trunked System, TRS can update SU over the air, when new site is added.

2.2.19. Off the Air Call Processing

Off the Air Call Processing, in Trunked System, is method of starting session from SU side without sending during call processing, when TRS starts session for individual SU.

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2.2.20. Intermittent Operation

SU can stop transmitting operation for frame unnecessary to receive by determining frame necessary to receive or frame unnecessary to receive, when SU is in idling status on Home Repeater of TRS.

2.2.21. Secondary Home Repeater

In Trunked System Secondary Home Repeater is function in which, SU always registers TR called Home Repeater, if line control of the TR becomes inoperative because of some trouble; TR calls Secondary Home Repeater which performs line control temporarily.

2.2.22. Priority Monitor

In Trunked System, in the status that SU is performing Group Call on Traffic Channel of TRS, when Group Call having high priority occurs on other Traffic Channel and when Individual talk request occurs for specified SU joining Group Call, corresponding SU exits from joining Group Call and can join other communication.

2.2.23. ID Validation

In Trunked System, using UID assigned to each SU or calling-to GID, only assigned ID can be permitted to perform communication.

2.2.24. Authentication

By attaching Electronic Serial Number (ESN) which is unique to each SU, justification of SU can be confirmed using the ESN, thereby preventing fraudulent use of system.

2.2.25. Encryption

Content of voice communication and Data communication can be concealed.

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2.3. Transfer Method

Modulation Method used in NXDN™ is Nyquist 4-Level FSK Modulation Method, specification of transmission method is shown in Table 2.3-1.

System Parameter	Description
Type of Modulation	Nyquist 4 Level FSK
Access Method	FDMA
Channel Spacing	6.25 kHz
Transmission Rate	4800 bps
Symbol Rate	2400 symbol/s
Speech Codec Rate	3600 bps

Table 2.3-1 Transfer Method Specifications

2.4. Layer Structure

In Radio Frequency protocol of NXDN™, three-layer Structure shown in Table 2.4-1 is used. Communication structure of LMR does not match OSI model because fast associated talk using PTT is basic.

Layer	Layer Name	Description
Layer 1	Basic interface	Layer of basic interface is basic structure of channel, in which definition and format of channel is specified.
Layer 2	Transfer control method	Layer of Transfer control method is a layer which specializes in transfer control between facing stations; synchronization and identification of channel, random access method and timing control are specified.
Layer 3	Connection control method.	Layer of connection control method is a layer of data transfer between end systems, Radio Frequency management, Mobility Management Message including call control and procedure are specified.

Table 2.4-1 Layer Structure

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3. Modulation

3.1. General Description

Transfer Method of NXDN™ is specified.

3.2. Modulation Method

Nyquist 4-Level FSK modulation method is used for Modulation purpose. By using 4-value FSK of non-linear modulation, C class power amplifier which was used by analog FM Modulation Method can be used successively. And VCO direct modulator which was used by analog FM Modulation Method can be used for modulator. And because the same frequency detector as analog FM Modulation Method can be used for demodulator, it is possible to standardize with circuit structure of previous analog FM Modulation Method in many points.

Overview of modulator and demodulator using 4-value FSK method is shown in Figure 3.2-1 and Figure 3.2-2.

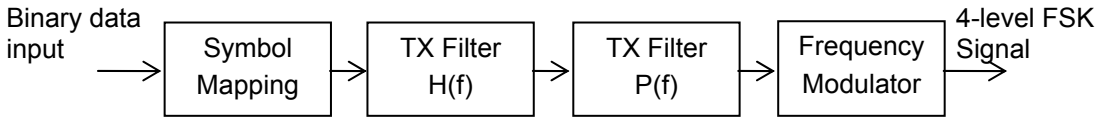

Figure 3.2-1 Diagram of 4-level FSK Modulator

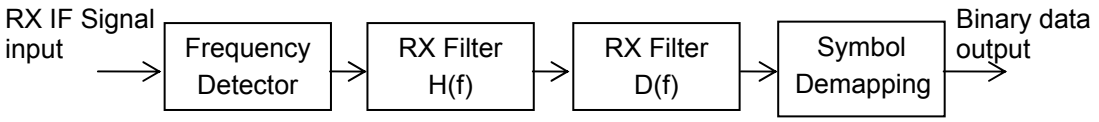

Figure 3.2-2 Diagram of 4-level FSK Demodulator

3.3. Symbol Mapping

2 value data signal sequence of serial input is converted to dibits every 2 bits from the header bit, and then is converted to 4-value symbols corresponding to each of 4 kinds of dibits. Correspondence of dibits, symbol and frequency shift is shown in Table 3.3-1.

Dibit	Symbol	Deviation
01	+3	+1050 Hz
00	+1	+350 Hz
10	-1	-350 Hz
11	-3	-1050 Hz

Table 3.3-1 Symbol Mapping Table

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3.4. Baseband Filter for Modulator

Baseband bandwidth limiting is performed for symbol sequence by sending filter before symbol sequence which is an input to modulator. Input signal to filter is impulse signal scaled to symbol level of Table 3.3-1, is input to filter in cycle of 1/Symbol Rate. Baseband bandwidth limiting uses spectrum which links level Nyquist raised cosine spectrum H(f) shown in following expression and sine function spectrum P(f). H(f) and P(f) have linear phase characteristic.

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

$$|P(f)| = \sin(\pi\ fT)/\pi\ fT \qquad , \quad 0 \le |f| \le (1+\alpha)/2T$$

Furthermore, T=416.7us, roll-off rateα=0.2.

3.5. Baseband Filter for Demodulator

Baseband bandwidth limiting is performed for signal whose frequency is detected by receiving filter specified as described below. Receiving Baseband bandwidth limiting uses spectrum which links level Nyquist raised cosine spectrum H(f) used in sending baseband bandwidth limiting and reciprocal spectrum D(f) of sine function. D(f) has linear phase characteristics.

$$|D(f)| = \pi\ fT/\sin(\pi\ fT) \qquad , \quad 0 \le |f| \le (1+\alpha)/2T$$

Furthermore, T=416.7us, roll-off rateα=0.2.

3.6. Reference Deviation of 4-level FSK

Frequency shift of modulator should be adjusted to frequency shift specified in Table 3.3-1. In that condition, frequency shift which becomes standard when following bit sequence is input to modulator.

. . . 01 01 11 11 01 01 11 11 01 01 11 11 01 01 11 11 . . .

Output signal when this bit sequence is input to sending Baseband Filter becomes the same waveform as sine wave with quarter frequency of symbol rate. Therefore peak of frequency shift is calculated by amplitude characteristic of sending Baseband Filter with the frequency, as described below.

$4/\pi \times \pm 1050 = \pm 1337\ \mathrm{Hz}$

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4. Basic Interface (Layer 1 Standard)

4.1. Outline

Basic interface (layer1) in interface of radio communication section of NXDN™ is specified. Definition of Channel Structure of frame and signal format will be described and method of correcting error and Scramble Method are specified.

4.2. Channel Structure

Radio Frequency Channel divided by physical Radio Frequency carrier and Functional Channel classified every logical function is defined, short names used often are also specified for convenience.

4.2.1. Definition of RF Channel

Radio Frequency Channel is attached to physical carrier (channel assigned every frequency), Radio Frequency Traffic Channel（RTCH2）used in Trunked System is specified for the classification. Type of Radio Frequency Channel is shown in Table 4.2-1.

RF Channel Type	Abbreviation
RF Traffic Channel 2	RTCH2

Table 4.2-1　RF Channel Description

4.2.1.1. RF Traffic Channel 2

Radio Frequency Traffic Channel 2 performs registering position, alerting system information, calling, receiving call, etc., and controls to transit Subscriber Unit to other Radio Frequency Traffic Channel 2 and transmission of talk data (voice encoding data) and Data communication.
Short name is defined as “RTCH2” originated from English name of “RF Traffic Channel 2”. Afterward “RF Traffic Channel 2” or “RTCH2” will be used.

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4.2.2. Definition of Functional Channel

Functional Channel is not a physical frequency channel, but is a logical channel on which transmission of data is assigned to every function. Type of Functional Channel is defined, and each short name is also specified. Overview of Functional Channel is shown in Table 4.2-2.

Functional Channel Type	Abbreviation
Signaling Control Channel	SCCH
Fast Associated Control Channel 1	FACCH1
User Data Channel 2	UDCH2
Fast Associated Control Channel 3	FACCH3
Voice Channel	VCH
Link Information Channel	LICH

Table 4.2-2 Definition of Functional Channel

4.2.2.1. Signaling Control Channel

Signaling Control Channel is bi-directional Control Channel attached to RTCH2, and aimed at transmitting signaling information, etc. in low speed always and transfer control information necessary for call connection in direction from Trunking Repeater to Subscriber Unit. Short name is defined as “SCCH” originated from English name of “Signaling Control Channel”. Afterwards “Signaling Control Channel” or “SCCH” will be used.

4.2.2.2. Fast Associated Control Channel 1

Fast Associated Control Channel 1 is bi-directional channel to transmit information of call, etc. and bi-directional Control Channel attached at the time of voice communication, and aimed at steeling VCH and transmitting signaling information and data, etc. in high speed. Short name is defined as “FACCH1” originated from English name of “Fast Associated Control Channel 1”. Afterwards “Fast Associated Control Channel 1” or “FACCH1” will be used.

4.2.2.3. User Data Channel 2

User Data Channel 2 is bi-directional data channel used on RTCH2 and transfer control information signal and user packet data. Short name is defined as “UDCH2” originated from English name of “User Data Channel 2”. Afterwards “User Data Channel 2” or “UDCH2” will be used.

4.2.2.4. Fast Associated Control Channel 3

Fast associated Control Channel 3 is bi-directional Control Channel attached at the time of Data communication of RTCH2, aimed at steeling UDCH2 and transferring signaling information and a part of data at high speed. Short name is defined as “FACCH3” originated from English name of “Fast Associated Control Channel 3”. Afterwards “Fast Associated Control Channel 3” or FACCH3” will be used.

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4.2.2.5. Voice Channel

Voice Channel is bi-directional channel used for transmitting voice encoding data, which is allocated on RTCH2. Short name is defined as “VCH” originated from English name of “Voice Channel”. Afterwards “Voice Channel” or “VCH” will be used.

4.2.2.6. Link Information Channel

Link information channel is bi-directional channel which is allocated on all Radio Frequency Channels, and aimed at transmitting information of Radio Frequency link such as type of Radio Frequency Channel and allocation of Functional Channel, etc. Short name is defined as “LICH” originated from English name of “Link Information Channel”. Afterwards “Link Information Channel” or “LICH” will be used.

4.2.3. Relation of the RF Channel and Functional Channel

Correspondence of Functional Channel used in Radio Frequency Channel is shown in Table 4.2-3.

Channel on RTCH2 is classified to user individual channel（USC－User Specific Channel）.

And LICH exists apart from these classifications.

RF Channel	Type	Functional Channel
RTCH2	USC	VCH
		SCCH
		FACCH1
		UDCH2
		FACCH3
	LICH	LICH

Table 4.2-3 Relation of the RF Channel and Functional Channel

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4.3. Frame Structure

Frame transmission is a process in which transmission data is transmitted separately every reference unit time is used for transmission of data. Frame Structure for frame transmission is specified. One frame time of Frame Structure of Radio Frequency Channel has 80ms.

4.3.1. Basic Frame Structure

When Trunking Repeater intervenes, offset of inbound frame and outbound frame is not specified.
And offset of sending frame at the time of direct communication between Subscriber Unit SU using Talk Around function and receiving frame is also not specified. And 40ms shown in Figure 4.3-1 is recommended as standard value of offset.

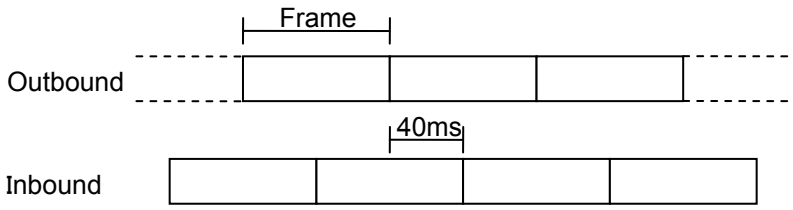

Figure 4.3-1 Frame Structure on the RTCH2

4.3.2. Mapping to Functional Channel

When Subscriber Unit performs voice communication in RTCH2, SCCH is allocated as described below.
SCCH has super Frame Structure with 4 frame unit during communication, and has non super Frame Structure with single frame unit at the start time and end time of sending.
Allocation of the other channel is not specified particularly.

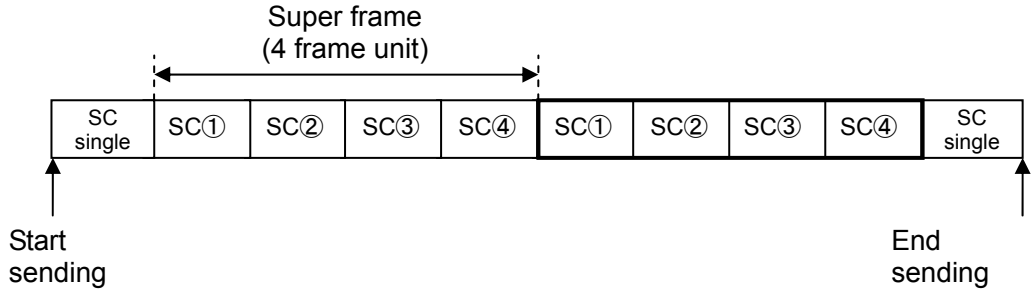

Figure 4.3-2 SCCH Channel Mapping

4.4. Frame Format

Signal format within frame of each Radio Frequency Channel is specified.
Frame time in each channel is 80ms.

4.4.1. Link Establishment for RTCH2

Format of one frame (384bit) used mainly at the time of establishing link in Radio

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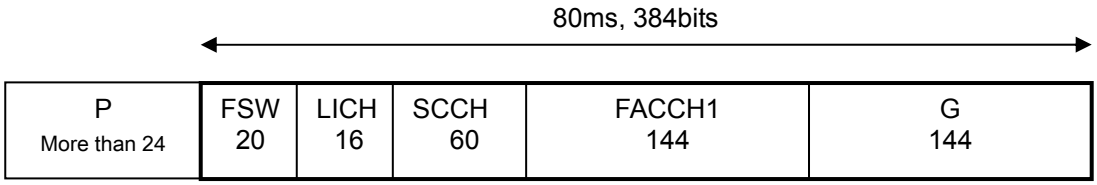
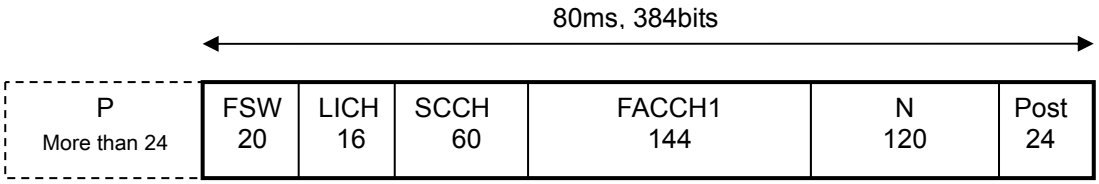
Frequency Traffic Channel2 (RTCH2) is described as below.

(1) Inbound Direction



(2) Outbound Direction



FSW: Frame Synchronization Word
LICH: Link Information Channel
SCCH: Signal Control Channel
FACCH1: Fast Associated Control Channel 1
G: Guard time
N: Null data
Post: Post field
P: Preamble (changing additional condition depending on whether initial sending or not. Details will be described later.)

Figure 4.4-1 RTCH2 Frame Format for Link Establishment

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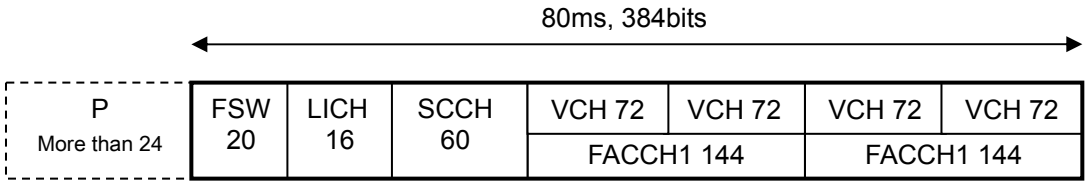
4.4.2. Voice communication on RTCH2

Format of one frame (384bit) in Radio Frequency Traffic Channel2 (RTCH2) at the time of voice communication is described as below.

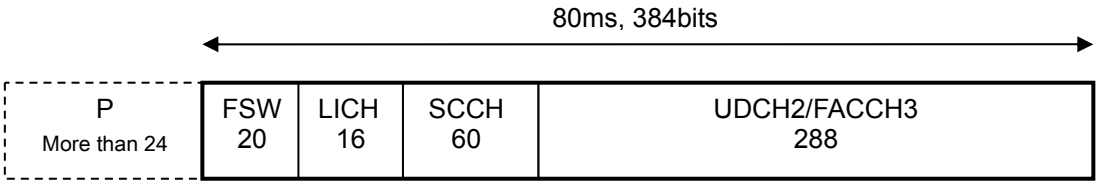


FSW: Frame Synchronization Word
LICH: Link Information Channel
SCCH: Signal Control Channel
VCH: Voice Channel
FACCH1 Fast Associated Control Channel 1
P: Preamble (changing additional condition depending on whether initial sending or not. Details will be described later.)

Figure 4.4-2 RTCH2 Frame Format for Voice communication

4.4.3. Data communication on RTCH2

Format of one frame (384bit) in Radio Frequency Traffic Channel2 (RTCH2) at the time of voice communication is described as below.



FSW: Frame Synchronization Word
LICH: Link Information Channel
SCCH: Signal Control Channel
UDCH2: User Data Channel 2
FACCH3: Fast Associated Control Channel 3
P: Preamble (changing additional condition depending on whether initial sending or not. Details will be described later.

Figure 4.4-3 RTCH2 Frame Format for Data communication

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4.4.4. Preamble

Preamble is allocated at the head and serves for receiving side to acquire initial synchronization. Pattern of Preamble is followed as Table 4.4-1.
Receiving side may use this fixed pattern for detecting synchronization with FSW.
And length of Preamble is specified to be 24 bit, but may be more than this length.
Symbol pattern in this case uses repeat of “+3, +3, -3, -3”.

Transmission Order →		
Arbitrary	First 3 symbols	Last 9 Symbols
+3, +3, -3, -3, …	Symbol: +3, +3, +3	Symbol: -3, +3, -3, +3, +3, -3, -3, -3, +3
	HEX: 5775FD	

Table 4.4-1 Preamble

4.4.5. Frame Synchronization Word

Frame Synchronization Word is 10symbol (20bit).

	Transmission Order →
Symbol	-3, +1, -3, +3, -3, -3, +3, +3, -1, +3
HEX	CDF59

Table 4.4-2 Frame Synchronization Word

4.4.6. Information Element of Post Field

Fixed pattern of Post Field is consists of the first half of 3 symbols (6bit) and the latter half of 9 symbols (18bit).
Receiving side may use fixed pattern of the latter half of 9 symbols for detecting synchronization with FSW.

Transmission Order →	
First 3 symbols	Last 9 Symbols
Symbol: +3, +3, +3	Symbol: -3, +3, -3, +3, +3, -3, -3, -3, +3

Table 4.4-3 Post Field Information

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4.5. Channel Coding

Channel Coding of each Functional Channel is described in this chapter.
Channel Coding indicates error detecting system, error correcting system, interleaving technique and bit allocation, etc.
And order of sending signal is referred to Chapter 4.5.3, CRC code is referred to Chapter 4.5.4.

4.5.1. Channel Coding on the RTCH2

Channel Coding of VCH is specified separately.

4.5.1.1. SCCH

(1) Coding Procedure
Coding Procedure is as shown in Figure 4.5-1.

(2) Error Detecting Code
7bit CRC
Generating Polynomial: $X^7 + X^3 + 1$

(3) Fixed Bit Insert
Fixed bit “0” of 4bit is added to the tail of bit sequence before error correcting coding.

(4) Error Correcting Code
Error Correcting Code is performing convolutional coding processing shown next by inputting bit sequence after inserting fixed bit.
Output bit is reading G1 and G2 alternatively in this order.
Convolutional coding of coding rate R=1/2 (constraint length K=5)
Convolutional coding of coding rate R=1/2 (constraint length K=5)
Generating Polynomial: $G_1(D) = 1 + D^3 + D^4$

$G_2(D) = 1 + D + D^2 + D^4$

(5) Punctured Coding
Punctured Coding is performing Punctured code processing shown next by inputting bit sequence after convolutional coding.
Output bit is erasing bit periodically; by erased bit position shown punctured matrix.
Punctured matrix:

$$\begin{bmatrix} 1 & 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 0 & 1 & 1 & 0 \end{bmatrix}$$

(6) Interleave
Interleave between frames is not performed.
Number of Information bits is 25bit, depth of Interleave is 5.

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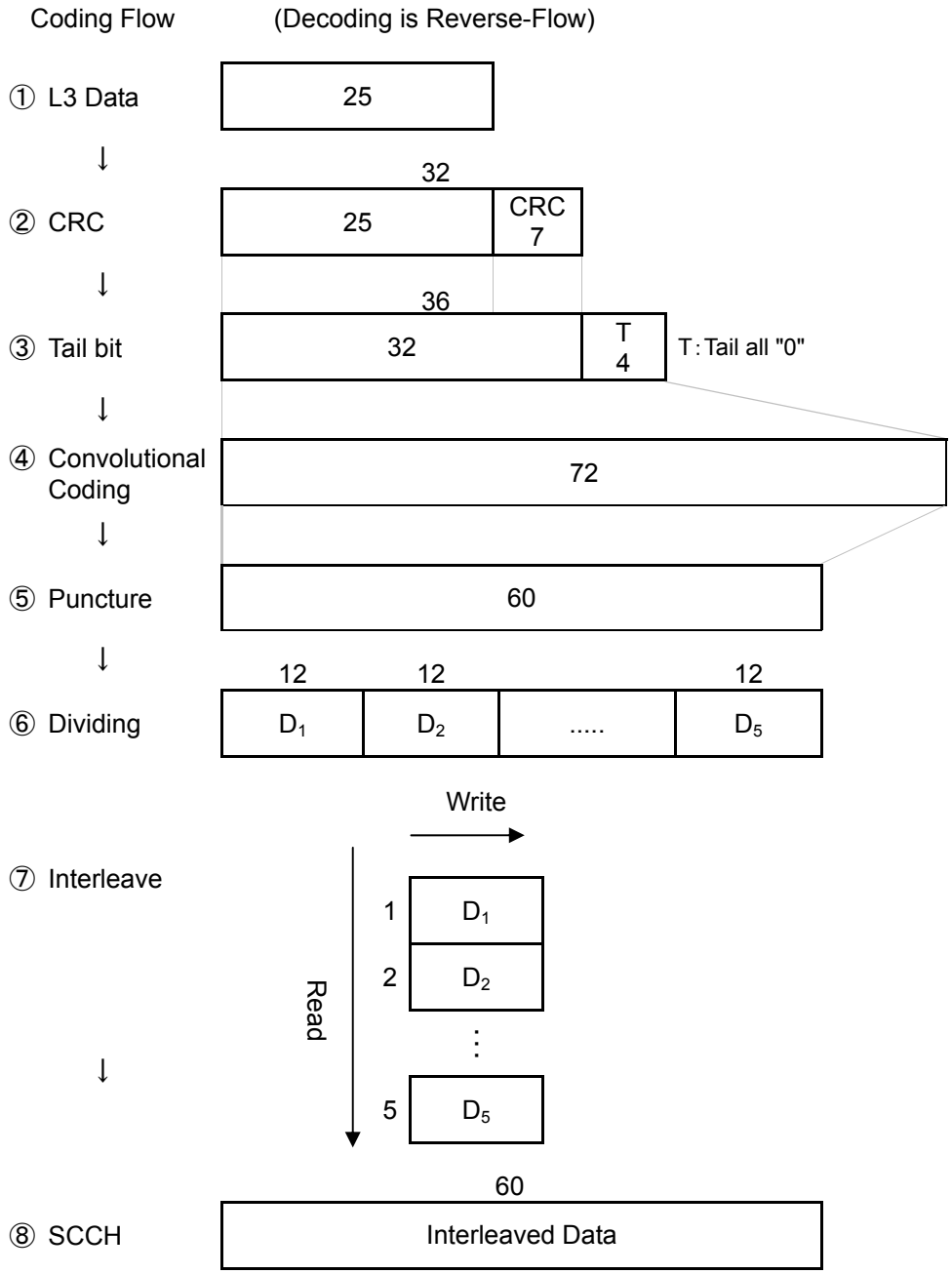

Figure 4.5-1 SCCH Coding Flow

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4.5.1.2. FACCH1

FACCH1 is decomposed into two channels from one Information Element.

(1) Coding Procedure
Coding Procedure is as shown in Figure 4.5-2.

(2) Error Detecting Code
12bit CRC
Generating Polynomial: $X^{12} + X^{11} + X^3 + X^2 + X + 1$

(3) Fixed Bit Insert
Fixed bit “0” of 4bit is added to the tail of bit sequence before error correcting coding.

(4) Error Correcting Code
Error Correcting Code is performing convolutional coding processing shown next by inputting bit sequence after adding and inserting fixed bit.
Output bit is reading G1 and G2 alternatively in this order.
Convolutional coding of coding rate R=1/2 (constraint length K=5)
Generating Polynomial:
$G_1(D) = 1 + D^3 + D^4$
$G_2(D) = 1 + D + D^2 + D^4$

(5) Punctured Coding
Punctured Coding is performing Punctured Code processing shown next by inputting bit sequence after convolutional coding.
Output bit is erasing bit periodically by erased bit position shown punctured matrix.
Punctured matrix: $\begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix}$

(6) Interleave
Interleave between frames is not performed, but is performed between two Functional Channels.
Number of Information bits is 80bit, depth of Interleave is 9.

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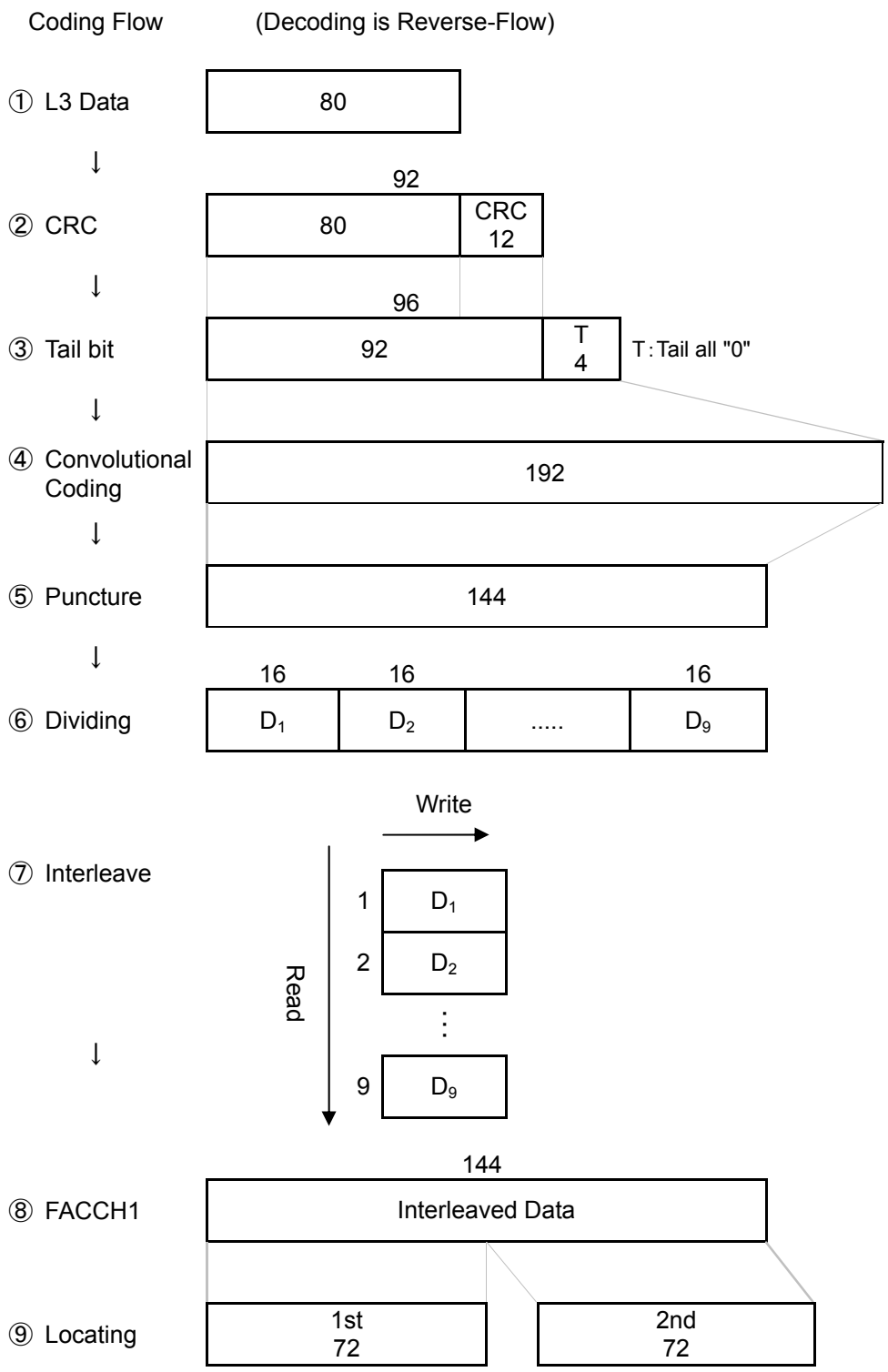

Figure 4.5-2 FACCH1 Coding Flow

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4.5.1.3. UDCH2 / FACCH3

UDCH2/FACCH3 is decomposed into two channels from one Information Element.

(1) Coding Procedure
Coding Procedure is as shown in Figure 4.5-3.

(2) Error Detecting Code
12bit CRC
Generating Polynomial: $X^{12} + X^{11} + X^3 + X^2 + X + 1$

(3) Fixed Bit Insert
Fixed bit “0” of 4 bits is added to the tail of bit sequence before error correction coding.

(4) Error Correction Code
Error Correction Code is performs convolutional code processing shown next by inputting bit sequence after inserting fixed bit.
Output bit is read as G1 and G2 in alternate order.
Convolutional coding is of coding rate R=1/2 (constraint length K=5)
Generating Polynomial:
$G_1(D) = 1 + D^3 + D^4$
$G_2(D) = 1 + D + D^2 + D^4$

(5) Punctured Coding
Punctured Coding is performed as Punctured Code processing shown next by inputting bit sequence after convolutional coding.
Output bit is erasing bit periodically by erased bit position as shown in the punctured matrix.
Punctured matrix: $\begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix}$

(6)Interleave
Interleaves between frames and between the first Functional Channel and the second channel are not performed.
Each number of Information bits after first decomposition and after second composition are 80bit, and depth of Interleave is 9.

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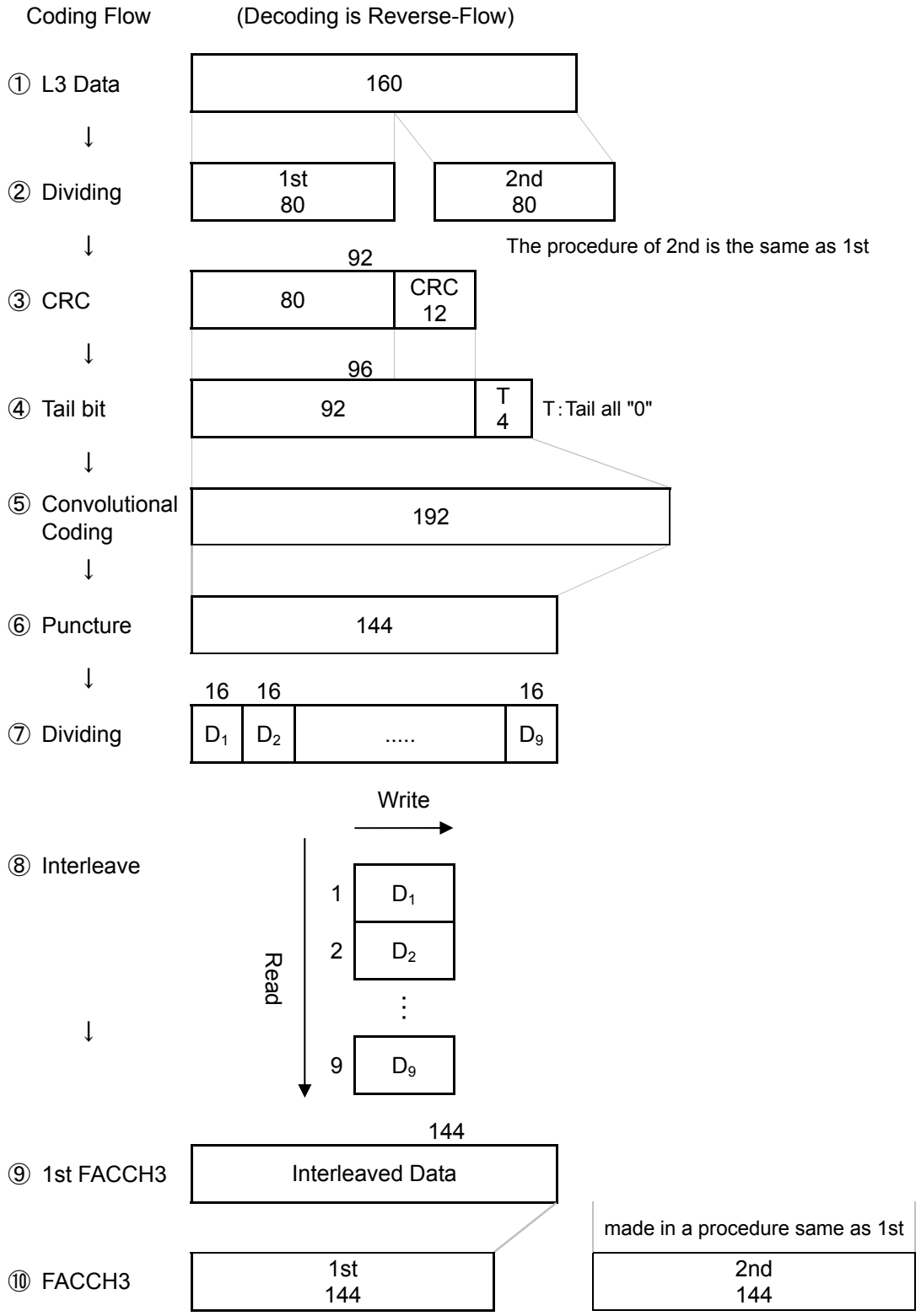

Figure 4.5-3 UDCH2 / FACCH3 Coding Flow

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4.5.2. LICH

(1) Coding Procedure
Coding Procedure is as shown in Figure 4.5-4.

(2) Error Detecting Code
One bit even parity
Range of parity is 4 bits from MSB side

(3) Error Correcting Code
No Error Correcting Code

(4) Interleave
No Interleave

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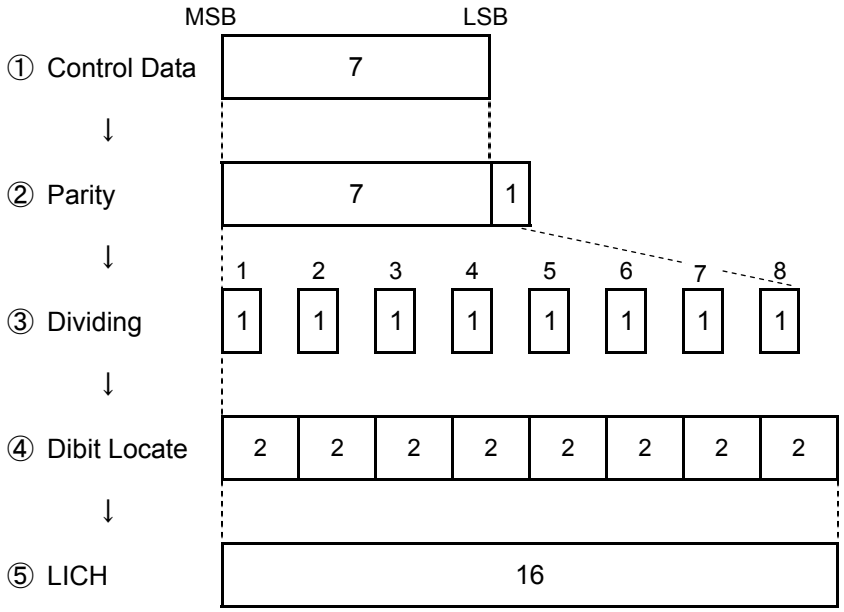
Encoding Flow (Decoding is Reverse-Flow)



Bit ⟷ Dibit Coding

Bit	Symbol
0 → 01	+3
1 → 11	-3

Decoding

Symbol	Bit
+3	01 → 0
+1	00 → 0
-1	10 → 1
-3	11 → 1

Figure 4.5-4 LICH Coding Flow

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4.5.3. Order of Transmitting Data

Order of sending signal will be described with FACCH1 of Radio Frequency Traffic Channel.
Bit structure of layer 3 message (D79 to D0) is shown in Figure 4.5−5.
Order of reading data is from Octet0 to Bit7 (D79).

Bit	7	6	5	4	3	2	1	0
Octet0	D79	D78	D77	D76	D75	D74	D73	D72
.					.			
.					.			
.					.			
Octet9	D7	D6	D5	D4	D3	D2	D1	D0

Figure 4.5-5 L3 Bit Structure

CRC bit (S11 to S0) and data sequence before convolutional coding of adding “0” of 4 bits as fixed bit are shown below.

D79.....D0	S11...S0	0000

Figure 4.5-6 Data before Convolutional Encoding

Convolutional coding includes inputting in the order from D79 to generation polynomial G1(D), G2(D) in Chapter 4.5.1.2 and readings generated code X2i-1, X2i (i = 1 to 96) in the order of X1, X2....

Punctured Coding includes erasing bit periodically at the position of “0” in punctured matrix from data sequence X1, X2....X192 which is coded convolutionally.

X2i-1	X1	X3	X5	X7	X9	X11	X13 ...X191	$\begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix}$
X2i	X2	X4	X6	X8	X10	X12	X14 ...X192	

Therefore here X2, X6, X10, X14 are erased and data after Punctured Coding become X1, X3, X4, X5, X7, X8, X9, X11, X12, X13.....X192.
Like this, if data sequence after Punctured Coding is Y1, Y2, Y3....Y144, Interleave is performed with allocation as Figure 4.5-7. Data sequence after bit Interleave is shown in Figure 4.5-8.

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And decoding of punctured code is performed by inserting dummy bit as received data corresponding to coded data position erased at the time of sending in receiving sequence and making receiving sequence equivalent to the case of original code

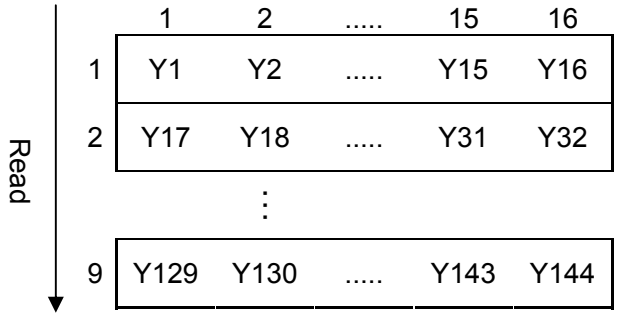

Figure 4.5-7 Interleaving

Y1 Y17 Y33.....Y129 Y2.....Y128 Y144

Figure 4.5-8 Interleaved data

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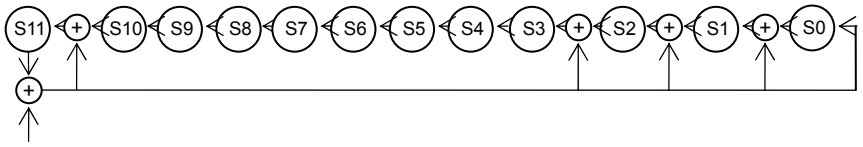
4.5.4. CRC Code

Each CRC is described.
Order is decided as descending order from octet0 and bit 7 of layer 3 data as the head.
Inputting to shift register from the high order, outputting value of shift register at the time of inputting the last bit are performed. Initial value is set to all 1.

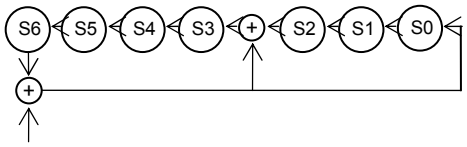
12bit CRC



Example

FACCH1 / FACCH3 Layer3　80bit	CRC 12bit
B79,b78,b77……b1,b0	S11,S10…S1,S0

7bit CRC



Example

SCCH Layer3　25bit	CRC 7bit
b24,b23,b22……b1,b0	S6,S5…S1,S0

Figure 4.5-9　CRC Coder

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4.6. Scramble Method

Synchronization word, control data except guard, Preamble and Post field, and voice data are scrambled.

Scrambling is performed in symbol unit and by integration (inversion/non inversion) of scrambled symbol value and output of scramble generator where 0 and 1 are each converted to +1 and -1.

Scramble generator uses PN code and generates scramble code appointed below as initial value. Initialization is performed for every frame.

Register of generator	S8	S7	S6	S5	S4	S3	S2	S1	S0
Initial value	0	1	1	1	0	0	1	0	0

Table 4.6-1 Default value of Scramble Code

Generator polynomial: $X^9 + X^4 + 1$

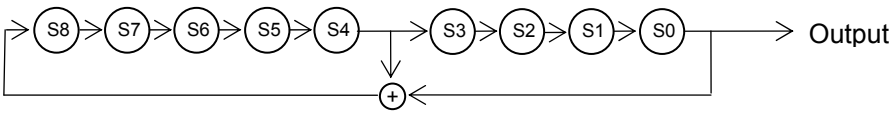

Figure 4.6-1 Scrambler

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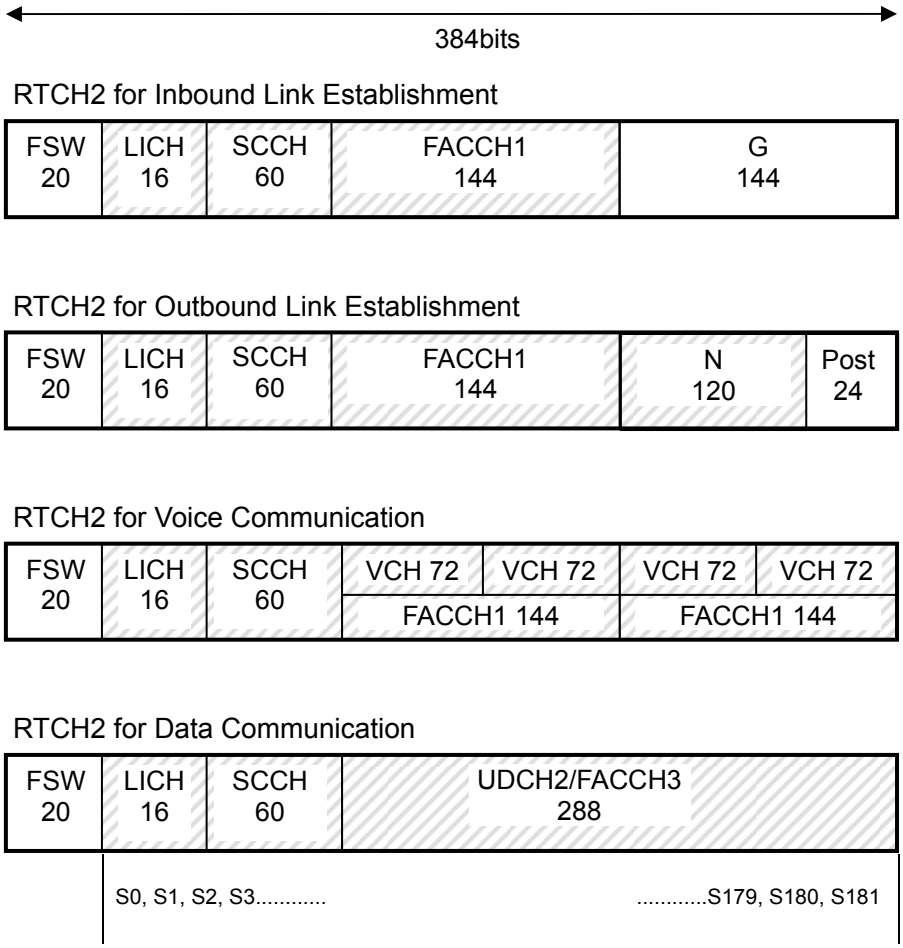

Figure 4.6-2 Scramble Range

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5. Transfer Control Type (Layer 2 Standard)

5.1. Outline

Transmission control scheme (Layer 2) in interface of Radio Frequency section of NXDN™ is specified. Layer2 is specified between facing stations with respect to identification of frame and channel, timing of transmitting and random access.

5.2. Identification Information of LICH

Radio Frequency Channel and Functional Channel are identified and Frame Structure attached to the Radio Frequency Channel and Functional Channel is also identified.

5.2.1. Structure of LICH

Link information channel is consists of 7 bits.

From MSB, 2bit identifies Radio Frequency Channel, the following 2 bits identifies Functional Channel and the furthermore following 2 bits writes Frame Structure(option) attached to Functional Channel. LSB indicates direction (inbound/outbound) of Radio Frequency section.

Type of Radio Frequency Channel is also used to determine synchronization of frame and Channel Coding is performed using this information.

Structure of link information channel is shown in Table 5.2-1.

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Transmission Order →
MSB LSB

	6	5	4	3	2	1	0
Signal Name	RF Channel Type		Functional Channel Type		Option		Direction
RTCH2	1	1	USC Type		Steal Flag		0:Inbound 1:Outbound

Functional Channel Type
USC Type (RTCH2)

4	3	Frame Structure Type
0	0	Non-Super Frame Structure / FACCH1
0	1	Non-Super Frame Structure / UDCH2
1	0	Super Frame Structure / VCH
1	1	Super Frame Structure / Idle

Option
Steel Flag (RTCH2)

2	1	USC = 00 (Non-Super frame)	USC = 01 (Non-Super frame)	USC = 10 (Super frame)	USC = 11 (Super frame) / Idle
1	1	Reserved	No steel UDCH2	No steel (only VCH)	Spare
1	0	Reserved	Reserved	FACCH1 for two VCHs in the latter half	Spare
0	1	FACCH1 for two VCHs in the first half G or N /Post for the latter half	Reserved	FACCH1 for two VCHs in the first half	Spare
0	0	FACCH1 for both	FACCH3	FACCH1 for both	Spare

Table 5.2-1 Configuration of LICH

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5.2.2. LICH Setting

Method of using status is actually assumed based on settings of LICH specified in Chapter 5.2.1 is shown below in Table 5.2-2.

RF channel	sending	Receiv -ing	RF CH type		Func. CH type		option		direction	Status
			6	5	4	3	2	1	0	
RTCH2	SU	TR/SU	1	1	1	0	1	1	0	At the time of sending voice communication by normal VCH in 4Frame Structure SCCH
	SU	TR/SU	1	1	1	0	1	0	0	At the time of sending voice communication steeled in the latter half in 4Frame Structure SCCH
	SU	TR/SU	1	1	1	0	0	1	0	At the time of sending voice communication steeled in the first half in 4Frame Structure SCCH
	SU	TR/SU	1	1	1	0	0	0	0	At the time of sending voice communication steeled in the first and latter half in 4Frame Structure SCCH
	SU	TR/SU	1	1	0	1	1	1	0	At the time of sending UDCH2 in 1Frame Structure SCCH
	SU	TR/SU	1	1	0	1	0	0	0	At the time of sending FACCH3 in 1Frame Structure SCCH
	SU	TR	1	1	0	0	0	1	0	At the time of sending FACCH1 in the first half and G in the latter half in 1Frame Structure SCCH
	SU	TR/SU	1	1	0	0	0	0	0	At the time of sending FACCH1 in the first and latter half in 1Frame Structure SCCH 1
	TR	SU	1	1	1	0	1	1	1	At the time of sending voice communication by normal VCH in 4Frame Structure SCCH
	TR	SU	1	1	1	0	1	0	1	At the time of sending voice communication steeled in the latter half in 4Frame Structure SCCH
	TR	SU	1	1	1	0	0	1	1	At the time of sending voice communication steeled in the first half in 4Frame Structure SCCH
	TR	SU	1	1	1	0	0	0	1	At the time of sending voice communication steeled in the first and latter half in 4Frame Structure SCCH
	TR	SU	1	1	0	1	1	1	1	At the time of sending UDCH2 in 1Frame Structure SCCH
	TR	SU	1	1	0	1	0	0	1	At the time of sending FACCH3 in 1Frame Structure SCCH
	TR	SU	1	1	0	0	0	1	1	At the time of sending FACCH1 in the first half and N / Post in the latter half in 1Frame Structure SCCH
	TR	SU	1	1	0	0	0	0	1	At the time of sending FACCH1 in the first and latter half in 1Frame Structure SCCH

【notice】

When relay station sends to Mobile Station from Console, Console is dealt in Mobile Station, so direction from Console towards relay station is inbound, and direction of sending of relay station is outbound.

Table 5.2-2 LICH Setting

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5.3. Frame Synchronization

Synchronization Establishment and Synchronization Error of frame are specified.

5.3.1. Synchronization Conditions

5.3.1.1. Frame Synchronization in Trunking Repeater Operation

Condition of establishing Frame Synchronization of Subscriber in Trunked System is as follows. Condition of establishing Frame Synchronization of Subscriber in Trunking Repeater is not specified.

(1) Initial Synchronization

When Frame Synchronization word of Home Repeater is received N_1 times successively, it means synchronization establishment. But when synchronization can be detected in state including 9 symbols in the latter half of Preamble, if Frame Synchronization word of Home Repeater can be received N_6 times successively, it may mean synchronization establishment.

Normally only channel switching from Home Repeater starts to the other Home Repeater. Therefore when timing of Frame Synchronization gained in Home Repeater is kept and Frame Synchronization word can be received N_2 times successively, it means synchronization establishment. LCH has no influence on synchronization establishment. However when synchronization is detected in state including 9 symbols in the latter half of post filed, Frame Synchronization word of Home Repeater can be received N_6 times successively, it may mean synchronization establishment.

(2) Resynchronization within Hold Time

When Hold Time is set at the time of Data communication, Trunking Repeater is operating to keep carrier within Hold Time limitedly after sending of Subscriber Unit, however Subscriber Unit does not need to keep synchronization at the time of sending.

(3) Resynchronization when timing can not be kept and after Synchronization Error

When synchronization can not be detected for the above conditions with respect to initial synchronization and when re-synchronizing from Synchronization Error, if Frame Synchronization word can be detected N_4 times successively, it may mean synchronization establishment.

5.3.1.2. Frame Synchronization in Direct Mode Operation (DMO)

Frame establishment condition at the time of direct communication by Talk Around function in Trunked System is as follows.

(1) Initial Synchronization

When Frame Synchronization word of Home Repeater can be received N_5 times successively, it means synchronization establishment. But when synchronization can be detected in state including 9 symbols in the latter half of Preamble and if Frame Synchronization word of Home Repeater can be received N_6 times successively, it may mean synchronization establishment. LICH has no influence on synchronization establishment.

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5.3.2. Synchronization Error Conditions

5.3.2.1. Synchronization Error in Trunking Repeater Operation

When synchronization word is not detected N_7 times successively, or when LICH indicates other than RTCH2 more than S_1 times successively, it means Synchronization Error. Operation after detecting Synchronization Error is not specified.

5.3.2.2. Synchronization Error in Direct Mode Operation (DMO)

When synchronization word is not detected N_7 times successively, or when LICH indicates other than RTCH2 more than S_1 times successively, it means Synchronization Error. Operation after detecting Synchronization Error is not specified.

5.4. RF Channel Activation and Inactivation

Start of RTCH2 is completed after analyzing sending wave of Trunking Repeater or another Subscriber Unit and establishing synchronization. RTCH2 can be stopped by cutting request, Synchronization Error and user operation.

5.5. System Synchronization

5.5.1. Reference Timing

Timing of sending and receiving using Home Repeater of Trunked System is shown in Figure 5.5-1.

Standard timing of sending and receiving if all RTCH2 timing to one TC of Master connected to Trunking Repeater to generate sending of all Trunking Repeater is performed at this timing.

However, time of sending and receiving of Subscriber Unit is not specified.

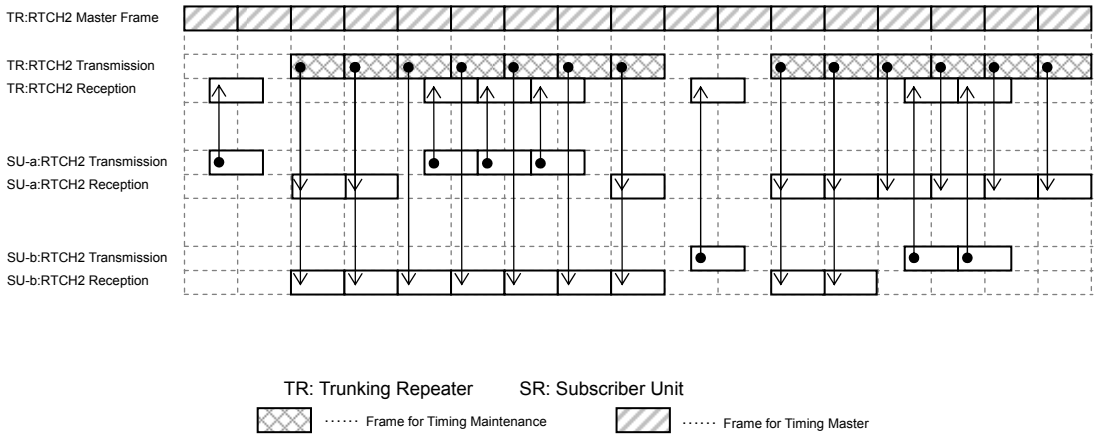

Figure 5.5-1 Timing for Transmitting and Receiving Frames

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5.5.2. Transmission Conditions for the Trunking Repeater

Sending of RTCH2 in Trunking Repeater starts at the time of receiving RTCH2 start request by layer 3, sending power specified at the time of head synchronization word of starting frame must have been output of layer 3 requests. End of sending is also controlled by stop request of layer 3.

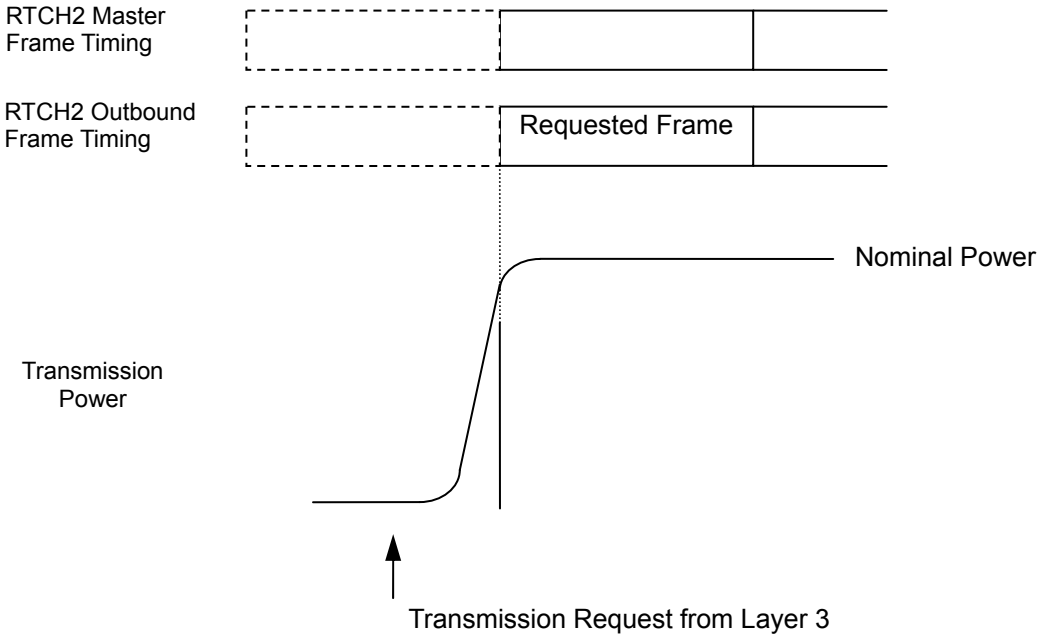

Figure 5.5-2 Transmission Power on RTCH2 for Trunking Repeater

5.5.3. Transmission Condition for the Subscriber Unit

Condition on timing of sending of Subscriber Unit in Trunked System is not specified particularly.

However, timing of sending at the time of establishing synchronization via Trunking Repeater is recommended to refer to symbol timing received.

At this time symbol determination point received and maximum point of impulse reply are in the same timing.

Subscriber Unit starts sending after 279 symbols from the time of synchronization word detection of outbound signal. Accuracy of this standard sending timing is as follows.

Accuracy: -1 to +1 symbol

5.6. Random Access Control

Inbound communication from Subscriber Unit in Trunked System is performed by random access operation.

Random access operation employs contention method using layer 3 information.

Resending operation at the time of clash follows start request of layer 3, but details are not specified.

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5.7. Quality Control

5.7.1. RSSI Detection

Subscriber Unit monitors receiving level of own station and may be used as information of autonomous sending control and site transit, etc. Method of calculating RSSI value (mobility average, section average, etc.) is not specified particularly.
And receiving level in Trunking Repeater is not specified.

5.7.2. BER Detection

Error rate detection (assumed value) is not specified particularly. However, it facilitates to detect radio disturbance, etc., so it is recommended to calculate.

5.7.3. Carrier Detection (Squelch Check)

Carrier detection can detect break of wave and can be applied to speeding up of SCAN determination, so it is recommended to calculate. Noise squelch and determination by symbol detection, etc. may be used.

5.8. Transmission Output Control

A Subscribers Unit can have function of autonomous sending control which is controlling sending power by own judgment.

5.9. Parameter for Layer 2

Main parameter specified value used in layer 2 is recommended value and is as in Table 5.9-1.

(1) Parameter

Notation	Name	Default
N_1	reserved	
N_2	Synchronization Establishment Parameter	1 (2bit error allowance)
N_3	Resynchronization(while holding the timing)parameter	1 (2bit error allowance)
N_4	Resynchronization parameter	2 (2bit error allowance)
N_5	Synchronization Establishment Parameter	2 (2bit error allowance)
N_6	Synchronization Establishment Parameter (Synchronization Including the Preamble)	1 (3bit error allowance)
N_7	Synchronization Error Parameter	5 (2bit error allowance)
S_1	Synchronization Error Counter (LICH)	5

Table 5.9-1 Parameter

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6. Connection Control Method (Layer 3 standard)

6.1. Overview

Process of setting of Radio Frequency line connection in Common Air Interface, maintenance, switching, cutting and recovery, etc. is specified in layer 3 specification. These processing is applied to message exchanged via RTCH2 used in NXDN^{TM} age in order to specify Radio Frequency management, characteristics necessary for call control, procedure and message.

6.2. Message Format

Basic structure of message used in layer 3 specification is provided. Basics of Layer 3 message is using fixed length format completed by one message.

6.2.1. Common Notation

There are 2 kinds of format of layer 3 messages; expression method of each kind will be described.

Basic format is shown in Figure 6.2-1.
Layer 3 messages are used in FACCH1, UDCH2 and FACCH3, and expressed by Octet indicating information of 8 bit unit and bit within the Octet, header Octet0 includes message type indicating message type.
Information Element included in the field after Octet1 is decided depending on Message Type
Therefore Octet length expressed by Message Type differs.

SCCH dedicated format is shown in Figure 6.2-2.
Layer-3 message is expressed by 3 Octet and 1 Bit, and header Octet 0; Bit 7-6 includes information identifying Channel Structure and structure information combined with information indicating message type, and Octet 0; Bit 5 includes Area Information.
Information Element included in field after Octet 0; Bit 4 is decided depending on structure information.

With respect to order of sent bits, sent bits are sent to Bit0 of Octet0 with Bit7 of Octet0 header, and then sent bit after Octet1 are sent in the same bit order.
Octet length differs according to message in basic format, with respect to short message where all Octets can not be filled with Information Element; rest of Octet is filled with Null.

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(1) Basic Format

Octet \ Bit	7	6	5	4	3	2	1	0
0	F1	F2	Message Type					
1	Elements							
2								
...								
n-1								
n								

Figure 6.2-1 Basic Layer 3 Message Format

Flag 1 (Octet 0; Bit 7)
Flag 1 is used as flag of each message. Method of using is referred in each message.

Flag 2 (Octet 0; Bit 6)
Flag 2 is used as flag of each message. Method of using is referred in each message.

Message Type (Octet 0; Bit 5-0)
Type of layer 3 message is shown.
At most 64 kinds of messages can be identified in each of Traffic Channel.

Elements (Octet 1 - Octet n)
Different Information Element is filled depending on each Message Type. Details of element are referred in Chapter 6.6.

(2) SCCH Dedicated Format

Octet \ Bit	7	6	5	4	3	2	1	0
0	Structure		Area	Elements				
1								
2								
3								

Figure 6.2-2 Layer 3 Message Format on SCCH

Structure (Octet 0; Bit 7-6)
Identification of Channel Structure and type of layer 3 message is shown.
At most 4 kinds of Channel Structures and 4 kinds of messages can be identified.

Area (Octet 0; Bit 5)
Details of Area are referred in Chapter 6.6.3.

Elements (Octet 0; Bit 4 - Octet 3; Bit 7)
Different Information Elements are filled depending on each Structure Type. Details of element are referred in Chapter 6.6.

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6.2.2. Functional Channel Format of RTCH2

Layer 3 message format of Functional Channel used in RTCH2 will be described.
Information capacity filled within Functional Channel of SCCH, FACCH1, FACCH3 and UDCH2 in RTCH2, and which can be carried by every Functional Channel is different.

6.2.2.1. SCCH Format

SCCH attached always to RTCH2 mainly carries control information of calling id information, etc.
SCCH has capacity to carry 3 Octet and 1 bit information, outbound SCCH is used to inform various kinds of alert information as well as control information of call from Trunking Controller to Subscriber Unit.

Octet \ Bit	7	6	5	4	3	2	1	0
0	Structure		Area	Elements				
1								
2								
3								

Figure 6.2-3 SCCH Message Format

6.2.2.2. FACCH1 Format

FACCH1 used with VCH for voice communication steeled is mainly used to carry temporal user data information during voice and mainly carries control information of calling id information, etc. at the time of being connected to Trunking. FACCH1 has capacity to carry 10 Octets information.

Octet \ Bit	7	6	5	4	3	2	1	0
0	F1	F2	Message Type					
1	Elements							
2								
...								
8								
9								

Figure 6.2-4 FACCH1 Message Format

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6.2.2.3. UDCH2 Format

UDCH2 is used to perform Data communication and has capacity to carry 20 Octets information.

As described in Chapter 6.4.1.2 and Chapter 6.4.1.3, layer 3 information is included in header UDCH2, UDCH2 except header UDCH2 is mainly used to carry User Data. Therefore method of using area after Octet0 and Octet1 is different between header UDCH2 and UDCH2 except header UDCH2.

Bit / Octet	7	6	5	4	3	2	1	0
0	F1	F2	Message Type					
1	Elements and/or User Data							
2								
...								
18								
19								

Figure 6.2-5 UDCH2 Message Format

6.2.2.4. FACCH3 Format

FACCH3, which is used by replacing UDCH2 for data call or is used independently, is mainly used to register the position, to carry setting information, or to perform Status Communication. FACCH3 has capacity to carry 20 Octets information.

Bit / Octet	7	6	5	4	3	2	1	0
0	F1	F2	Message Type					
1	Elements							
2								
...								
18								
19								

Figure 6.2-6 FACCH3 Message Format

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6.3. Structure Field

The structure included in the Functional Channel SCCH of Radio Frequency Channel RTCH2 is representative of the structure information of the Functional Channel and also information indicating a type of layer-3 message.
Structure information of Functional Channel is shown in Table 6.3-1 and type of message is shown in Table 6.3-2.

Bit 7	Bit 6	Description
0	0	4/4 SCCH (tail), or single SCCH
0	1	3/4 SCCH
1	0	2/4 SCCH
1	1	1/4 SCCH (header)

Table 6.3-1 Structure Type on RTCH2 with SCCH

Bit 7	Bit 6	Message Name (Alias)
0	0	Information4 (INFO4)
0	1	Information3 (INFO3)
1	0	Information2 (INFO2)
1	1	Information1 (INFO1)

Table 6.3-2 Type of Messages on SCCH

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6.4. Message Definitions

Definition of layer-3 message of FACCH1, UDCH2, and FACCH3 is provided in this chapter.
Each message decides which Functional Channel is used to send which control information and classified largely into three messages depending on each purpose

- Call Control Message used at the time of talk for various kinds of calling processing and cutting processing of talk.
- Mobility Management Message used at the time of registering position and updating various kinds of set information.
- Broadcast Message used to inform about Trunked System.

Detailed definition of function of each message, Functional Channel and system format used is provided in later chapters. And the Information Element of M/O on the right side of message format indicates Mandatory or Option.

Definition of layer 3 message of Functional Channel SCCH is shown in Chapter 6.5.

6.4.1. Call Control Messages

Call Control Message is message used at the time of voice communication service; Data communication service and additional services such as status are performed. Call Control Message can be further classified into more detailed messages as shown from Table 6.4-1 to Table 6.4-4.

Message Name (Alias)	Description	In/Out	CH	Trunked Type	Message Type
Voice Call (VCALL)	Indication of performing voice communication.	Both	FA1	Both	00 0001
Data Call (Header Format) (DCALL)	Indication of performing Data communication.	Both	UD2	Both	00 1001
Data Call (User Data Format) (DCALL)	Indication of performing Data communication.	Both	UD2	Both	00 1011
Data Call Acknowledge (DCALL_ACK)	Indication of replying to Data communication.	Both	UD2	Both	00 1100
Transmission Release (TX_REL)	Indication of releasing sending right.	Both	FA1 FA3	Both	00 1000
Transmission Release Extension (TX_REL_EX)	Indication of releasing sending right.	Out	FA1 FA3	Multi	00 0111
Header Delay (HEAD_DLY)	Indication of delay time until header frame is sent.	Both	FA3	Both	00 1111

Table 6.4-1 Messages used on a RTCH2

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Message Name (Alias)	Description	In/Out	CH	Trunked Type	Message Type
Short Data Call Request (Header Format) (SDCALL_REQ)	Indication of requesting Short Data Communication or voice parallel Data communication.	Both	FA1	Both	11 1000
Short Data Call Request (User Data Format) (SDCALL_REQ)	Indication of performing Short Data Communication or voice parallel Data communication.	Both	FA1	Both	11 1001
Short Data Call Response (SDCALL_RESP)	Indication of reply to Short Data Communication or voice parallel Data communication.	Both	FA1	Both	11 1011
Status Inquiry Request (STAT_INQ_REQ)	Indication of requesting reference of status.	Both	FA1 FA3	Both	11 0000
Status Inquiry Response (STAT_INQ_RESP)	Indication of replying to reference of status.	Both	FA1 FA3	Both	11 0001
Status Request (STAT_REQ)	Indication of sending notice of status.	Both	FA1 FA3	Both	11 0010
Status Response (STAT_RESP)	Indication of replying to notice of status.	Both	FA1 FA3	Both	11 0011
Remote Control Request (REM_CON_REQ)	Indication of requesting Remote Control.	Both	FA1 FA3	Both	11 0100
Remote Control Response (REM_CON_RESP)	Indication of replying to requesting Remote Control	Both	FA1 FA3	Both	11 0101

Table 6.4-2 Messages used for Supplemental Service

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Message Name (Alias)	Description	In/Out	CH	Trunked Type	Message Type
Call Request (CALL_REQ)	Indication of requesting communication.	In	FA1	Both	00 0000
Call Response (CALL_RESP)	Indication of replying to requesting communication.	Out	FA1	Both	00 0000
Call Connection Response (CALL_CONN_RESP)	Indication of replying to connection for communication.	Out	FA3	Both	00 0110
Voice Call Request (VCALL_REQ)	Indication of requesting voice communication.	In	FA1 FA3	Multi	00 0100
Voice Call Assignment (VCALL_ASSGN)	Indication of allocating Traffic Channel to voice communication.	Out	FA1	Multi	00 0100

Table 6.4-3 Messages used for Calling Procedure

Message Name (Alias)	Description	In/Out	CH	Trunked Type	Message Type
Idle (IDLE)	Indication of idling state.	Both	FA1 FA3	Both	01 0000
Disconnect Request (DISC_REQ)	Indication of requesting cutting communication and cancel of service.	In	FA1	Multi	01 0001
Disconnect (DISC)	Indication of cutting of communication and cancel of service.	Out	FA1	Multi	01 0001

Table 6.4-4 Other Messages

6.4.1.1. Voice Call (VCALL)

Voice Call is message used while performing voice communication on Traffic Channel.

Flag1: Spare
Flag2: Spare

Bit / Octet	7	6	5	4	3	2	1	0	M/O
0	F1	F2	Message Type						M
1	CC Option								
2	Call Type			Voice Call Option					
3	Home Repeater / Source Prefix								
4	Source Unit ID								
5	Home Repeater / Destination Prefix								
6	Destination Group or Unit ID								
7	Cipher Type		Key ID						

Figure 6.4-1 Voice Call Format

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Talk form is shown by value of Call Type (Octet 2; Bit7-5). Set value of Octet3-6 depending Call Type is shown in Table 6.4-5.

Call Type	Source ID	Destination ID
Group Call	Unit ID on sending side	Group ID
Individual Call	Unit ID on sending side	Unit ID on receiving side
Interconnect Call (call from SU)	Subscriber Unit ID	PSTN ID
Interconnect Call (call from PSTN)	PSTN ID	Subscriber Unit ID

Table 6.4-5 Configuring ID of VCALL for each Call Type

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6.4.1.2. Data Call (Header format) (DCALL)

Data Call is message used when performing Data communication of confirmation distribution or non-confirmation distribution format. Data Call uses two kinds of Header format consists of header portion of layer-3 information and User Data format consists of User Data portion to carry User Data. Header format is used on header UDCH2 and User Data format is used on UDCH2 except header UDCH2.
Receiver judges number of UDCH2 following header UDCH2, information length of User Data, and information of resending by inspecting header portion of Header format, thereby constructing User Data correctly.

Header format used in Data communication is shown in Figure 6.4-2.
Set value of Octet3-6 depending on Call Type follows as Table 6.4-5.

Flag1: Spare
Flag2: Spare

Octet \ Bit	7	6	5	4	3	2	1	0	M/O
0	F1	F2	Message Type						M
1	CC Option								
2	Call Type			Data Call Option					
3	Home Repeater / Source Prefix								
4	Source Unit ID								
5	Home Repeater / Destination Prefix								
6	Destination Group or Unit ID								
7	Cipher Type		Key ID						
8	Packet Information								
9									
10									

Figure 6.4-2 Header Format of Data Call

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6.4.1.3. Data Call (User Data format) (DCALL)

Data Call is a message used to carry user data following Header format of Chapter 6.4.1.2 in Data communication. This user data format is used on UDCH2 except header UDCH2. This format includes only information indicating order of sending UDCH2 and order of data block. However User Data area to send the last block includes Message CRC calculated by the whole User Data.

Flag1: Spare
Flag2: Spare

Octet \ Bit	7	6	5	4	3	2	1	0	M/O
0	F1	F2	Message Type						M
1	Packet Frame Number				Block Number				
2	User Data Area								M
...									
19									

Figure 6.4-3 User Data Format of Data Call

6.4.1.4. Data Call Acknowledge (DCALL_ACK)

Data Call Acknowledge is message used as reply when receiving Data communication confirmation distribution form. This message reports received result and caller performs process of resending depending on the contents.

Flag1: Spare
Flag2: Spare

Octet \ Bit	7	6	5	4	3	2	1	0	M/O
0	F1	F2	Message Type						M
1	CC Option								
2	Call Type			Data Call Option					
3	Home Repeater / Source Prefix								
4	Source Unit ID								
5	Home Repeater / Destination Prefix								
6	Destination Unit ID								
7	Response Information								
8									
9	Error Block Flag								
10									

Figure 6.4-4 Data Call Acknowledge Format

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6.4.1.5. Transmission Release (TX_REL)

Transmission release is message used at the end of sending on Traffic Channel.
This message is used in the last frame of sending, thereby, receiver can identify end of sending.
Format of Figure 6.4-5 is used in inbound direction, format of Figure 6.4-6 is used in outbound direction.

Flag1: Spare
Flag2: Spare

Bit / Octet	7	6	5	4	3	2	1	0	M/O
0	F1	F2	Message Type						M
1	CC Option								
2	Call Type			Spare					
3	Home Repeater / Source Prefix								
4	Source Unit ID								
5	Home Repeater / Destination Prefix								
6	Destination Group or Unit ID								

Figure 6.4-5 Inbound Transmission Release Format

Bit / Octet	7	6	5	4	3	2	1	0	M/O
0	F1	F2	Message Type						M
1	CC Option								
2	Call Type			Free Repeater					
3	Home Repeater / Source Prefix								
4	Source Unit ID								
5	Home Repeater / Destination Prefix								
6	Destination Group or Unit ID								

Figure 6.4-6 Outbound Transmission Release Format

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6.4.1.6. Transmission Release Extension (TX REL EX)

Transmission Release Extension is a message in a Multi Trunked System used by the TC on the Traffic CH when the Traffic CH is in a released state.
This message is used on the outbound Traffic CH and the SU that receives it can understand that no other SU is transmitting on this Traffic CH.

Flag1: Spare
Flag2: Spare

Bit / Octet	7	6	5	4	3	2	1	0	M/O
0	F1	F2	Message Type						M
1	CC Option								
2	Call Type			Free Repeater					
3	Home Repeater / Source Prefix								
4	Source Unit ID								
5	Home Repeater / Destination Prefix								
6	Destination Group or Unit ID								
7	TX	Spare							

Figure 6.4-7 Transmission Release Extension Format

This message is the extended version of the TX REL message, and only the additional Octet 7 is different.
Transmission Flag (Octet7, Bit 7)
Is a flag to show whether transmission on the Traffic CH is permitted or prohibited.
TX = 0 : transmission prohibited
TX = 1 : transmission permitted

6.4.1.7. Header Delay (HEAD_DLY)

Header delay is message used to indicate delay time until valid header frame is sent, when performing non voice communication such as Data communication on Traffic Channel.

Flag1: Spare
Flag2: Spare

Bit / Octet	7	6	5	4	3	2	1	0	M/O
0	F1	F2	Message Type						M
1	CC Option								
2	Call Type			Spare					
3	Home Repeater / Source Prefix								
4	Source Unit ID								
5	Home Repeater / Destination Prefix								
6	Destination Group or Unit ID								
7	Delay Count								
8									

Figure 6.4-8 Header Delay Format

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6.4.1.8. Short Data Call (Header format) (SDCALL_REQ)

Short Data Call is message used when performing Short Data Communication or voice parallel Data communication and has form to use FACCH1 on Traffic Channel. Short Data Call uses two kinds of Header format consists of header portion of layer-3 information and User Data format dedicated to User Data. Header format is used on header FACCH1 and User Data format is used on FACCH1 except header FACCH1. Receiver judges number of FACCH1 following header FACCH1, information length of User Data, and information of resending by inspecting header portion of Header format, thereby constructing User Data correctly.

Flag1: Spare
Flag2: Spare

Bit / Octet	7	6	5	4	3	2	1	0	M/O
0	F1	F2	Message Type						M
1	CC Option								
2	Call Type			Data Call Option					
3	Home Repeater / Source Prefix								
4	Source Unit ID								
5	Home Repeater / Destination Prefix								
6	Destination Group or Unit ID								
7	Cipher Type		Key ID						
8	Packet Information								
9									

Figure 6.4-9 Header Format of Short or Simultaneous Data Call

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6.4.1.9. Short Data Call (User Data format) (SDCALL_REQ)

Short Data Call is message used to carry user data following Header format of Chapter 6.4.1.8 in Short Data Communication or voice parallel Data communication. This user data format is used on FACCH1 except header FACCH1.
This format includes only information indicating order of sending FACCH1 and order of data block. However User Data area to send the last block includes Message CRC calculated by the whole User Data.

Flag1: Spare
Flag2: Spare

Octet \ Bit	7	6	5	4	3	2	1	0	M/O
0	F1	F2	Message Type						M
1	Packet Frame Number				Block Number				
2	User Data Area								M
...									
9									

Figure 6.4-10 User Data Format of Short or Simultaneous Data Call

6.4.1.10. Short Data Call Response (SDCALL_RESP)

Short Data Call Response is message used as reply when receiving Short Data Communication or voice parallel Data communication of confirmation distribution form. This message reports received result and caller performs process of resending depending on the contents.

Flag1: Spare
Flag2: Spare

Octet \ Bit	7	6	5	4	3	2	1	0	M/O
0	F1	F2	Message Type						M
1	CC Option								
2	Call Type			Data Call Option					
3	Home Repeater / Source Prefix								
4	Source Unit ID								
5	Home Repeater / Destination Prefix								
6	Destination Group or Unit ID								
7	Cause (SS)								
8	Error Block Flag								
9									

Figure 6.4-11 Short or Simultaneous Data Call Response Format

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6.4.1.11. Status Inquiry Request (STAT_INQ_REQ)

Status Inquiry Request is message used when current status of other Subscriber Unit is referred. Subscriber Unit performs processing of reply status, when receiving this message.

Flag1: Spare
Flag2: Spare

Bit / Octet	7	6	5	4	3	2	1	0	M/O
0	F1	F2	Message Type						M
1	CC Option								
2	Call Type			Status Call Option					
3	Home Repeater / Source Prefix								
4	Source Unit ID								
5	Home Repeater / Destination Prefix								
6	Destination Unit ID								

Figure 6.4-12 Status Inquiry Request Format

6.4.1.12. Status Inquiry Response (STAT_INQ_RESP)

Status Inquiry Response is message used to reply current status, after receiving Status Inquiry Request to Subscriber Unit.

Flag1: Spare
Flag2: Spare

Bit / Octet	7	6	5	4	3	2	1	0	M/O
0	F1	F2	Message Type						M
1	CC Option								
2	Call Type			Spare					
3	Home Repeater / Source Prefix								
4	Source Unit ID								
5	Home Repeater / Destination Prefix								
6	Destination Unit ID								
7	Cause (SS)								
8	Status								

Figure 6.4-13 Status Inquiry Response Format

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6.4.1.13. Status Request (STAT_REQ)

Status Request is message used when Subscriber Unit sends current status.

Flag1: Spare
Flag2: Spare

Octet \ Bit	7	6	5	4	3	2	1	0	M/O
0	F1	F2	Message Type						M
1	CC Option								
2	Call Type			Status Call Option					
3	Home Repeater / Source Prefix								
4	Source Unit ID								
5	Home Repeater / Destination Prefix								
6	Destination group or Unit ID								
7	Spare								
8	Status								

Figure 6.4-14 Status Request Format

6.4.1.14. Status Response (STAT_RESP)

Status Response is message used to reply received result, after receiving Status Request which Subscriber Unit sent.

Flag1: Spare
Flag2: Spare

Octet \ Bit	7	6	5	4	3	2	1	0	M/O
0	F1	F2	Message Type						M
1	CC Option								
2	Call Type			Spare					
3	Home Repeater / Source Prefix								
4	Source Unit ID								
5	Home Repeater / Destination Prefix								
6	Destination Unit ID								
7	Cause (SS)								

Figure 6.4-15 Status Response Format

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6.4.1.15. Remote Control Request (REM_CON_REQ)

Remote Control Request is used when SU controls other SU remotely.

Flag1: Spare
Flag2: Spare

Bit / Octet	7	6	5	4	3	2	1	0	M/O
0	F1	F2	Message Type						M
1	CC Option								
2	G/U	Spare	D	Control Command					
3	Home Repeater / Source Prefix								
4	Source Unit ID								
5	Home Repeater / Destination Prefix								
6	Destination Unit ID								
7	Control Parameter								
8									

Figure 6.4-16 Remote Control Request Format

Three flag setting of Octet 2 is as following.
G/U (Group ID or Unit ID)
Content of Information Element set in Octet5-6 is shown.
G/U= 0 : Group ID
G/U= 1 : Unit ID

D (Delivery)
D indicates whether this message is processed in non-confirmation manner or confirmation manner.
D= 0 : non-confirmation manner where reply is unnecessary.
D= 1 : confirmation manner where reply is necessary
(but valid only where G/U=Unit ID).

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6.4.1.16. Remote Control Response (REM_CON_RESP)

Remote control response is message used to reply received result, when receiving Remote Control Request requested by other SU or TRS/CRS.

Flag1: Spare
Flag2: Spare

Bit / Octet	7	6	5	4	3	2	1	0	M/O
0	F1	F2	Message Type						M
1	CC Option								
2	G/U	Spare	Spare	Control Command					
3	Home Repeater / Source Prefix								
4	Source Unit ID								
5	Home Repeater / Destination Prefix								
6	Destination Unit ID								
7	Spare								
8	Cause (SS)								

Figure 6.4-17 Remote Control Response Format

6.4.1.17. Call Request (CALL_REQ)

In Trunked System, Call Request is message used on Traffic Channel when SU requests connection to perform communication. When TC receives this message, TC processes following contents of Information Element.
System ID is arbitrary Information Element assigned by CC Option.

Flag1: Spare
Flag2: Spare

Bit / Octet	7	6	5	4	3	2	1	0	M/O
0	F1	F2	Message Type						M
1	CC Option								
2	Call Type		Spare						
3	Home Repeater / Source Prefix								
4	Source Unit ID								
5	Home Repeater / Destination Prefix								
6	Destination Group or Unit ID								
-/7	System ID Option								O
-/8	System ID								
-/9									

Figure 6.4-18 Call Request Format

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6.4.1.18. Call Response (CALL_RESP)

In Trunked System, call response is message used by TC on Traffic Channel to reply processed result of TC to connection request from SU.
System ID is arbitrary Information Element assigned by CC Option.

Flag1: Spare
Flag2: Spare

Octet \ Bit	7	6	5	4	3	2	1	0	M/O
0	F1	F2	Message Type						M
1	CC Option								
2	Call Type			Free Repeater					
3	Home Repeater / Source Prefix								
4	Source Unit ID								
5	Home Repeater / Destination Prefix								
6	Destination Group or Unit ID								
-/7	System ID Option								O
-/8	System ID								
-/9									

Figure 6.4-19 Call Response Format

6.4.1.19. Call Connection Response (CALL_CONN_RESP)

In Trunked System, Call Connection Response is message used by TC on Traffic Channel to reply connection situation for connection request from SU when performing communication between sites.
System ID is arbitrary Information Element assigned by CC Option.

Flag1: Spare
Flag2: Spare

Octet \ Bit	7	6	5	4	3	2	1	0	M/O
0	F1	F2	Message Type						M
1	CC Option								
2	Call Type			Free Repeater					
3	Home Repeater / Source Prefix								
4	Source Unit ID								
5	Home Repeater / Destination Prefix								
6	Destination Group or Unit ID								
7	Cause (VD)								
-/8	System ID Option								O
-/9	System ID								
-/10									

Figure 6.4-20 Call Connection Response Format

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6.4.1.20. Voice Call Request (VCALL_REQ)

In Trunked System, Voice Call Request is message used when SU requests Traffic Channel to perform voice communication. When TC receives this message, TC processes following contents of Information Element.

VCALL_REQ has 3 kinds of format shown below, depending on Call Type.
When Call Type is Individual Call, format of Figure 6.4-21 is used.

Flag1: Spare
Flag2: Spare

Bit / Octet	7	6	5	4	3	2	1	0	M/O
0	F1	F2	Message Type						M
1	CC Option								
2	Call Type			Voice Call Option					
3	Source Prefix								
4	Source Unit ID								
5	Destination Prefix								
6	Destination Unit ID								

Figure 6.4-21 Voice Call Request Format for Individual Call

When Call Type is Speed Dial Call, format of Figure 6.4-22 is used.
In this case, Octet 5-6 indicates Unit ID appointing PSTN, Octet 7 indicates shortened number on receiving side set in advance for telephone number.

Bit / Octet	7	6	5	4	3	2	1	0	M/O
0	F1	F2	Message Type						M
1	CC Option								
2	Call Type			Voice Call Option					
3	Source Prefix								
4	Source Unit ID								
5	Spare								
6	PSTN ID								
7	Speed Dial								

Figure 6.4-22 Voice Call Request Format for Speed Dial

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When Call Type is Dialing Call, format of Figure 6.4-23 is used to send.
In this case, Octet 5-6 indicates Unit ID appointing PSTN, Octet 7-19 indicates telephone number on receiving side. By setting the first digit of telephone number to Digit 1, it is possible to send 26 digits telephone number at most, if telephone number has less than 26 digits, then the latter half is filled with Fillers.

Octet \ Bit	7	6	5	4	3	2	1	0	M/O
0	F1	F2	Message Type						M
1	CC Option								
2	Call Type				Voice Call Option				
3	Source Prefix								
4	Source Unit ID								
5	Spare								
6	PSTN ID								
7	Digit 1				Digit 2				
8	Digit 3				Digit 4				
…	…				…				
19	Digit 25				Digit 26				

Figure 6.4-23 Voice Call Request Format for Interconnect

6.4.1.21. Voice Call Assignment (VCALL_ASSGN)

SU uses Voice Call Assignment message on Traffic Channel, when Traffic Channel is allocated to request of voice communication, in Trunked System.

Flag1: Spare
Flag2: Spare

Octet \ Bit	7	6	5	4	3	2	1	0	M/O
0	F1	F2	Message Type						M
1	CC Option								
2	Call Type				Voice Call Option				
3	Source Prefix								
4	Source Unit ID								
5	Destination Prefix								
6	Destination Unit ID								
7	Call Timer								
8	Spare								

Figure 6.4-24 Voice Call Assignment Format

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6.4.1.22. Idle (IDLE)

Idle is message used when there is no information to be sent particularly such as when repeater is sending Idle.

Flag1: Spare
Flag2: Spare

Bit / Octet	7	6	5	4	3	2	1	0	M/O
0	F1	F2	Message Type						M

Figure 6.4-25 Idle Format

6.4.1.23. Disconnect Request (DISC_REQ)

Disconnect Request is message used when SU requests end of communication on Traffic Channel or when service is cancelled.

Flag1: Spare
Flag2: Spare

Bit / Octet	7	6	5	4	3	2	1	0	M/O
0	F1	F2	Message Type						M
1	CC Option								
2	Call Type			Spare					
3	Source Prefix								
4	Source Unit ID								
5	Destination Prefix								
6	Destination Unit ID								
7	Cause (DREQ)								

Figure 6.4-26 Disconnect Request Format

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6.4.1.24. Disconnect (DISC)

Disconnect is message used when releasing Traffic Channel of Trunking Repeater or when service is cancelled.

Flag1: Spare
Flag2: Spare

Octet \ Bit	7	6	5	4	3	2	1	0	M/O
0	F1	F2	Message Type						M
1	CC Option								
2	Call Type			Spare					
3	Source Prefix								
4	Source Unit ID								
5	Destination Prefix								
6	Destination Unit ID								
7	Cause (DISC)								

Figure 6.4-27 Disconnect Format

Set value of Octet3-6 depending on call type is shown in Table 6.4-6.

Call Type	Source ID	Destination ID
Individual Call	Unit ID on originating side	Unit ID on arriving side.
Interconnect Call (Call from SU)	Subscriber Unit ID	PSTN ID
Interconnect Call (Call from PSTN)	PSTN ID	Subscriber Unit ID

Table 6.4-6 Configuring ID of DISC for each Call Type

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6.4.2. Mobility Management Messages

Mobility Management Message is message used in processing of position registration, recognition, joining group and updating set information of Subscriber Unit.

Message Name (Alias)	Description	In/Out	CH	Trunked Type	Message Type
Registration Request (REG_REQ)	Indication of requesting Registration.	In	FA3	Multi	10 0000
Registration Response (REG_RESP)	Indication of replying to request of Registration.	Out	FA3	Multi	10 0000
Registration Clear Request (REG_C_REQ)	Indication of requesting deleting Registration.	In	FA3	Multi	10 0010
Registration Clear Response (REG_C_RESP)	Indication of replying to request of deleting Registration.	Out	FA3	Multi	10 0010
Group Registration Request (GRP_REG_REQ)	Indication of requesting Registration of group.	In	FA3	Multi	10 0100
Group Registration Response (GRP_REG_RESP)	Indication of replying to request of Registration.	Out	FA3	Multi	10 0100
Authentication Inquiry Request (AUTH_INQ_REQ)	Indication of requesting reference of recognition.	Both	FA3	Single	10 1000
		Out	FA3	Multi	
Authentication Inquiry Response (AUTH_INQ_RESP)	Indication of replying to reference request of recognition.	Both	FA3	Single	10 1001
		In	FA3	Multi	
Data Write (Header Format) (DWR)	Indication of performing Data Write communication.	Out	FA3	Multi	10 1011
Data Write (Data Format) (DWR)	Indication of performing Data Write communication.	Out	FA3	Multi	10 1100
Data Write Acknowledge (DWR_ACK)	Indication of replying to Data Write communication.	In	FA3	Multi	10 1101

Table 6.4-7 Messages for Mobility management

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6.4.2.1. Registration Request (REG_REQ)

SU uses Registration Request Message on Traffic Channel, when registering SU.

Flag1: Spare
Flag2: Spare

Bit / Octet	7	6	5	4	3	2	1	0	M/O
0	F1	F2	Message Type						M
1	Registration Option								
2	(Subscriber Home) System ID								
3									
4	Source Prefix								
5	Source Unit ID								
6	Group Prefix								
7	Group ID								
8	Subscriber Type								
9									
10	Version Number								
11	Registration Sequence Number								
12									

Figure 6.4-28 Registration Request Format

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6.4.2.2. Registration Response (REG_RESP)

SU uses Registration Response Message on Traffic Channel, when replying to Registration Request from SU.
Home Repeater and Secondary Home Repeater is Information Element appointed except Home Site.
Visitor Unit ID and Visitor Group ID is arbitrary Information Element appointed by Registration Option.

Flag1: Spare
Flag2: Spare

Bit / Octet	7	6	5	4	3	2	1	0	M/O
0	F1	F2	Message Type						M
1	Registration Option								
2	(Subscriber Home) System ID								
3									
4	Destination Prefix								
5	Destination Unit ID								
6	Group Prefix								
7	Group ID								
8	Cause (MM)								
-/9	Spare			Home Repeater					O
-/10	Spare			Secondary Home Repeater					
-/11	Spare								O
-/12	Visitor Unit ID								
-/13	Spare								
-/14	Visitor Group ID								

Figure 6.4-29 Registration Response Format

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6.4.2.3. Registration Clear Request (REG_C_REQ)

Registration Clear Request is message used by SU on Traffic Channel, when erasing Registration information of SU.

Flag1: Spare
Flag2: Spare

Bit / Octet	7	6	5	4	3	2	1	0	M/O
0	F1	F2	Message Type						M
1	Registration Option								
2	(Subscriber Home) System ID								
3									
4	Source Prefix								
5	Source Unit ID								

Figure 6.4-30 Registration Clear Request Format

6.4.2.4. Registration Clear Request (REG_C_RESP)

Registration Clear Request is message used by SU on Traffic Channel, when replying to Registration erasing request from SU.

Flag1: Spare
Flag2: Spare

Bit / Octet	7	6	5	4	3	2	1	0	M/O
0	F1	F2	Message Type						M
1	Registration Option								
2	(Subscriber Home) System ID								
3									
4	Destination Prefix								
5	Destination Unit ID								
6	Cause (MM)								

Figure 6.4-31 Registration Clear Response Format

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6.4.2.5. Group Registration Request (GRP_REG_REQ)

SU uses Group Registration Request message on Traffic Channel, when registering group to which SU belongs.

Flag1: Spare
Flag2: Spare

Octet \ Bit	7	6	5	4	3	2	1	0	M/O
0	F1	F2	Message Type						M
1	Group Registration Option								
2	Source Prefix								
3	Source Unit ID								
4	Group Prefix								
5	Group ID								

Figure 6.4-32 Group Registration Request Format

6.4.2.6. Group Registration Response (GRP_REG_RESP)

SU uses Group Registration Response message on Traffic Channel, when replying to Registration Request from SU.
Visitor Group ID is arbitrary Information Element assigned by Group Registration Option.

Flag1: Spare
Flag2: Spare

Octet \ Bit	7	6	5	4	3	2	1	0	M/O
0	F1	F2	Message Type						M
1	Group Registration Option								
2	Destination Prefix								
3	Destination Unit ID								
4	Group Prefix								
5	Group ID								
6	Cause (MM)								
-/7	Visitor Group Prefix								O
-/8	Visitor Group ID								

Figure 6.4-33 Group Registration Response Format

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6.4.2.7. Authentication Inquiry Request (AUTH_INQ_REQ)

Authentication Inquiry Request is message used to inquire recognition information, when confirming justification of SU.
System ID is arbitrary Information Element appointed by Authentication Option.

Flag1: Spare
Flag2: Spare

Octet \ Bit	7	6	5	4	3	2	1	0	M/O
0	F1	F2	Message Type						M
1	Authentication Option								
2	Home Repeater / Source Prefix								
3	Source Unit ID								
4	Home Repeater / Destination Prefix								
5	Destination Unit ID								
6	Authentication Parameter								
7									
-/8	System ID Option								O
-/9	System ID								
-/10									

Figure 6.4-34 Authentication Inquiry Request Format

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6.4.2.8. Authentication Inquiry Response (AUTH_INQ_RESP)

Authentication Inquiry Response is message used to inform recognition information, when confirming justification of SU.
System ID is arbitrary Information Element assigned by Authentication Option.

Flag1: Spare
Flag2: Spare

Octet \ Bit	7	6	5	4	3	2	1	0	M/O
0	F1	F2	Message Type						M
1	Authentication Option								
2	Home Repeater / Source Prefix								
3	Source Unit ID								
4	Home Repeater / Destination Prefix								
5	Destination Unit ID								
6	Authentication Value								
7									
8									
9									
10									
11									
12									
-/13	System ID Option								O
-/14	System ID								
-/15									

Figure 6.4-35 Authentication Inquiry Response Format

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6.4.2.9. Data Write (Header Format) (DWR)

Data Write is a message used when starting communication, updating set information of SU.

Flag1: Spare
Flag2: Spare

Octet \ Bit	7	6	5	4	3	2	1	0	M/O
0	F1	F2	Message Type						M
1	Data Write Option								
2	Spare				Spare				
3	Source Prefix								
4	Source Unit ID								
5	Destination Prefix								
6	Destination Unit ID								
7	Spare		Spare						
8	Packet Information								
9									
10									

Figure 6.4-36 Header Format for Data Write

6.4.2.10. Data Write (System Data Format) (DWR)

Data Write is a message used to carry system data following Header format in communication, updating set information of SU. Except header, this format is used. In addition, Message CRC calculated from the whole System Data is included in System Data Area which sends the last block.

Flag1: Spare
Flag2: Spare

Octet \ Bit	7	6	5	4	3	2	1	0	M/O
0	F1	F2	Message Type						M
1	Packet Frame Number				Block Number				
2	System Data Area								M
...									
19									

Figure 6.4-37 System Data Format for Data Write

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6.4.2.11. Data Write Acknowledge (DWR_ACK)

Data Write Acknowledge is a message used as reply when receiving communication updating set information of SU.
Received result is reported by this message, and TR performs process of resending depending on the contents.

Flag1: Spare
Flag2: Spare

Bit / Octet	7	6	5	4	3	2	1	0	M/O
0	F1	F2	Message Type						M
1	Data Write Option								
2	Spare				Spare				
3	Source Prefix								
4	Source Unit ID								
5	Destination Prefix								
6	Destination Unit ID								
7	Response Information								
8									
9	Error Block Flag								
10									

Figure 6.4-38 Data Write Acknowledge Format

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6.4.3. Broadcast Messages

Broadcast Message is a message used to inform Subscriber Unit of service information and site information of Trunked System.

Message Name (Alias)	Description	In/Out	CH	Trunked Type	Message Type
Service Information (SRV_INFO)	Informing service information which site provides.	Out	FA1	Multi	01 1001
Adjacent Site information (ADJ_SITE_INFO)	Informing various kinds of information of adjacent site.	Out	FA1	Multi	01 1011

Table 6.4-8 Broadcast Messages

6.4.3.1. Service information (SRV_INFO)

Service information is a message which TC uses on Traffic Channel, when informing SU about information of service which site provides.

Flag1: Spare
Flag2: Spare

Bit / Octet	7	6	5	4	3	2	1	0	M/O
0	F1	F2	Message Type						M
1	Spare								
2	System ID (for current site)								
3									
4	Site Code								
5	Service Information								
6									
7	Restriction Information								
8									
9									

Figure 6.4-39 Service Information Format

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6.4.3.2. Adjacent Site information (ADJ_SITE_INFO)

Adjacent Site information is a message which TC uses on Traffic Channel, while informing SU about System ID and Site Code of adjacent site, and can alert site information of two adjacent sites.
When number of adjacent site is less than 2, System ID of Null and value of Site Code are used.

Flag1: Spare
Flag2: Spare

Octet \ Bit	7	6	5	4	3	2	1	0	M/O
0	F1	F2	Message Type						M
1	Spare							Index	
2	Adjacent Site Option (1)								
3	Adjacent Site System ID (1)								
4									
5	Adjacent Site Code (1)								
6	Adjacent Site Option (2)								
7	Adjacent Site System ID (2)								
8									
9	Adjacent Site Code (2)								

Figure 6.4-40 Adjacent Site Information Format

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6.4.4. Non-Standard Messages

Non-Standard Messages are messages where method of using Information Element is not defined.

Message Name (Alias)	Description	In/Out	CH	Conventional/ Trunked	Message Type
Proprietary Form (PROP_FORM)	Message which can be defined per maker.	Both	Any	Both	11 1111

Table 6.4-9 Non-Standard Messages

6.4.4.1. Proprietary Form (PROP_FORM)

Proprietary Form is a message where content of Information Element can be defined freely, when maker wants to add unique feature.
Manufacturer Number indicates maker number used in ESN. Contents can be defined freely after Octet2. Octet length 'n' differs from one Functional Channel to another.

Flag1: Spare
Flag2: Spare

Bit / Octet	7	6	5	4	3	2	1	0	M/O
0	F1	F2	Message Type						M
1	Manufacturer Number								
2	Manufacturer Definable Area								O
...									
n-1									
n									

Figure 6.4-41 Proprietary Form Format

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6.4.5. List of Message Type

Correspondence of Message Type and layer-3 message is shown as list.

Type	RTCH2	
	Outbound	Inbound
00 0000	CALL_RESP	CALL_REQ
00 0001	VCALL	←
00 0010		
00 0011		
00 0100	VCALL_ASSGN	VCALL_REQ
00 0101		
00 0110	CALL_CONN_RESP	
00 0111	TX REL EX	
00 1000	TX_REL	←
00 1001	DCALL (Header)	←
00 1010		
00 1011	DCALL (User Data)	←
00 1100	DCALL_ACK	←
00 1101		
00 1110		
00 1111	HEAD_DLY	←
01 0000	IDLE	←
01 0001	DISC	DISC_REQ
01 0010		
01 0011		
01 0100		
01 0101		
01 0110		
01 0111		
01 1000		
01 1001	SRV_INFO	
01 1010		
01 1011	ADJ_SITE_INFO	
01 1100		
01 1101		
01 1110		
01 1111		

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Type	RTCH2	
	Outbound	Inbound
10 0000	REG_RESP	REG_REQ
10 0001		
10 0010	REG_C_RESP	REG_C_REQ
10 0011		
10 0100	GRP_REG_RESP	GRP_REG_REQ
10 0101		
10 0110		
10 0111		
10 1000	AUTH_INQ_REQ	←
10 1001	AUTH_INQ_RESP	←
10 1010		
10 1011	DWR (Header)	
10 1100	DWR (System Data)	
10 1101		DWR_ACK
10 1110		
10 1111		
11 0000	STAT_INQ_REQ	←
11 0001	STAT_INQ_RESP	←
11 0010	STAT_REQ	←
11 0011	STAT_RESP	←
11 0100	REM_CON_REQ	←
11 0101	REM_CON_RESP	←
11 0110		
11 0111		
11 1000	SDCALL_REQ (Header)	←
11 1001	SDCALL_REQ (User Data)	←
11 1010		
11 1011	SDCALL_RESP	←
11 1100		
11 1101		
11 1110		
11 1111	PROP_FORM	←

Table 6.4-10　List of Layer3 Messages

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6.5. Message Definitions of SCCH

Definition of Functional Channel SCCH used on RTCH2 is provided in this chapter.
SCCH is used to inform various kinds of call processing, cutting process of talk and information from TC.
Detailed definition is provided in later chapters. And Information Element of M/O on the right side of message format indicates Mandatory or Option.

6.5.1. SCCH Messages

In Trunked System, type of layer-3 message dealt on SCCH is decided depending on structure type which identifies structure of channel, on Traffic Channel in inbound and outbound direction, 4 kinds of messages can be identified each direction.

Message Type (Alias)	Description	In/Out	CH	Trunked Type	Structure Type
Information4 (INFO4)	Indication of ID information on receiving side and control information of TRS.	Both	SC	Both	00
Information3 (INFO3)	Indication of ID information o sending side of SU.	Both	SC	Both	01
Information2 (INFO2)	Indication of ID information on receiving side of SU.	Both	SC	Both	10
Information1 (INFO1)	Indication of additional information of call control system.	Both	SC	Both	11

Table 6.5-1 Messages used on SCCH

6.5.2. Inbound Signaling Message (ISM)

Inbound signaling message is a message which SU sends to TC of Repeater at the time of communication in Trunked System.
Information4 (INFO4) and Information2 (INFO2) are the same information, only Information4 (INFO4) is used, when super Frame Structure is not employed such as at the time of Data communication and establishing link.

6.5.2.1. Information4 (INFO4)

This message is a format which deals ID of SU on receiving side and uses repeater information.
Message where Repeater in Use field is changed to “31” is sent at the end of sending.

Bit / Octet	7	6	5	4	3	2	1	0	M/O
0	Structure		Area	Repeater in Use					M
1	Home Repeater / Destination Prefix								
2	Destination Group or Unit ID								
3	G/U								

Figure 6.5-1 ISM INFO4 Format

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6.5.2.2. Information3 (INFO3)

This message is format which deals with ID of sender and use repeater information at the time of voice communication.

Bit / Octet	7	6	5	4	3	2	1	0	M/O
0	Structure		Area	Repeater in Use					M
1	Home Repeater / Source Prefix								
2	Source Unit ID								
3	Spare								

Figure 6.5-2 ISM INFO3 Format

6.5.2.3. Information2 (INFO2)

This message is format which deals with ID of SU on receiving side AND uses repeater information at the time of voice communication and the same format with Chapter 6.5.2.1, which is referred in Figure 6.5-1.

6.5.2.4. Information1 (INFO1)

This message is format which deals with communication option information and uses repeater information mainly at the time of voice communication.

Bit / Octet	7	6	5	4	3	2	1	0	M/O
0	Structure		Area	Repeater in Use					M
1	Pass Character (31)					Call Option			
2	Cipher Type		Key ID						
3	Spare								

Figure 6.5-3 ISM INFO1 Format

6.5.3. Outbound Signaling Message (OSM)

This message is to be sent from TC of repeater to SU in Trunked System.

6.5.3.1. Information4 (INFO4)

This message is format which deals with ID of SU on receiving side and crosses reference repeater information at the time of communication.
Format is shown in Figure 6.5-4.
The message where Go to Repeater field is “0” and the G/U field is “1” is the Registration Command (REG_COMM) message.
Message where Go to Repeater field is changed to “31”, is sent at the end of sending.
At the time of freedom of Home Repeater, Idle message shown in Figure 6.5-5 is sent at regular intervals.
Information for stopping service temporarily such as sending CWID is sent by format shown in Figure 6.5-6. When super Frame Structure is not employed such as at the time of Data communication, information of free repeater is sent by format shown in Figure 6.5-7.
In Multi Trunked System, site Identification Information is sent by format shown in Figure 6.5-8. In this message information is necessary for identifying each site of TRS networked. It is necessary to exclude Site Type by detecting this message so as to obtain the site at the time of roaming of SU and compare with allocated value to be matched.

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Octet \ Bit	7	6	5	4	3	2	1	0	M/O
0	Structure		Area	Go to Repeater					M
1	Home Repeater / Destination Prefix								
2	Destination Group or Unit ID								
3	G/U								

Figure 6.5-4 OSM INFO4 (Busy Repeater Message) Format

Octet \ Bit	7	6	5	4	3	2	1	0	M/O
0	Structure		Area	Repeater Number1					M
1	Repeater Number2								
2	ID=2046								
3	Spare								

Figure 6.5-5 OSM INFO4 (Idle Repeater Message) Format

Octet \ Bit	7	6	5	4	3	2	1	0	M/O
0	Structure		Area	Repeater Number1					M
1	Repeater Number2								
2	ID=2045								
3	Spare								

Figure 6.5-6 OSM INFO4 (Halt Repeater Message) Format

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Bit / Octet	7	6	5	4	3	2	1	0	M/O
0	Structure		Area	Free Repeater1					M
1	Free Repeater2								
2	ID=2044								
3	Spare								

Figure 6.5-7 OSM INFO4 (Free Repeater Message) Format

Bit / Octet	7	6	5	4	3	2	1	0	M/O
0	Structure		Area	Site Type					M
1	Site Code								
2	ID=2041								
3	Spare								

Figure 6.5-8 OSM INFO4 (Site ID Message) Format

6.5.3.2. Information3 (INFO3)

This message is format which deals with ID of sender and free repeater information at the time of voice communication.

Bit / Octet	7	6	5	4	3	2	1	0	M/O
0	Structure		Area	Free Repeater 1					M
1	Home Repeater / Source Prefix								
2	Source Unit ID								
3	Spare								

Figure 6.5-9 OSM INFO3 Format

6.5.3.3. Information2 (INFO2)

This message is format which deals with ID of SU on receiving side and crosses reference repeater information mainly at the time of voice communication and the same format with Chapter 6.5.3.1.

6.5.3.4. Information1 (INFO1)

This message is format which deals with communication option and free repeater information mainly at the time of voice communication.

Bit / Octet	7	6	5	4	3	2	1	0	M/O
0	Structure		Area	Free Repeater 1					M
1	Free Repeater 2					Call Option			
2	Cipher Type		Key ID						
3	Spare								

Figure 6.5-10 OSM INFO1 Format

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6.6. Element Definitions

Definition of various kinds of Information Element filled in layer-3 message is provided in this chapter.

6.6.1. Message Type

Message Type consists of 6 bits indicates type of layer-3 message of FACCH1, UDCH2 and FACCH3.

6.6.2. System ID

System ID consists of 19 bits is used in Multi Trunked System and is consists of Integrator Code and System Code to identify the operations manager of a system and system.
Value of Integrator Code and System Code is managed by management system in an integrated manner; proper value for each Trunked System is allocated from management system.

Bit	18 – 15	14 - 0
	Integrator Code	System Code

Figure 6.6-1 System ID Format

6.6.2.1. Integrator Code

Integrator code consists of 4 bits is identification code given only for the operations manager of a system. When it is not necessary to distinguish particularly, all bits may use Default value of “1”.

6.6.2.2. System Code

System Code consists of 15 bits is value allocated uniquely every Trunked System to identify Trunked System.

6.6.3. Area

Area is used for the purpose to prevent from cross talk adjacent to Trunked System with the same frequency.

Value(Bit)	Description
0/1	Setting 0 at the time of normal use, and set 1 for adjacent site in the case of occurring of radio disturbance.

Table 6.6-1 Area Values

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6.6.4. Site Type

Site Type consists of 2 bits is information indicating site coverage area to select and use proper Roaming Algorithm by SU.

Value(Bit)	Description
00	Reserving
01	Wide coverage area zone site.
10	Middle coverage area zone site.
11	Narrow coverage area zone site.

Table 6.6-2 Site Type Values

6.6.5. Site Code

Site Code consists of 8 bits, it is value set that uniquely identifies every site within TRS.

Value(Dec)	Description
0	Reserving as special number
1 – 250	Usable voluntarily every TRS.
251 – 255	Reserving as special number.

Table 6.6-3 Site Code Values

6.6.6. Home Repeater / Prefix

Home Repeater / Prefix consists of 5 bits are value allocated to identify Sub Group of each SU within Trunked System. In Single Trunked System, number matched with Home Repeater set every Sub Group within site is used.

Value(Dec)	Description
0	Used as Filler(Single Trunked System) Number indicating Prefix dedicated to visitor SU （Multi Trunked System）
1 – 30	Number indicating Sub Group of SU.
31	Reserving as special number.

Table 6.6-4 Home Repeater / Prefix ID Values

6.6.6.1. Home Repeater / Source Prefix

Home Repeater / Source Prefix consists of 5 bits are number of Home Repeater or Source Prefix allocated to Subscriber Unit of the message sender.

6.6.6.2. Home Repeater / Destination Prefix

Home Repeater / Destination Prefix consists of 5 bits are number of Home Repeater or Destination Prefix allocated to Subscriber Unit of the message destination.

6.6.7. Unit ID

Unit ID is consists of 11 bits and is value allocated to every unit within System to identify unit within System, and distinguished every Home Repeater or Prefix ID. The Prefix of the Unit which has a Special ID is "0".

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Value(Dec)	Definition	Description
0000	Null Unit ID	Used as filler without appointing specific Unit
0001 – 2000	Standard Unit ID	Unit ID definable uniquely every Home Repeater or Prefix ID
2001 – 2040	Special IDs	Reserving as special ID
2041	Special ID	Special ID indicating Site ID
2042	Special ID	Special ID indicating Interconnect (PSTN) talk
2043	Special ID	Special ID indicating session communication with TC
2044	Special ID	Special ID indicating Free Repeater
2045	Special ID	Special ID indicating Halt state
2046	Special ID	Special ID indicating Idle state
2047	All Unit	ID indicating all Unit

Table 6.6-5 Unit ID Values

6.6.7.1. Visitor Unit ID

Visitor Unit ID indicates Unit ID where TRS allocates temporally to SU at the time of performing Registration process by SU roaming from other system.

While SU is within this system, individual communication is performed using Visitor Unit ID and when being apart from system allocated Visitor Unit ID is released.

How range of Visitor Unit ID is allocated from range of Standard Unit ID of Prefix “0” is depending on System.

6.6.7.2. Source Unit ID

Source Unit ID used in layer-3 message indicates Unit ID of Subscriber Unit of the message sender.

6.6.7.3. Destination Unit ID

Destination Unit ID used in layer-3 message indicates Unit ID of Subscriber Unit of the message destination.

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6.6.8. Group ID

Group ID is consists of 11 bits and is value allocated to every group within System to identify group within the System, and distinguished every Home Repeater or Prefix ID. The Prefix of the Unit which has a Special ID is "0".

Value(Dec)	Definition	Description
0000	Null Group ID	Used as filler without appointing specific Group
0001 – 2000	Standard Group ID	Group ID definable uniquely every Home Repeater or Prefix ID
2001 – 2040	Special IDs	Reserving as special ID
2041	Special ID	Special ID indicating Site ID
2042	Special ID	Special ID indicating Interconnect (PSTN) talk
2043	Special ID	Special ID indicating session communication with TC
2044	Special ID	Special ID indicating Free Repeater
2045	Special ID	Special ID indicating Halt state
2046	Special ID	Special ID indicating Idle state
2047	All Group	ID indicating all Group

Table 6.6-6 Group ID Values

6.6.8.1. Visitor Group ID

Visitor Group ID indicates Group ID where TRS allocates temporarily to SU at the time of performing Registration processing by SU roaming from other system.
While SU is within this system, individual communication is performed using Visitor Group ID and when being apart from system allocated Visitor Group ID is released.
How range of Visitor Group ID is allocated from range of Standard Group ID of Prefix “0” depends on System.

6.6.9. G/U

G/U is used to distinguish whether ID of SU on receiving side is GID or UID.

Value(Bit)	Description
0	GID
1	UID

Table 6.6-7 G/U Values

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6.6.10. Free Repeater

Free Repeater is consists of 5 bits and it is repeater number usable for communication at the time.

Number of Free repeater number differs depending on type of message. Method of opting free repeater sent from TC is arbitrary. Detail of selection, holding or updating of received communicable free repeater is not specified.

Value(Dec)	Description
0	All TR are Busy
1 – 30	Number indicating channel of TR usable for communication.
31	Reserving as special number.

Table 6.6-8 Free Repeater Values

6.6.11. Repeater in Use / Go to Repeater

Repeater in Use is consists of 5 bits in inbound direction and it is repeater number which SU is sending. Go to Repeater of this position in outbound direction becomes repeater number of repeater connected to SU where the following Home Repeater / Prefix ID and ID are matched.

The message where Go to Repeater field is “0” and the G/U field is “1” is the Registration Command (REG_COMM) message.

At the end of sending of SU, message including number of “31” called End of Transmission (EOT) is sent.

Value(Dec)	Description
0	Registration Command (REG_COMM)
1 – 30	Number indicating channel of TR.
31	End of Transmission (EOT)

Table 6.6-9 Repeater in Use / Go to Repeater Values

6.6.12. Electronic Serial Number

Electronic Serial Number (ESN) is consists of 48 bits and it is unique number written by every maker.

6.6.13. Authentication Parameter

Authentication Parameter is consists of 16 bits and it is variable used in recognition processing.

6.6.14. Authentication Value

Authentication Value is consists of 56 bits and it is recognition value used in recognition processing.

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6.6.15. Registration Option

Registration Option is consists of 5 bits and it is additional information of position Registration system message.

Bit	4	3	2	1	0
	Em	H/V	Spare	Spare	Spare

Figure 6.6-2 Registration Option Format

Field	Description
Emergency	Indicates whether message of emergency state or not. 0: message of Non Emergency(normal) 1: message of Emergency
Home / Visitor	Indicates whether including Visitor ID in massage or not. 0: not including(Registration in Home or Single System) 1: including(Visitor Registration in Multi system)

Table 6.6-10 Registration Option Values

6.6.16. Group Registration Option

Group Registration Option is consists of 8 bits and it is used to indicate additional information in Group Registration processing.

Bit	7	6	5	4	3	2	1	0
	Em	H/V	←			Spare		→

Figure 6.6-3 Group Registration Option Format

Field	Description
Emergency	Indicates whether message of emergency state or not. 0: message of Non Emergency(normal) 1: message of Emergency
Home / Visitor	Indicates whether including Visitor ID in massage or not. Only GRP_REG_RESP is valid 0: not including(Registration in Home or Single System) 1: including(Visitor Registration in Multi system)

Table 6.6-11 Group Registration Option Values

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6.6.17. Authentication Option

Authentication Option consists of 8 bits indicates additional information of recognition processing.

Bit	7	6	5	4	3	2	1	0
	Em	Spare	H/V	T-Type	←	Spare		→

Figure 6.6-4 Authentication Option Format

Field	Description and Value
Emergency	Indicates whether message of emergency state or not. 0: message of Non Emergency(normal) 1: message of Emergency
Home / Visitor	Indicates whether including Visitor ID in massage or not. 0: not including(recognition reference in Home or Single System) 1: including(Visitor recognition reference in Multi system)
T-Type	Indicates type of Trunked System. 0: Single Trunked System 1: Multi Trunked System

Table 6.6-12 Authentication Option Values

6.6.18. Data Write Option

Data Write Option consists of 8 bits indicating additional information of information update processing.

Bit	7	6	5	4	3	2	1	0
	Em	←			Spare			→

Figure 6.6-5 Data Write Option Format

Field	Description
Emergency	Indicates whether message of emergency state or not. 0: message of Non Emergency(normal) 1: message of Emergency

Table 6.6-13 Data Write Option Values

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6.6.19. CC Option

CC Option consists of 8 bits that indicates additional information of call control system message.

Bit	7	6	5	4	3	2	1	0
	Em	I / I	Priority	T-Type	←	Spare		→

Figure 6.6-6 CC Option Format

Field	Description and Value
Emergency	Indicates whether message of emergency state or not. 0: message of Non Emergency(normal) 1: message of Emergency
Intra / Inter	Indicates whether an originating or incoming call is between different systems. 0: Intra-System (or Single System) 1: Inter-System
Priority	Indicates whether call with high priority or not. 0: normal call 1: call with priority
T-Type	Indicates type of Trunked System. 0: Single Trunked System 1: Multi Trunked System

Table 6.6-14 CC Option Values

6.6.20. Call Option

Call Option consists of 3 bits that indicates additional information of call control system message.

Set value is the same value with bit7, bit4, bit5 of Figure 6.6-6 shown in Chapter 6.6.19 CC Option.

Bit	2	1	0
	Em	T-Type	Priority

Figure 6.6-7 Call Option Format

6.6.21. Call Type

Call Type consists of 3 bits is value for identifying talk form in call.

Value(Bit)	Definition	Description
000	Broadcast Call	Indicates unidirectional Group Call.
001	Conference Call	Indicates bi-directional Group Call.
010	Unspecified Call	Indicates no appointing Call Type. This value is used only on TX_REL message.
011	Session Call	Indicates session communication with TC.
100	Individual Call	Indicates Individual Call.
101	Reserved	
110	Interconnect Call	Indicates PSTN call.
111	Speed Dial Call	Indicates PSTN using shortened number.

Table 6.6-15 Call Type Values

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6.6.22. Voice Call Option

Voice Call Option consists of 5 bits, it is used to indicate supplementary information in call of voice communication.

Bit	4	3	2	1	0
	Duplex	Spare	Transmission Mode		

Figure 6.6-8 Voice Call Option Format

Field	Description and Value
Duplex	Indicates access method. 0: Half Duplex access method(Subscriber Unit is Simplex) 1: Duplex access method
Transmission Mode	Indicates communication parameter such as transmission rate, Vocoder, etc. 000: 4800bps/EHR0 Other than those above: reserved

Table 6.6-16 Voice Call Option Values

6.6.23. Data Call Option

Data Call Option consists of 5 bits, it is used to indicate supplementary information in call of Data communication.

Bit	4	3	2	1	0
	Duplex	Spare	Transmission Mode		

Figure 6.6-9 Data Call Option Format

Field	Description and Value
Duplex	Indicates access method. 0: Half Duplex access method(Subscriber Unit is Simplex) 1: Duplex access method
Transmission Mode	Indicates communication parameter such as transmission rate, etc. 000: 4800bps Other than those above: reserved

Table 6.6-17 Data Call Option Values

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6.6.24. Status Call Option

Status Call Option consists of 5 bits, it is used to indicate supplementary information in call of Status Communication.

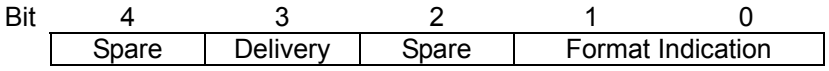

Figure 6.6-10 Status Call Option Format

Field	Description and Value
Delivery	Indicates whether non-confirmation manner or confirmation manner. 0: non-confirmation manner unnecessary for reply 1: confirmation manner necessary for reply
Format Indication	Indicates content of Status message. 00: Status Other than those above: reserved

Table 6.6-18 Status Call Option Values

6.6.25. System ID Option

System ID Option consists of 5 bits that indicates additional information of System ID included in message used in Multi Trunked System.

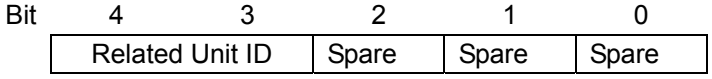

Figure 6.6-11 System ID Option Format

Field	Description
Related Unit ID	Indicates whether System ID relates to Source Unit ID or Destination Unit ID. When related Unit ID is assigned in format of each message, it is necessary for the set to be matched with the related Unit ID. 10: system ID of Source Unit ID 01:system ID of Destination Unit ID Other than those above is reserved

Table 6.6-19 System ID Option Values

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6.6.26. Digit

Digit consists of 4 bits, it is value that indicates digit of telephone number and DTMF signal.

Digit sent after extension DTMF Code uses value of Extended DTMF Code.

Value (Bit)	DTMF Code	Extended DTMF Code
0000	Filler	reserved
0001	“1”	“A”
0010	“2”	“B”
0011	“3”	“C”
0100	“4”	“D”
0101	“5”	reserved
0110	“6”	reserved
0111	“7”	reserved
1000	“8”	reserved
1001	“9”	reserved
1010	“0”	reserved
1011	“*”	reserved
1100	“#”	reserved
1101	reserved	reserved
1110	reserved	reserved
1111	extension	not used

Table 6.6-20 Digit Values

6.6.27. Speed Dial

Speed Dial consists of 8 bits, it is value to indicate shortened number.

Value(Hex)	Definition	Description
00	Null Dial	Used as filler not assigning specific shortened number.
01-FF	System definable	Shortened number definable in System

Table 6.6-21 Speed Dial Values

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6.6.28. Packet Information

Packet Information consists of 24 bits, it is used to indicate structure content of sending packet of Data communication.
In the case of SDCALL_REQ, only Octet 0 and Octet 1 are used and TX Fragment Count is not used.

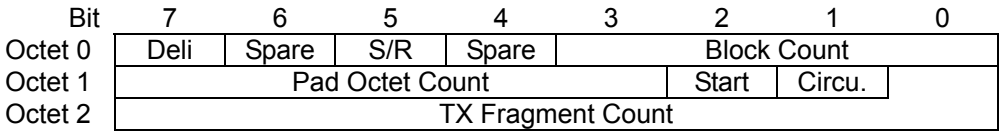

Figure 6.6-12 Packet Information Format

Field	Description and Value
Delivery Flag (Octet 0; Bit 7)	Indicates whether non-confirmation manner or confirmation manner. 0: non-confirmation unnecessary for reply 1:confirmation manner necessary for reply
Spare (Octet 0; Bit 6)	
Selective Retry Flag (Octet 0; Bit 5)	Indicates whether selective sending packet of resending or not. 0: normal sending packet 1: selective sending packet of resending
Spare (Octet 0; Bit 4)	
Block Count (Octet 0; Bit 3-0)	Indicates number of User Data block included in sending packet. Valid range is from 1 to 16 blocks (0000 to 1111).
Pad Octet Count (Octet 1; Bit 7-3)	Indicates Octet number of Null included in the last block of sending packet. Valid range of UDCH2 is from 0 to 18 Octet (00000 to 10010). Valid range of FACCH3 is from 0 to 18 Octet (00000 to 10010). Valid range of FACCH1 is from 0 to 8 Octet (00000 to 01000).
Start Fragment Flag (Octet 1; Bit 2)	Indicates whether header fragment or not. 0: other than header. 1: header（In the case of SDCALL_REQ, 1 is fixed）
Circular Fragment Flag (Octet 1; Bit 1)	Indicates whether TX Fragment Count circulates or not. 0: not circulate（In the case of SDCALL_REQ, 0 is fixed.） 1: circulate
TX Fragment Count (Octet 1; Bit 0 to Octet 2; Bit 0)	Indicates number and order of fragment. In the case where Circular Fragment Flag = 0: In sending header fragment, (number of fragment-1) is set, and in sending the last fragment, (number of fragment-1) becomes 0. In the case where Circular Fragment Flag = 1: In sending header fragment, maximum value (all bits are 1) is set, decrement is performed every fragment using calculation of mod9.

Table 6.6-22 Packet Information Values

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6.6.29. Block Number

Block Number consists of 4 bits, it is used to indicate order of fragmented block when fragment is fragmented to generate a plurality of blocks.

Value (Bit)	Definition	Description
1111	Block No.15	Indicates the 15th block.
1110 - 0001	Block No.14 to No.1	Indicates from the 14th block to the first block.
0000	Block No.0	Indicates the 0th block (the last block).

Table 6.6-23 Block Number Values

When sending selective resending, Block Number corresponding to block of resending target is reused, and Block Number of User Data format within packet of selective resending is set.

6.6.30. Packet Frame Number

Packet Frame Number consists of 4 bits, it is used to indicate order of frame to be sent with respect to user data format included in sending packet.

Value (Bit)	Definition	Description
1111	Frame No.15	Indicates the 15th block.
1110 - 0001	Frame No.14 to No.1	Indicates from the 14th block to the first block.
0000	Frame No.0	Indicates the 0th block (the last block).

Table 6.6-24 Packet Frame Number Values

Sending packet is consists of 16 user data format at most; in this case, header format corresponds to 16^{th} frame, value from 15^{th} to 0^{th} in Packet Frame Number of the following non-header user data format are used sequentially.

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6.6.31. Response Information

Response Information consists of 16 bits, it is used to indicate structure content of reply packet of Data communication.

Bit	7	6	5	4	3	2	1	0
Octet 0	Spare	Spare	Class		Type			
Octet 1	RX Fragment Count							

Figure 6.6-13 Response Information Format

Class	Type	Description
00	001	ACK（succeeded to receive）
01	001	ACK_S（selective resending request）
11	001	NACK（sending all request）
	010	NACK（memory full）
	011	NACK（Abort）

Table 6.6-25 Class and Type Values

Field	Description and Value
Spare (Octet 0; Bit 7)	Backup
Spare (Octet 0; Bit 6)	Backup
RX Fragment Count (Octet 0; Bit 0 to Octet 1; Bit 0)	Indicating TX Fragment Count received.

Table 6.6-26 Response Information Values

6.6.32. Error Block Flag

Error Block Flag consists of 16 bits, it is used to indicate block necessary to be resent because of failing to receive in reply message of Data communication and voice parallel Data communication.

Bit	7	6	5	4	3	2	1	0
Octet 0	F15	F14	F13	F12	F11	F10	F9	F8
Octet 1	F7	F6	F5	F4	F3	F2	F1	F0

Figure 6.6-14 Error Block Flag Format

Field	Description and Value
Fx	Indicates whether receiving is succeeded or not with respect to each Block Number from No.15 to No.0. 0: succeeded to receive or unused block. 1: failed to receive.

Table 6.6-27 Error Block Flag Values

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6.6.33. Status

Status consists of 8 bits, it is used to indicate status of user or Subscriber Unit. Status includes status (1 to 207) definable freely in user or system and status (208 to 255) defined in this document.

Value (Hex)	Definition	Description
00	Null Status	Used as Filler not assigning specific Status.
01 – CF	User definable	Status well-defined by user
D0	Paging Status	Paging
D1 – DF	Reserved	Reserving for using as defined Status
E0	Emergency Status	Emergency
E1	Emergency Status	Emergency by Man-down
E2	Emergency Status	Emergency Termination
E3	Emergency Status	Emergency by Stationary Detection
E4	Emergency Status	Emergency by Motion Detection
E5	Emergency Status	Emergency by Lone Worker
E6 – FF	Reserved	Reserving for using as defined Status

Table 6.6-28 Status Values

6.6.34. Control Command

Control Command consists of 5 bits that indicates remote control command in REM_CON_REQ/RESP. Type of ID usable in REM_CON_REQ (Group ID or Unit ID) is limited by value of Control Command.

Value (Bit)	Definition	ID type	Description
00000	Stun	Both	SU being in Stun state
00001	Revival	Both	Releasing Stun state of SU.
00010	Kill	Both	SU being in Kill state
00011	Reserved		Reserving
00100	Remote Monitor	Unit ID	SU sending automatically
Other values	Reserved		Reserving

Table 6.6-29 Control Command Values

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6.6.35. Control Parameter

Control Parameter consists of 2 Octets that indicates control parameter depending on Control Command Information Element.

Bit	7	6	5	4	3	2	1	0
Octet 0	Parameter 1							
Octet 1	Parameter 2							

Figure 6.6-15 Control Parameter Format

Command	Definition of Parameter 1	Definition of Parameter 2
Stun	Bit 7: Mode 0: Tx Inhibition 1: Tx & Rx Inhibition Bit 6-0: Spare	Bit 7-0: Spare
Revival	Bit 7-0: Spare	Bit 7-0: Spare
Kill	Bit 7-0: Spare	Bit 7-0: Spare
Remote Monitor	Bit 7: Mode 0: Normal Mode 1: Silence Mode Bit 6-0: Spare	Bit 7: Transmission Duration 00h: Reserved 01 to FFh: 1s to 255s

Table 6.6-30 Control Parameter Values

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6.6.36. Cipher Type

Cipher Type consists of 2 bits, it is used to indicate Encryption method.

Value (Bit)	Definition
00	Non-Ciphered Mode
01	Scramble Mode
10	reserved
11	reserved

Table 6.6-31 Cipher Mode Values

6.6.37. Key ID

Key ID consists of 6 bits, it is used to indicate cryptography key used in Encryption.

Value (Hex)	Definition
00	Non-Ciphered Mode Default or Unspecified Key ID
01 – 3F	User definable

Table 6.6-32 Key ID Values

6.6.38. Delay Count

Delay Count consists of 16 bits that indicates number of rest frames until valid frame is sent.

Value (Hex)	Definition
0000	Number of rest frames = 0 (last)
0001	Number of rest frames = 1
0010	Number of rest frames = 2
…	…
03FE	Number of rest frames = 1022
03FF	Number of rest frames = 1023
Others	Reserved

Table 6.6-33 Delay Count Values

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6.6.39. Cause

Cause consists of 8 bits and has 5 kinds of forms below depending on the type of message.

Cause (MM) is Information Element included in reply message of mobility management system and is used to inform received result such as position registration request message.
Cause (VD) is Information Element included in communication connection request of call control system and reply message of voice communication and is used to inform received result and state of request message.
Cause (SS) is Information Element included in Status Communication of call control system, Short Data Communication/simultaneous Data communication and reply message of remote control function, and is used to inform received result of request message.
Cause (DREQ) is Information Element included in cutting message (DISC_REQ) and is used to inform of cutting reason when SU performs cutting operation.
Cause (DISC) is Information Element included in cutting message (DISC) and is used to inform of cutting reason when TC performs cutting operation.

Unused values of Type and Indication are reserved.

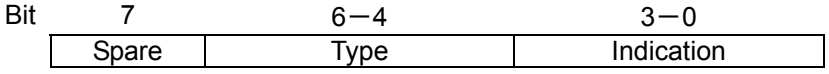

Figure 6.6-16 Cause Format

Type	Indication	Definition
000 normal	0001	Registration is accepted
	0100	Location is accepted, but Group is failed
	0101	Location is accepted, but Group is refused
	0110	Registration is failed
	1000	Registration is refused
101 Resource Unavailable	0001	Network failure
	0010	Temporary failure
	0011	Equipment congestion
	1111	Other class for Resource unavailable
110 Unusable service	0000	Request for unusable service
	1000	System by which System ID is different
	1100	Stun processing
	1110	Kill processing
	1111	Other class for service unusable or unsupported
111 Procedure error	0000	Lack of mandatory information elements
	0001	Undefined information element or Invalid contents
	1111	Other class for procedure error

Table 6.6-34 Cause (MM) Values

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Type	Indication	Definition
001 Normal 1	0000	Accepted normal
	0001	Called group is not permitted for the service
	0010	Calling SU is not permitted for the service
	0011	Called SU is not permitted for the service
	0100	Called SU has not done the registration yet
	0101	No response from the called SU
	0110	Incoming call rejection for a called SU
	1000	Called SU is in busy
	1001	Called group is in busy
	1010	Calling SU is in busy
	1100	SU has not been registered yet
	1101	Group has not been registered yet
	1110	Queuing interruption
010 Normal 2	0000	Calling SU is not permitted for use
	0001	Called SU is not permitted for use
	0010	Group is not permitted for use
011 Normal(Queue）	0000	All channel resources are in use
	0001	All phone line resources are in use
	0010	Called unit is being alerted
	0011	Phone line is being alerted
	1000	Called SU is in busy
	1001	Called group is in busy
	1111	The other queue not indicating reason particularly
101 Resource Unavailable	0000	Channel unavailable
	0001	Network failure
	0010	Temporary failure
	0011	Equipment congestion
	1111	Other class for Resource unavailable
110 Unusable service	0000	Request for unusable service
	0001	Request for unsupported service
	1111	Other class for service unusable or unsupported
111 Procedure error	0000	Lack of mandatory information elements
	0001	Undefined information element or Invalid contents
	1111	Other class for procedure error

Table 6.6-35　Cause (VD) Values

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Type	Indication	Definition
000 Normal(data reply)	0001	ACK (Receive success) [1]
	0010	ACK (Send success)
	0100	ACK_S (selective resending request) [1]
	1000	NACK (sending all request) [1]
	1001	NACK (memory full) [1]
	1010	NACK (Abort) [1]
001 Normal 1	0000	Accepted normal
	0001	Called group is not permitted for the service
	0010	Calling SU is not permitted for the service
	0011	Called SU is not permitted for the service
	0100	Called SU has not done the registration yet
	0101	No response from the called SU
	0110	Incoming call rejection for a called SU
	1000	Called SU is in busy
	1001	Called group is in busy
	1010	Calling SU is in busy
	1100	SU has not been registered yet
	1101	Group has not been registered yet
010 Normal 2	0000	Calling SU is not permitted for use
	0001	Called SU is not permitted for use
	0010	Group is not permitted for use
101 Resource Unavailable	0000	Channel unavailable
	0001	Network failure
	0010	Temporary failure
	0011	Equipment congestion
	1111	Other class for Resource unavailable
110 Unusable service	0000	Request for unusable service
	0001	Request for unsupported service
	1111	Other class for service unusable or unsupported
111 Procedure error	0000	Lack of mandatory information elements
	0001	Undefined information element or Invalid contents
	1111	Other class for procedure error

[1] In Single Trunked System, Only these Causes are necessary.

Table 6.6-36 Cause (SS) Values

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Type	Indication	Definition
001 normal	0000	Disconnect by user
	0100	Disconnect by timer
	1111	Other disconnect request

Table 6.6-37 Cause (DREQ) Values

Type	Indication	Definition
001 normal(SU)	0000	Disconnect by user
	0001	Disconnect by PSTN
	0100	Disconnect by timer
	1111	Other disconnect from SU
010 normal(TC)	0000	Disconnect by timer of TC
	1111	Other disconnect from TC
101 Resource Unavailable	0000	Channel unavailable
	0001	Network failure
	0010	Temporary failure
	0011	Equipment congestion
	1111	Other class for Resource unavailable
110 Unusable service	0000	Request for unusable service
	0001	Request for unsupported service
	1111	Other class for service unusable or unsupported
111 Procedure error	0000	Lack of mandatory information elements
	0001	Undefined information element or Invalid contents
	1111	Other class for procedure error

Table 6.6-38 Cause (DISC) Values

6.6.40. Call Timer

The Call Timer consists of 6 bits, and is used to indicate maximum time that a Mobile Station on the Traffic channel (CH) of a Trunked System can continuously transmit.

Value (Bit)	Definition
00 0000	Unspecified (SU dependent)
00 0001	15 seconds
00 0010	30 seconds
・・・	15 second steps
00 1100	180 seconds
00 1101	210 seconds
・・・	30 second steps
01 1010	600 seconds
01 1011	reserved
・・・	・・・
11 1110	reserved
11 1111	reserved

Table 6.6-39 Call Timer Values

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6.6.41. Service Information

Service Information consists of 16 bits, it is used to indicate service which TRS supports. The service is indicated by 16 flags, service corresponding to the case where flag is “1” indicates to be usable.

Bit	7	6	5	4	3	2	1	0
Octet 0	SIF1	SIF2	SIF3	SIF4	SIF5	SIF6	SIF7	SIF8
Octet 1	SIF9	SIF10	SIF11	SIF12	SIF13	SIF14	SIF15	SIF16

Figure 6.6-17 Service Information Format

Value (Bit)	
SIF1	Multi Site Service
SIF2	Multi System Service
SIF3	Location Registration Service
SIF4	Group Registration Service
SIF5	Authentication Service
SIF6	Reserved
SIF7	Reserved
SIF8	Reserved
SIF9	Reserved
SIF10	Reserved
SIF11	Reserved
SIF12	Reserved
SIF13	Spare
SIF14	Spare
SIF15	Spare
SIF16	Spare

Table 6.6-40 Service Information Flags

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6.6.42. Restriction Information

Restriction Information consists of 24 bits, it is used to indicate restriction for supporting function and SU restricted, etc. in TRS.

Bit	7	6	5	4	3	2	1	0
Octet 0	Mobile Station operation information				Access cycle interval			
Octet 1	Regulation group appointing				Regulation information			
Octet 2	←		Spare				→	ISO

Figure 6.6-18 Restriction Information Format

Mobile Station operation information (Octet 0, Bit 7-4)				
Bit 7	Bit 6	Bit 5	Bit 4	Description and Value
0				No access regulation
1				With Access regulation
	0			No maintenance regulation
	1			With maintenance regulation
		Spare	Spare	Bit 5 and Bit 4 are for backup.

Access cycle interval (Octet 0, Bit 3-0)				
Bit 3	Bit 2	Bit 1	Bit 0	Description and Value
0	0	0	0	No regulation
0	0	0	1	20 frames
				...
1	1	1	1	300 frames

Regulation group appointing (Octet 1, Bit 7-4)				
Bit 7	Bit 6	Bit 5	Bit 4	Description and Value
0				No assignment of Group 4
1				With assignment of Group 4
	0			No assignment of Group 3
	1			With assignment of Group 3
		0		No assignment of Group 2
		1		With assignment of Group 2
			0	No assignment of Group1
			1	With assignment of Group 1

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Regulation information (Octet 1, Bit 3-0)				
Bit 3	Bit 2	Bit 1	Bit 0	Description and Value
0				General Mobile Station, No position registration regulation.
1				General Mobile Station, With position registration regulation.
	0			General Mobile Station, No originating regulation.
	1			General Mobile Station, With originating regulation.
		Spare	Spare	Bit 1 and Bit 0 are for backup.

Field	Description and Value
Temporarily Isolated Site (Octet 2, Bit 0)	In the Multi Site Service system, it is used to indicate that a site is temporarily isolated from the network due to a breakdown or other problem. Is valid only when SIF 1 in the Service Information is "1". 0: Normal Condition 1: Isolated Condition

Table 6.6-41 Restriction Information Values

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6.6.43. Adjacent Site System ID

Adjacent Site System ID consists of 19 bits that indicates System ID of adjacent site.

6.6.44. Adjacent Site Code

Adjacent Site Code consists of 8 bits that indicates site code of adjacent site and is the same format with Chapter 6.6.5, which is referred to Table 6.6-3.

6.6.45. Adjacent Site Option

Adjacent Site Option consists of 5 bits that indicates additional information of adjacent site.

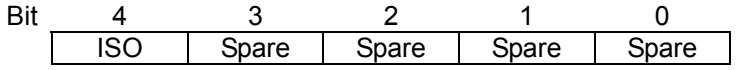

Figure 6.6-19 Adjacent Site Option Format

Field	Description and Value
Temporarily Isolated Site (Bit 4)	In the Multi Site Service system, it is used to indicate that a site is temporarily isolated from the network due to a breakdown or other problem. Is valid only when SIF 1 in the Service Information is "1" 0: Normal Condition 1: Isolated Condition

Table 6.6-42 Adjacent Site Option Values

6.6.46. Index

The Index consists of 1 bit, and is a flag that distinguishes information sent with an Adjacent Site information.
It can indicate the information of up to four adjoining sites by distinguishes two adjacent site's information bits, included in each message.

6.6.47. Registration Sequence Number

Registration Sequence Number consists of 16 bits, it is used to indicate number of times where Subscriber Unit registers to TRS.

6.6.48. Subscriber Type

The Subscriber Type consists of 16 bits, and is used to identify the classification of the Subscriber Unit.

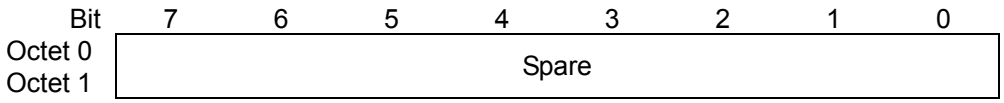

Figure 6.6-20 Subscriber Type Format

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6.6.49. Version Number

Version Number consists of 8 bits, it is used to indicate version of Multi Trunked System corresponding to Trunking Controller and Subscriber Unit.

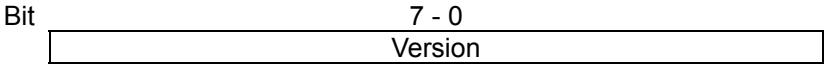

Figure 6.6-21 Version Number Format

Field	Description and Value
Version	Indicates version of Multi Trunked System. However, notation is not specified.

Table 6.6-43 Version Number Values

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7. Voice Coding Method

7.1. Outline

Voice code system used on this system is improved version of MBE (Multi-Band excitation) system, and uses AMBE+2 System, which is developed by DVSI Company.
Coding is done by performing voice coding of voice signal at 2450bps by generating voice coding data of 49 bits every 20ms. This “49 bits” becomes VCH data of 72 bits by adding redundant bit of 23 bits to perform error correction.

Block diagram of Encoder of Vocoder is shown in Figure 7.1-1, block diagram of Decoder of Vocoder is shown in Figure 7.1-2.

Detailed specification is referred to AMBE+2 document of DVSI Company, in later section, test pattern used in various kinds of tests are defined.
Data sequence noted is described in hexadecimal number; order of sending data is from left side of data sequence to right side of data sequence at last.

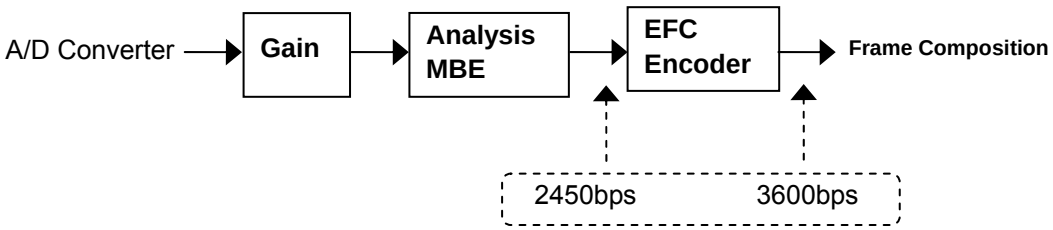

Figure 7.1-1 Diagram of Vocoder (Encoder)

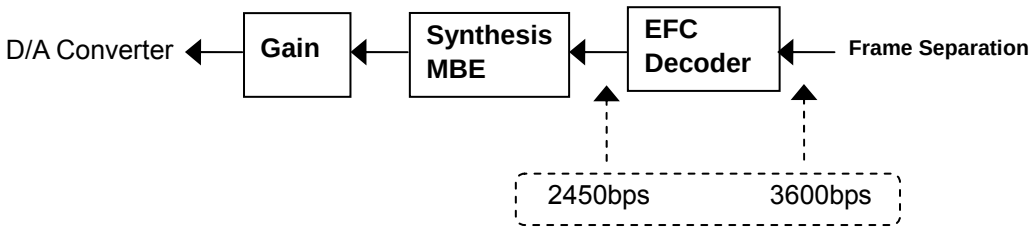

Figure 7.1-2 Diagram of Vocoder (Decoder)

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7.2. Vocoder Test Signals

7.2.1. Tone Test Pattern

Tone Test Pattern has single tone with 1031Hz at -22dBm0.
Data sequence of 49 bits after voice coding generated at the time and data sequence of 72 bits after FEC thereafter are shown below.

Data after voice coding(49 bits)	FEE2 1212 1210 0 (49 bits of high order are valid.)
Data after FEC (72bits)	CEA8 FE83 ACC4 5820 0A

7.2.2. Silence Test Pattern

Silence Test Pattern has low level voice frequency band less than -90dBm0.
Data sequence of 49 bits after voice coding generated at the time and data sequence of 72 bits after FEC thereafter are shown below.

Data after voice coding(49 bits)	F801A99F8CE08 (49 bits of high order are valid.)
Data after FEC (72bits)	B9E8 8152 6173 002A 6B

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8. Glossaries

Broadcast Data Call
: Data communication of 1 to N

Broadcast Status Call
: Simple fixed message transmission of 1 to N

Common Air Interface (CAI)
: Specification of communication method on specification point of Um

Console
: Device to control system and send communication command

Control Channel
: General name of bi-directional channel to transfer control information necessary for mobility management and call connection

Data Call
: Data communication of 1 to 1

Dibit
: Information unit processed with unit of 2 bits

Direct Mode Operation (DMO)
: Operation method of performing communication directly between Subscriber Unit including operation method using Talk Around function of Subscriber Unit

Dispatcher
: Operator or facility to command communication

Duplex
: Communication method of sending and receiving simultaneously

Enhanced Half Rate (EHR)
: Mode to operate at voice coding rate (including error correction) of 3600bps in AMBE+2Vocoder

Fast Associated Control Channel 1 (FACCH1)
: Functional Channel to transfer control information in high speed by ceasing voice information on RTCH2 channel

Fast Associated Control Channel 3 (FACCH3)
: Functional Channel to transfer control information alone or attached to packet data on RTCH2

Fixed Station (FS)
: Radio operated in fixed set state without moving among Subscriber Unit

Frame
: Minimum unit to distinguish one block of information on Radio Frequency carrier

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Frame Sync Word (FSW)
Fixed bit sequence used for Frame Synchronization

Frequency Division Multiple Access (FDMA)
Connection method to share channel by a plurality of users by dividing channel on frequency axis

Group Call
Voice communication of 1 to N (point to multi-point) including unidirectional Broadcast Call and bi-directional Conference Call

Hold Time
Time to continue sending by repeater in a certain period of time when it is impossible to receive inbound signal

Inbound Signal
Direction (signal) to be sent toward Repeater from Subscriber Unit

Inbound Message
Layer-3 message to be sent towards Repeater from Subscriber Unit

Individual Call
Voice communication of 1 to 1(point to point)

Interconnect Call
Voice communication of 1 to 1 or 1 to N performed to connect with telephone line

IP Network
Network using Internet Protocol

Layer 1 (L1)
Basic Interface which is layer of basic structure of Radio Frequency Channel and specifies definition of channel and format

Layer 2 (L2)
Transmission Control which is layer that specializes in transmission control between facing station and specifies identification of channel and timing

Layer 3 (L3)
Connection Control which is layer of data transfer between end systems and specifies means of call control, mobility management and Radio Frequency management

Link Information Channel (LICH)
Functional Channel to transfer control information to identify Radio Frequency Channel and Functional Channel

Mobile Station (MS)
Radio of portable type and on-board type operated for moving mainly among Subscriber Unit

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Nyquist 4-Level FSK (4LFSK)
FSK Modulation Method having 4 symbol amplitudes using Nyquist filter for Baseband Filter.

Nyquist Response
Band limiting filter without generating interference between code and having odd-symmetric characteristics with respect to decay area of filter

Octet
Block of information divided every 8 bits

Out bound Signal
Direction (signal) to be sent from Repeater to Subscriber Unit

Out bound Message
Layer 3 message to be sent from Repeater to Subscriber Unit

Preamble
Unique bit pattern to be sent before sending frame to use of establishing of bit synchronization

Private Branch Exchange (PBX)
Telephone exchange installed in the office premise to perform intercommunicating communication and business communication with exterior

Public Switched Telephone Network (PSTN)
General subscriber telephone line network called public switched telephone line network

Repeater Unit (RU)
Sending and receiving device with function to relay electric wave

RF Traffic Channel 2 (RTCH2)
Radio Frequency carrier used to transfer user communication information in Trunking Repeater Site. Radio carrier of at least one Trunking Repeater in Site is used.

Roll Off Factor
“α” is for expression. Roll off Factor is value indicating characteristics of Nyquist filter, if value is small, output spectrum has narrow band, but transmission deterioration is larger to gap of determination timing.

Root Nyquist Response
Square root of Nyquist characteristics

Semi Duplex
Communication method where one radio operates by Simplex method and the other radio operates by Duplex method.

Signaling Control Channel (SCCH)
Functional Channel to transfer signaling information at low speed always on RTCH2

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Short Data Call
Data communication of 1 to 1 on Traffic Channel, limited with respect to data amount

Simplex
Communication method to send or receive only, not to send and receive simultaneously

Simultaneous Data Call
Data communication at low speed to be performed simultaneously during voice communication

Status Call
Simple fixed message transfer of 1 to 1

Subscriber Unit (SU)
Generic name including radio of all types of portable type, on- board type and fixed type

Super frame
Group of frame consists of a plurality of frames

Symbol

Unit of signal used on modulation operation. Signal consists of 2 bits information in Nyquist 4-Level FSK (4LFSK).

Symbol Rate
Changing speed of state of carrier wave modulated by baseband signal. Speed of modulation signal

Traffic Channel
A general name to indicate a bidirectional channel used for information transfer regarding voice or data communication, etc.

Trunked System
LMR system having facility to allocate line of Radio Frequency Channel automatically to utilize spectrum validly

Trunking Controller (TC)
Control device to perform Radio Frequency line control

Trunking Repeater (TR)
Device consists of Repeater Unit and Trunking Controller and to perform line control or relay operation using 2 Radio Frequency Channels

Trunking Repeater Site (TRS)
Facility consists of a plurality of Trunking Repeaters and providing service area of minimum unit in Trunked System

User Data Channel 2 (UDCH2)
Functional Channel to transfer packet data on RTCH2

User Specific Channel (USC)

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User Specific Channel (USC) is representative of classification of Functional Channel and includes Functional Channel used on RTCH2.

Vocoder

Voice Coding (Voice Code) processing. Coder performs processing to translate from analog voice signal to pressured digital voice data. Decoder performs to decode original analog voice signal from digital voice data.

Voice Channel (VCH)

Functional Channel to transfer voice information on RTCH2

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9. Appendix

9.1. Dealing with Spare Field and Reserve Field

In this specification, definition with respect to a part of bit pattern expressed in Backup (or Spare) and Reserving (or Reserved) is given.
Backup and reserving field is field to be secured for extension in the future; the method of dealing with these is as follows.

Filed	Sending processing	Receiving processing
Backup field	Using Null pattern as long as not being appointed particularly	ignoring
Reserving field	Prohibited to use reserving bit pattern	Processing as field or message where content is not valid

Table 9.1-1 Dealing with Spare Field and Reserve Field

9.2. Emission Designator

Necessary Bandwidth used in types of radio wave of NXDN™ is defined.
Because NXDN™ is Nyquist 4-Level FSK (4LFSK) Modulation Method, Necessary Bandwidth Bn is expressed using calculation formula of Multilevel Frequency Shift Keying in CFR Title47§2.202.

$Bn = (R/\log_2 S) + 2DK$

R = bit rate
S = number of signaling states
D = peak frequency deviation
K = numerical factor

Necessary Bandwidth is calculated as below.

$Bn = (4800 / \log_2 4) + 2 \times 1471 \times 0.516 = 3918 \approx 4000$ Hz i.e. 4K00

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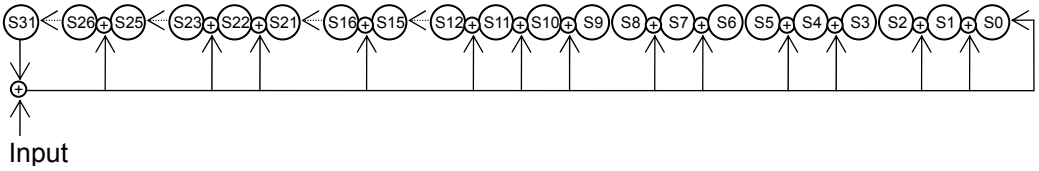
9.3. Calculation method for Message CRC

In Data communication, CRC is used as a mean to verify that packet data is sure to be received. This Message CRC is CRC of 32 bits and is calculated from User Data included in one packet data.

Calculation method of Message CRC will be described using Figure 9.3-1. Value of shift register at the time of inputting the last bit is output of 32 bit CRC by inputting to shift register from header bit of User Data consists of N bits in turn. One packet data is constructed by adding this 32 bit CRC after the last bit of User Data.

Initial value of shift register is All 1.

Generating polynomial $X^{32}+X^{26}+X^{23}+X^{22}+X^{16}+X^{12}+X^{11}+X^{10}+X^{8}+X^{7}+X^{5}+X^{4}+X^{2}+X+1$



Example

User Data (N bits)	CRC 32bit
bN-1,bN-2,bN-3……b1,b0	S31,S30……S1,S0

Figure 9.3-1 Message CRC Code

9.4. Receiving condition of message

When received message includes undefined Message Type, the message is ignored.

When received message is longer than expected message length, redundant Information Element is ignored and the message is processed using information in the expected message length.

When received message does not include any part of essential Information Element, the message is ignored.

When received message does not include any part of option Information Element, the message is ignored.

When essential Information Element of received message does not include valid content, the message is ignored.

When option Information Element of received message does not include valid content, the message is ignored.

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9.5. Definition of Cause

With respect to 5 kinds of contents of cause, the minimum of definition is given as

9.5.1. Cause used in Mobility Management System Message

Type = normal

Indication	Definition
0001	Registration is accepted This indicates success of position Registration Request or Group Registration Request
0100	Location is accepted, but Group is failed This indicates success of position Registration Request, but fail of Group Registration Request.
0101	Location is accepted, but Group is refused This indicates success of position Registration Request, but refusal of Group Registration Request
0110	Registration is failed This indicates fail of position Registration Request or Group Registration Request.
1000	Registration is refused This indicates refusal of position Registration Request or Group Registration Request.

Type = unusable service

Indication	Definition
1000	System by which System ID is different This indicates SU requesting Registration to system by which System ID is different.
1100	Stun processing This indicates prohibiting SU used fraudulently to send.
1110	Kill processing This indicates stopping SU used fraudulently to operate.

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9.5.2. Cause used in Call Control System Message such as Voice Communication

Type = normal 1

Indication	Definition
0000	Accepted normal This Indicates that the request is accepted.
0001	Called group is not permitted for the service This indicates that service requested by the calling SU is not permitted to the called group.
0010	Calling SU is not permitted for the service This indicates that the service requested by the calling SU cannot be permitted.
0011	Called SU is not permitted for the service This indicates that the service requested by the calling SU is not permitted to the called SU.
0100	Called SU has not done the registration yet This indicates that no location registration information of the called SU is available and it is out of a system.
0101	No response from the called SU This indicates that there is no response from the called SU to the reception request.
0110	Incoming call rejection for a called SU This indicates that the called SU rejects the incoming call request.
1000	Called SU is in busy This indicates that arriving SU is in talking to be used in the case where arriving SU is in another talk, when Individual Call Request is sent.
1001	Called group is in busy This indicates that arriving Group is in talking to be used in the case where the Group ID is used in another talk, when communication connection request is sent.
1010	Calling SU is in busy This indicates that Unit ID of calling SU is in use.
1100	SU has not been Registered yet This indicates Non Registration information of Unit ID of originating SU. SU receiving this cause starts Registration processing.
1101	Group has not been Registered yet This indicates Non Registration information of Group ID. SU receiving this cause starts Group Registration processing.
1110	Queuing interruption This indicates that the queue state is paused and the call processing is terminated by the timer of the TRS or disconnect request from a SU during the queue state by Channel Busy (Cause = 011 0000, etc.).

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Type = normal 2

Indication	Definition
0000	Calling SU is not permitted for use This indicates that the Unit ID of the calling SU is prohibited from accessing to the system. For example, this is used when a SU sends a service request that contains a Unit ID that has been erased from a system or has been changed to an access prohibition.
0001	Called SU is not permitted for use This indicates that the Unit ID of the called SU is prohibited from accessing to the system. For example, this is used when a SU sends a service request that contains a Unit ID that has been erased from a system or has been changed to an access prohibition.
0010	Group is not permitted for use This indicates that the Group ID is prohibited from accessing to the system. For example, this is used when a SU sends a service request that contains a Group ID that has been erased from a system or has been changed to an access prohibition.

Type = normal (Queue)

Indication	Definition
0000	All channel resources are in use This indicates that all RTCH2s are in use. The SU that received this cause becomes in the queued state.
0001	All phone line resources are in use This indicates that all PSTN lines are in use. SU receiving this cause changes to queue state.
0010	Called unit is being alerted This indicates that the called SU is being called. The SU that received this cause becomes in the queued state.
0011	Phone line is being alerted This indicates that all PSTN lines are in call. SU receiving this cause changes to queue state.
1000	Called SU is in busy This indicates that the called SU is in busy. For example this is used if the called SU is engaging in other calls when the Individual Call request is placed. The SU that received this cause becomes in the queued state.
1001	Called group is in busy This indicates that the called group is in busy. For example this is used if the Group ID is in use for other calls when the Group Call request is placed. The SU that received this cause becomes in the queued state.
1111	The other queue not indicating reason particularly This indicates not to appoint reason particularly with general cause in cue state. SU receiving this cause changes to queue state.

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9.5.3. Cause used in Call Control System Message of Status communication and Short Data communication

Type = normal (data reply)

Indication	Definition
0001	ACK (Receive Success) This indicates success to receive normally in Destination Unit ID.
0010	ACK (Send Success) This indicates that reception is properly completed in the TRS. In the unconfirmed type, this is treated in the same manner as Indication = 0000 and represents that the procedure is completed, and in the confirmed type, this indicates that the procedure is in the process.
0100	ACK_S (Selective Retry Request) This indicates fail to receive a part of packet in Destination Unit ID. This value is used in SDCALL_RESP.
1000	NACK (Complete Retry Request) This indicates fail to receive in Destination Unit ID.
1001	NACK (Memory Full) This indicates no free memory in Destination Unit ID.
1010	NACK (Abort) This indicates to stop receiving processing in Destination Unit ID.

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Type = normal 1

Indication	Definition
0000	Accepted normal This indicates that the request is accepted.
0001	Called group is not permitted for the service This indicates that service requested by the calling SU is not permitted to the called group.
0010	Calling SU is not permitted for the service This indicates that the service requested by the calling SU cannot be permitted.
0011	Called SU is not permitted for the service This indicates that the service requested by the calling SU is not permitted to the called SU.
0100	Called SU has not done the registration yet This indicates that no location registration information of the called SU is available and it is out of a system.
0101	No response from the called SU This indicates that there is no response from the called SU to the reception request.
0110	Incoming call rejection for a called SU This indicates that the called SU rejects the incoming call request.
1000	Called SU is in busy This indicates that arriving SU is in talking to be used in the case where arriving SU is in another talk, when Individual Call Request is sent.
1001	Called group is in busy This indicates that arriving Group is in talking to be used in the case where the Group ID is used in another talk, when communication connection request is sent.
1010	Calling SU is in busy This indicates that Unit ID of calling SU is in use to be used in the case of calling to autonomous Unit ID.
1100	SU has not been Registered yet This indicates Non Registration information of Unit ID of originating SU. SU receiving this cause starts Registration processing.
1101	Group has not been Registered yet This indicates Non Registration information of Group ID. SU receiving this cause starts Group Registration processing.

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Type = normal 2

Indication	Definition
0000	Calling SU is not permitted for use This indicates that the Unit ID of the calling SU is prohibited from accessing to the system. For example, this is used when a SU sends a service request that contains a Unit ID that has been erased from a system or has been changed to an access prohibition.
0001	Called SU is not permitted for use This indicates that the Unit ID of the called SU is prohibited from accessing to the system. For example, this is used when a SU sends a service request that contains a Unit ID that has been erased from a system or has been changed to an access prohibition.
0010	Group is not permitted for use This represents that the Group ID is prohibited from accessing to the system. For example, this is used when a SU sends a service request that contains a Group ID that has been erased from a system or has been changed to an access prohibition.

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9.5.4. Cause used in Disconnect Request Message

Type = normal

Indication	Definition
0000	Disconnect by user This indicates to start cutting process by performing cutting operation by SU user.
0100	Disconnect by timer This indicates to start cutting process by timer of SU.
1111	Other disconnect request This indicates not to appoint reason particularly with general cause of disconnect request.

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9.5.5. Cause used in Disconnect Message

Type = normal (SU)

Indication	Definition
0000	Disconnect by user This indicates to start cutting process by performing cutting operation by SU user.
0001	Disconnect by PSTN This indicates to start cutting process by PSTN.
0100	Disconnect by timer This indicates to start cutting process by timer of SU.
1111	Other disconnect from SU This indicates not to appoint reason particularly with general cause where SU starts disconnect process.

Type = normal (TC)

Indication	Definition
0000	Disconnect by timer of TC This indicates to start cutting process by timer of TC.
1111	Other disconnect from TC This indicates not to appoint reason particularly with general cause where TC starts disconnect process.

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9.5.6. Common Causes

This section describes commonly used Type for 5 different Causes. However, the Type and Indication to be applied vary depending on Cause, hence refer to Section 6.6.39 for details.

Type = Resource Unavailable

Indication	Definition
0000	Channel unavailable This indicates that a channel cannot be processed due to restricted state, etc.
0001	Network failure This indicates that processes cannot be properly executed since the network is functionally failed.
0010	Temporary failure This indicates that processes cannot be properly executed since temporary failure occurred on the connection to the network.
0011	Equipment congestion This indicates that processes cannot be properly executed since equipment on the network are congesting due to heavy traffic.
1111	Other class for resource unavailable This is a common cause for resource unavailable status and it does not specify the reason.

Type = Unusable service

Indication	Definition
0000	Request for unusable service This indicates that the requested service is unusable.
0001	Request for unsupported service This indicates that the requested service is unsupported.
1111	Other class for service unusable or unsupported This is common cause for service unavailable or unsupported status and it does not specify the reason.

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Type = Procedure error

Indication	Definition
0000	Lack of mandatory information elements This indicates shortage of necessary information element in the received message.
0001	Undefined information element or Invalid contents This indicates that contents of information element of the received message are undefined or invalid value.
1111	Other class for procedure error This is a common cause for procedure error and it does not specify the reason.

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9.6. Detailed Classification of Service and Selectivity of Operation

Here, service is classified in more detail with respect to function provided by CAI defined in Chapter 2.2, and level furthermore corresponding to each system will be revealed.

Services			Multi Trunked	Single Trunked
Voice Services	Vocoder	Half Rate (4800bps)	M	M
	Group Call	Broadcast	SO	SO
		Conference	M	M
	Individual Call		M	M
	Interconnect Call	Speed Dialing	SO	N/A
		Dialing	SO	N/A
Data Services	Short Data Call	Broadcast	SO	SO
		Individual	SO	SO
	Simultaneous Data Call	Broadcast	SO	SO
		Individual	SO	SO
	Data Call	Broadcast	SO	SO
		Individual	SO	SO
Supplementary Services	Status Call		SO	SO
	Status Inquiry		SO	SO
	Remote Control Function		SO	SO
	Emergency		SO	SO
	Encryption		SO	SO
	Late Entry		M	M
	ESN Validation		SO	SO
System Services	Mobility Management	Registration	M	N/A
		Registration Clear	SO	N/A
		Registration Command	SO	N/A
		Group Registration	SO	N/A
		Data Write	M	N/A
	Authentication		M	SO
	Multi-System Operation	System Roaming	SO	N/A
		Visitor ID capability	SO	N/A
	Multi-Site Operation	Site Roaming	M	N/A
		Adjacent Site information	M	N/A
	Restriction Control		SO	N/A
	Calling mode	Priority Monitor	SO	SO
		Transmission Trunking	M	M
		Message Trunking	SO	SO
	Other	Intermittent Reception	SO	N/A
		Secondary Home Repeater	SO	SO
		ID Validation	SO	SO
		Halt Repeater	SO	SO
Other Service	Proprietary Form		OP	OP

Table 9.6-1 List of Service Availability

M (Mandatory) indicates service which any system must accommodate.
SO (Standard Option) indicates service which is accommodated in every system voluntarily.
OP (Option) indicates service which is accommodated in every system voluntarily and also service whose specification is voluntary to every system.

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10. Revision History

Version	Date	Revised Contents
1.0	2011.03.10	Version 1.0 release
1.1	2012.06.15	Modify Copyright Notification Section 1: This correction Section 6: Modify the message element in STAT_INQ_RESP and STAT_RESP (Status Call Option -> Spare), modify the message element in REG_REQ (Destination Prefix -> Group Prefix), add contents of cause of TYPE-C, This correction of sections 6.6.2 and 6.6.2.1(infrastructure maker -> the operations manager of a system), Correction of Table 6.6-34(Non association system -> the system by which System ID is different). Message elements of GRP_REG_RESP in Figure 6.4-33 were modified (Source Prefix -> Destination Prefix and Source Unit ID -> Destination Unit ID). Section9:Add contents of cause of TYPE-C, Correction of section 9.5.1(Non association system -> the system by which System ID is different), Various errors in writing are corrected. Trunked Type of CALL_CONN_RESP in Table 6.4.3 was modified. (Multi -> Both) A description was added in Section 6.4.2.10. (The Data includes a Message CRC.) In Section 6.6.7 and 6.6.8, descriptions about Prefix of Unit which has a Special ID were modified. In Table 9.6-1, some service names were modified for the unification with other parts.

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