FLEX-TD RADIO PAGING SYSTEM

ARIB STANDARD

RCR STD-43A

I S S U E D	JUNE	27,	1995
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Association of Radio Industries and Businesses

Introduction

The Association of Radio Industries and Businesses(ARIB) has been investigating and summarizing the basic technical requirements for establishing standards for developing a radio paging system in Japan. These will appear in the form of standards and specifications governing the use of radio facilities and equipment for systems that transmit over radio waves. The standards are being developed based on the participation of and discussions with the various radio equipment manufacturers, operators and users.

The standards and specifications contained herein will serve as guidelines for developing standards for private use based on the public established technical standards in Japan. Their purpose is to enable effective use of radio frequencies by avoiding interference among users, conflicts among the standards of individual operators, and so forth so that all parties involved, including radio equipment manufacturers, users and others will be able to ensure the quality and compatibility of radio facilities and equipment.

These standards are being established principally for "FLEX-TD Radio Paging System". In order to ensure fairness, impartiality and openness among all parties involved, during the drafting stages, we invite radio equipment manufacturers, telecommunications operators and users both domestically and overseas to participate openly in the activities of the Standards Committee so as to develop standards with the total agreement of all parties involved.

The scope of application of these standards covers the minimum requirements for communications. They are designated to serve as practical guidelines for telecommunications equipment operators in developing original specifications and systems that fall within the scope of the standards.

We hope that the standards will aid all parties involved, including radio equipment manufacturers, telecommunications operators, users, and others in the development of an excellent radio paging system in Japan.

Note : Although this ARIB Standard contains no specific reference to any Essential Industrial Property Right relating thereto, the holder of such Essential Industrial Property Right states that "YYY" is the holder of the Industrial Property Right "XXX" covering this ARIB Standard and agrees not to assert such right "XXX" and to grant a license unconditionally to the use of such right "XXX" to anyone using this ARIB Standard. However this does not apply to anyone who uses this ARIB Standard and also owns and lays claim to any other Essential Industrial Property Right whose scope is included in any or all parts of the contents of the provisions of this ARIB Standard.

Patent holder	Name of Patent	Registration No./Application No.*	Remarks
NTT Mobile Communications Network Inc.	(1) Radio paging system (2) Mobile communication system and pagers	WO94/17607 PCT/JP95/00134	Applied in U.S., Chine,EPC(U.K., Germany)
Nippon Motorola Ltd.	(1) Decoder for pager (2) Selection paging signaling system (3) TDMA selection paging signaling system	PCT/US82/01437 1743433 PCT/US90/03876 511020 (applied 1990) PCT/US90/07356 502794 (applied 1991)	
FUJITSU LIMITED	(1) Radio paging system	190035 (laid-opened 1990)	

*Japan unless otherwise indicated

Contents

Chapter 1 General

1.1 Scope of application

This standard specifies the radio frequency interface (hereinafter referred to as "air interface") between the base station and the radio pager (hereinafter referred to as "pager") for the 280MHz band FLEX-TD Radio Paging System.

1.2 System overview

The FLEX-TD Radio Paging System is used to provide radio paging services at frequencies operating on the 280MHz band. This system consists of the pagers and infrastructure facilities as shown in Fig. 1.2-1 below.

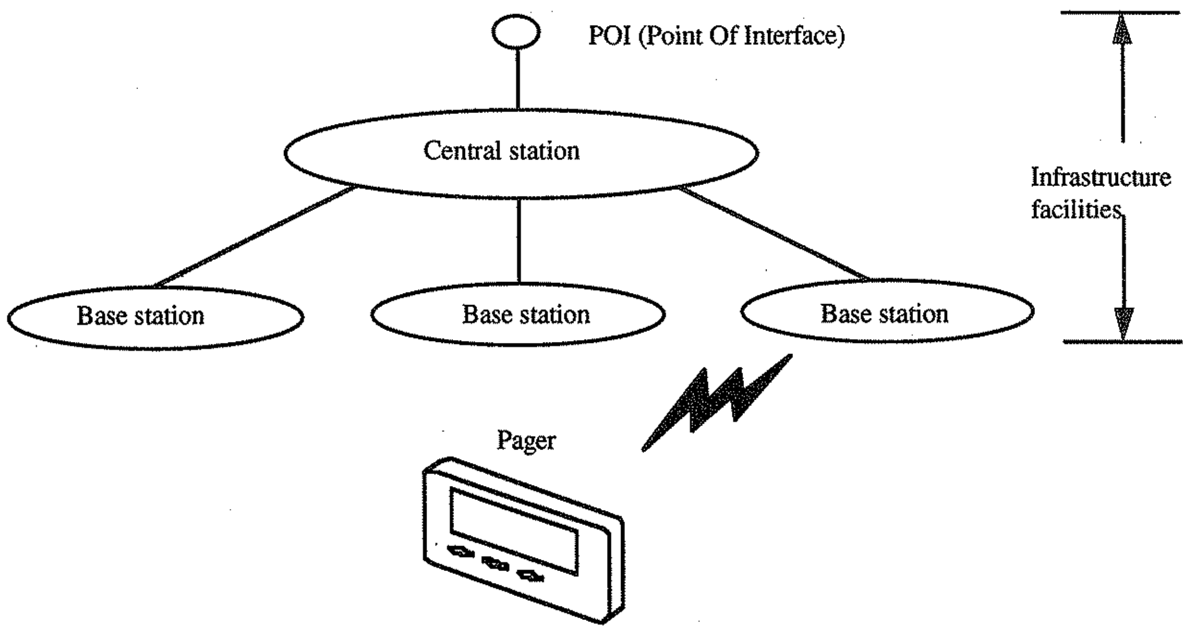


Fig. 1.2-1 : Overview of FLEX-TD Radio Paging System

1.2.1 Infrastructure facilities

Infrastructure facilities are used for paging.

Infrastructure facilities are configured of base stations (consisting of antennas, transmitters and phase compensation equipment) and a central station (equipment which performs call connection, subscriber authentication, coding, etc.).

1.2.2 Pager

The pager is used to receive radio paging signals from the base station.

The pager consists of the circuits which feature paging signal reception, demodulating, decoding, display and alerting functions.

1.3 Services provided by the FLEX-TD system

1.3.1 Basic services

The type of basic services provided via this system are listed in Table 1.3.1-1. Each service provider chooses and supplies the Services from the list in Table 1.3.1-1. Also the types of messages and vectors which can be used for transmitting paging call are shown in Table 1.3.1-2.

Table 1.3.1-1 : Basic services

Service	Description
Tone-Only	Provides the basic(Tone-Only) paging function only.
Kana Numeric service	Provides basic paging service together with an associated message reporting function. 4-bit code (Section 3.10.2.1) is used for transmitting numeric, symbol and Kana characters.
Alphanumeric service	Provides basic paging service together with an associated message reporting function. 4-bit (Section 3.10.2.1) or 7-bit codes (JIS X0201 3.10.2.2) are used for transmitting alphanumeric, symbol, etc.
Japanese Text service	Provides basic paging service together with an associated message reporting function. 4-bit (Section 3.10.2.1) or 8-bit or 16-bit codes (Shift JIS Code, Section 3.10.2.3) are used for transmitting alphanumeric, symbol, Katakana, Hiragana, Kanji, etc.
Transparent data service	Provides basic paging service together with an associated message reporting function. This function reports the bit series transferred from the caller as it is using binary messages as described in Section 3.10.1.2.

Table 1.3.1-2 : The available types of Vectors and Messages which can be used for paging call with associated message information.

	Vector							Message				Code			
	Standard Numeric	Special Format Numeric	Number-ed Numeric	Short Message	Alpha-numeric	HEX/ Binary	Short Instruct-ion	Standard/ Special Format Numeric	Number-ed Numeric	Alpha-numeric	HEX/ Binary	4-bit	7-bit	Shift JIS	Binary
Tone Only				YES								YES			
Kana Numeric Service	YES	YES	YES	YES			YES	YES	YES			YES			
Alphanumeric Service	YES	YES	YES	YES	YES		YES	YES	YES	YES		YES	YES		
Japanese Text Service	YES	YES	YES	YES		YES	YES	YES	YES		YES (HEX)	YES		YES	
Transparent data Service						YES	YES				YES (Binary)				YES

1.3.2 Supplementary service

Supplementary services provided by this system are listed in Table 1.3.2-1.

Refer to Chapter 8 for the supplementary services.

Table 1.3.2-1 : Supplementary services

Service	Outline
Priority Call service	Service whereby paging of the specified pager takes priority over other pagers.
Group Call service	Service whereby pagers are grouped and common messages are transmitted to the pagers within the pertinent group.
Multi area/Roaming service	When the user registers areas other than the Home area with the Infrastructure facilities, the user can use the paging service outside of the Home area.
Message Numbering service	Service whereby the Infrastructure facility assigns a message number for pages to each address used by the pager.
Source Indication service	Service whereby 8 types of Short Messages for identifying the calling party are transmitted.
Special Format service	Service whereby Numerical Messages sent to the pager are converted into the format specified in the ID-ROM.
Short Message services	Service whereby short numerical messages of 3-digits for Short Addresses or 8-digits for Long Addresses are transmitted.
Real-time clock maintenance service	Service whereby the pager clock is adjusted by Time information sent from the Infrastructure facility.
Subscriber Information service	Service wherein the user receives various information messages.

Chapter 2 Technical Requirements for Facilities

2.1 Base station transmission requirements

2.1.1 Frequency

Transmission frequency band is 280MHz.

2.1.2 Transmission speed and modulation scheme

Combinations of transmission speeds and modulation schemes shall be as listed in the table below.

Item No.	Transmission speed/modulation scheme
1	1600bps/2-level FSK
2	3200bps/2-level FSK
3	3200bps/4-level FSK
4	6400bps/4-level FSK

2.1.3 Frequency deviation

For the 2-level FSK, frequency deviation shall be +4.8kHz for "1" and -4.8kHz for "0".

For the 4-level FSK, frequency deviation shall be +4.8kHz for "10", +1.6 kHz for "11", -1.6kHz for "01 and -4.8kHz for "00".

2.1.4 Tolerance for frequency deviation

Tolerance for frequency deviation shall be within ±200Hz for the 2-level FSK, and within ±60Hz for the 4-level FSK.

2.1.5 Adjacent channel leakage power

When the carrier is modulated by 1600bps, 3200bps or 6400bps signals, power radiated within bandwidth of ±8kHz of which the center frequency is separated by 25kHz from the carrier frequency, shall be 70dB or lower than the power of the carrier frequency.

2.1.6 Spurious emission

The average power for spurious emission for each frequency supplied to the feeder is 2.5μW or less when the average power for the fundamental frequency is 25W or less. When the average power for the fundamental frequency exceeds 25W, it should be 70dB lower than the average power of the fundamental frequency and 1 mW or less.

2.1.7 Occupied frequency bandwidth

The occupied frequency bandwidth shall be defined as the frequency bandwidth which is determined by the edge frequencies, whereby the power of emissions averaged over the frequency range both above and below the edge frequencies is 0.5% of the total radiated power. Occupied frequency bandwidth must be 16kHz or less.

2.1.8 Frequency stability

The maximum allowable deviation from the assigned frequency for the center frequency of the occupied frequency band shall be within $\pm 5.0 \times 10^{-8}$.

2.1.9 Shaping of baseband signal

A low pass filter with 3dB cutoff frequency of 3.2kHz or more, or filter equivalent to this low pass filter shall be used.

2.1.10 Simulcasting

(1) Frequency offset

This system uses multiple base stations in a service area. Radiowaves are transmitted for a page from these base stations simultaneously over the same radio channel. In order for the pager to reduce mutual interference between individual base stations, each base station uses a different frequency offset for the carrier frequency.

The offset frequency must be within ±150Hz.

(2) Deviation for bit and symbol phases between base stations

The deviation for bit and symbol phases between base stations must be within ±5μsec.

2.1.11 Transmission speed accuracy

The absolute accuracy for transmission speed must be within $\pm 5 \times 10^{-6}$.

2.2 Pager requirements

Pager must support all combinations of signaling speeds and modulation schemes described in Section 2.1.2.

In order to receive paging call, the pagers specified in Table 2.2-1 must receive the minimum types of Vector specified for the pertinent type of pager.

Table 2.2-1: Minimum Vectors which pagers must support

Type of Pager	Vector
Numeric Pager	① Standard Numeric Vector (V(011))
	② Short Message Vector (V(010) and t(00))
Alphanumeric Pager	① Alphanumeric Vector (V(101))
	② Standard Numeric Vector (V(011))
	③ Short Message Vector (V(010) and t(00))
	④ Short Instruction Vector (V(001) and i(000)) (Applies to Any and All Phase pagers)

Note: Refer to Section 3.9 for Vector and Section 3.3.4 for phase.

2.2.1 Reception frequency

The reception frequency band is 280MHz and channel spacing is 25kHz.

2.2.2 Receiver sensitivity

(1) Built-in antenna type pager

a) Refer to table 2.2.2-1 below for On-body type pager.

Table 2.2.2-1 : Receiver sensitivities for On-body type pager

	Transmission speed	Receiver sensitivity
Reference sensitivity (static)	1600 bps	18 dBμV/m or less
	3200 bps	20 dBμV/m or less
	6400 bps	23 dBμV/m or less
Sensitivity under fading condition (average)	1600 bps	25 dBμV/m or less
	3200 bps	27 dBμV/m or less
	6400 bps	30 dBμV/m or less

b) Refer to table 2.2.2-2 below for other types of pager.

Table 2.2.2-2 : Receiver sensitivities for other types of pager

	Transmission speed	Receiver sensitivity
Reference sensitivity (static)	1600 bps	23 dBμV/m or less
	3200 bps	25 dBμV/m or less
	6400 bps	28 dBμV/m or less
Sensitivity under fading condition (average)	1600 bps	30 dBμV/m or less
	3200 bps	32 dBμV/m or less
	6400 bps	35 dBμV/m or less

(2) Pager with antenna terminal

Receiver sensitivity for pager with antenna terminal must be as listed in Table 2.2.2-3 below.

Table 2.2.2-3 : Receiver sensitivity for pager with antenna terminal.

	Transmission speed	Receiver sensitivity
Reference sensitivity (static)	1600 bps	-5 dBμV or less
	3200 bps	-3 dBμV or less
	6400 bps	0 dBμV or less
Sensitivity under fading condition (average)	1600 bps	2 dBμV or less
	3200 bps	4 dBμV or less
	6400 bps	7 dBμV or less

2.2.3 Adjacent channel selectivity

Adjacent channel selectivity must be 60dB or more.

Adjacent channel must be 25kHz away from the Test-Channel.

Note that definition for adjacent channel selectivity is that the ratio between the tolerable interference signal level and the reference sensitivity when simultaneously applying a desired signal having the level of reference sensitivity +3dB and an interference signal detuned 25kHz from the desired signal (modulated by a pseudo noise series signal with 32,767-bit code length).

2.2.4 Intermodulation characteristics

(1) Built-in antenna type pager

1) For 3rd-order intermodulation, the ratio between the tolerable interference level and the desired signal level must be 40dB or more when applying a 50dBμV/m desired signal along with two interference signals detuned 50kHz and 100kHz respectively (modulated by pseudo noise series signal with 32,767-bit code length)

2) For 2nd-order intermodulation, it is not necessary to measure pager whose 1st IF frequency exceeds the reception frequency bandwidth. However, pager with 1st IF frequency which is lower than the reception frequency bandwidth, the ratio between the tolerable interference signal level and the desired signal level must be 40dB or more when applying a desired signal of 50dBμV/m along with a combination of two interference signals which cause 2nd-order intermodulation.

3) In the case of pager utilizing direct conversion method, for 2nd-order intermodulation, the ratio between the tolerable interference signal level and desired signal level must be 40dB or more when applying a desired signal of 50dBμV/m under the following two conditions :

a. wherein two interference signals detuned ±50kHz from the desired signal (modulated by a pseudo noise series signal with 32,767-bit code length) are used.

b. wherein two interference signals: one is detuned 50kHz from a desired signal and another is detuned 50kHz from the twice the desired signal (modulated by a pseudo noise series signal with 32,767-bit code length) are used.

(2) Pager with antenna terminal

1) For 3rd-order intermodulation, the ratio between the tolerable interference level and the desired signal level must be 40dB or more when applying a 40dBμV desired signal along with two interference signals, detuned 50kHz and 100kHz, respectively (modulated by pseudo noise series signal with 32,767-bit code length).

2) For 2nd-order intermodulation, it is not necessary to measure pager whose 1st IF frequency exceeds the reception frequency bandwidth. However, pager with a 1st IF frequency which is lower than the reception frequency bandwidth, the ratio between the tolerable interference signal level and the desired signal level must be 40dB or more when applying a desired signal of 40dBμV along with a combination of two interference which cause 2nd-order intermodulation.

3) In the case of pager utilizing the direct conversion method, for 2nd-order intermodulation, the ratio between the tolerable interference signal level and desired signal level must be 40dB or more when applying a desired signal of 40dBμV under the following two conditions:

a. wherein two interference signals detuned ±50kHz from a desired signal (modulated by a pseudo noise series signal with 32,767-bit code length) are used.

b. wherein two interference signals: one is detuned 50kHz from a desired signal and another is detuned 50kHz from twice the desired signal are used.

2.2.5 Spurious response

Spurious response must be 40dB or more.

The definition of spurious response is the ratio between the tolerable interference signal level and the reference sensitivity when a desired signal with the level of reference sensitivity +3dB and an interference signal detuned 25kHz from the desired signal (modulated by a pseudo noise serial signal with 32,767-bit code length) are applied simultaneously.

2.2.6 Limitation of spurious emission

Limitation of spurious emission must be 4,000µµW or less.

Chapter 3 Signaling

3.1 Frame structure

3.1.1 Basic structure

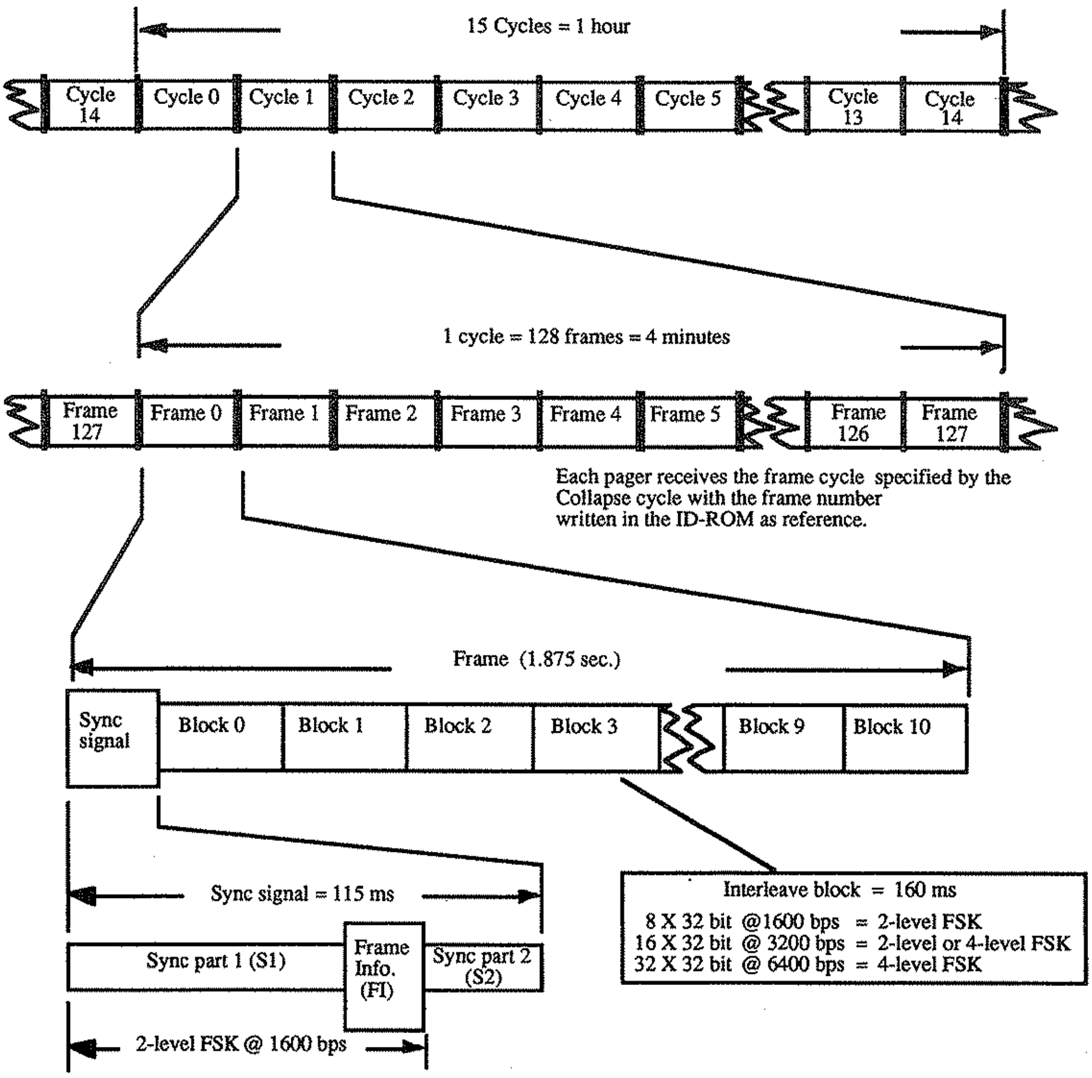


Fig. 3.1.1-1 : Basic signal structure

As shown in Fig. 3.1.1-1 above, fifteen Cycles, numbered sequentially from 0 to 14, are transmitted within one hour. Each Cycle is structured of 128 Frames (with 4 minutes being equivalent to a complete Cycle). The Frames in the Cycle are numbered sequential from 0 to 127. Each Frame has a frame length of 1.875 sec., and 32 Frames are transmitted per minute. Also, each individual Frame is structured of a sync. signal along with 11 blocks. The blocks in a Frame are numbered sequentially from 0 to 10. Unless otherwise noted, the word "Frame" in the specification includes all 11 blocks and a synchronization signal. At a transmission speed of 1600bps, each block is structured of 8 words, for a total of 88 words in all 11 blocks. At transmission speeds of 3200bps and 6400bps multiplexing is performed, in which case 88 words are contained in a "phase" (Refer to Section 3.3).

In instances when multiple transmission is not performed, the words composing a phase are numbered from 0 to 87 (Refer to Section 3.4.2 for a description of word numbering during multiple transmission).

Frame Information word consists of a 4-bit Cycle number and 7-bit Frame number. In principle Frame No. 0 in Cycle No. 0 is synchronized on real time at the top of each hour, which enables the pager to synchronize the clock on real time.

Sync part 1 (S1) of each Frame is transmitted at 1600bps and provides information on frame timing, the 1600bps symbol timing and the signal speed for other parts of the Frame. The Frame Information Word includes Cycle and Frame numbers, low traffic time-division multiplex phase indication (in instances when the address field does not exceed the area of block 0), and also a 4-bit checksum to ensure information reception quality.

Sync part 2 (S2) of each Frame is synchronized at the block speed for the pertinent Frame in order to enable correct separation and decoding of the multiplex signal for the message block.

When Frames are transmitted, a minimum of one Frame per minute must be transmitted.

However, there are instances when a channel can not be occupied continuously for 4 minutes due to the sharing of that channel by several Providers (herein after referred to simply as "channel sharing") in some countries. In such instances, it is permissible to transmit a minimum of one Frame per 4 minutes. Also, if possible, during idle time on the channel it is desirable that the Idle Frames filled with 11 Idle Blocks (such as those described in Section 3.4.1 wherein block 0 includes Block Information Words) are transmitted.

3.1.2 Collapse cycle

One of the 128 Frames is assigned to the address of each pager. If a pager receives messages only in the assigned Frame, it will only be able to receive a message once every 4 minutes. Also, the message paging delay could be a maximum of 4 minutes. On the other hand, when transmission takes place at the normal 4-minute cycle and the maximum paging delay is incurred, the battery savings can be maximized, as a pager only needs to be set to the reception state once every 4 minutes. However, when it is desirable to shorten the paging delay, it can also be shortened by changing what is referred to as a "Collapse cycle".

The Collapse cycle is 2^m, while m is the Collapse cycle value. If the value of m is varied (by setting it to 0, 1, 2, 3......7) the reception cycle is changed to 1, 2, 4, 8,......128, accordingly. By setting m = 4, for example, the pager can be set to the reception state at every $2^4=16$ Frames. Assuming that the Frame number assigned to the pager is n, the pager will be in a reception state on each Frame of n, n+16, n+32,...... In other words, if the Frame number is expressed as 7 bits, the pager receives messages in the Frames which match up with the lower 4 bits (4 LSB) of the 7 bits. The smaller the value that is set for m, the shorter the paging delay becomes, but conversely the battery savings ratio drops, increasing battery consumption. These 2 parameters are set based on the operation control methods employed by the individual operators. On the Infrastructure facilities side, the value of m is specified by the Block Information Word. The Collapse cycle which is selected in this instance, is referred to as "system Collapse cycle". System Collapse cycle information which is sent to the pager must be identical for all Frames and all phases. On the pager side, the value of m is written on an address basis in the ID-ROM. Also this data is memorized in the base station facilities and the Collapse cycle which is set is called the "pager Collapse cycle". When the value of m for the system and the value of m for the pager differ, normally the smaller value takes priority. In instances when multiple transmission is employed, however, system Collapse cycle always takes priority over pager Collapse cycle.

Examples of how a Collapse cycle operates are given below. If one channel is shared, for example, there will be instances when the pertinent system cannot occupy one channel continuously for 4 minutes. In such cases, if the Collapse cycle is shortened, each Frame can transmitted at a shorter cycle which allows traffic for the pertinent system to be concentrated into a shorter transmission time, thus making it possible to shorten the duration that the channel is occupied.

The followings are examples of how a Collapse cycle operates.

Example : When system Collapse cycle value m is 3 (system Collapse cycle= 8), each Frame is transmitted as shown in Table 3.1.2-1 below :

Table 3.1.2-1 : Examples of transmission to each Frame

	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7
LSB	000	001	010	011	100	101	110	111	000				...			
Frames to be transmitted	0	1	2	3	4	5	6	7					...			
	8	9	10	11	12	13	14	15					...			
	16	17	18	19	20	21	22	23					...			
	24	25	26	27	28	29	30	31					...			
	32	33	34	35	36	37	38	39					...			
	40	41	42	43	44	45	46	47					...			
	48	49	50	51	52	53	54	55					...			
	56	57	58	59	60	61	62	63					...			
	64	65	66	67	68	69	70	71					...			
	72	73	74	75	76	77	78	79					...			
	80	81	82	83	84	85	86	87					...			
	88	89	90	91	92	93	94	95					...			
	96	97	98	99	100	101	102	103					...			
	104	105	106	107	108	109	110	111					...			
	112	113	114	115	116	117	118	119					...			
	120	121	122	123	124	125	126	127					...			

Example 2 :When the base Frame number is set to 63 and the Collapse cycle = 4 (2^2), Frames are received in the cycles shown in Fig. 3.1.2-1.

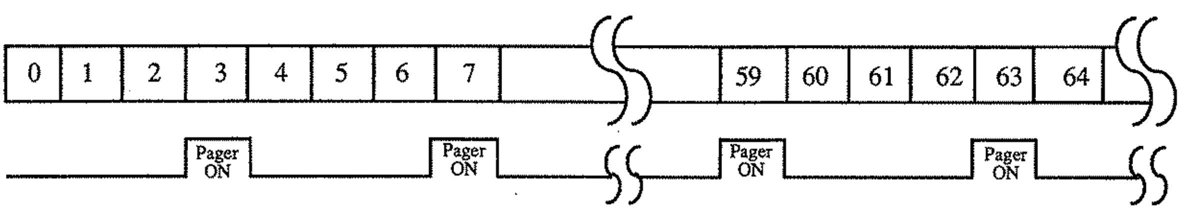


Fig. 3.1.2-1 : Reception example for Collapse cycle

3.1.3 Coexistence of multiple Collapse cycles at multiple transmission

As described in the previous section, the System Collapse cycle takes priority over the Pager Collapse cycle when multiple transmission is employed. Therefore, in this case, in principle, the Collapse cycle is determined by the System Collapse cycle.

But, in order to also enable the use of several different types of pagers for multiple transmission, an option of assigning multiple Collapse cycles to one RF channel using TD Collapse cycle described in Section 3.6 is also available. The TD Collapse cycle takes priority over the system Collapse cycle in operation of a pager. In such cases, there must not be any conflicts in the Frame assignment to each channel.

For example, in the case of the 2^m, System Collapse cycle, as a condition for assigning TD Collapse cycle $2^q (1 \leqq m < q \leqq 7)$ to each Frame, Frame number F_a (which TD Collapse cycle 2^q is not assigned to) must meet the following conditions :

$$F_a = F_{a0} + k \cdot 2^m \; (0 \leqq F_{a0} < 2^m, \; k=0,1, \cdots < 128 / 2^m)$$

and, Frame number F_b (which TD Collapse cycle 2^q is assigned to) must satisfy the following conditions:

$$F_b = F_{b0} + j \cdot 2^q \; (0 \leqq F_{b0} < 2^q, \; j=0,1, \cdots < 128 / 2^q)$$
$$F_{b0} \neq F_a$$

Examples 1 and 2 below show how two Collapse cycles are assigned to Frames.

Example 1 : When two Collapse cycles $2^m = 16$ and $2^q = 32$ are allocated

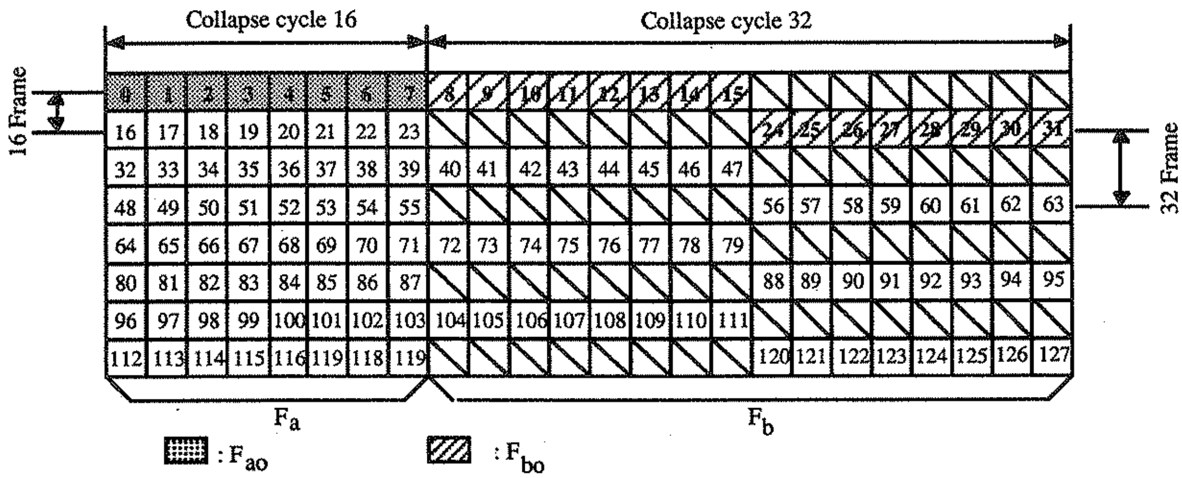


Fig 3.1.3-1 : Allocation example of Two Collapse cycles.

Example 2 : Reception model when the Collapse cycle equals 4 and TD Collapse cycle equals 32.

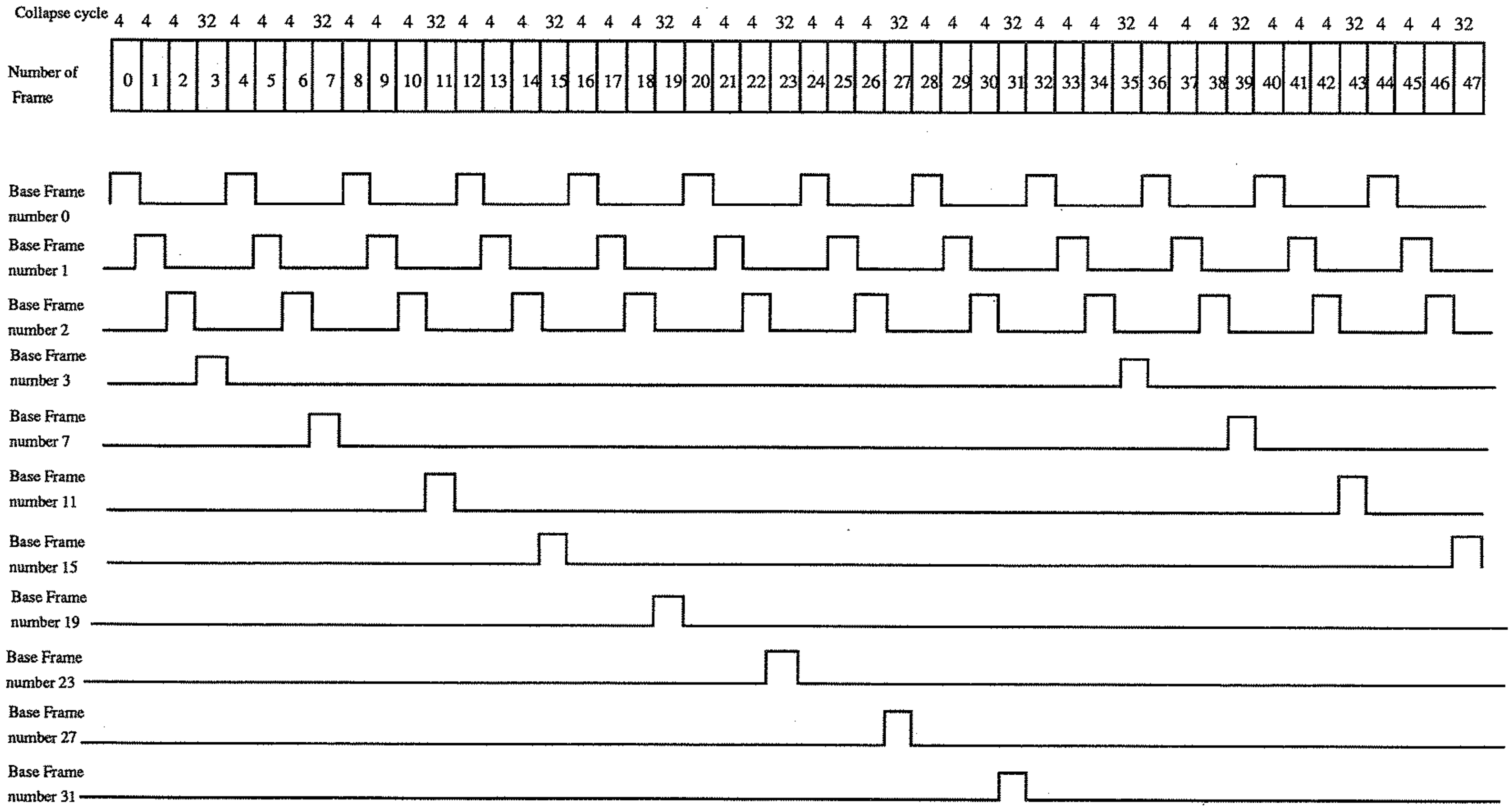


Fig. 3.1.3-2 Reception example for two Collapse cycles

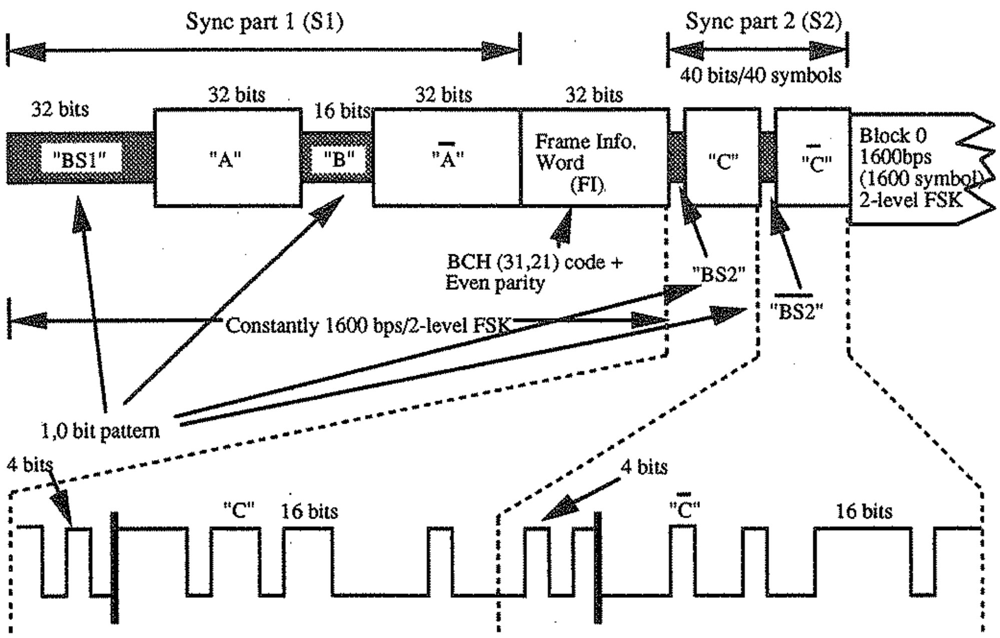
3.2 Synchronization signal

The respective sync. signal structures are defined in the figures and tables listed below:

1600bps/2-level	:	Fig. 3.2-1, Table 3.2-1
3200bps/2-level	:	Fig. 3.2-2, Table 3.2-2
3200bps/4-level	:	Fig. 3.2-3, Table 3.2-3
6400bps/4-level	:	Fig. 3.2-4, Table 3.2-4

Also note that sync. signal "A" in Sync part 1 differs based on frame speed and is defined in Table 3.2-5.

In addition signals marked $\overline{}$ (such as "$\overline{A}$", etc., in the figures) or indicated as "inv.A" etc., in the tables are inverse signals of the respective A signal, etc.



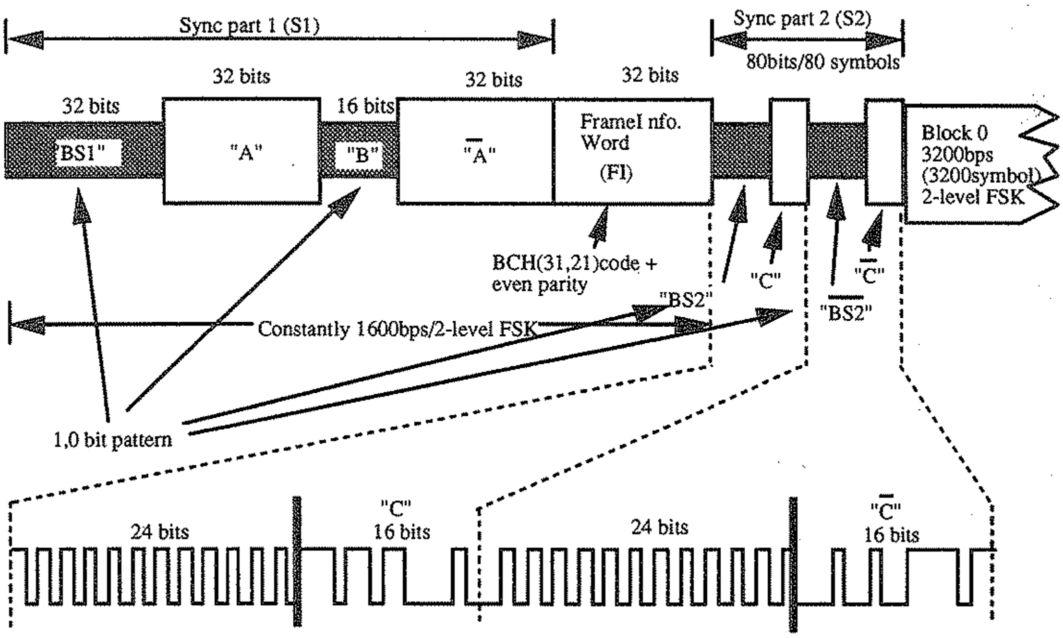
* Sync. part 2 : When the data blocks are transmitted at 1600bps 2-level, sync. part 2 is defined as shown in the figure above.

Fig. 3.2-1 : 1600bps/2-level sync. signal structure

Table 3.2-1 : Bit stream for 1600bps/2-level frame speed

BS1	1010101010101010	1010101010101010
A (A1)	0111100011110011	0101100100111001
B	0101010101010101	
inv.A (A1)	1000011100001100	1010011011000110
Frame Info.	iiiiiiiiiiiiiiii	iiiiipppppppppp
BS2	1010	
C	1110110110000100	
inv.BS2	0101	
inv.C	0001001001111011	

* The LSB on the left is transmitted first



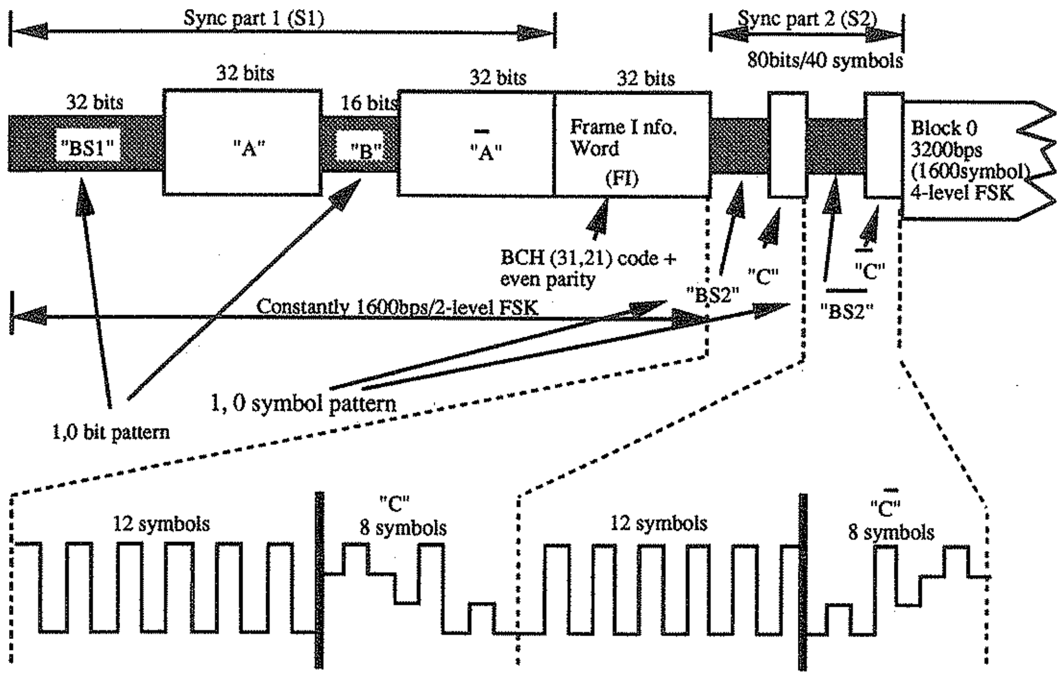
* Sync. part 2 : When the data blocks are transmitted at 3200bps 2-level, sync. part 2 is defined as shown in the figure above.

Fig. 3.2-2 : 3200bps/2-level sync. signal structure

Table 3.2-2 : Bit stream for 3200bps/2-level frame speed

BS1	1010101010101010 1010101010101010
A (A2)	1000010011100111 0101100100111001
B	0101010101010101
inv.A (A2)	0111101100011000 1010011011000110
Frame Info.	iiiiiiiiiiiiiiii iiiiipppppppppp
BS2	1010101010101010 10101010
C	1110110110000100
inv.BS2	0101010101010101 01010101
inv.C	0001001001111011

* The LSB on the left is transmitted first



* Sync. part 2 : When the data blocks are transmitted at 3200bps/4-level, sync. part 2 is defined as shown in the figure above.

BS2	"C"
1000100010001000100010001000	1110110110000100
inv.BS2	inv."C"
0010001000100010001000100010	0001001001111011

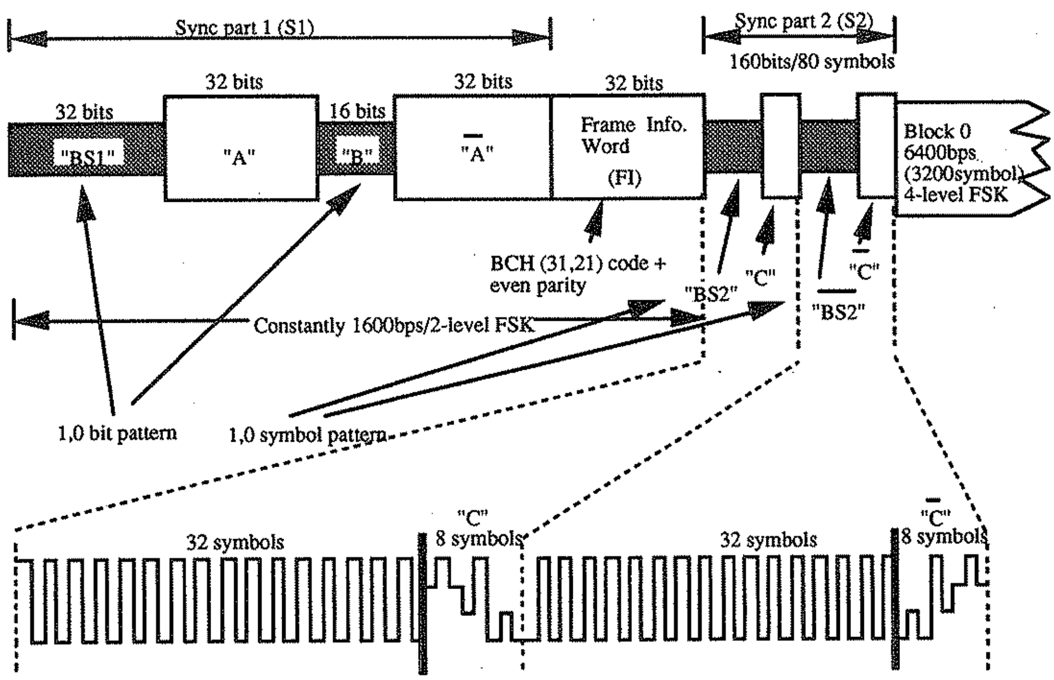
Decoded data sample

Fig. 3.2-3 : 3200bps/4-level sync. signal structure

Table 3.2-3 : Bit stream for 3200bps/4-level frame speed

BS1	1010101010101010 1010101010101010
A (A3)	0100111110010111 0101100100111001
B	0101010101010101
inv.A (A3)	1011000001101000 1010011011000110
Frame Info.	iiiiiiiiiiiiiiii iiiiipppppppppppp
BS2	101010101010 (symbol)
C	1110110110000100 (decoded value)
inv.BS2	010101010101 (symbol)
inv.C	0001001001111011 (decoded value)

* The LSB on the left is transmitted first



* Sync. part 2 : When the data blocks are transmitted at 6400bps/4-level, sync. part 2 is defined as shown in the figure above.

```
   BS2: 1000100010001000100010001000100010001000100010001000100010001000
   "C": 1110110110000100
inv.BS2: 0010001000100010001000100010001000100010001000100010001000100010
 inv"C": 0001001001111011
```

Decoded data sample

Fig. 3.2-4 : 6400bps/ 4-level sync. signal structure

Table 3.2-4 : Bit stream for 6400bps/ 4-level frame speed

BS1	1010101010101010	1010101010101010	
A (A4)	0010000101011111	0101100100111001	
B	0101010101010101		
inv.A (A4)	1101111010100000	1010011011000110	
Frame Info.	iiiiiiiiiiiiiiii	iiiiipppppppppp	
BS2	1010101010101010	1010101010101010	(symbol)
C	1110110110000100	(decoded value)	
inv.BS2	0101010101010101	0101010101010101	(symbol)
inv.C	0001001001111011	(decoded value)	

* The LSB on the left is transmitted first

Table 3.2-5 : "A" binary pattern

Frame speed	1 2 3 4 5 6 7 16	17 32
A1 1600bps/2-level	0 1 1 1 1 0 0 0 1 1 1 1 0 0 1 1	0 1 0 1 1 0 0 1 0 0 1 1 1 0 0 1
A2 3200bps/2-level	1 0 0 0 0 1 0 0 1 1 1 0 0 1 1 1	0 1 0 1 1 0 0 1 0 0 1 1 1 0 0 1
A3 3200bps/4-level	0 1 0 0 1 1 1 1 1 0 0 1 0 1 1 1	0 1 0 1 1 0 0 1 0 0 1 1 1 0 0 1
A4 6400bps/4-level	0 0 1 0 0 0 0 1 0 1 0 1 1 1 1 1	0 1 0 1 1 0 0 1 0 0 1 1 1 0 0 1
A5 Reserved	1 1 0 1 1 1 0 1 0 1 0 0 1 0 1 1	0 1 0 1 1 0 0 1 0 0 1 1 1 0 0 1
A6 Reserved	0 0 0 1 0 1 1 0 0 0 1 1 1 0 1 1	0 1 0 1 1 0 0 1 0 0 1 1 1 0 0 1
A7 Reserved	1 0 1 1 0 0 1 1 1 0 0 0 0 0 1 1	0 1 0 1 1 0 0 1 0 0 1 1 1 0 0 1
A8 Reserved	0 1 1 0 0 0 1 1 0 1 0 0 0 0 0 1	0 1 0 1 1 0 0 1 0 0 1 1 1 0 0 1
A9 Reserved	0 0 0 1 1 0 1 1 1 1 1 0 0 0 1 0	0 1 0 1 1 0 0 1 0 0 1 1 1 0 0 1
A10 Reserved	0 0 1 0 1 1 0 0 1 0 0 0 0 1 1 0	0 1 0 1 1 0 0 1 0 0 1 1 1 0 0 1
A11 Reserved	1 0 1 0 0 1 0 1 1 1 1 0 1 0 0 0	0 1 0 1 1 0 0 1 0 0 1 1 1 0 0 1
A12 Reserved	1 0 0 1 0 0 1 0 1 0 0 0 1 1 0 0	0 1 0 1 1 0 0 1 0 0 1 1 1 0 0 1
A13 Reserved	0 1 1 0 1 1 1 0 1 0 0 1 1 0 0 0	0 1 0 1 1 0 0 1 0 0 1 1 1 0 0 1
A14 Reserved	1 0 1 1 1 1 1 0 0 1 0 1 1 0 1 0	0 1 0 1 1 0 0 1 0 0 1 1 1 0 0 1
A15 Reserved	1 1 1 1 0 0 0 1 1 0 0 1 1 1 0 1	0 1 0 1 1 0 0 1 0 0 1 1 1 0 0 1
Ar Re-synchronization	1 1 0 0 1 0 1 1 0 0 1 0 0 0 0 0	0 1 0 1 1 0 0 1 0 0 1 1 1 0 0 1

The LSB on the left is transmitted first

* ("A" = BCH (31, 21) code + even parity, but is transmitted in reverse order of the other code word)

3.2.1 Emergency Re-synchronization transmission

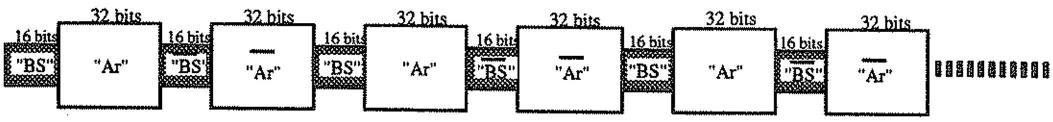


Fig. 3.2.1-1 : Emergency Re-synchronization transmission

Table 3.2.1-1 : Emergency Re-synchronization transmission

BS	1010101010101010	
A (Ar)	1100101100100000	0101100100111001
inv.BS	0101010101010101	
inv.A (Ar)	0011010011011111	1010011011000110

The LSB on the left is transmitted first

With the FLEX-TD system, in such instances as when error occurs with the spare time reference system or when other important parts fail which result in loss of the synchronization timing for base station facilities, an Emergency Re-synchronization signal must be sent before a new paging message is transmitted.

Note: As the FLEX-TD system is a synchronization paging system which does not require preambles once the pager has established frame synchronization, transmission must be performed at that same timing; otherwise the pager will stop receiving.

The Re-synchronization pattern in Fig. 3.2.1-1 and Table 3.2.1-1 must be transmitted for a continuous period which is equivalent to the battery saving cycle for a pager having the maximum Collapse cycle value. For example, if the system has a pager with a maximum Collapse cycle value of "7," the Re-synchronization pattern must be transmitted continuously for 4 minutes in order to ensure that the pager receives the Re-synchronization command correctly at least once.

In rare instances, however, such as when the Collapse cycle value for the system is set for "0" (wherein all pagers will receive a transmission on each Frame), the Re-synchronization pattern need only be transmitted for a 1.875 sec. duration.

The Re-synchronization pattern follows the definition for synchronization part "A" in the sync. signal structure described in Section 3.2. The "Ar" pattern defined in the previous section is selected for pattern "A", while "Ar" is appended with the 16-bit signal 1,0,1.0... which separates the inverse "Ar" signal. At present, a method for regulating how to start and end transmissions for Re-synchronization has yet not been specified (so far the only item specified in this respect is that the overall transmission time length must be at least equal to that of the pager having the longest battery saving cycle in the system).

3.3 Interleave and multiplexing

Each interleave block occupies 160 ms of the transmission time, regardless of the specified frame speed. As shown in Tables 3.3-1, 3.3-2 and 3.3-3 below, the amount of information per block increases according to the specified frame speed. A Frame is structured of multiplexed 1600bps data strings, wherein 1600bps is non-multiplexed, 3200bps is 2-channel multiplexed and 6400bps is 4-channel multiplexed. Each of the channels used in this configuration is called a "phase". 1600bps is structured of one phase (a), 3200bps is structured of 2 phases (a,c) and 6400bps is structured of 4 phases (a,b,c,d). The tables also provide a method for combining information data strings, which are referred to as "multiplex phases."

Table 3.3-1 : 1600bps block (8 word x 32 bits)

	1 2 3 4 5 6 7 ············· 21	22 · · · · · · · · · 31	3 2
	Information bits	Parity bits	Even parity
Word 0a	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	p
Word 1a	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	p
Word 2a	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	p
Word 3a	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	p
Word 4a	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	p
Word 5a	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	p
Word 6a	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	p
Word 7a	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	p

Table 3.3-2 : 3200bps block (16 word x 32 bits)

	1 2 3 4 5 6 7 • • • • • • • • • • • • • 21 Information bits	22 • • • • • • • • • 31 Parity bits	3 2 Even parity
Word 0a	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	p
Word 0c	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	p
Word 1a	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	p
Word 1c	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	p
•	•	•	•
•	•	•	•
•	•	•	•
•	•	•	•
Word 6a	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	p
Word 6c	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	p
Word 7a	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	p
Word 7c	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	p

Table 3.3-3 : 6400bps block (32 word x 32 bits)

	1 2 3 4 5 6 7 • • • • • • • • • • • • • 21 Information bits	22 • • • • • • • • • 31 Parity bits	3 2 Even parity
Word 0a	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	p
Word 0b	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	p
Word 0c	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	p
Word 0d	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	p
Word 1a	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	p
•	•	•	•
•	•	•	•
•	•	•	•
•	•	•	•
Word 6d	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	p
Word 7a	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	p
Word 7b	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	p
Word 7c	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	p
Word 7d	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	p

3.3.1 Block size

All blocks have a length of 160 ms and when the channel bit rate increases, the level of multiplexing increases accordingly.

1600bps	-	8 words	8 x 32 =	256 bits	Multiplexing level 1
3200bps	-	16 words	16 x 32 =	512 bits	Multiplexing level 2
6400bps	-	32 words	32 x 32 =	1024 bits	Multiplexing level 4

3.3.2 Transmission of blocks

All words consist of BCH (31,21) codes and even parity extending horizontally from each of words 0a,0b,0c,0d,.....7a,7b,7c,7d.

Binary bit series are either subject to direct modulation (2-level FSK), or when 3200bps/6400bps (4-level FSK) is used, the first bit series is made to pass through a 2-bit symbol converter, and symbol conversion is performed so that the first 2 bits are always processed as a pair and converted into 4-level symbols. Of the first 2 bits for 3200bps/4-level FSK, bit 0a is converted into the MSB for the symbol and bit 0c into the LSB. Of the first 2 bits for the 6400bps/4-level FSK, bit 0a is converted into the MSB for the symbol and bit 0b into the LSB. (The MSB for a symbol is positioned at the left side of the symbol as described in Section 2.1.3.)

As shown in Table 3.3-1, on the radio channel, bit series are transmitted vertically, from the top left end row down through the bottom right end row. At 3200bps and 6400bps, the bit series are transmitted vertically as shown in Table 3.3-2 and 3.3-3, respectively. As the tables illustrate, the block structure used for 3200bps and 6400bps is a combination of code interleave and multiple 1600bps data strings which are multiplexed (or else it can be assumed that multiple interleaved data strings have been multiplexed). The example used for 6400bps in Table 3.3-3 shows how transmission starts, beginning from word 0a and continues in the order of words 0b, 0c, 0d, 1a,....7a, 7b, 7c, 7d...

This transmission procedure is also illustrated in Fig. 3.3.2-1. "w7b1 ~ w6b3" in the figure represent words and bits (in this case, "w7b1" indicates bit "1" of word "7", which corresponds to the first information bit).

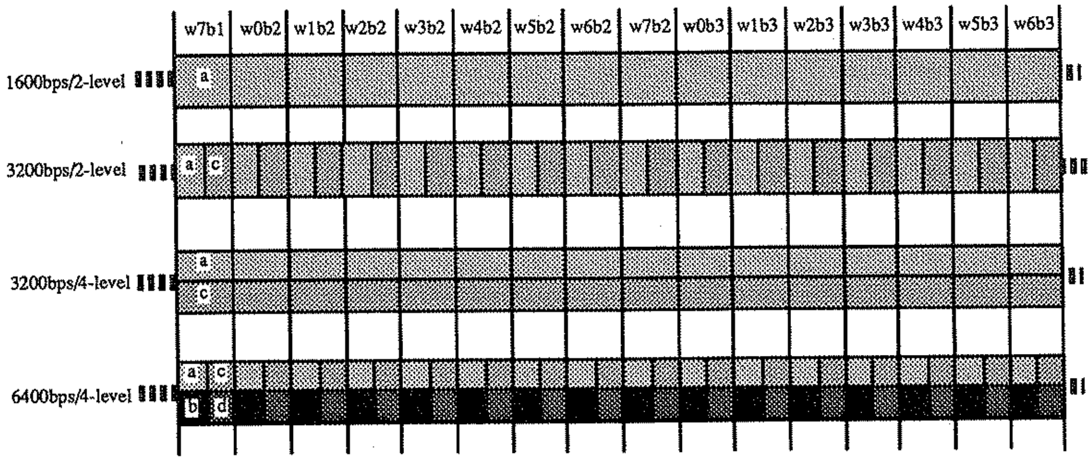


Fig. 3.3.2-1 : Interleaving and multiplexing

3.3.3 Reception of blocks

Each pager extracts phases "a", "b", "c" or "d" depending on the values assigned to it from the bit series arranged in an 8 x 32 array in its memory. At this point, BCH (31, 21) codes and even parity can be detected and processed by the 2-bit error correction algorithm. The error condition is checked for each word and the information bits are extracted for further processing.

3.3.4 Specifying phases

If a Frame is multiplexed and multiple phases exist, the contents of the respective phase remain independent of each other (except for the Collapse cycle, Carry On and multiple transmission). An example of 6400bps single transmission is shown in Fig. 3.3.4-1 below.

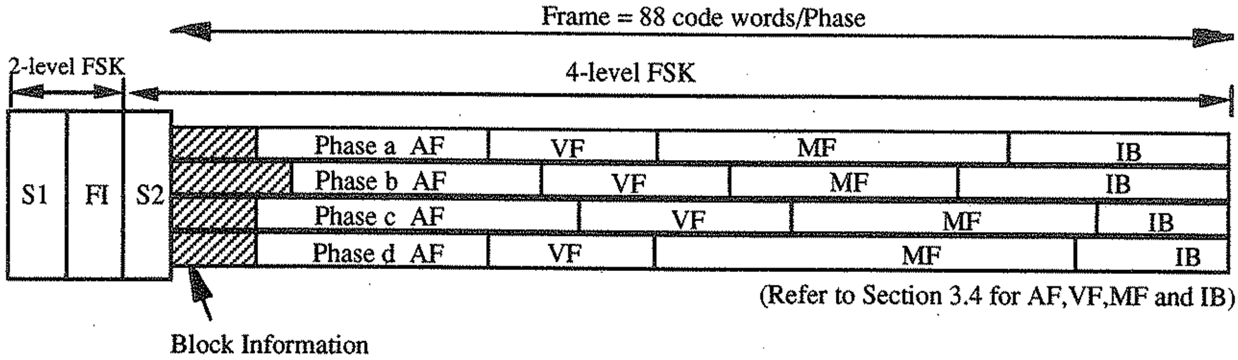


Fig. 3.3.4-1 : Independent operation of the respective phases at 6400bps

Phase value 0, 1, 2 or 3 is assigned to the ID-ROM of each pager. If the phase value assigned at 6400bps is "0", the pager receives "a" if "1" is assigned, it receives "b"; if "2", it receives "c", and if "3" is assigned, it receives "d". If the phase value is "0 or 1" at 3200bps, the pager receives "a"; if it is "2 or 3," it receives "c". In addition, if the phase value is 0, 1, 2, or 3 at 1600bps, the pager receives "a".

Also note that the method whereby the pager specifies the phase is regulated by the ID-ROM. The following 3 methods can be used. The Infrastructure facility transmits using the phase which matches up with the one specified by the pager. (Refer to Section 3.8.3)

(1) Single phase

The method whereby one of the four phase values is assigned to the pager (with this method, the pager receives a page only in the phase specified by the assigned phase value).

(2) Any phase

The method whereby the pager can monitor addresses in all phases, but message reception for each page is performed only in the single phase (this is because pagers having Any phase mode use only the phase assigned by the operator at the time of each transmission).

Note : For each single address in a Frame, a message can be received up to two times (in this instance the message is not necessarily assigned to the same phase). Also, for pagers having two addresses which perform group call page using a common address, it is not necessarily assigned to the same phase.(Refer to Section 3.8.5)

(3) All phase

The method whereby pagers can receive all phases, including messages. (Details for this method are presently under study.)

(4) In items (1), (2) and (3) above, the word "address" means Short and Long Address for an individual and a group call page.

3.4 Transmission order

3.4.1 Transmission order in Frame (single transmission)

Fig. 3.4.1-1 below illustrates the transmission order in a Frame (note that the boundaries between fields are not restricted by the boundaries between blocks).

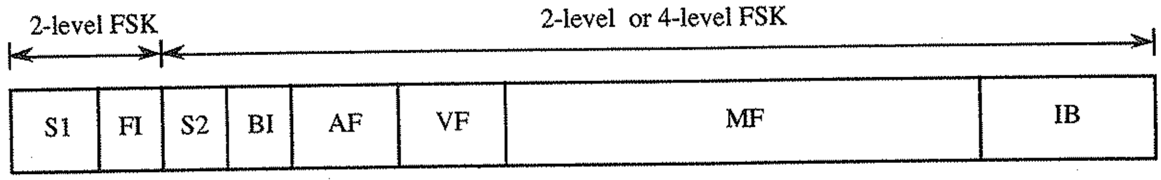


Fig. 3.4.1-1 : Frame transmission sequence

Synchronization part 1 (S1)

Synchronization part 1 is structured of 112 bits for 1600bps modulated by 2-level FSK. The system utilizes 16 patterns for synchronization. These patterns are used for specifying the type (combination of each signaling speed and modulation scheme) for subsequent Frames of the four types (refer to Section 3.2).

Frame Information (FI)

Frame Information Word is a 32-bit word transmitted at 1600bps, 2-level FSK modulation, which includes Frame number, Cycle number, etc.—(refer to Section 3.6 for details).

Synchronization part 2 (S2)

Synchronization part 2 provides the block synchronization timing information to the pager. When 1600bps frame speed is used, the S2 signal is structured of a 40 bit (40 symbol) pattern transmitted at 1600bps/2-level FSK; when a 3200bps/2-level FSK frame speed is used, it is structured of an 80 bit (80 symbol) pattern transmitted at 3200bps; when 3200bps/4-level FSK frame speed is used it is structured of an 80 bit (40 symbol) pattern transmitted by 3200bps/4-level FSK, and 160 bit (80 symbol) with 6400bps frame speed (refer to Section 3.2 for details).

Block Information (BI)

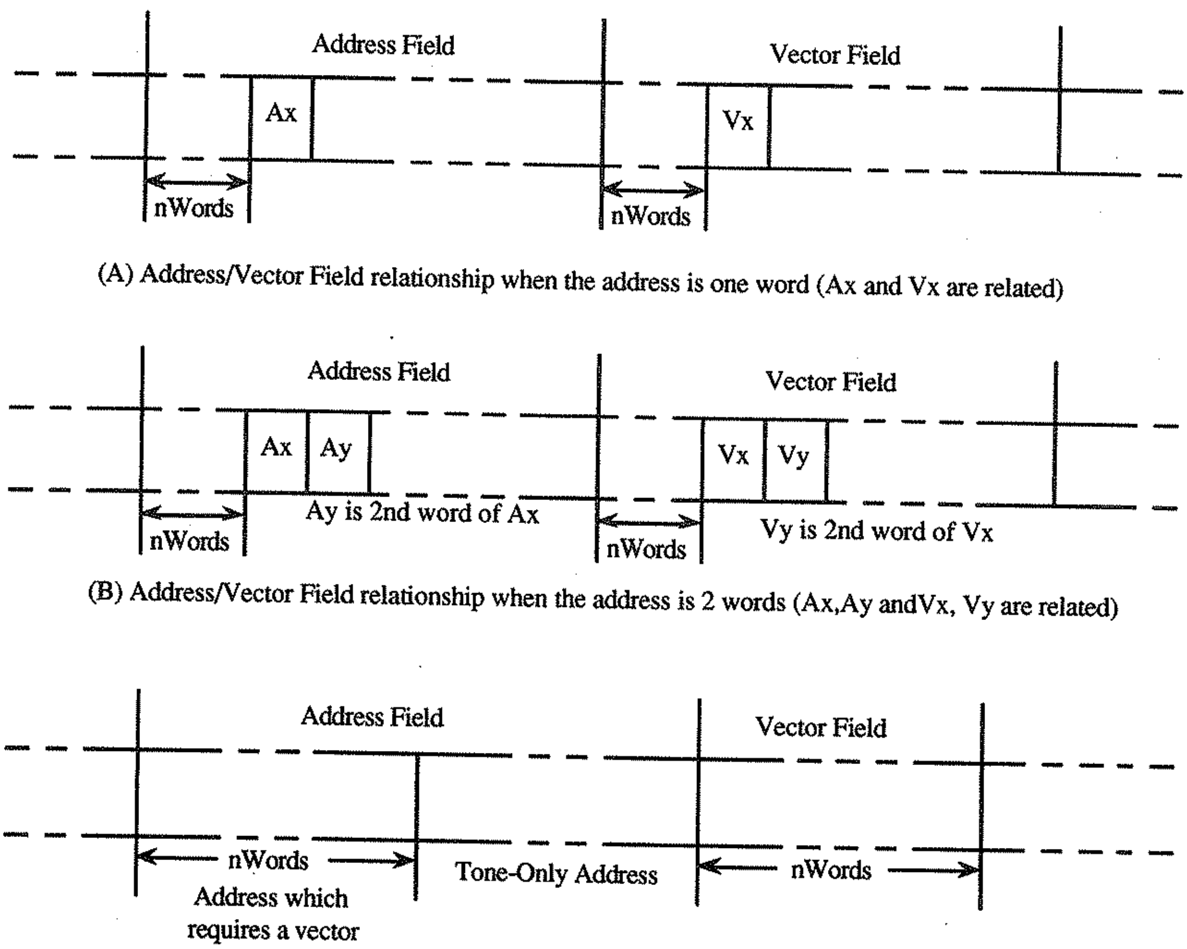
The 1st, 2nd, 3rd or 4th words in the 1st block (block 0) contain the Block Information. In typical cases, the Block Information is one word, consisting of 2 bits which are used to indicate the word number where the Address Field starts, 6 bits which specify the starting point for the Vector Field, 2 bits which indicate traffic overflow to subsequent Frames (i.e., Carry On), 3 bits which indicate the number of low order Frame number bits (LSB) to be received by the pager (system Collapse), and 4 bits which indicate the number of words included in the Priority Address field at the top of the Address Field (refer to 3.7 for details).

Address Field (AF)

The Address Field starts immediately after the Block Information Word(s) and is structured of Short Addresses consisting of one word, and Long Addresses consisting of 2 words. The Tone-Only Address is positioned at the end of the Address Field , as it does not require related vectors. The Priority Address is positioned at the top of the field (refer to Section 3.8 for details).

Vector Field (VF)

The Vector Field starts from the point indicated by the Block Information Word and maintains a one-to-one pair relationship with the Address Field. Each vector in the Vector Field indicates the word number where the corresponded message word starts and the number of message words in the Frame. Also it indicates the type of the related message in the Frame. Fig. 3.4.1-2 shows the relationship between the Address and Vector Fields (refer to Section 3.9 for details).



(A) Address/Vector Field relationship when the address is one word (Ax and Vx are related)

(B) Address/Vector Field relationship when the address is 2 words (Ax,Ay andVx, Vy are related)

(C) Address/Vector Field relationship when Tone-Only Address exist (vector does not exists)

Fig. 3.4.1-2 : Relationship between Address and Vector Fields

Message field (MF)

The message field includes the message words specified by the Vector Fields. (Refer to Section 3.10 for details)

Idle Block (IB)

Blocks which are not in use must be filled with alternating all 1's and 0's code words, so as to generate a 1, 0 pattern at 1600bps on the channel. In instances when 4-level FSK is used, the default for the blocks must contain the appropriate pattern for them so that the same binary waveform is generated at 1600bps on the channel. Necessary information is written over the default for a block, while Idle blocks are maintained as they are. The default structures for Idle blocks are given in Table 3.4.1-1 below.

Table 3.4.1-1 : Idle block structure

1600bps/2-level

word 0	1 1 1 1 1 1 · · · · · ·
word 1	0 0 0 0 0 0 · · · · · ·
word 2	1 1 1 1 1 1 · · · · · ·
word 3	0 0 0 0 0 0 · · · · · ·
word 4	1 1 1 1 1 1 · · · · · ·
word 5	0 0 0 0 0 0 · · · · · ·
word 6	1 1 1 1 1 1 · · · · · ·
word 7	0 0 0 0 0 0 · · · · · ·

3200bps/2-level

word 0	a	1 1 1 1 1 1 · · · · · ·
	c	1 1 1 1 1 1 · · · · · ·
word 1	a	0 0 0 0 0 0 · · · · · ·
	c	0 0 0 0 0 0 · · · · · ·
word 2	a	1 1 1 1 1 1 · · · · · ·
	c	1 1 1 1 1 1 · · · · · ·
word 3	a	0 0 0 0 0 0 · · · · · ·
	c	0 0 0 0 0 0 · · · · · ·
:	:	:
word 7	a	0 0 0 0 0 0 · · · · · ·
	c	0 0 0 0 0 0 · · · · · ·

3200bps/4-level

word 0	a	1 1 1 1 1 1 · · · · · ·
	c	0 0 0 0 0 0 · · · · · ·
word 1	a	0 0 0 0 0 0 · · · · · ·
	c	0 0 0 0 0 0 · · · · · ·
word 2	a	1 1 1 1 1 1 · · · · · ·
	c	0 0 0 0 0 0 · · · · · ·
word 3	a	0 0 0 0 0 0 · · · · · ·
	c	0 0 0 0 0 0 · · · · · ·
:	:	:
word 7	a	0 0 0 0 0 0 · · · · · ·
	c	0 0 0 0 0 0 · · · · · ·

6400bps/4-level

word 0	a	1 1 1 1 1 1 · · · · · ·
	b	0 0 0 0 0 0 · · · · · ·
	c	1 1 1 1 1 1 · · · · · ·
	d	0 0 0 0 0 0 · · · · · ·
word 1	a	0 0 0 0 0 0 · · · · · ·
	b	0 0 0 0 0 0 · · · · · ·
	c	0 0 0 0 0 0 · · · · · ·
	d	0 0 0 0 0 0 · · · · · ·
word 2	a	1 1 1 1 1 1 · · · · · ·
	b	0 0 0 0 0 0 · · · · · ·
	c	1 1 1 1 1 1 · · · · · ·
	d	0 0 0 0 0 0 · · · · · ·
:	:	:
word 7	a	0 0 0 0 0 0 · · · · · ·
	b	0 0 0 0 0 0 · · · · · ·
	c	0 0 0 0 0 0 · · · · · ·
	d	0 0 0 0 0 0 · · · · · ·

Note : "a ~ d" represent phases

The Frame structure can be shortened in block units only when there are unused blocks in one transmission. In such instances, the block structure must include block 0 (Block Information Word). Fig. 3.4.1-3 below shows a case when no addresses, vectors or message information are contained in a block. The block area indicated by dotted lines in Fig. 3.4.1-3 contains no transmission data and can be filled with Idle blocks.

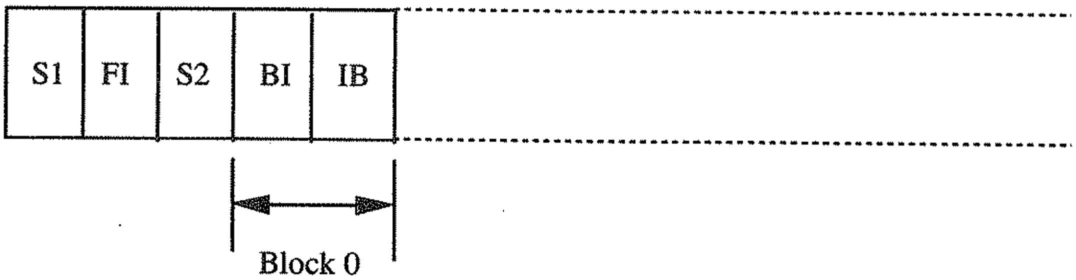


Fig. 3.4.1-3 : The Frame transmission sequence in minimum.

Also, Fig. 3.4.1-4 is an example of the Block Information Word structure when no addresses, vectors or messages are contained.

1 2 3 4 5 6 7 • • • • • • • • • • • • • • 21	22 … 31	32
Information bits	Parity bits	
x_0 x_1 x_2 x_3 p_0 p_1 p_2 p_3 a_0 a_1 v_0 v_1 v_2 v_3 v_4 v_5 c_0 c_1 m_0 m_1 m_2	p p p p p p p p p p	p
0 1 0 1 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 1	0 1 1 0 0 0 0 1 1 0	0

Ex. : No addresses, no vectors, no messages, no Carry on and System Collapse cycle value m=4

Even parity

Fig 3.4.1-4 : The Block Information Word structure when no address, vectors or messages are contained.

3.4.2 Frame structure for multiple transmission

Fig. 3.4.2-1 shows an example of the Frame structure for multiple transmission.

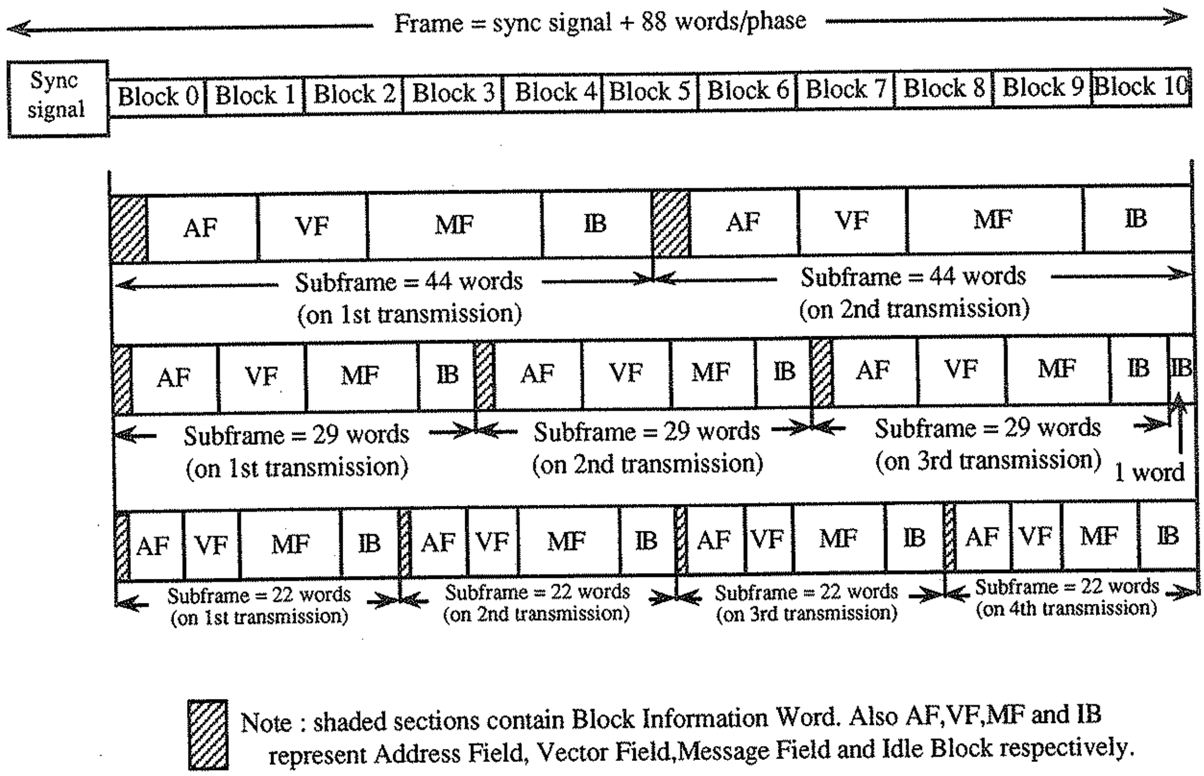


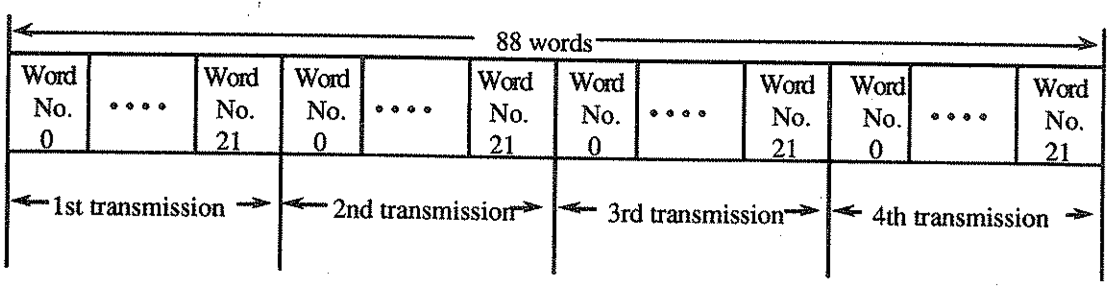
Fig. 3.4.2-1 : Example of Frame structure for multiple transmission

A Frame is divided into multiple Subframes corresponding to the number of words defined by the number of times transmission is performed. If transmitted two times (repeated once), the Frame is divided into two Subframes, if transmitted three times (repeated twice), the Frame is divided into three Subframes, and if transmitted four times (repeated three times), then it is divided into four Subframes.

In any of above transmissions, each Subframe is transmitted at a repeated transmission interval equivalent to the System Collapse cycle. Accordingly, at the 1st transmission, the 1st Subframe of the pertinent Frame is transmitted, and at the 2nd transmission, the 2nd Subframe of the next pertinent Frame is transmitted with a delay corresponding to the transmission repeating interval from the 1st transmission, at the 3rd transmission, the 3rd Subframe is transmitted with a delay corresponding to the transmission repeating interval from the 2nd transmission, and at the 4th transmission, the 4th Subframe is transmitted with a delay corresponding to the transmission repeating interval from the 3rd transmission. An example of 3x multiple transmission is shown in Fig. 3.4.2-3. A Subframe consists of the Block Information Word, plus Address, Vector and Message Fields and Idle Blocks. The Frame structure for 2x, 3x and 4x transmission sequences is as shown in Fig. 3.4.2-1..

Regardless of the number of repeated transmissions, the specifications for the Block Information Word, Address Field, Vector Field, Message Field and Idle Blocks contained in the 1st Subframe of the 1st transmission shall accord with Section 3.4.1. Also, the same bit stream as transmitted for the 1st transmission is transmitted for the Block Information Word, Address Field, Vector Field, Message Field and Idle Blocks in the 2nd, 3rd and 4th transmissions. In case of 3x transmission, the specification for the last word of the Idle Block shall accord with Section 3.4.1 and is identical to word 7 in Table 3.4.1-1.

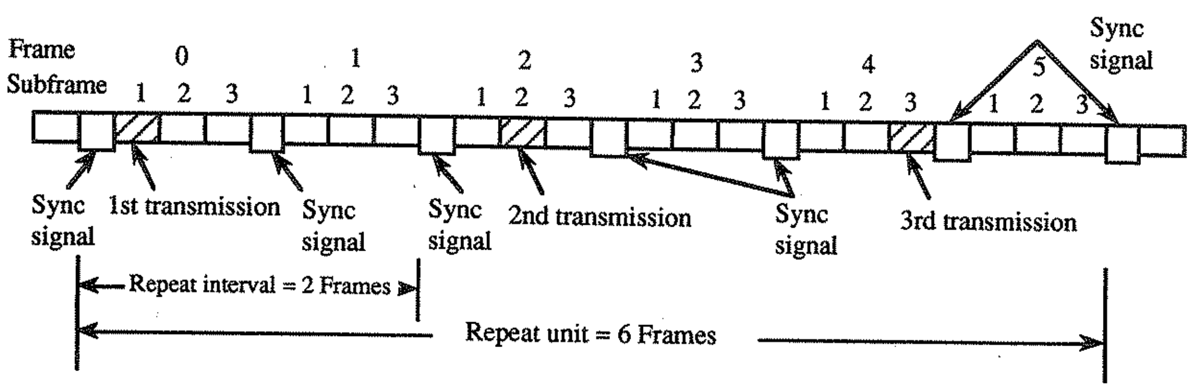
The word numbers for Subframes are assigned from 0 to 43 for 2x transmission sequences, from 0 to 28 for 3x transmission sequences and from 0 to 21 for 4x multiple transmission sequences. For example, the word structure for 4x transmission sequences is shown in Fig. 3.4.2-2 below.



Note : Word No. 0 always contains Block Information Word

Fig. 3.4.2-2 : Word structure for 4x multiple transmission

Fig. 3.4.2-3 gives an example of the Subframe structure for 3x multiple transmission.



No. of transmissions (from Frame Info. Word) = 3
System Collapse value (from Block Info. Word)= 1
System Collapse cycle = 2^1 (repeat interval) = 2 Frames
Repeat unit = 3 (No. of transmissions) x 2 Frames(repeat interval) = 6 Frames

Fig. 3.4.2-3 : Example of Subframe structure for 3x multiple transmission

If the system has paging information being transmitted when changing the collapse cycle, transmission speed, modulation scheme or the number of repeated transmissions for the base station facilities, the base station facilities waits until transmission of the multiple transmission units for the paging information is completed, then changes these parameters. Once the parameters are changed, Frames without paging information are transmitted for the duration of one repeat unit at the value before the change.

3.4.2.1 Definition for multiple transmission on the system

The number of transmissions on the system is defined by the Frame Information Word.(Refer to Section 3.6 for details)

3.5 Error correction

3.5.1 Basic word structure

Fig. 3.5.1-1 below shows the basic word structure.

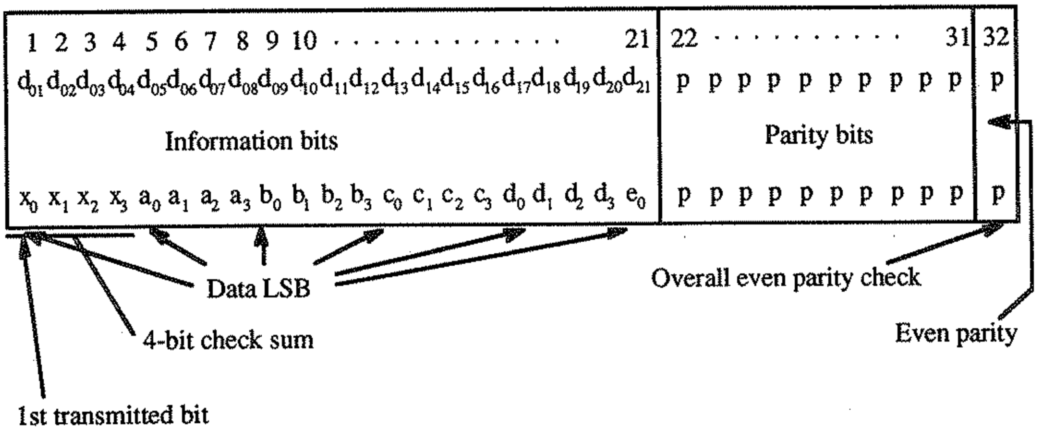


Fig. 3.5.1-1 : Basic word structure

A type of word which has a 4-bit checksum in the information bits utilizes the 4-bit checksum defined below:

4 LSB of 1's complement for X= (A+B+C+D+E)

$A= (a_3, a_2, a_1, a_0)$ $C = (c_3, c_2, c_1, c_0)$ $E= e_0$
$B= (b_3, b_2, b_1, b_0)$ $D = (d_3, d_2, d_1, d_0)$

Example : Calculates checksum for the following information bit 5-21

XXXX 1010 0011 1001 1100 1

Rearrange 4-bit fields so that the LSBs of each field is positioned at the far right.

```
  0101
  1100
  1001
  0011
     1
------
011110
```

1's compliment of the result of calculation = 100001
4LSB = 0001
Rearrange 4-bit fields so that the LSB of each 4-bit field is positioned at the far left = 1000 1010 0011 1001 1100 1

3.5.2 BCH generator polynomial

One word is expressed by (BCH [31, 21] + even parity). The generator polynomial is expressed by the following equation:

$$\text{Generator polynomial : } G(x) = X^{10} + X^{9} + X^{8} + X^{6} + X^{5} + X^{3} + X^{0}$$

The 21 information bits correspond to the coefficients for the polynomial having terms from X^{30} to X^{10}. This polynomial is divided by the generator polynomial (modulo 2). As a result of this division, remainder which are the coefficients for X^{9} to X^{0} serve as BCH checksum bits for bit No. 22 ~ 31.

Bit 32 is the even parity bit for the overall word decided by bits 1 ~ 31.

3.6 Frame Information Word

The structure of the Frame Information Word is shown in Fig. 3.6-1. The Frame Information Word is structured of one word.

1 2 3 4 5 6 7 • • • • • • • • • • • • • • 21	22 • • • • • • • • • 31	32
Information bits	Parity bits	
x_0 x_1 x_2 x_3 c_0 c_1 c_2 c_3 f_0 f_1 f_2 f_3 f_4 f_5 f_6 n_0 r_0 t_0 t_1 t_2 t_3	p p p p p p p p p p	p
0 1 0 1 1 1 0 0 0 0 1 1 1 1 0 0 1 1 0 0 0	0 1 1 1 0 0 0 1 0 0	0
Example : Cycle 3, Frame 60, No. of transmissions : 2		

Even parity

Fig. 3.6-1 : Structure of Frame Information Word

c : Cycle number [0 - 14] : c_3, c_2, c_1, c_0 maximum 15 Cycles

f : Frame number [0 - 127] : $f_6, f_5, f_4, f_3, f_2, f_1, f_0$ (128 Frames per Cycle)

n : Roaming Network : when n=1, roaming allowed

when n=0, roaming not allowed.

r : multiple transmission indication :

When r=1 : [t_3, t_2, t_1, t_0] indicate the information for multiple transmission.

When r=0 : the number of transmissions is 1x and [t_3, t_2, t_1, t_0] serve as flags which indicate Low Traffic during each phase of the Frame.

t : t is defined by the value of r :

When r=0 : [t_3, t_2, t_1, t_0] serve as Low Traffic Flags corresponding to phase (d, c, b, a).

At 3200bps: [$t_3 = t_2, t_1 = t_0$] shows Frame is 2 phases.

At 1600bps : [$t_3 = t_2 = t_1 = t_0$] shows Frame is 1 phase.

t=1 : indicates that the address field does not exceed block 0.
t=0 : indicates that the address field exceeds block 0.

These flags are used for indicating Low Traffic and that all addresses have been allocated to block 0 at an earlier stage. When there is Carry On or a change in the Collapse cycle, flags are not set for 1, even when traffic is low.

When r=1, [t_1, t_0] define the No. of transmissions at that point :

[t_1, t_0] =	0, 1	No. of transmissions = 2
	1, 0	No. of transmissions = 3
	1, 1	No. of transmissions = 4
	0, 0	Reserved

And [$t_3 t_2$] is used to indicate a TD Collapse cycle which enables use of a different Collapse cycle from the System Collapse cycle in multiple transmissions.

[t_3 t_2] =	0, 0	Apply dictated System Collapse cycle
	0, 1	TD Collapse cycle value 6
	1, 0	TD Collapse cycle value 7
	1, 1	TD Collapse cycle value 5

When TD Collapse cycle value is used, the TD Collapse cycle value takes priority over the System Collapse cycle value.

x : 4-bit checksum

3.7 Block Information

3.7.1 Block Information Word 1

The structure for Block Information Word 1 is shown in Fig. 3.7.1-1 below. Block Information Word 1 is structured of one word.

1 2 3 4 5 6 7 • • • • • • • • • • • • • • • 21	22 • • • • • • • • • 31	32
Information bits	Parity bits	
x_0 x_1 x_2 x_3 p_0 p_1 p_2 p_3 a_0 a_1 v_0 v_1 v_2 v_3 v_4 v_5 c_0 c_1 m_0 m_1 m_2	p p p p p p p p p p	p
0 1 0 1 0 1 0 1 0 1 0 0 1 1 1 1 1 0 0 1 1	1 0 1 1 1 1 0 0 1 0	0

Ex. : addresses start at word #3, vectors start at word #60 and Carry On to the next Frame; System Collapse cycle value of 6 and the first 10 words in the Address Field are the Priority Addresses .

Even parity

Fig. 3.7.1-1 : Structure of Block Information Word 1

p : indicates the number of words [(0 ~15) P_3, P_2, P_1, P_0] of Priority Addresses at the top of the Address Field.

a : specifies the end of the Block Information field (0 ~ 3). [a_1, a_0 = (00, 01, 10, 11)] indicates that the Address Field starts from word 1, 2, 3 or 4 respectively.

v : specifies the word number (1-63) where the Vector Field starts designated by the

6 bits (V_0 through V_5). When the vector field does not exist, this field is set to the position of the word that follows the last Tone-Only Address (note that the Tone-Only Address has no vectors). When no addresses exist, it is set to the position of the word which follows the last Block Information Word.

c : indicates flags [$c_1 c_0$, = (00, 01, 10, 11)] for traffic "Carry On." These normally indicate that information to be sent in the pertinent Frame can also be transmitted in subsequent Frames. Flags apply only to pagers which receive the Frames based on the Collapse cycle and the values for Carry On must be identical for all phases in one Frame. Also note that Carry On is not allowed for multiple transmission.

$(c_1 c_0)$ =	0, 0	No Carry On
	0, 1	Carry On 1 Frame
	1, 0	Carry On 2 Frames
	1, 1	Carry On 3 Frames

m : System Collapse cycle values (0 - 7), m=0 is not allowed for multiple transmission.

m_2	m_1	m_0	
0	0	0	: Frame cycle $2^0 = 1$ (the pager decodes all Frames)
0	0	1	: Frame cycle $2^1 = 2$ (the pager decodes every 2nd Frame)
•			
•			
1	1	1	: Frame cycle $2^7 = 128$ (the pager decodes once every 128 Frames)

x : 4-bit checksum

3.7.2 Block Information Word 2, 3 and 4 (as required)

The structure of Block Information Word 2, 3 and 4 are shown in Fig. 3.7.2-1. Block Information Word 2,3 and 4 each consist of one word.

1 2 3 4 5 6 7 • • • • • • • • • • • • • • • • 21	22 • • • • • • • • • 31	32
Information bits	Parity bits	
x_0 x_1 x_2 x_3 f_0 f_1 f_2 s_0 s_1 s_2 s_3 s_4 s_5 s_6 s_7 s_8 s_9 s_{10} s_{11} s_{12} s_{13}	p p p p p p p p p p	p
1 1 0 1 1 0 0 1 0 1 0 0 1 1 1 1 1 0 0 1 1	1 1 1 1 1 0 0 0 1 1	0
Ex. date format : 1999, 31, 12 (December 31, 1999)		

Even parity

Fig. 3.7.2-1 : Structure of Block Information 2, 3 and 4

f : Type [f_2 f_1 f_0] of the word format and indicates the content specified by s.
s : See table 3.7.2-1 for data.
x : 4-bit checksum

The word formats are listed in Table 3.7.2-1.

Table 3.7.2-1 : Word formats

f_2	f_1	f_0	s_{13}	s_{12}	s_{11}	s_{10}	s_9	s_8	s_7	s_6	s_5	s_4	s_3	s_2	s_1	s_0	
0	0	0	i_8	i_7	i_6	i_5	i_4	i_3	i_2	i_1	i_0	C_4	C_3	C_2	C_1	C_0	SSID1 (local channel ID, Coverage Zone)
0	0	1	m_3	m_2	m_1	m_0	d_4	d_3	d_2	d_1	d_0	Y_4	Y_3	Y_2	Y_1	Y_0	month/day/year
0	1	0	s_2	s_1	s_0	M_5	M_4	M_3	M_2	M_1	M_0	H_4	H_3	H_2	H_1	H_0	second/minute/hour
0	1	1	Reserved														
1	0	0	Reserved														
1	0	1	I_9	I_8	I_7	I_6	I_5	I_4	I_3	I_2	I_1	I_0	A_3	A_2	A_1	A_0	System Information, Type
1	1	0	Reserved														
1	1	1	C_9	C_8	C_7	C_6	C_5	C_4	C_3	C_2	C_1	C_0	T_3	T_2	T_1	T_0	SSID2 (Country Code, Traffic Management Flag)

Note : Block Information Word 1 is transmitted at the beginning of the Block Information Word field. The transmission order for Block Information Words 2, 3 and 4 in each frame is not regulated.

The roaming system channel must transmit Block Information Word formats 000 and 111 for the "Simulcast System ID" (SSID). The SSID words contain the Local channel ID, Coverage Zones, Country Codes and Traffic Management Flags(TMF) and must be transmitted according to the rules described in Chapter 6. Block Information Words 001, 010 and 101 contain Time-related information. However, when such Time-related information is transmitted, at least 1 Time-related Block Information Word (Block Information Word 001, 010 or 101) must be transmitted in each Phase of Frame 0 Cycle 0. (Refer to Chapter 6 for details.)

Local channel ID/Coverage Zone/Country Code/Traffic Management Flag

- LID with Coverage Zone, Country Code and Traffic Management Flag defines a specific simulcast coverage area. On RF channels which support SSID Roaming, Block Information Word 000 must be transmitted in every Frame; also Block Information Word 111 must be transmitted in Frame 0 through Frame 3. Therefore, if channels are shared or other existing signal codes are mixed on one channel (hereafter referred to as "channel mixing), transmission of Frame 0 through Frame 3 must not be blocked.
  Country Codes comply with CCITT (ITU-T) E.212 Annex A. Japan's Country Code is "440."
  The 4 Traffic Management Flag indicate which of the four traffic groups the channel is assigned to. After a pager which is roaming has detected a channel having the LID, Coverage Zones and Country Codes which match up with those for the pager, the pager corresponds with only one of the 4 flags. When more than 1 flags is set to 0, the pager assigned to this group must search for other channels with the same LID, Coverage Zone and Country Code which has it's flag set to 1.

Month, Day, Year/Second, Minute, Hour/Time Zone

Date, Time and Time Zone based on the Standard time in each region are transmitted by Block Information Word 001,010 and 101 respectively. However, to display or update the data more frequently, the information can be transmitted in other Frames.

- Month ,Day, Year

The field for month is 4 bits (0001-1100, Jan.-Dec.) ,the field for day is 5 bits (00001-11111,1-31) and the field for year is 5 bits (00000-11111,1994-2025).

- Second, Minute, Hour

  The field for Hour is 5 bits (00000-10111,0-23),the field for Minute is 6 bits (000000-111011,0-59 minutes) and the field for Second is 3 bits (000-111,1/8 minutes or 7.5 seconds interval). The synchronization to the real time is based on the rising edge of the 1st bit of the Bit Sync. 1 of the Frame 0 for the Cycle which contains that Frame. (in the case of multiple transmission, the Frame first transmission is done)

System Message/Time Zone

- 4 bits [A_3 through A_0] of Block Information Word 101 indicate whether the instructions and the System Messages from the infrastructure facility are sent in the present Frame or not. Also these 4 bits indicate types of messages or types of pertinent pagers, and so forth.

  It is allowed to put one Block Information Word 101 for System Messages in each Frame and each phase. When there are corresponding Operator Messaging Address to Block Information Word 101 for the System Message being transmitted, System Messages must be transmitted by both methods (i.e., by Block Information Word 101 and Operator Messaging Addresses). In instances, Operator Messaging Addresses is used, System Messages are transmitted in the same manner as regular paging. (Regarding Operator Messaging Addresses, refer to Section 3.8.2.4)

Table 3.7.2-2 : Word Format Table of Block Information Word 101

I_9	I_8	I_7	I_6	I_5	I_4	I_3	I_2	I_1	I_0	A_3	A_2	A_1	A_0	Types of message and Instructions
r	r	r	r	r	r	r	r	r	r	0	0	0	0	System Message for all pagers
r	r	r	r	r	r	r	r	r	r	0	0	0	1	System Message for all pagers in Home
r	r	r	r	r	r	r	r	r	r	0	0	1	0	System Message for all roaming pagers
r	r	r	r	r	r	r	r	r	r	0	0	1	1	System Message for SSID pagers
S_5	S_4	S_3	r	L_0	Z_4	Z_3	Z_2	Z_1	Z_0	0	1	0	0	Time related for all pagers and additional Time Instruction
S_5	S_4	S_3	r	L_0	Z_4	Z_3	Z_2	Z_1	Z_0	0	1	0	1	Additional Time Instruction
B_0	N_0	O_1	O_0	F_5	F_4	F_3	F_2	F_1	F_0	0	1	1	0	Channel Set Up Instruction
r	r	r	r	r	r	r	r	r	r	0	1	1	1	Reserved
				•							•			•
				•							•			•
				•							•			•
r	r	r	r	r	r	r	r	r	r	1	1	1	1	Reserved

r represents reserved bits.

- System Message for all pagers ($A_3A_2A_1A_0$=0000)

  Operator Messaging Address; 1 1111 0111 1000 0001 0000 is used.(From MSB to LSB. Refer to Table 3.8.1-1)

- System Message for all pagers in Home ($A_3A_2A_1A_0$=0001)

  Operator Messaging Address; 1 1111 0111 1000 0001 0001 is used.(From MSB to LSB. Refer to Table 3.8.1-1)

- System Message for all Roaming pagers ($A_3A_2A_1A_0$=0010)

  Operator Messaging Address ; 1 1111 0111 1000 0001 0010 is used.(From MSB to LSB. Refer to Table 3.8.1-1)

- System Message for all SSID pagers ($A_3A_2A_1A_0$=0011)

  Operator Messaging Address ; 1 1111 0111 1000 0001 0011 is used.(From MSB to LSB. Refer to Table 3.8.1-1)

- System Message Time related for all pagers and additional Time Instruction. ($A_3A_2A_1A_0$=0100)

  Operator Messaging Address ; 1 1111 0111 1000 0001 0100 is used.(From MSB to LSB. Refer to Table 3.8.1-1)

Three bits of extended Second field (S_3 through S_5, 000-111, 1/64 minute or 0.9375 second) extend the Second field in Block Information Word 010. 1 bit of Day Light Saving Time Flag (L_0) indicates a type of Time Saving. For L_0=0, transmitted Time Instruction indicates Day Light Saving Time. 5 bits of 32 Time Zone field (Z_4 through Z_0) are used to indicate one of Time Zones shown in Table 3.7.2-3.

- Additional Time Instruction ($A_3A_2A_1A_0$=0101)

Three bits of extended Second field (S_5 through S_3, 000-111, 1/64 minute or 0.9375 second) extend the Second field in Block Information Word 010. 1 bit of Day Light Saving Time Flag (L_0) indicates a type of Time Saving. For L_0=0, transmitted Time Instruction indicates Day Light Saving Time. 5 bits of Time Zone field (Z_4 through Z_0) are used to indicate one of 32 Time Zones shown in Table 3.7.2-3.

- Channel Set Up Instruction ($A_3A_2A_1A_0$=0110)

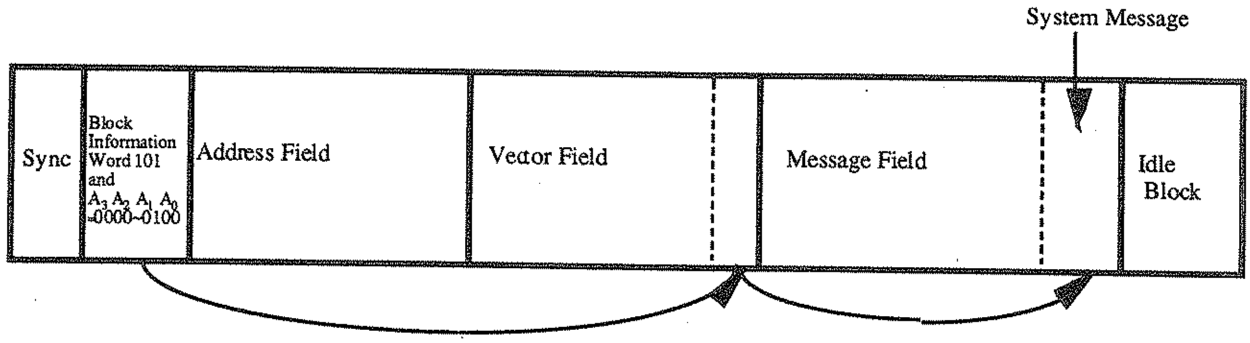
When System Message Bit (B_0) in the Block Information Word is set to "1", it indicates that the channel supports a transmission of System Messages. Also, when NID System Message Bit (N_0) is set to "1", it indicates that the channel supports a transmission of System Messages. 2 bits of Maximum Carry On field (O_1, O_2) indicates the maximum values of Carry On for roaming pagers. 6 bits of Frame Offset field (F_5 through F_0,1-63) indicates Frame Offset values for pagers which function Frame Offset.

Transmission of System Message

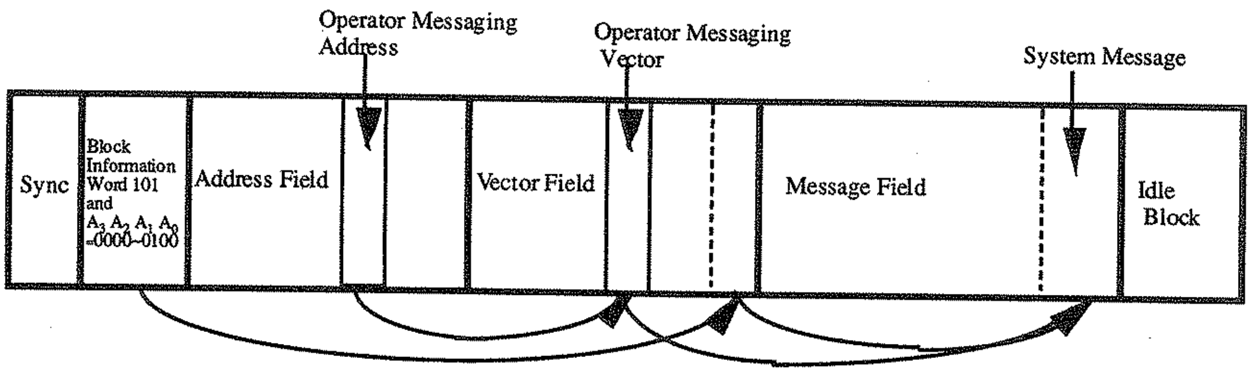
- As shown in Fig.3.7.2-2, when System Messages are transmitted by Block Information Word 101 at $A_3A_2A_1A_0$= 0000~0100 in Frame 0, corresponding vectors except Secure vector (Note other types of vector are not applied to Message Numbering service) are transmitted at the end of the vector field and the System Messages are transmitted in the Message field. (Note that even when data is frequently displayed or updated, it can be transmitted within other Frames.) The transmission of a System Message by Block Information Word 101 must be one time per each phase.

  Tone-Only Addresses (without vectors) cannot be transmitted in Frames used for transmitting System Messages. And, it is possible to transmit System Messages by Operator Messaging Addresses.

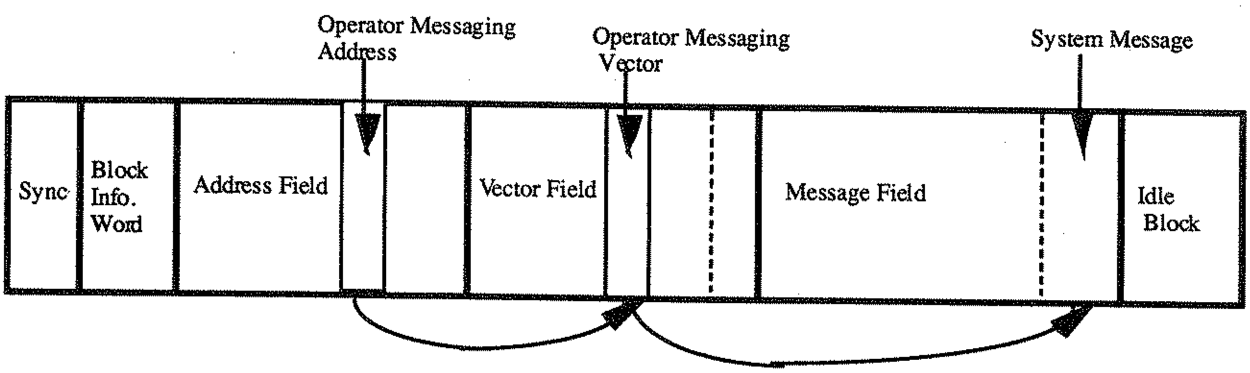
  Fig. 3.7.2-2 shows combinations of transmissions for System Messages using both BIW101 and Operator Messaging Addresses



(a) The transmission of System Message by Block Information Word.



(b) The transmission of System Message by Block Information and Operator Messaging Address.



(c) The transmission of System message by Operator Messaging Address.

Figure 3.7.2-2 : Transmission of System Message

Table 3.7.2-3 : Time Zone conversion table

Zone area Z_4 Z_3 Z_2 Z_1 Z_0	Difference from Greenwich Mean Time
1 0 0 0 0	—
1 0 0 0 1	+5h 45m
1 0 0 1 0	+6h 30m
1 0 0 1 1	+9h 30m
1 0 1 0 0	-3h 30m
1 0 1 0 1	-11h
1 0 1 1 0	-10h
1 0 1 1 1	-9h
1 1 0 0 0	-8h
1 1 0 0 1	-7h
1 1 0 1 0	-6h
1 1 0 1 1	-5h
1 1 1 0 0	-4h
1 1 1 0 1	-3h
1 1 1 1 0	-2h
1 1 1 1 1	-1h
0 0 0 0 0	-0h
0 0 0 0 1	+1h
0 0 0 1 0	+2h
0 0 0 1 1	+3h
0 0 1 0 0	+4h
0 0 1 0 1	+5h
0 0 1 1 0	+6h
0 0 1 1 1	+7h
0 1 0 0 0	+8h
0 1 0 0 1	+9h (Japan)
0 1 0 1 0	+10h
0 1 0 1 1	+11h
0 1 1 0 0	+12h
0 1 1 0 1	+3h 30m
0 1 1 1 0	+4h 30m
0 1 1 1 1	+5h 30m

3.8 Address

3.8.1 Address structure and type

(1) The address types and ranges are listed in Table 3.8.1-1. The only addresses regarded as a special address are Tone-Only Addresses which do not require vector and message (Short Addresses and Long Addresses listed in Table 3.8.1-1 can be assigned to be Tone-Only Addresses).

(2) An address is structured of either 1 or 2 words.

A Long Address consists of a combination of 2 words from the set of Long Address 1 to 4, described in Section 3.8.2.2.

Each of other addresses is structured of one word.

(3) Reserved Short Addresses are reserved for future use. How to apply Information Service Addresses is under study. Refer to Section 6.1.2 for details on Network Addresses.

(4) The 5 Operator Messaging Addresses having 0000 through 0100 as 4 LSB's are used to transmit System Messages . And 2 Operator Messaging Addresses having 1110 or 1111 as 4 LSB's are used to transmit instructions for changes in systems. The rest of 9 addresses are reserved for future use.

(5) Addresses are memorized as needed in each pager. The number of addresses which can be memorized in each pager is not limited.

(6) Addresses are transmitted in the address field. Addresses as with higher priority are sent in the top of the address field and the Tone-Only Addresses are positioned at the end of the address field. The number of address words with higher priority is specified by Block Information Word 1.

Table 3.8.1-1 : Address type and range

Type	HEX	Binary (information bit) MSB LSB	Decimal	Quantity	Remarks
Long Address 1	000001 008000	0 0000 0000 0000 0000 0001 0 0000 1000 0000 0000 0000	1 32,768	32,768	
Short Address	008001 1E0000	0 0000 1000 0000 0000 0001 1 1110 0000 0000 0000 0000	32,769 1,966,080	1,933,312	
Long Address 3	1E0001 1E8000	1 1110 0000 0000 0000 0001 1 1110 1000 0000 0000 0000	1,966,081 1,998,848	32,768	
Long Address 4	1E8001 1F0000	1 1110 1000 0000 0000 0001 1 1111 0000 0000 0000 0000	1,998,849 2,031,616	32,768	
Reserved Short Address	1F0001 1F27FF	1 1111 0000 0000 0000 0001 1 1111 0010 0111 1111 1111	2,031,617 2,041,855	10,239	Reserved for future use
Information Service Address	1F2800 1F67FF	1 1111 0010 1000 0000 0000 1 1111 0110 0111 1111 1111	2,041,856 2,058,239	16,384	Under study
Network Address	1F6800 1F77FF	1 1111 0110 1000 0000 0000 1 1111 0111 0111 1111 1111	2,058,240 2,062,335	4,096	Refer to 6.1.2
Temporary Address	1F7800 1F780F	1 1111 0111 1000 0000 0000 1 1111 0111 1000 0000 1111	2,062,336 2,062,351	16	
Operator Messaging Address	1F7810 1F781F	1 1111 0111 1000 0001 0000 1 1111 0111 1000 0001 1111	2,062,352 2,062,367	16	Refer to 3.8.2.4
Reserved Short Address	1F7820 1F7FFE	1 1111 0111 1000 0010 0000 1 1111 0111 1111 1111 1110	2,062,368 2,064,382	2,015	Reserved for future use
Long Address 2	1F7FFF 1FFFFE	1 1111 0111 1111 1111 1111 1 1111 1111 1111 1111 1110	2,064,383 2,097,150	32,768	

Total 2,097,150

3.8.2 Address word

The LSB of an address is transmitted first.

3.8.2.1 Short Address, Reserved Short Address

1 2 3 4 5 6 7 8 9 10 • • • • • • • • • • • 21	22 • • • • • • • • • 31	32
Information bits	Parity bits	Even parity
$d_0\ d_1\ d_2\ d_3\ d_4\ d_5\ d_6\ d_7\ d_8\ d_9\ d_{10}\ d_{11}\ d_{12}\ d_{13}\ d_{14}\ d_{15}\ d_{16}\ d_{17}\ d_{18}\ d_{19}\ d_{20}$	p p p p p p p p p p	p

Fig. 3.8.2.1-1 : Word structure for Short Address

d : Short Address information bits

d_0 is the LSB of the address, while d_{20} is the MSB of the address.

The Reserved Short Address is reserved for future use.

3.8.2.2 Long Address (2 words)

	1 2 3 4 5 6 7 8 9 10 • • • • • • • • • • • 21	22 • • • • • • • • • 31	32
	Information bits	Parity bits	Even parity
1st word	$d_0\ d_1\ d_2\ d_3\ d_4\ d_5\ d_6\ d_7\ d_8\ d_9\ d_{10}\ d_{11}\ d_{12}\ d_{13}\ d_{14}\ d_{15}\ d_{16}\ d_{17}\ d_{18}\ d_{19}\ d_{20}$	p p p p p p p p p p	p
2nd word	$e_0\ e_1\ e_2\ e_3\ e_4\ e_5\ e_6\ e_7\ e_8\ e_9\ e_{10}\ e_{11}\ e_{12}\ e_{13}\ e_{14}\ e_{15}\ e_{16}\ e_{17}\ e_{18}\ e_{19}\ e_{20}$	p p p p p p p p p p	p

Fig. 3.8.2.2-1 : Word structure for Long Address

d : 1st word information bits of Long Address

d_0 is the LSB of the address, while d_{20} is the MSB of the address.

e : 2nd word information bits of Long Address

e_0 is the LSB of the address, while e_{20} is the MSB of the address.

A Long Address consists of 2 words (1st and 2nd words). Long Addresses 1 ~ 4 are defined as part of Long Addresses and are used in the combinations listed in Table 3.8.2.2-1.

A part of combinations of Long Address Set 2-3 and combinations of Long Address Set 2-4 are reserved for future use. Also a part of the combination of Long Address Set 2-3 is used for Information Service Addresses.

When a Long Address is used, a corresponding double vector is required.

Table 3.8.2.2-1 : Combination of Long Address

Long Address 1st word	Long Address 2nd word
Long Address 1	Long Address 2
Long Address 1	Long Address 3
Long Address 1	Long Address 4
Long Address 2	Long Address 3
Long Address 2	Long Address 4

3.8.2.3 Temporary Address

When used, Temporary Addresses are specified by the Short Instruction Vector in Section 3.9.6.

The base address for the Temporary Addresses is 1 1111 0111 1000 0000 0000 (from MSB to LSB).

The Temporary Address is obtained by adding binary 0000 through binary 1111 (as indicated by $a_3 \sim a_0$ of the Short Instruction Vector) to the base address.

3.8.2.4 Information Service Address, Network Address, Operator Messaging Address

How the Information Service Addresses are to be used is under investigation.

Refer to Section 6.1.2 for details on Network Addresses.

The types of Operator Messaging Addresses are shown in Table 3.8.2.4-1 below.

Table 3.8.2.4-1 : Operator Messaging Address

Type of Message and Instruction	Operator Messaging Address MSB LSB
System Message for all pagers	1 1111 0111 1000 0001 0000
System Message for all pagers in Home area	1 1111 0111 1000 0001 0001
System Message for all roaming pagers	1 1111 0111 1000 0001 0010
System Message for all SSID pagers	1 1111 0111 1000 0001 0011
Time related Message for all pagers	1 1111 0111 1000 0001 0100
Reserved	1 1111 0111 1000 0001 0101
:	:
Reserved	1 1111 0111 1000 0001 1101
SSID Change Instruction	1 1111 0111 1000 0001 1110
System Event Notification	1 1111 0111 1000 0001 1111

- SSID Change Instruction (1 1111 0111 1000 0001 1110)

When SSID related changes occur in the system, there are instances when the Change Instruction is transmitted to SSID pagers by using Operator Messaging Addresses. In case of systems which split traffic by utilizing the TMF in the SSID, the Change Instruction must always be transmitted. With other systems, transmission of the Change Instruction is optional. The SSID Change Instruction is used to transmit change information and the pager adds the change information to the scan list. The System Event Notification is used to notify the pager of the type of changes which take place.

The contents of the SSID Change Instruction can be one or both of the following:

(1) To change Traffic split by TMF in SSID
(2) To add new frequencies related to SSID Coverage Zones

The trasnmission timing of the Instruction shall be the mandatory Frames for roaming (i.e, Frame 0 through 7 for NID system and Frame 0 through 3 for SSID only system) in 2 Cycles before and 2 Cycles after the Cycle which contained the change (this is a total of 5 Cycles).

Also the instruction shall be placed in the same phase as SSID. However, it is desirable to be transmitted once an hour after that transmissions to allow all pagers can receive the Instruction.

- System Event Notification (1 1111 0111 1000 0001 1111)

The System Event Notification is used to pre-alert pagers that some change will occur in the system within the next 4 Cycles. This address is used together with Short Instruction Vector ($i_2i_1i_0$=001) and it must be transmitted in each Frame for a minimum duration of 1-full cycle of the Collapse cycle specified by the infrastructure facilities.

Notified System Event is shown as follows.

(1) Traffic split by SSID TMF
(2) Traffic split by NID TMF
(3) Any changes of Channel Set Up Instruction
(4) Adding the new Frequency related to NID
(5) Adding the new Frequency related to SSID Coverage Zone

- System Message (1 1111 0111 1000 0001 0000 -1 1111 0111 1000 0001 0100)

5 addresses having 4 LSB's is 0000 through 0100 are used for System Message transmission. Refer to Section 3.7.2.

3.8.3 The relationship between address and phase

(1) Addresses which have been assigned to Single phase pagers must be assigned with one of four available phases.(a,b,c,d)

(2) If a Single phase pager has multiple addresses, all addresses must be in the same phase.

(3) The information as to which address is assigned to which type of pager (i.e., Single phase, Any phase or All phase pagers) must be memorized in the infrastructure facilities for each address to form an address basis. Also, for addresses which are assigned to a Single phase pagers, which address is assigned to phase a,b,c or d for each address to form the address basis is memorized in the infrastructure facilities. The information for the assigned phase and address must be memorized in the pager.

(4) Addresses which are assigned to a Single phase pagers must always be sent in their assigned phase.

(5) Addresses which are assigned to Any phase pagers are assigned to one of four available phases (a,b,c or d) for transmission and the address is transmitted in that phase.

(6) The manner in which phases are used for All phase pagers is presently under study.

(7) The phase assignment of Temporary Addresses must meet with the requirements of item (1),(2) and (5) above.

(8) In terms (1) through (5) above, the word "address" refers to Short and Long Addresses for both individual and group call pages.

3.8.4 Relationship between address and Frame

Each address is assigned to one of Frames 0 to 127. The same address must not be assigned to a multiple number of Frames. Information on the Frame to which each address is assigned is memorized in the infrastructure facilities and the pager.

If a pager has more than one address, all addresses must be assigned to the same Frame (except in the case of special pagers).The word "address" refers to Short and Long Addresses for both individual and group call pages.

3.8.5 Rules for using address at transmission of message

(1) For messages which have not been fragmented, the same address can be used up to two times for any Frame, and in the case of multiple transmissions, the same address can be used up to two times in each Subframe. This rule shall apply to all phases in multiplexed Frames. For example, for addresses assigned to Any phase pagers, addresses for the same or a different phases can be used up to two times per Subframe for a multiplexed Frame.

(2) When one address is used for transmitting a message that has been fragmented, the same address cannot be used for transmitting other messages which have been fragmented until the entire fragmented message has been transmitted.

(3) The same address can be reused only once in any Frame (Subframe in multiple transmission) for transmitting messages which have not been fragmented while this address is being used to transmit entire fragmented message.

(4) When a Temporary Address is assigned, the same Temporary Address cannot be used again until its associated message has been completely transmitted.

(5) When the pager has multiple addresses, items (1) to (3) above shall apply to each of the pager's addresses.

(6) In items (1) and (3) above, the word "address" refers to Short and Long Addresses for both individual and group call pages.
In item (2) above, the word "address" refers to Network Addresses, Operator Messaging Addresses ,Short and Long Addresses for both individual and group call pages.

3.8.6 CAPCODE

Addresses, Frame numbers, the Collapse cycles and phases are the parameters required to page individual pagers. Also, from the standpoint of system operation, in some instances CAPCODE is used as the unified method for handling all of these parameters together.

CAPCODE is used to facilitate the handling of information related to pagers. It is also used as a protocol for transferring data between networks, such as the TNPP (TELOCATOR NETWORK PAGING PROTOCOL). Please refer to appendix A regarding CAPCODE.

3.9 Vector

Table 3.9-1 lists the types of vectors. v_2, v_1, v_0 in the table are the codes in the information bits in the word format. Definitions of the respective vectors are given in the following sections.

Table 3.9-1 : Vector types

$v_2\ v_1\ v_0$	Vector	Overview
000	Secure Message Vector	Used by the operator to control the pager.
001	Short Instruction Vector	Used for executing Short Instructions, such as specifying Temporary Address operation or notifying System Event Notification
010	Short Message Vector	Used for Network ID extension or Short Message. Also used for Tone-Only.
011	Standard Numeric Vector	Indicates that the message is numerical data.
100	Special Format Numeric Vector	Indicates that a Numeric Message may be formatted as specified in the ID-ROM.
101	Alphanumeric Vector	Indicates that the message is alphanumeric data.
110	HEX/Binary Vector	Indicates that the message is HEX/Binary data.
111	Numbered Numeric Vector	Indicates that a message number is assigned to the Numeric Message.

3.9.1 Numeric Vectors

There are three types of Numeric Vector : Standard Numeric Vector, Special Format Numeric Vector and Numbered Numeric Vector. The word format for each vector is shown in Fig. 3.9.1-1 below.

1 2 3 4 5 6 7 8 9 • • • • • • • • • • • • 21	22 • • • • • • • • • 31	32
Information bits	Parity bits	Even parity
$x_0\ x_1\ x_2\ x_3\ v_0\ v_1\ v_2\ b_0\ b_1\ b_2\ b_3\ b_4\ b_5\ b_6\ n_0\ n_1\ n_2\ K_0\ K_1\ K_2\ K_3$	p p p p p p p p p p	p
Ex. : 0 0 0 1 1 1 0 1 1 1 0 0 0 0 1 1 0 0 1 1 1	0 1 1 0 1 0 0 1 1 1	1

Fig. 3.9.1-1 : Word format for Numeric Vectors

The definition for the codes used in Fig. 3.9.1-1 and examples of usage are as follows :

x : 4-bit checksum (in compliance with Section 3.5.1.)

v : Type of vector (in compliance with Table 3.9-1.)

$v_2\ v_1\ v_0 = 0\ 1\ 1$: Standard Numeric Vector

$v_2\ v_1\ v_0 = 1\ 0\ 0$: Special Format Numeric Vector (a received message may be formatted as specified in the ID ROM)

$v_2\ v_1\ v_0 = 1\ 1\ 1$: Numbered Numeric Vector (this is a Numeric Vector with message number assigned — refer to "N" in Section 3.10.1.1 "Numeric Message")

The example shows the Standard Numeric Vector.

b : Indicates the word number at which the message starts =

$1 \bullet b_0 + 2 \bullet b_1 + 4 \bullet b_2 + 8 \bullet b_3 + 16 \bullet b_4 + 32 \bullet b_5 + 64 \bullet b_6$

The value should be within a range of 3 to 87 decimal (it is 7 in the example in Fig. 3.9.1-1).

n : Indicates the number of words in the message = $1+ 1 \bullet n_0 + 2 \bullet n_1 + 4 \bullet n_2$

The value should be within a range of 1 to 8 (it is 4 in the example in Fig. 3.9.1-1).

K : Indicates the 4 LSBs of the checksum of a message (refer to Section 3.10).
When a Long Address is used, a 2nd word is required for the vector, and the 1st word of the message is placed at the 2nd word of the vector. In this instance, the number of words in the message included in the message field related to this address is one word less than the number of words "n" in the entire message. Also, the word number at the top of the message, indicated by the vector is the word number of the 2nd word of the vector if the message consists of one word, and is the word number of the beginning of the message included in the message field if the message consists of multiple words.

3.9.2 Short Message Vector

The Short Message Vector is a vector which does not use message fields and has the word format shown in Fig. 3.9.2-1 below.

1 2 3 4 5 6 7 8 9 • • • • • • • • • • • • • 21	22• • • • • • • • •31	32	
Information bits	Parity bits	Even parity	
$x_0\ x_1\ x_2\ x_3\ v_0\ v_1\ v_2\ t_0\ t_1\ d_0\ d_1\ d_2 \sim\ \sim d_9\ d_{10}\ d_{11}$	p p p p p p p p p p	p	1st word
$d_{12}\ d_{13}\ d_{14} \sim\ \sim d_{30}\ d_{31}\ d_{32}$	p p p p p p p p p p	p	2nd word

Note : $d_{12} \sim d_{32}p \sim pp$ of the 2nd word are used when this vector is used in conjunction with a Long Address.

Fig. 3.9.2-1 : Word format for Short Message Vector

The definition of each code in Fig. 3.9.2-1 is as below:

x : 4-bit checksum (as indicated in Section 3.5.1). When a 2nd code word is used, the check character doesn't check the 2nd code word.

v : Indicates the type of vector (as listed in Table 3.9-1.)

$v_2\,v_1\,v_0 = 010$: Short Message Vector

t and d : Indicates the type of Short Message (as listed in Table 3.9.2-1.)

Table 3.9.2-1 : Types of Short Messages

t1 t0	d_{11} d_{10} d_9 d_8 d_7 d_6 d_5 d_4 d_3 d_2 d_1 d_0 d_{32} d_{31} d_{30} d_{29} d_{28} d_{27} d_{26} d_{25} d_{24} d_{23} d_{22} d_{21} d_{20} d_{19} d_{18} d_{17} d_{16} d_{15} d_{14} d_{13} d_{12} (2nd word)
0 0	(1) When the address is a Network Address: F_3 F_2 F_1 F_0 M_2 M_1 M_0 A_4 A_3 A_2 A_1 A_0 $A_4 \sim A_0$ indicate Service Area Identifier. $M_2 \sim M_0$ indicate Multiplier .$F_3 \sim F_0$ indicate Traffic Management Flag. (refer to Section 6.1.2) (2) When the address is other than a Network Address: c_3 c_2 c_1 c_0 b_3 b_2 b_1 b_0 a_3 a_2 a_1 a_0 d_{32} h_3 h_2 h_1 h_0 g_3 g_2 g_1 g_0 f_3 f_2 f_1 f_0 e_3 e_2 e_1 e_0 d_3 d_2 d_1 d_0 (2nd word) For Short Address, a 3-digit Numeric Message (a,b,c) is indicated; for Long Address, a double vector is used. In the same manner, $d_0 \sim d_{11}$ indicate 3 digits (a, b, c) while $d_{12} \sim d_{31}$ indicate 5 digits (d, e, f, g, h), to compose an 8-digit message in total. Also, d_{32} , which is a spare bit, is set for 0. (Refer to the numeric character table in Section 3.10.2.1 for definition of this code).
0 1	s_8 s_7 s_6 s_5 s_4 s_3 s_2 s_1 s_0 S_2 S_1 S_0 s_{29} s_{28} s_{27} s_{26} s_{25} s_{24} s_{23} s_{22} s_{21} s_{20} s_{19} s_{18} s_{17} s_{16} s_{15} s_{14} s_{13} s_{12} s_{11} s_{10} s_9 (2nd word) For Short Address, S_2 S_1 S_0 indicate up to 8 Source codes and $s_8 \sim s_0$ are Not Used bits. For Long Address, S_2 S_1 S_0 indicate up to 8 Source codes and $s_{29} \sim s_0$ are Not Used bits.
1 0	s_1 s_0 R_0 N_5 N_4 N_3 N_2 N_1 N_0 S_2 S_1 S_0 s_{22} s_{21} s_{20} s_{19} s_{18} s_{17} s_{16} s_{15} s_{14} s_{13} s_{12} s_{11} s_{10} s_9 s_8 s_7 s_6 s_5 s_4 s_3 s_2 (2nd word) For Short Address, S_2 S_1 S_0 indicate up to 8 Source codes, $N_5 \sim N_0$ indicate the message number within 0 to Max. 63, R_0 is the Message Retrieval Flag and s_1 s_0 are Not Used bits. For Long Address, S_2 S_1 S_0 indicate up to 8 Source codes, $N_5 \sim N_0$ indicate the message number within 0 to Max. 63, R_0 is the Message Retrieval Flag and $s_{22} \sim s_0$ are idle bits. When the Message Retrieval Flag is set to 1, the pager must check Numbered Messages and check each address separately. In addition, missing numbers indicate reception errors; messages received with R=0 are excluded from the message number order and are not checked for missing numbers.
1 1	Reserved

Note : Not used bits are set for 0 and unused numeric characters are set for space (HEX C). The Source code can be added by the specified operation of the caller (in regard to message numbers, refer to "N" and "R" of Section 3.10.1.1 Numeric Message).

3.9.3 HEX/Binary Vector

Fig. 3.9.3-1 below shows the word format for HEX/Binary Vector

1 2 3 4 5 6 7 8 9 • • • • • • • • • • • 21	22 • • • • • • • • 31	32
Information bits	Parity bits	Even parity
x_0 x_1 x_2 x_3 v_0 v_1 v_2 b_0 b_1 b_2 b_3 b_4 b_5 b_6 n_0 n_1 n_2 n_3 n_4 n_5 n_6	p p p p p p p p p p	p

Fig. 3.9.3-1 : Word format for HEX/Binary Vector

The codes in Fig. 3.9.3-1 are defined as below :

x : 4-bit check sum (as indicated in Section 3.5.1).

v : Indicates the type of vector (as listed in Table 3.9-1).

v_2 v_1 v_0 = 1 1 0 : HEX/Binary Vector

b : Indicates the word number at which the message starts in this Frame=

$1 \cdot b_0 + 2 \cdot b_1 + 4 \cdot b_2 + 8 \cdot b_3 + 16 \cdot b_4 + 32 \cdot b_5 + 64 \cdot b_6$

(Note that this value should be within a range of 3 to 87.)

n : Indicates the number of words in a message in this Frame =

$1 \cdot n_0 + 2 \cdot n_1 + 4 \cdot n_2 + 8 \cdot n_3 + 16 \cdot n_4 + 32 \cdot n_5 + 64 \cdot n_6$

(Note that this value should be within a range of 2 to 85.)

When a Long Address is used, a 2nd word is required for the vector, and the 1st word of the message is placed at the 2nd word of the vector. In this instance, the number of words in the message included in the message field related to this address is one word less than the number of words "n" in the entire message. Also, the word number at the beginning of the message, indicated by the vector is the word number at the beginning of the message included in the message field.

3.9.4 Alphanumeric Vector

Fig. 3.9.4-1 below shows the word format for Alphanumeric Vector

1 2 3 4 5 6 7 8 9 • • • • • • • • • • • 21	22 • • • • • • • • 31	32
Information bits	Parity bits	Even parity
$x_0\ x_1\ x_2\ x_3\ v_0\ v_1\ v_2\ b_0\ b_1\ b_2\ b_3\ b_4\ b_5\ b_6\ n_0\ n_1\ n_2\ n_3\ n_4\ n_5\ n_6$	p p p p p p p p p p	p

Fig. 3.9.4-1 : Word format for Alphanumeric Vector

The codes given in Fig. 3.9.4-1 are defined as below :

x : 4-bit check sum (as indicated in Section 3.5.1).

v : Indicates the type of vector (as listed in Table 3.9-1).

$v_2\ v_1\ v_0 =$ 1 0 1 : Alphanumeric Vector

b : Indicates the word number at which the message starts=

$$1 \cdot b_0 + 2 \cdot b_1 + 4 \cdot b_2 + 8 \cdot b_3 + 16 \cdot b_4 + 32 \cdot b_5 + 64 \cdot b_6$$

(Note that this value should be within a range of 3 to 87.)

n : Indicates the number of message words in this Frame =

$$1 \cdot n_0 + 2 \cdot n_1 + 4 \cdot n_2 + 8 \cdot n_3 + 16 \cdot n_4 + 32 \cdot n_5 + 64 \cdot n_6$$

(Note that this value should be within a range of 2 to 85.)

When a Long Address is used, a 2nd word is required for the vector, and the 1st word of the message is placed at the 2nd word of the vector. In this instance, the number of words in the message included in the message field, related to this address is one word less than the number of words "n" in the entire message. Also, the word number at the beginning of the message, indicated by the vector is the word number at the beginning of the message included in the message field.

3.9.5 Secure Message Vector

Fig. 3.9.5-1 below shows the word format for Secure Message Vector

1 2 3 4 5 6 7 8 9 • • • • • • • • • • • • 21	22 • • • • • • • • • 31	32
Information bits	Parity bits	Even parity
$x_0\ x_1\ x_2\ x_3\ v_0\ v_1\ v_2\ b_0\ b_1\ b_2\ b_3\ b_4\ b_5\ b_6\ n_0\ n_1\ n_2\ n_3\ n_4\ n_5\ n_6$	p p p p p p p p p p	p

Fig. 3.9.5-1 : Word format for Secure Message Vector

The codes given in Fig. 3.9.5-1 are defined as below :

x : 4-bit check sum (as indicated in Section 3.5.1).

v : Indicates the type of vector (as listed in Table 3.9-1).

$v_2\ v_1\ v_0 = 0\ 0\ 0$: Secure Message Vector

b : Indicates the word number at which the message starts=

$1 \cdot b_0 + 2 \cdot b_1 + 4 \cdot b_2 + 8 \cdot b_3 + 16 \cdot b_4 + 32 \cdot b_5 + 64 \cdot b_6$

(Note that this value should be within a range of 3 to 87.)

n : Indicates the number of message words in this Frame =

$1 \cdot n_0 + 2 \cdot n_1 + 4 \cdot n_2 + 8 \cdot n_3 + 16 \cdot n_4 + 32 \cdot n_5 + 64 \cdot n_6$

(Note that this value should be within a range of 2 to 85.)

When a Long Address is used, a 2nd word is required for the vector, and the 1st word of the message is placed at the 2nd word of the vector. In this instance, the number of words in the message included in the message field related to this address is one word less than the number of words "n" in the entire message. Also, the word number at the beginning of the message, indicated by the vector is the word number at the beginning of the message included in the message field.

3.9.6 Short Instruction Vector

Fig. 3.9.6-1 below shows the word format for Short Instruction Vector

1 2 3 4 5 6 7 8 9 • • • • • • • • • • • • 21	22 • • • • • • • • • 31	32	
Information bits	Parity bits	Even parity	
x_0 x_1 x_2 x_3 v_0 v_1 v_2 i_0 i_1 i_2 d_0 d_1 d_2 ~ ~ d_9 d_9 d_{10}	p p p p p p p p p p	p	1st word
d_{11} d_{12} d_{13} ~ ~ d_{29} d_{30} d_{31}	p p p p p p p p p p	p	2nd word

Note : d_{11} ~ d_{31} of the 2nd word are used when this vector is used together with a Long Address. All unused bits are set to 0.

Fig. 3.9.6-1 : Word format for Short Instruction Vector

The codes given in Fig. 3.9.6-1 are defined as below :

x : 4-bit check sum (as indicated in Section 3.5.1). When a 2nd code word is used, the check character doesn't check the 2nd code word.

v : Indicates the type of vector (as listed in Table 3.9-1).

v_2 v_1 v_0 = 0 0 1: Short Instruction Vector

i : Defines the type of instruction (as listed in Table 3.9.6-1).

d : Defined by the function of the vector (as listed in Table 3.9.6-1).

Table 3.9.6-1 : Definitions of commands and functions

Type	i_2	i_1	i_0	d_{10}	d_9	d_8	d_7	d_6	d_5	d_4	d_3	d_2	d_1	d_0
Temporary Address	0	0	0	a_3	a_2	a_1	a_0	f_6	f_5	f_4	f_3	f_2	f_1	f_0
				address (4 bits)				Frame (7 bits)						
System Event	0	0	1	e_{10}	e_9	e_8	e_7	e_6	e_5	e_4	e_3	e_2	e_1	e_0
				Event Flags (11 bits) e_0 -- Traffic split by SSID TMF (Refer to 6.1.1) e_1 -- Traffic split by NID TMF (Refer to 6.1.2) e_2 -- Change of Channel Set Up Instruction by BIW101(... ... 0110) (Refer to 3.7.2) e_3 -- Adding new Freq. related to NID e_4 -- Adding new Freq. related to SSID Coverage Zone e_{10}~e_5 -- All reserved and default to 0.										
Reserved	0	1	0											
Reserved	0	1	1											
Reserved	1	0	0											
Reserved	1	0	1											
Reserved	1	1	0											
Reserved for test	1	1	1											

Note 1 : Refer to Section 3.8 "Address" and Chapter 5 "Group message" for information on the operation of Temporary Addresses

Note 2 : Refer to Section 3.8.2.4 for System Event.

3.10 Message signal

The following types of messages are defined as message signals.

Table 3.10-1 : Message types

$v_2v_1v_0$	Message	Overview
000	Secure Message	Used by the operator to control the pager.
011	Standard Numeric Message	Normal Numeric Message which indicates one character in 4 bits.
100	Special Format Numeric Message	Numeric Message which indicates one character in 4 bits. A received message may be formatted as specified in the ID-ROM.
101	Alphanumeric Message	Alphanumeric Message which indicates one character in 7 bits.
110	HEX/Binary Message	Hexadecimal or Binary Message.
111	Numbered Numeric Message	Numeric Message with a message number assigned.

3.10.1 Message field

3.10.1.1 Numeric Message

3.10.1.1.1 Standard and Special Formats

1	2	3	4	5	6	7	.	.	.	.	.	.	.	.	.	.	.	.	.	21	22.......31	32
Information bits																					Parity bits	Even parity
1st word																						
K_4	K_5	a_0	a_1	a_2	a_3	b_0	b_1	b_2	b_3	c_0	c_1	c_2	c_3	d_0	d_1	d_2	d_3	e_0	e_1	e_2	pppppppppp	p
2nd word																						
e_3	f_0	f_1	f_2	f_3	g_0	g_1	g_2	g_3	h_0	h_1	h_2	h_3	i_0	i_1	i_2	i_3	j_0	j_1	j_2	j_3	pppppppppp	p
3rd word																						
k_0	k_1	k_2	k_3	l_0	l_1	l_2	l_3	m_0	m_1	m_2	m_3	n_0	n_1	n_2	n_3	o_0	o_1	o_2	o_3	q_0	pppppppppp	p
4th word																						
q_1	q_2	q_3	r_0	r_1	r_2	r_3	s_0	s_1	s_2	s_3	t_0	t_1	t_2	t_3	u_0	u_1	u_2	u_3	v_0	v_1	pppppppppp	p
5th word																						
v_2	v_3	w_0	w_1	w_2	w_3	y_0	y_1	y_2	y_3	z_0	z_1	z_2	z_3	A_0	A_1	A_2	A_3	B_0	B_1	B_2	pppppppppp	p
6th word																						
B_3	C_0	C_1	C_2	C_3	D_0	D_1	D_2	D_3	E_0	E_1	E_2	E_3	F_0	F_1	F_2	F_3	G_0	G_1	G_2	G_3	pppppppppp	p
7th word																						
H_0	H_1	H_2	H_3	I_0	I_1	I_2	I_3	J_0	J_1	J_2	J_3	V_0	V_1	V_2	V_3	L_0	L_1	L_2	L_3	M_0	pppppppppp	p
8th word																						
M_1	M_2	M_3	O_0	O_1	O_2	O_3	P_0	P_1	P_2	P_3	Q_0	Q_1	Q_2	Q_3	T_0	T_1	T_2	T_3	U_0	U_1	pppppppppp	p

Fig. 3.10.1.1.1-1 : Standard Format (V = 011) and Special Format (V = 100)

Transmission of data starts from the LSB.

K: Message Checksum (6-bit with the first 4 bits included in the vector word).

This checksum is calculated by initializing the Message Checksum (K) to "0" and adding the information bits for each word contained in the message (including control information, and the end character and bits in the last message word) to the checksum register.

The information bits in each word are classified into 3 groups. The 1st group and 2nd group consist of 8 bits respectively (comprising bits 1 through 8 and bits 9 through 16). The 3rd group consists of 5 bits (comprising bits 17 through 21). Bits 1, 9 and 17 are the LSB for individual groups. After the binary sum, the lower 8 bits are obtained and the 2 MSB are shifted 6 bits to the right and added to the 6 LSB to form a new sum. A 1's complement of the sum acquired by the above calculation is obtained and the 6 LSB's is transmitted as the checksum of the message.

<Example Message Checksum calculations for Standard Numeric Messages or Special Format Numeric Messages>

	b_1	b_0	a_3	a_2	a_1	a_0	0	0	Calculated as $K_5 = K_4 = 0$
	d_1	d_0	c_3	c_2	c_1	c_0	b_3	b_2	
1st word				e_2	e_1	e_0	d_3	d_2	
	g_2	g_1	g_0	f_3	f_2	f_1	f_0	e_3	
	i_2	i_1	i_0	h_3	h_2	h_1	h_0	g_3	
2nd word				j_3	j_2	j_1	j_0	i_3	
	l_3	l_2	l_1	l_0	k_3	k_2	k_1	k_0	
	n_3	n_2	n_1	n_0	m_3	m_2	m_1	m_0	
3rd word				q_0	o_3	o_2	o_1	o_0	
					•				
					•				
					•				
	P_0	O_3	O_2	O_1	O_0	M_3	M_2	M_1	
	T_0	Q_3	Q_2	Q_1	Q_0	P_3	P_2	P_1	
8th word +				U_1	U_0	T_3	T_2	T_1	Binary addition
......	x_7	x_6	x_5	x_4	x_3	x_2	x_1	x_0	Obtain the lower 8 bits and shift the 2 MSB
					↓				
	....		x_5	x_4	x_3	x_2	x_1	x_0	6 bits to the right
+							x_7	x_6	Binary addition
	...		x_5'	x_4'	x_3'	x_2'	x_1'	x_0'	
					↓				1's complement for the lower 6 bits
	...		$\overline{x_5'}$	$\overline{x_4'}$	$\overline{x_3'}$	$\overline{x_2'}$	$\overline{x_1'}$	$\overline{x_0'}$	

$\underbrace{\overline{x_5'}\ \overline{x_4'}}_{K_5,\ K_4}$ Message field $\quad \underbrace{\overline{x_3'}\ \overline{x_2'}\ \overline{x_1'}\ \overline{x_0'}}_{K_3 \sim K_0}$ Vector field

<Example calculation when message is 32808590 for a Standard Numeric Message>

```
            Message   :  3 2 8 0 8 5 9 0
1st word of message   :  KK1100010000010000000pppppppppp
2nd word of message   :  1101010010000000110011pppppppppp
1st word of message   :       10001100
                              00100000
                                 00000
2nd word of message   :       00101011
                              10000001
                       +         11001     Binary addition
                             101110001
                              01110001     Lower 8 bits
                                 ↓
                                110001
                       +            01     Binary addition
                                110010
                                110010     Lower 6 bits
                                 ↓
                      00          1101     Complement of 1
                    K5, K4      K3 ~ K0
                 Message field  Vector field

1st word of message   :  0011000100000010000000pppppppppp
```

Contents of the message

The contents of a message start from bit 3 of the 1st word of the message. If the message includes 1 to 4 characters, it consists of only one word; if it includes 5 to 10 characters, it consists of 2 words. When the message includes 32 to 36 characters, it consists of 7 words and if it includes 37 to 41 characters, it consists of 8 words. Only words which include numeric messages are transmitted. In this instance, the checksum is calculated by using only words that comprise the message, including the "space" characters in the last word and partial characters contained in the remainder.

Space characters (HEX C) are inserted to fill unused 4 bit character positions in the last word and 0s are inserted to fill remaining partial characters.

Refer to Section 3.10.2.1 for Numeric Messages.

<Example of last word in a Numeric Message>

Content of message	Information bits					
	1	2	3	C	C	Remaining bit
•••1 2 3	1000	0100	1100	0011	0011	0
Last word			Last word			

Special Format Numeric Messages

The received messages may be displayed using the format specified by the ID-ROM in the pager. For example, spaces or dashes are inserted. In some instances, this function can be used to realize a reduction in the transmission of additional words on the radio channel.

3.10.1.1.2 Numbered Format

	1	2	3	4	5	6	7	.	.	.	.	.	.	.	.	.	.	.	.	.	21	22........31	32
	Information bits																					Parity bits	Even parity
1st word	K_4	K_5	N_0	N_1	N_2	N_3	N_4	N_5	R_0	S_0	a_0	a_1	a_2	a_3	b_0	b_1	b_2	b_3	c_0	c_1	c_2	pppppppppp	p
2nd word	c_3	d_0	d_1	d_2	d_3	e_0	e_1	e_2	e_3	f_0	f_1	f_2	f_3	g_0	g_1	g_2	g_3	h_0	h_1	h_2	h_3	pppppppppp	p
3rd word	i_0	i_1	i_2	i_3	j_0	j_1	j_2	j_3	k_0	k_1	k_2	k_3	l_0	l_1	l_2	l_3	m_0	m_1	m_2	m_3	n_0	pppppppppp	p
4th word	n_1	n_2	n_3	o_0	o_1	o_2	o_3	q_0	q_1	q_2	q_3	r_0	r_1	r_2	r_3	s_0	s_1	s_2	s_3	t_0	t_1	pppppppppp	p
5th word	t_2	t_3	u_0	u_1	u_2	u_3	v_0	v_1	v_2	v_3	w_0	w_1	w_2	w_3	y_0	y_1	y_2	y_3	z_0	z_1	z_2	pppppppppp	p
6th word	z_3	A_0	A_1	A_2	A_3	B_0	B_1	B_2	B_3	C_0	C_1	C_2	C_3	D_0	D_1	D_2	D_3	E_0	E_1	E_2	E_3	pppppppppp	p
7th word	F_0	F_1	F_2	F_3	G_0	G_1	G_2	G_3	H_0	H_1	H_2	H_3	I_0	I_1	I_2	I_3	J_0	J_1	J_2	J_3	V_0	pppppppppp	p
8th word	V_1	V_2	V_3	L_0	L_1	L_2	L_3	M_0	M_1	M_2	M_3	O_0	O_1	O_2	O_3	P_0	P_1	P_2	P_3	Q_0	Q_1	pppppppppp	p

Fig. 3.10.1.1.2-1 : Numbered Format (V = 111)

Transmission of data starts from the LSB.

K: Message Checksum (6-bit with the first 4 bits included in the vector word).

This checksum is calculated by initializing the Message Checksum (K) to "0" and adding the information bits for each word contained in the message (including control information and the end character and bit in the last message word) to the checksum register.

The information bits in each word are classified into 3 groups. The 1st group and 2nd group consist of 8 bits respectively (comprising bits 1 through 8 and bits 9 through 16). The 3rd group consists of 5 bits (comprising bits 17 through 21). Bits 1, 9 and 17 are the LSB for individual groups. After the binary sum, the lower 8 bits are obtained and the 2 MSB are shifted 6 bits to the right and added to the 6 LSB to form a new sum. A 1's compliment of the sum acquired by the above calculation is obtained and the 6 LSB's is transmitted as the checksum of the message.

<Example Message Checksum calculations for Numbered Numeric Messages>

	N_5	N_4	N_3	N_2	N_1	N_0	0	0	Calculated as $K_4 = K_5 = 0$
	b_1	b_0	a_3	a_2	a_1	a_0	S_0	R_0	
1st word				c_2	c_1	c_0	b_3	b_2	
	e_2	e_1	e_0	d_3	d_2	d_1	d_0	c_3	
	g_2	g_1	g_0	f_3	f_2	f_1	f_0	e_3	
2nd word				h_3	h_2	h_1	h_0	g_3	
	j_3	j_2	j_1	j_0	i_3	i_2	i_1	i_0	
	l_3	l_2	l_1	l_0	k_3	k_2	k_1	k_0	
3rd word				n_0	m_3	m_2	m_1	m_0	
					⋮				
	M_0	L_3	L_2	L_1	L_0	V_3	V_2	V_1	
	P_0	O_3	O_2	O_1	O_0	M_3	M_2	M_1	
8th word +				Q_1	Q_0	P_3	P_2	P_1	Binary addition
.....	x_7	x_6	x_5	x_4	x_3	x_2	x_1	x_0	Obtain the lower 8 bits and shift the 2 MSB 6 bits to the right
					↓				
...			x_5	x_4	x_3	x_2	x_1	x_0	
							x_7	x_6	Binary addition
...			x_5'	x_4'	x_3'	x_2'	x_1'	x_0'	
			↓						1's complement for the lower 6 bits
...			$\overline{x_5}'$	$\overline{x_4}'$	$\overline{x_3}'$	$\overline{x_2}'$	$\overline{x_1}'$	$\overline{x_0}'$	
			K_5, K_4 Message field		$K_3 \sim K_0$ Vector field				

N: Message number

If the infrastructure facilities supports the Message Numbering service (i.e., the Short Message Vector V(010) and t (10), Numbered Numeric Message, HEX/Binary Message and Alphanumeric Message for each address), a series of message numbers ranging from 0 to a maximum of 63 can be assigned. After the last message number 63 is assigned, the message assignment cycle starts over, assigning numbers in sequential order starting with 0. The maximum number of message numbers is assigned by the infrastructure facility and a pager must accord with that value. If any received message numbers are skipped, the pager can provide a warning to the user. In order for the user to recognize messages which are numbered from 1 to a maximum value of N+1, message search numbers are displayed as N+1. When the pager receives a message with R=0, it does not assume a skipping the number.

R: Message Retrieval Flag

The Message Retrieval Flag is normally set for 1, in which case, the pager must check numbered messages separately for each address. If any numbers are skipped, a reception error is indicated. Note, however, messages which are received out of sequence wherein R=0 need not be checked for skipped numbers.

It is set for 0 on retransmission of the message. Numbered Numeric Vectors are used to indicate that the infrastructure facility supports the Message Numbering Service.

S: Special Format

When the S bit is set for 1 in the Numbered Message format, it indicates that the Special Format is used.

Contents of the message

The contents of the message start from bit 11 of the 1st word of the message. If the message includes 1 to 2 characters, it consists of only one word; if it includes 3 to 8 characters, it consists of 2 words. When the message includes 30 to 34 characters, it consists of 7 words, and if it includes 35 to 39 characters, it consists of 8 words. Only the words which include numeric messages are transmitted. In this instance, the checksum is calculated by using only words that comprise the message, including "space" characters in the last word and partial characters contained in the remainder.

Space characters (HEX C) are inserted to fill unused 4-bit character positions in the last word and 0s are inserted to fill remaining partial character.

Refer to Section 3.10.2.1 for Numeric Messages.

Special Format Numeric Message

The received messages may be displayed using the format specified by the ID-ROM in the pager. For example, spaces or dashes are inserted. In some instances, this function can be used to realize a reduction in the transmission of additional words on the radio channel.

3.10.1.2 HEX/Binary Message

1	2	3	4	5	6	7	.	.	.	.	.	.	.	.	.	.	.	.	.	21	22........31	32
Information bits																					Parity bits	Even parity
1st word																						
K_0	K_1	K_2	K_3	K_4	K_5	K_6	K_7	K_8	K_9	K_{10}	K_{11}	C_0	F_0	F_1	N_0	N_1	N_2	N_3	N_4	N_5	pppppppppp	p
2nd word																						
R_0	M_0	D_0	H_0	B_0	B_1	B_2	B_3	s_0	s_1	s_2	s_3	I_0	S_0	S_1	S_2	S_3	S_4	S_5	S_6	S_7	pppppppppp	p
3rd word																						
a_0	a_1	a_2	a_3	b_0	b_1	b_2	b_3	c_0	c_1	c_2	c_3	d_0	d_1	d_2	d_3	e_0	e_1	e_2	e_3	f_0	pppppppppp	p
4th word																						
f_1	f_2	f_3	g_0	g_1	g_2	g_3	h_0	h_1	h_2	h_3	i_0	i_1	i_2	i_3	j_0	j_1	j_2	j_3	k_0	k_1	pppppppppp	p
5th word																						
k_2	k_3	l_0	l_1	l_2	l_3	m_0	m_1	m_2	m_3	n_0	n_1	n_2	n_3	o_0	o_1	o_2	o_3	q_0	q_1	q_2	pppppppppp	p
6th word																						
q_3	r_0	r_1	r_2	r_3	s_0	s_1	s_2	s_3	t_0	t_1	t_2	t_3	u_0	u_1	u_2	u_3	v_0	v_1	v_2	v_3	pppppppppp	p
.																						
.																						
nth word																						
i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	pppppppppp	p

Fig. 3.10.1.2-1 : Vector type V = 110 (First fragment only)

1	2	3	4	5	6	7	.	.	.	.	.	.	.	.	.	.	.	.	.	21	22........31	32
Information bits																					Parity bits	Even parity
1st word																						
K_0	K_1	K_2	K_3	K_4	K_5	K_6	K_7	K_8	K_9	K_{10}	K_{11}	C_0	F_0	F_1	N_0	N_1	N_2	N_3	N_4	N_5	pppppppppp	p
2nd word																						
a_0	a_1	a_2	a_3	b_0	b_1	b_2	b_3	c_0	c_1	c_2	c_3	d_0	d_1	d_2	d_3	e_0	e_1	e_2	e_3	f_0	pppppppppp	p
3rd word																						
f_1	f_2	f_3	g_0	g_1	g_2	g_3	h_0	h_1	h_2	h_3	i_0	i_1	i_2	i_3	j_0	j_1	j_2	j_3	k_0	k_1	pppppppppp	p
4th word																						
k_2	k_3	l_0	l_1	l_2	l_3	m_0	m_1	m_2	m_3	n_0	n_1	n_2	n_3	o_0	o_1	o_2	o_3	q_0	q_1	q_2	pppppppppp	p
5th word																						
q_3	r_0	r_1	r_2	r_3	s_0	s_1	s_2	s_3	t_0	t_1	t_2	t_3	u_0	u_1	u_2	u_3	v_0	v_1	v_2	v_3	pppppppppp	p
.																						
.																						
nth word																						
i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	pppppppppp	p

Fig. 3.10.1.2-2 : Vector type V = 110 (All fragments other than the first fragment)

Transmission of data starts from the LSB.

K: Fragment Checksum (12 bits)

This checksum is calculated by initializing the Fragment Checksum (K) to "0" and adding the information bits in each word contained in the message fragment (including control information, and the end character and bit in the last message word) to the checksum register.

The information bits in each word are classified into 3 groups. The 1st group and 2nd group consist of 8 bits respectively (comprising bits 1 through 8 and bits 9 through 16). The 3rd group consists of 5 bits (comprising bits 17 through 21). Bits 1, 9 and 17 are the LSB for individual groups. A 1's complement of the binary sum is obtained and the 12 LSB's is transmitted as the checksum of the message.

<Example Fragment Checksum calculations for HEX/Binary Message>

	0	0	0	0	0	0	0	0	Calculate as $K_0 \sim K_{11} = 0$
	N_0	F_1	F_0	C_0	0	0	0	0	
1st word				N_5	N_4	N_3	N_2	N_1	
	B_3	B_2	B_1	B_0	H_0	D_0	M_0	R_0	
	S_2	S_1	S_0	s_4	s_3	s_2	s_1	s_0	Calculate $S_7 \sim S_0$ for Signature Field separately
2nd word				S_7	S_6	S_5	S_4	S_3	
	b_3	b_2	b_1	b_0	a_3	a_2	a_1	a_0	
	d_3	d_2	d_1	d_0	c_3	c_2	c_1	c_0	
3rd word				f_0	e_3	e_2	e_1	e_0	

Last word +

$$\cdots\ x_{11}\ x_{10}\ x_9\ x_8\ x_7\ x_6\ x_5\ x_4\ x_3\ x_2\ x_1\ x_0$$

Binary addition
1's complement for lower 12 digits

$$\downarrow$$

$$\underbrace{\cdots\ \overline{x_{11}}\ \overline{x_{10}}\ \overline{x_9}\ \overline{x_8}\ \overline{x_7}\ \overline{x_6}\ \overline{x_5}\ \overline{x_4}\ \overline{x_3}\ \overline{x_2}\ \overline{x_1}\ \overline{x_0}}_{K_{11} \sim K_0}$$

Message field

C: Message Continued Flag (1 bit)

When the Message Continued Flag is set for 1, it indicates that fragments of the current message exist in some or all of the subsequent Frames until a fragment with C=0 is detected.

F: Message Fragment Number (2 bits)

A message can be divided into several fragments for transmission (refer to Chapter 4 for methods used for fragmenting long messages).

This is a modulo 3 message fragment number which increments by 1 for each of the consecutive fragments. The first fragment starts with "11" and is incremented by 1 by modulo 3 for each of the subsequent fragments (1 1, 0 0, 0 1, 1 0, 0 0, 0 1, 1 0, 0 0....).

The state for "1 1" after the first fragment is skipped in order to prevent it from being mistaken as the first fragment of a non-consecutive message. The last fragment is indicated by resetting the Message Continued Flag to 0.

N: Message Number

If the infrastructure facilities supports the Message Numbering service (for Short Message Vector V(010) and t(10), Numbered Numeric Message, HEX/Binary Message and Alphanumeric Message for each address), a series of message numbers ranging from 0 to a maximum of 63 can be assigned. After 63 is assigned as the last message number, the message assignment cycle starts over again, assigning numbers in sequential order beginning with 0. The maximum number of message numbers is assigned by the infrastructure facility and a pager must accord with that value. If any received message numbers are skipped, the pager can provide a warning to the user. In order for the user to recognize messages which are numbered from 1 to a maximum value of N+1, message search numbers are displayed as N+1. If the system does not have the capability to support the message numbers for each address, those message numbers which are newly assigned to a message must be unique numbers so as to identify the fragments for the same message. (i.e., message numbers which differ from those assigned to other messages that are being processed at the same address).

R: Message Retrieval Flag

When the R bit is set for 1, the pager must check numbered messages (it must check each address separately). Missing numbers indicate that message reception errors have occurred. Messages received with R=0 are excluded from the message number order and are not checked for skipping the numbers.

M: Mail Drop Flag (1 bit)

When the M bit is set for 1, it indicates that the received message can be handled separately from ordinary messages.

D: Display Direction Field (1 bit)

When this bit is set for D_0=0, it indicates the display direction is from left to right; when set for D_0=1, it indicates the display direction is from right to left. This function is allowed only for data transmitted as characters with blocking length other than 0001.

H: Header Message Flag (1 bit)

When this bit is set for H_0=1, it indicates that the pertinent message is a header and a transparent message (refer to Table 1.3.1-1) with the same message number will follow; when it is set for H_0=0, it indicates that the pertinent message is not a header.

B: Blocking Length

Indicates the number of bits or data unit per character. When $B_3B_2B_1B_0$=0001, for example, it indicates that 1 bit per character is set; if it equals 1111, it indicates 15 bits per character are set; when 0000, it indicates 16 bits per character are set. (Default value = 0001)

I: Status Information Field Enabler

When I_0=0, it indicates that the data is standard HEX/Binary Message.

When Io=1, the first 8 bits (3rd word of the first fragment) of the data field indicate the encoding method for the rest of the message. At present, the encoding method definition is reserved.

s: 4 reserved bits for future use (Default value = 0000)

S: Signature Field (8 bits)

Signature is defined as the 1's complement of binary sum for the entire message (including all fragments) for every 8 bits "[$b_3\ b_2\ b_1\ b_0\ a_3\ a_2\ a_1\ a_0$+ $d_3\ d_2\ d_1\ d_0 c_3\ c_2\ c_1\ c_0$......]", beginning with the first 8 bits which follow directly after the Signature Field. The 8 LSB of the result is transmitted as the Message Signature.

Note : The termination bits are not assumed as part of the message and the sum calculation for S does not included any termination bits

<Example calculation of HEX/Binary Messages Signature field>

$$
\begin{array}{cccccccccc}
 & b_3 & b_2 & b_1 & b_0 & a_3 & a_2 & a_1 & a_0 \\
 & d_3 & d_2 & d_1 & d_0 & c_3 & c_2 & c_1 & c_0 \\
 & f_3 & f_2 & f_1 & f_0 & e_3 & e_2 & e_1 & e_0 \\
 & h_3 & h_2 & h_1 & h_0 & g_3 & g_2 & g_1 & g_0 \\
 & j_3 & j_2 & j_1 & j_0 & i_3 & i_2 & i_1 & i_0 \\
 & l_3 & l_2 & l_1 & l_0 & k_3 & k_2 & k_1 & k_0 \\
 & n_3 & n_2 & n_1 & n_0 & m_3 & m_2 & m_1 & m_0 \\
 & q_3 & q_2 & q_1 & q_0 & o_3 & o_2 & o_1 & o_0 \\
 & s_3 & s_2 & s_1 & s_0 & r_3 & r_2 & r_1 & r_0 \\
 & & & & & \vdots & & & \\
+ & & & & & *_3 & *_2 & *_1 & *_0 \\
\hline
\cdots & x_7 & x_6 & x_5 & x_4 & x_3 & x_2 & x_1 & x_0 \\
 & & & & & \downarrow & & & \\
\cdots & \bar{x}7 & \bar{x}6 & \bar{x}5 & \bar{x}4 & \bar{x}3 & \bar{x}2 & \bar{x}1 & \bar{x}0
\end{array}
$$

$$\underbrace{\bar{x}7\ \bar{x}6\ \bar{x}5\ \bar{x}4\ \bar{x}3\ \bar{x}2\ \bar{x}1\ \bar{x}0}_{S_7 \sim S_0}$$

Binary addition for message in all fragments

Termination bits are not included for calculation

1's complement

Fields running from R to S are transmitted only in the first fragment of the message; those fields running from K to N form the first word of all the fragments in a long message.

Contents of message

The first fragment in the message starts from the 3rd word and the remainder of the message in the 2nd and subsequent fragments start from the 2nd word.

Refer to Section 3.10.2.3 for Japanese Text Service.

Termination of the message

(1) Each fragment in a message must end at the boundaries between characters, and characters which continue into the next fragment must start from bit 1 in the 2nd word.

(2) Excluding the last fragment, when a valid bit in the last character in a fragment ends in the middle of the last word, the remaining bits are filled by all 0's or 1's (whichever is the reverse value of the last valid data bit). In this instance, when the last word ends at the

valid data bit of the last character that does not have a remainder, it is not necessary to add extra 0's or 1's .

<Example of termination a HEX/Binary Message (for fragments other than the last fragment)>

- When the last word remains:

	Information bits	
	11010011101100	1111111
	Message	Remaining bits

- When terminating exactly on the last word:

Information bits
11010010110101010100110
Message (word for terminating is not added)

(3) Excepting cases when the message ends in the last bit of the last word (not having a remainder) and the last character is set for all 1's or 0's, (2) above applies to the last fragment.

When the last character is set for all 1's or 0's, an extra word is added which should be set to all 1's or 0's which are the reverse value of the last valid data bits .

<Examples of termination HEX/Binary Message (at the last fragment)>

Example of when the last character is not set to all 0's or 1's (ex., 3 bit/character) :

Information bit
11010010110101010100110 Last character is 110 and additional words are not added.
message

Examples of when the last character is set to all 0's or 1's (ex., 1 bit/character) :

Information bits
11010010110101010100110
message

Information bits
111111111111111111111 As the last character is 0's, a word consisting of all the bits that are the reverse value the last bit is added.
message

Message Header

The Message Header is a message that can be displayed in relation to transparent data message and both messages are completed independently. The pager uses Header Messages to associate with corresponding data files which have the same message number transmitted sequentially. (Note that data files follow the header.)

3.10.1.3 Alphanumeric Message

1	2	3	4	5	6	7	.	.	.	.	.	.	.	.	.	.	.	.	.	21	22.......31	32
									Information bits												Parity bits	Even parity
1st word																						
K_0	K_1	K_2	K_3	K_4	K_5	K_6	K_7	K_8	K_9	C_0	F_0	F_1	N_0	N_1	N_2	N_3	N_4	N_5	R_0	M_o	pppppppppp	p
2nd word																						
S_0	S_1	S_2	S_3	S_4	S_5	S_6	a_0	a_1	a_2	a_3	a_4	a_5	a_6	b_0	b_1	b_2	b_3	b_4	b_5	b_6	pppppppppp	p
3rd word																						
c_0	c_1	c_2	c_3	c_4	c_5	c_6	d_0	d_1	d_2	d_3	d_4	d_5	d_6	e_0	e_1	e_2	e_3	e_4	e_5	e_6	pppppppppp	p
4th word																						
f_0	f_1	f_2	f_3	f_4	f_5	f_6	g_0	g_1	g_2	g_3	g_4	g_5	g_6	h_0	h_1	h_2	h_3	h_4	h_5	h_6	pppppppppp	p
5th word																						
i_0	i_1	i_2	i_3	i_4	i_5	i_6	j_0	j_1	j_2	j_3	j_4	j_5	j_6	k_0	k_1	k_2	k_3	k_4	k_5	k_6	pppppppppp	p
.																						
.																						
nth word																						
i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	pppppppppp	p

Fig. 3.10.1.3-1 : Vector type V = 101 (First fragment only)

1	2	3	4	5	6	7	.	.	.	.	.	.	.	.	.	.	.	.	.	21	22.......31	32
									Information bits												Parity bits	Even parity
1st word																						
K_0	K_1	K_2	K_3	K_4	K_5	K_6	K_7	K_8	K_9	C_0	F_0	F_1	N_0	N_1	N_2	N_3	N_4	N_5	U_0	V_o	pppppppppp	p
2nd word																						
a_0	a_1	a_2	a_3	a_4	a_5	a_6	b_0	b_1	b_2	b_3	b_4	b_5	b_6	c_0	c_1	c_2	c_3	c_4	c_5	c_6	pppppppppp	p
3rd word																						
d_0	d_1	d_2	d_3	d_4	d_5	d_6	e_0	e_1	e_2	e_3	e_4	e_5	e_6	f_0	f_1	f_2	f_3	f_4	f_5	f_6	pppppppppp	p
4th word																						
g_0	g_1	g_2	g_3	g_4	g_5	g_6	h_0	h_1	h_2	h_3	h_4	h_5	h_6	i_0	i_1	i_2	i_3	i_4	i_5	i_6	pppppppppp	p
5th word																						
j_0	j_1	j_2	j_3	j_4	j_5	j_6	k_0	k_1	k_2	k_3	k_4	k_5	k_6	l_0	l_1	l_2	l_3	l_4	l_5	l_6	pppppppppp	p
.																						
.																						
nth word																						
i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	pppppppppp	p

Fig. 3.10.1.3-2 : Vector type V = 101 (All fragments excluding first fragment)

LSB of the data is transmitted first.

K: Fragment Checksum (10 bits)

This checksum is calculated by initializing the Fragment Checksum (K) to "0" and adding the information bits in each word contained in the message fragment (including control information, and the termination character and bits in the last message word) to the checksum register.

The information bits in each word are classified into 3 groups. The 1st group and 2nd group consist of 8 bits respectively (comprising bits 1 through 8 and bits 9 through 16). The 3rd group consists of 5 bits (comprising bits 17 through 21). Bits 1, 9 and 17 are the LSB of individual groups. A 1's complement of the binary sum is obtained and the 10 LSB's is transmitted as the checksum of the message.

<Example Fragment Checksum calculations for Alphanumeric Messages>

	0	0	0	0	0	0	0	0	Calculate as $K_0 \sim K_9 = 0$
	N_2	N_1	N_0	F_1	F_0	C_0	0	0	
1st word				M_0	R_0	N_5	N_4	N_3	
	a_0	S_6	S_5	S_4	S_3	S_2	S_1	S_0	
	b_1	b_0	a_6	a_5	a_4	a_3	a_2	a_1	Calculate $S_6 \sim S_0$ for Signature Field separately
2nd word				b_6	b_5	b_4	b_3	b_2	
	d_0	c_6	c_5	c_4	c_3	c_2	c_1	c_0	
	e_1	e_0	d_6	d_5	d_4	d_3	d_2	d_1	
3rd word				e_6	e_5	e_4	e_3	e_2	
				⋮					
Last word +									Binary addition

$$\ldots x_9\ x_8\ x_7\ x_6\ x_5\ x_4\ x_3\ x_2\ x_1\ x_0$$

$$\downarrow \quad \text{1's complement of lower 10 bits}$$

$$\underbrace{\ldots \overline{x_9}\ \overline{x_8}\ \overline{x_7}\ \overline{x_6}\ \overline{x_5}\ \overline{x_4}\ \overline{x_3}\ \overline{x_2}\ \overline{x_1}\ \overline{x_0}}_{K_9 \sim K_0}$$

Message field

C: Message Continued Flag (1 bit)

When the Message Continued Flag is set for 1, it indicates that fragments of the current message exist in subsequent Frames.

F: Message Fragment Number (2 bits)

A message can be divided into several fragments for transmission (refer to Chapter 4 for methods used for fragmenting long messages).
This is a modulo 3 message fragment number which increments by 1 for each of the consecutive fragments. The first fragment starts with "11" and is incremented by 1 by modulo 3 for each of the subsequent fragments (1 1, 0 0, 0 1, 1 0, 0 0, 0 1, 1 0, 0 0....)
The state for "1 1" after the first fragment is skipped in order to prevent it from being mistaken as the first fragment of a non-consecutive message. The last fragment is indicated by resetting the Message Continued Flag to 0.

N: Message Number

If the infrastructure facilities supports the Message Numbering service (for Short Message Vector V(010) and t(10), Numbered Numeric Message, HEX/Binary Message and Alphanumeric Message for each address), a series of message numbers ranging from 0 to a maximum of 63 can be assigned. After 63 is assigned as the last message number, the message assignment cycle starts over again, assigning numbers in sequential order beginning with 0. The maximum number of message numbers is assigned by the infrastructure facility and a pager must accord with that value. If any received message numbers are skipped, the pager can provide a warning to the user. In order for the user to recognize messages which are numbered from 1 to a maximum value of N+1, message search numbers are displayed as N+1. If the system does not have the capability to support the message numbers for each address, those message numbers which are newly assigned to a message must be unique numbers so as to identify fragments for the same message. (i.e., message numbers which differ from those assigned to other messages that are being processed at the same address).

R: Message Retrieval Flag

When the R bit is set for 1, the pager must check numbered messages.(It must check each address separately). Missing numbers indicate that message reception errors have occurred. Messages received with R=0 are excluded from the message number order and are not checked for skipping the numbers.

M: Mail Drop Flag (1 bit)

When the M bit is set for 1, it indicates that the received message can be handled separately from ordinary messages.

S: Signature Field (7 bits)

Signature is defined as the 1's complement of binary sum for the entire message (including all fragments) for every 7 bits [$a_6\ a_5\ a_4\ a_3\ a_2\ a_1\ a_0 + b_6\ b_5\ b_4\ b_3\ b_2\ b_1\ b_0$ ....] starting from the first 7 bits that directly follow the Signature Field. The 7 LSB's of the result is transmitted as the Message Signature.

<Example calculations of an Alphanumeric Message Signature field>

$$
\begin{array}{cccccccc}
 & a_6 & a_5 & a_4 & a_3 & a_2 & a_1 & a_0 \\
 & b_6 & b_5 & b_4 & b_3 & b_2 & b_1 & b_0 \\
 & c_6 & c_5 & c_4 & c_3 & c_2 & c_1 & c_0 \\
 & d_6 & d_5 & d_4 & d_3 & d_2 & d_1 & d_0 \\
 & e_6 & e_5 & e_4 & e_3 & e_2 & e_1 & e_0 \\
 & f_6 & f_5 & f_4 & f_3 & f_2 & f_1 & f_0 \\
 & g_6 & g_5 & g_4 & g_3 & g_2 & g_1 & g_0 \\
 & h_6 & h_5 & h_4 & h_3 & h_2 & h_1 & h_0 \\
 & i_6 & i_5 & i_4 & i_3 & i_2 & i_1 & i_0 \\
 & & & & \vdots & & & \\
+ & *_6 & *_5 & *_4 & *_3 & *_2 & *_1 & *_0 \\
\hline
\cdots & x_6 & x_5 & x_4 & x_3 & x_2 & x_1 & x_0 \\
 & & & & \downarrow & & & \\
\cdots & \overline{x_6} & \overline{x_5} & \overline{x_4} & \overline{x_3} & \overline{x_2} & \overline{x_1} & \overline{x_0}
\end{array}
$$

$$\underbrace{\overline{x_6}\ \overline{x_5}\ \overline{x_4}\ \overline{x_3}\ \overline{x_2}\ \overline{x_1}\ \overline{x_0}}_{S_6 \sim S_0}$$

Binary addition for all fragment messages

Function character ETX and NUL in Enhanced Fragmentation are not included for calculation

1's complement

U,V: Fragment Control bit

These bits exist in every fragments except for the first fragment. When symbolic characters (like Chinese characters which use 1,2 or 3 ASCII 7-bit characters for each character) are transmitted using an Alphanumeric Message format, the control bits can determine the location of the character in each fragment based on the Enhanced Fragmentation Rules. Default value=0,0

Contents of message

The content of message starts from the 2nd word in the message. Each 7-bit field is composed of JIS X 0201 characters. Except in the case of Enhanced Fragmentation, unused 7-bit characters in the message word are filled with function characters ETX($03).

Refer to Section 3.10.2.2 for alphanumeric characters.

<Example of termination of an Alphanumeric Message>

Contents of message	Information bit		
	A	B	ETX
... AB	1000001	0100001	1100000
Last word	Message		Remainder (characters) Function character ETX ($03) is used.

When there is no remainder in the last word, the message ends as is.

Enhanced Fragmentation rules

When Alphanumeric Messages are used for symbolic characters like Chinese characters in 7 bit ASCII, a specific fragment rule must be applied to maintain the boundary of the character. The following rules are used for determination the character position in the next fragment when previous fragments are missed during reception.

(1) A pager must recognize one or more function characters NUL($00) which are used as the reminder character only at the end of a fragment. The pager must remove function characters NUL($00) so as not to affect the displayed message. All function characters NUL($00) in any other locations should be considered as reception errors. (This provides a method for terminating complete characters and preventing the pagers which can not totally comply with the Enhanced Fragmentation Rules from operating abnormally.)

(2) The last fragment is to be completed by filling the unused character positions with function characters ETX($03) or function characters NUL($00). In addition to function characters ETX($03) which are defined in Alphanumeric Messages, function characters NUL($00) need to be newly defined. If the message ends on the last character position in the last word, insertion of function characters ETX($03) or NUL($00) is not required.

(3) Fragment Control bits (Uo,Vo) in the control information field are valid for supporting decoding in all fragments which follow the first fragment. For the first fragment, the message starts with the default character mode.

The Fragment Control bits are defined as follows for the second and subsequent fragments.

Uo	Vo	
0	0	Enhanced Fragment Rules are not supported by the infrastructure facility.
0	1	Reserved (for a second alternative character mode)
1	0	Default character mode.
1	1	Alternative character mode.

When Fragment Control bits (Uo,Vo) are (0,0),a pager decodes messages and allows characters to be split between fragments. When Fragment Control bits (Uo,Vo) are not (0,0),each fragment starts from the character boundary defined above.

<Examples of the Enhanced Fragmentation Rules>

Conditions for this examples;

* 2 ASCII codes for 1 symbolic character
* The default character mode is symbolic characters
* Each symbolic character represents XX and ##
* The alternative character mode represents a and b.
* Function character SI (Shift In) shifts the pager to the alternative character mode.
* Function character SO (Shift Out) returns to the default mode.

-In cases when the alternative character mode UV=1,1

First fragment	2nd Word	Sig	SI	a	Sig: Signature Field
	3rd Word	b	a	b	
	4th Word	a	b	a	
	5th Word	b	a	b	
Second fragment UV=1,1	2nd Word	a	b	a	
	3rd Word	b	a	b	
	4th Word	a	b	a	
	5th Word	b	a	b	

-In cases when Enhanced Fragmentation Rules are not supported (U,V=0,0).

First fragment	2nd Word	Sig	X	X
	3rd Word	#	#	X
	4th Word	X	#	#
	5th Word	X	X	#
Second fragment UV=0,0	2nd Word	#	X	X
	3rd Word	#	#	X
	4th Word	X	#	#
	5th Word	X	X	ETX

- In cases when Default character mode and Alternative character mode are mixed.

First fragment	2nd Word	Sig	X	X
	3rd Word	#	#	SI
	4th Word	a	b	a

	5th Word	b a b
Second fragment UV=1,1	2nd Word	a b a
	3rd Word	b a SO
	4th Word	X X #
	5th Word	# X X
Third fragment UV=1,0	2nd Word	# # X
	3rd Word	X # #
	4th Word	X X #
	5th Word	# X X

- In case when Default character mode.

First fragment	2nd Word	Sig X X
	3rd Word	# # X
	4th Word	X # #
	5th Word	X X NUL
Second fragment UV=1,0	2nd Word	# # X
	3rd Word	X # #
	4th Word	X X #
	5th Word	# X X
Third fragment UV=1,0	2nd Word	# # X
	3rd Word	X # #
	4th Word	X X #
	5th Word	# X X

3.10.1.4 Secure Message

1	2	3	4	5	6	7	.	.	.	.	.	.	.	.	.	.	.	.	.	21	22........31	32
Information bits																					Parity bits	Even parity
1st word																						
K_0	K_1	K_2	K_3	K_4	K_5	K_6	K_7	K_8	K_9	C_0	F_0	F_1	N_0	N_1	N_2	N_3	N_4	N_5	t_0	t_1	pppppppppp	p
2nd word																						
a_0	a_1	a_2	a_3	a_4	a_5	a_6	b_0	b_1	b_2	b_3	b_4	b_5	b_6	c_0	c_1	c_2	c_3	c_4	c_5	c_6	pppppppppp	p
3rd word																						
d_0	d_1	d_2	d_3	d_4	d_5	d_6	e_0	e_1	e_2	e_3	e_4	e_5	e_6	f_0	f_1	f_2	f_3	f_4	f_5	f_6	pppppppppp	p
4th word																						
g_0	g_1	g_2	g_3	g_4	g_5	g_6	h_0	h_1	h_2	h_3	h_4	h_5	h_6	i_0	i_1	i_2	i_3	i_4	i_5	i_6	pppppppppp	p
5th word																						
j_0	j_1	j_2	j_3	j_4	j_5	j_6	k_0	k_1	k_2	k_3	k_4	k_5	k_6	l_0	l_1	l_2	l_3	l_4	l_5	l_6	pppppppppp	p
.																						
.																						
nth word																						
i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	pppppppppp	p

Fig. 3.10.1.4-1 : Vector type V = 000 (all fragments)

Transmission of data starts from LSB.

K: Fragment Checksum (10 bits)

This checksum is calculated by initializing the Fragment Checksum (K) to "0" and adding the information bits in each word contained in the message fragment (including control information, and the termination character and the bits in the last message word) to the checksum register.
The information bits in each word are classified into 3 groups. The 1st group and 2nd group consist of 8 bits respectively (comprising bits 1 through 8 and bits 9 through 16). The 3rd group consists of 5 bits (comprising bits 17 through 21). Bits 1, 9 and 17 are the LSB of individual groups. A 1's complement of the binary sum is obtained and the 10 LSB's is transmitted as the checksum of the message.

<Example Fragment Checksum calculations for Secure Messages >

			0	0	0	0	0	0	0	0	Calculated as $K_0 \sim K_9 = 0$
			N_2	N_1	N_0	F_1	F_0	C_0	0	0	
1st word						t_1	t_0	N_5	N_4	N_3	
			b_0	a_6	a_5	a_4	a_3	a_2	a_1	a_0	
			c_1	c_0	b_6	b_5	b_4	b_3	b_2	b_1	
2nd word						c_6	c_5	c_4	c_3	c_2	
			e_0	d_6	d_5	d_4	d_3	d_2	d_1	d_0	
			f_1	f_0	e_6	e_5	e_4	e_3	e_2	e_1	
3rd word						f_6	f_5	f_4	f_3	f_2	
							⋮				
Last word +											Binary addition
•••	x_9	x_8	x_7	x_6	x_5	x_4	x_3	x_2	x_1	x_0	
							↓				1's complement for lower 10 bits
•••	$\overline{x_9}$	$\overline{x_8}$	$\overline{x_7}$	$\overline{x_6}$	$\overline{x_5}$	$\overline{x_4}$	$\overline{x_3}$	$\overline{x_2}$	$\overline{x_1}$	$\overline{x_0}$	

$K_9 \sim K_0$

Message field

C: Message Continued Flag (1 bit)

When the Message Continued Flag is set for 1, it indicates that fragments of the current message exist in subsequent Frames.

F: Message Fragment Number (2 bits)

A message can be divided into several fragments for transmission (refer to Chapter 4 for methods used for fragmenting long messages).

This is a modulo 3 message fragment number which increments by 1 for each of the consecutive fragments. The first fragment starts with "11" and is incremented by 1 by modulo 3 for each of the subsequent fragments (1 1, 0 0, 0 1, 1 0, 0 0, 0 1, 1 0, 0 0....)

The state for "1 1" after the first fragment is skipped in order to prevent it from being mistaken as the first fragment of a non-consecutive message. The last fragment is indicated by resetting the Message Continued Flag to 0.

N: Message Number

The Message Numbering service is not performed for Secure Messages.
The Message Number N is used for identification of fragments for the same message. Multiple messages for same address must have different message numbers. The range of the message numbers is 0 through 63.

t : Secure Message Type Field(2 bits)

t_1t_0=00	represents 7 bit Alphanumeric Message data.
t_1t_0=10	represents binary message data.
t_1t_0=01	represents data defined separately.
t_1t_0=11	reserved.

Contents of message

The content of the message starts from the 2nd word in the message.
Wherein t_1t_0=00, a message is transmitted alphanumeric message characters.
Each 7-bit field is composed of JIS X 0201 characters. (Refer to Section 3.10.2.2 regarding alphanumeric character codes.)
Wherein t_1t_0=10, the contained data is assumed to be binary data.
Since Secure Messages start with a specific control code, the first 7 bits start with numeric or alphanumeric characters.

Message termination

For Alphanumeric Messages wherein t1t0=00, unused 7-bit characters are filled with function character ETX ($03). For Binary Messages wherein t1t0=10, when a valid bit in the last character in a fragment will end in the middle of the last word , the remaining bits will be filled with either all 0's or 1's, whichever is the reverse value of the last valid data bit. In such instances, if the last word ends on a valid data bit of a last character which does not have a remainder, a termination word which is filled with the reverse value of the last bit must be added.
The termination method is not defined for specific data wherein t1t0=01.

<Example of termination of Secure Messages>

When t1t0=00,

Contents of message		Information bits	
	A	B	ETX
... AB	1000001	0100001	1100000
Last word	Message		Remainder (characters)
			Function character ETX ($03) is used.

When there is no remainder in the last word, the message ends as is.

When t1t0=10,

	Information bits	
• When the last word remains:	11010011101100	1111111
	Message	Remaining bits

- When termination exactly on the last word:

Information bits
110100101101010100110
Information bits
111111111111111111111

As the last bit is 0, a word consisting of all the bits that are the reverse value of the last bit is added.

Registration Acknowledgment Message (Option)

The Registration Acknowledgment Messages are transmitted using a Secure Message. (Refer to Section 6.7)

1 2 3 4 5 6 7 8 9 • • • • • • • • • • • 21	22 • • • • • • • • • 31	32
Information bits	Parity bits	Even parity
1st word K_0 K_1 K_2 K_3 K_4 K_5 K_6 K_7 K_8 K_9 C_0 F_0 F_1 N_0 N_1 N_2 N_3 N_4 N_5 t_0 t_1	p p p p p p p p p p	p
2nd word 1 0 1 1 1 1 0 r_0 r_1 r_2 r_3 r_4 r_5 r_6 r_7 r_8 r_9 r_{10} r_{11} r_{12} r_{13}	p p p p p p p p p p	p

Fig. 3.10.1.4-2 : Registration Acknowledgment Message (Option) V=000, t1t0=00

K,C,F,N and t are identical in the figure with those used in Fig. 3.10.1.4-1.
The Secure Message type field t1t0 in the 1st word represents 7 bit Alphanumeric Message data wherein t_1t_0=00.
Bit 1 through 7 in the 2nd word contain the Operation code ("=" $3D) for the Registration Acknowledgment Message. Bit 8 through 21(r0-r13) are reserved. (i.e. filled with the default function character ETX($03))

3.10.2 Character table

3.10.2.1 Numeric character table

Table 3.10.2.1-1 : below defines numerical characters

Character	B3	B2	B1	B0
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
Spare	1	0	1	0
U	1	0	1	1
Space	1	1	0	0
—	1	1	0	1
]	1	1	1	0
[	1	1	1	1

<Free Words>

Free Words are used for transmitting alphabetical, numerical and KANA codes in 2-digit units. Numerical characters inserted between the Free Word recognition characters specified in the following are transmitted as Free Words in 2-digit units according to Table 3.10.2.1-2. The transmission order is in row and column, and the corresponding characters are converted and displayed on the pager according to Table 3.10.2.1-2.

Table 3.10.2.1-2 : FreeWord conversion table

Row \ Column	1	2	3	4	5	6	7	8	9	0
1	ア	イ	ウ	エ	オ	A	B	C	D	E
2	カ	キ	ク	ケ	コ	F	G	H	I	J
3	サ	シ	ス	セ	ソ	K	L	M	N	O
4	タ	チ	ツ	テ	ト	P	Q	R	S	T
5	ナ	ニ	ヌ	ネ	ノ	U	V	W	X	Y
6	ハ	ヒ	フ	ヘ	ホ	Z	?	!	—	/
7	マ	ミ	ム	メ	モ	¥	&	📟	☎	☕
8	ヤ	(	ユ	)	ヨ	*	#	Space	♥	Note
9	ラ	リ	ル	レ	ロ	1	2	3	4	5
0	ワ	ヲ	ン	゛	゜	6	7	8	9	0

Note) The code for row "8" and column "0" is a control code and is not displayed. For example, it is possible to shift to Option conversion tables by using this control code.

Free Word recognition code

Free Word start ... combination of hyphen characters "-" "-" in the numeric character table (see Table 3.10.2.1-1).

Free Word end ... The space character in the numeric character table (see Table 3.10.2.1-1).

Examples of Free Words

(Free Word start)	ト	ウ	キ	ヨ	ウ	(Free Word end)
- -	45	13	22	85	13	Space

3.10.2.2 Alphanumeric character table

Table 3.10-2.2-1 lists Alphanumeric characters. Function characters which cannot be supported by the pager are ignored in the display process and use of display space is not necessary.

Table 3.10.2.2-1 : Alphanumeric character table - JIS X 0201

				B7	0	0	0	0	1	1	1	1
				B6	0	0	1	1	0	0	1	1
				B5	0	1	0	1	0	1	0	1
B4	B3	B2	B1	HEX	0	1	2	3	4	5	6	7
0	0	0	0	0	NUL	DLE	SP	0	@	P	`	p
0	0	0	1	1	SOH	DC1	!	1	A	Q	a	q
0	0	1	0	2	STX	DC2	"	2	B	R	b	r
0	0	1	1	3	ETX	DC3	#	3	C	S	c	s
0	1	0	0	4	EOT	DC4	$	4	D	T	d	t
0	1	0	1	5	ENQ	NAK	%	5	E	U	e	u
0	1	1	0	6	ACK	SYN	&	6	F	V	f	v
0	1	1	1	7	BEL	ETB	'	7	G	W	g	w
1	0	0	0	8	BS	CAN	(	8	H	X	h	x
1	0	0	1	9	HT	EM	)	9	I	Y	i	y
1	0	1	0	A	LF	SUB	*	:	J	Z	j	z
1	0	1	1	B	VT	ESC	+	;	K	[	k	{
1	1	0	0	C	FF	FS	,	<	L	¥	l	|
1	1	0	1	D	CR	GS	-	=	M	]	m	}
1	1	1	0	E	SO	RS	.	>	N	^	n	-
1	1	1	1	F	SI	US	/	?	O	_	o	DEL

3.10.2.3 KANJI character table

Shift JIS codes are used for the KANJI character table.

<Shift JIS code>

A "Shift JIS code" is a 2-byte code used to represent KANJI characters.

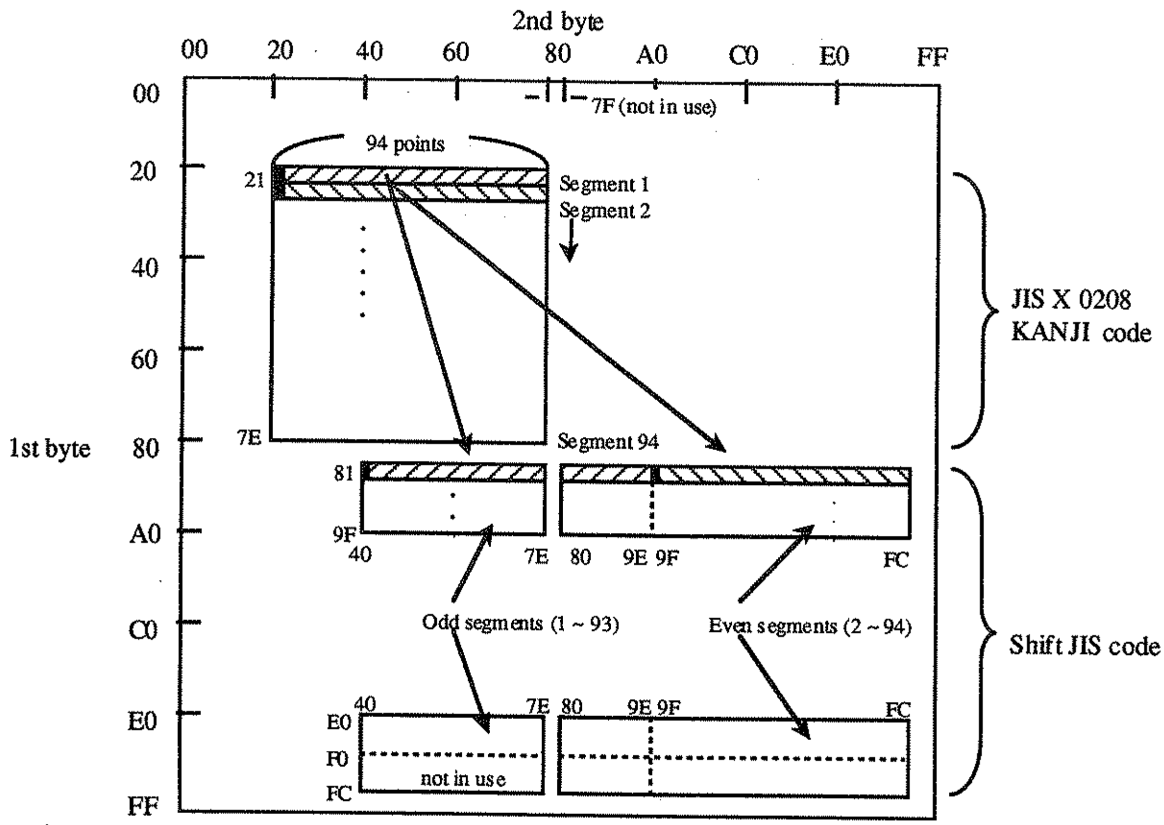
Byte 1 uses a JIS 8-unit character table. It specifies the KANJI character table in segment units as shown in Table 3.10.2.3-1, using 60 characters [HEX 81 to 9F and E0 to EF] which are not defined in the JIS 80-unit character table to cover the KANJI characters.

Byte 2 utilizes character strings which are shifted from the KANJI Table.

If HEX 81 is specified by byte 1, for example, segments 1 and 2 (consisting 94 types x 2 = 188) of the KANJI character table are converted into HEX 40 ~ FC (consisting of 188 types excluding 7F) of byte 2 for assignment in byte 2 while maintaining the form of the KANJI character table.

KANJI character table used : JIS X0208

Table 3.10.2.3-1 : Method of indication used by shift JIS code



Chapter 4 Long Message Transmission

This chapter lays down the regulations governing the methods used for long message transmission which require that transmission take place over multiple Frames.

4.1 Fragmentation of long messages

When long messages are transmitted, in cases when the full length of a message cannot be contained in one Frame, the individual message must be broken down into fragments. Accordingly, the respective fragments need to be transmitted over several Frames in order for the complete message to be transmitted as one message. Note that it is also possible to transmit other messages which arise during transmission of a long message in multiple fragments by giving the other message priority over the pertinent long message.

One example of such transmission is given below, in which an Alphanumeric Message with a Short Address is transmitted using the single transmission method. After removing one Block Information Word, one address word and one vector word from the maximum 88 words (refer to Section 3.4 for the number of words in a Frame), the maximum length of message words which can be transmitted in one Frame is 85 words .

In the case of an Alphanumeric Message (which uses 7-bits per character), after the 1st word in the Message Field has been removed from the 85 words, the maximum number of words which can be transmitted for the message is 84 words. As 3 characters can be sent per word, the maximum number of characters which can be sent in one Frame is 251 characters [3 characters/word x 84 words -1 = 251].Therefore, longer messages which have more than 251 characters are transmitted by Fragmentation.

In addition, in that other paging messages to other pagers can also exist within the same Frame that a fragmented message is being sent in, in cases where the maximum 251 characters which constitute a message cannot be transmitted in the same Frame, the pertinent message can be transmitted by Fragmentation.

4.2 Fragmentation

The following requirements must be met for Fragmentation.

① Once an individual, Operator Messaging, NID or radio group address is used to begin transmitting a fragmented message, that same address must not be used to start a new fragmented transmission until the first fragmented transmission has been completed. During multiple transmission, however, note that the pertinent address can be used to transmit another fragmented message at the point where the first transmission of all the fragments in the original message has been completed.

② For the duration of time that an individual or radio group address is being used to send a fragmented message, that same address must not appear more than one in any Frame for single transmission (or in any Subframe for multiple transmission) to send an unfragmented message.

③ Numeric Messages (those having a vector type of 011,100,111) cannot be fragmented.

④ The transmission interval between each fragment of the same message must be 32 Frames (equivalent to 1 minute) or less. When use of the pertinent channel is shared with another system, however, (or in the case of multiple transmission or Multi-area/Roaming channel), the transmission interval for each fragment can be 128 Frames (equivalent to 4 minutes) or less .

In a Fragmentation, fragments can be also transmitted in the Frames not based on the Collapse cycle. Also, it is possible to combine with Carry On described in Chapter 3 (Refer to Section 3.7).

Also note that for transmitting messages in fragments, the method of Fragmentation differs based on whether the single transmission method is used, or the multiple transmission is used.

4.2.1 Fragmentation using the single transmission method

(1) Cases when Carry On is not used

Refer to Fig. 4.2.1-1 for an example of Fragmentation when Carry On is not used.

The 1st fragment is transmitted by matching it up with the Frame based on the Pager Collapse value or the System Collapse value (refer to Section 3.1.2). Regardless of the Collapse value, however, the 2nd and subsequent fragments are generally sent in Frames which have continuance with the Frame in which the 1st fragment was transmitted. (Note, however, in that other paging messages to other pagers exist or the channel is mixed with other signaling , there will be instances in which subsequent Frames will not have continuance with the Frame in which the 1st fragment was transmitted.)

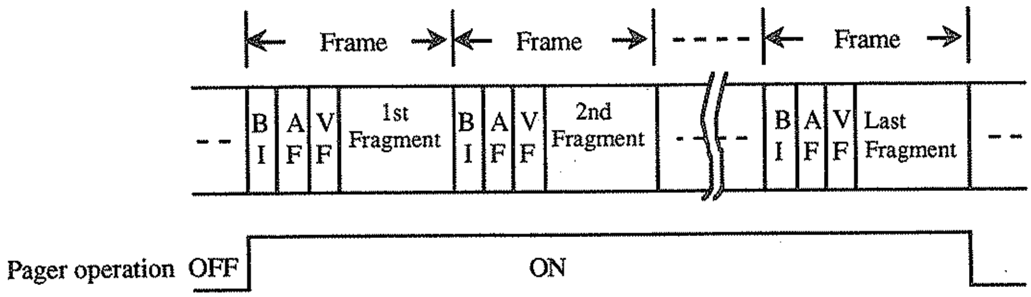
In addition, the respective addresses for the pertinent pager are inserted into the Address Field of each Frame where the pertinent messages exist; also, the respective vectors for the fragments corresponding to the Frames are inserted into the Vector Field.

(2) Cases when Carry On is used

There are cases in which the Carry On outlined in Chapter 3 can be used during Fragmentation.

As in "Cases when Carry On is not used" as described in (1) above, with Fragmentation when Carry On is used, as shown in Fig. 4.2.1-2, regardless of the Collapse value, the 2nd and subsequent fragments can be sent in Frames having continuance with the Frame in which the 1st fragment was sent. Also, in the same manner as in (1), above, in that other paging messages to other pagers exist or the channel is mixed with other signaling ,there will be instances when subsequent Frames do not have continuance with the Frame in which the 1st fragment was transmitted.

In addition, a Carry On flag (in the Block Information Word for the Frame in which the 1st fragment is sent) is used to designate the Frames in which the 1st fragment may be sent (refer to Section 3.7 for "Carry On flags").



BI : Block Information Word (refer to section 3.7)

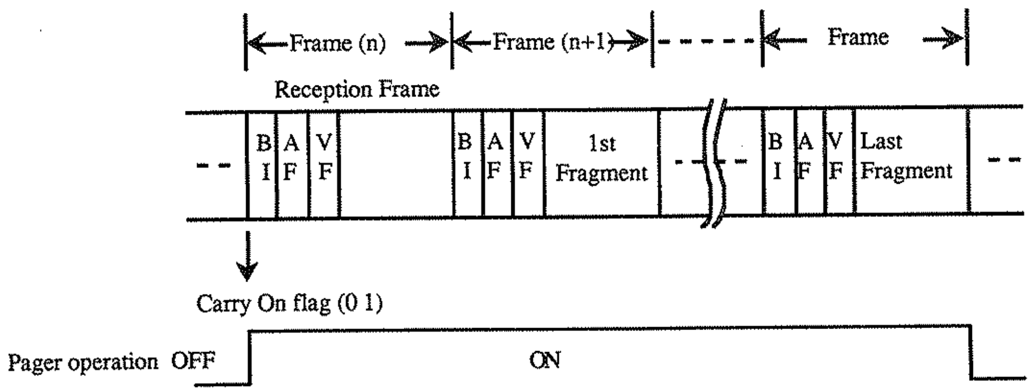
AF : Address Field (refer to section 3.8)

VF : Vector Field (refer to section 3.9)

Note 1 : The first Frame is the reception Frame specified by the Collapse value.

Note 2 : Each fragment indicates a HEX/Binary Message (see Section 3.10.1.2), Alphanumeric Message (see Section 3.10.1.3) or Secure Message (see Section 3.10.1.4).

Fig. 4.2.1-1 : Example of Fragmentation using the single transmission method in cases when Carry On is not used



Note 1 : "Reception Frame" refers to the Frame specified by the Collapse value.

Note 2 : The figure shows an example when Carry On flag in the Block Information Word for the reception Frame is "01". First fragment is transmitted in Frame n or in Frame n+1.

Fig. 4.2.1-2 : Example of Fragmentation using the single transmission method in cases when Carry On is used

4.2.2 Fragmentation for multiple transmission

For transmission of fragments by multiple transmission, depending on the pager, sometimes it is possible to transmit fragments according to the Collapse cycle designated by the infrastructure facilities, and at other times it is possible to transmit fragments in continuous Frames. The method to be used for transmitting fragments is determined by and stored in the pager. Note, however, that Fragmentation using continuous Frames is not permitted when multiple Collapse cycles exist (refer to Section 3.1.3). In addition, Carry On cannot be used for multiple transmission. (Also, refer to Section 3.4.2 for regulations regarding multiple transmission).

(1) Fragmentation for multiple transmission based on the dictated Collapse cycle by the infrastructure facility.

With this method, the respective fragments are transmitted in accordance with the reception Frame for the pertinent pager which is determined by the System Collapse value designated by the Block Information (refer to Section 3.7) or by the TD Collapse value designated by the Frame Information Word(refer to Section 3.6).

Fig. 4.2.2-1 below is an example of Fragmentation

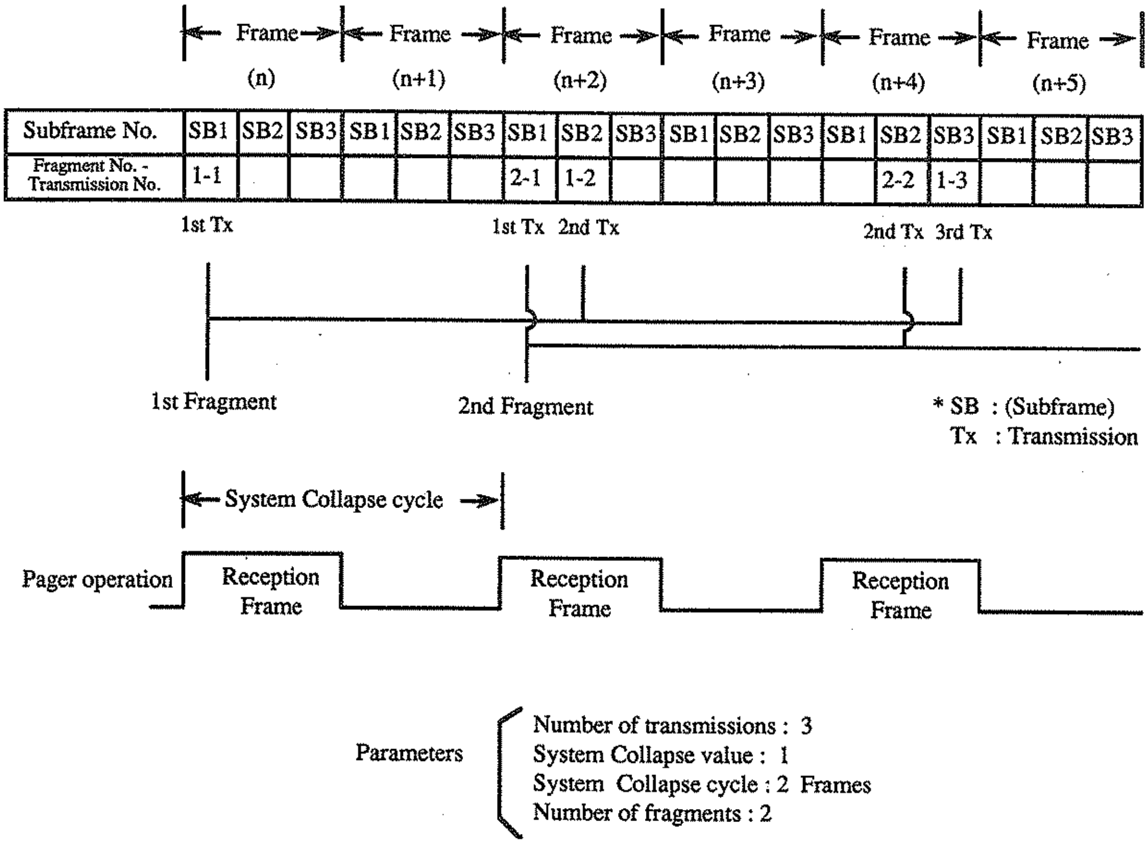


Fig. 4.2.2-1 : Example of Fragmentation according to the System Collapse cycle

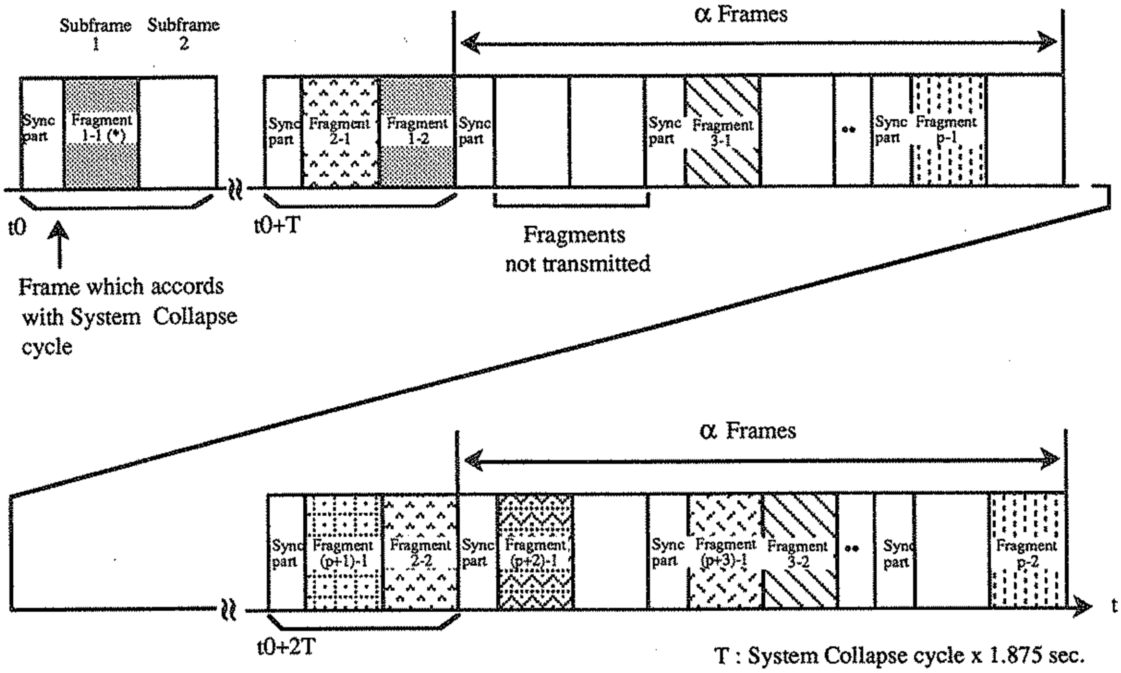
(2) Fragmentation using continuing Frames.

With this method, the respective fragments can be sent in the Frame which are received by the pager in accordance with the System Collapse value and in the α Frames which follow continuously after the Frame. (Note, however, in that other paging messages to other pagers exist or the channel is mixed with other signaling, there will be instances in which subsequent Frames will not have continuance with the Frame in which the 1st fragment was transmitted.) The following regulations govern this type of transmission.

① In cases of when fragments are transmitted in continuous α Frames (i.e., in Frames which do not follow the Collapse cycle), transmission begins on the first Frame after skipping the Frame following immediately after the Frame whereby transmission of all the 1st fragments is completed by multiple transmission.

② Maximum of α shall be less than the System Collapse cycle

Fig. 4.2.2-2 below gives an example of Fragmentation using continuous Frames.



(*) The notations for the fragments in the fig. (i.e., Fragment 1-1, etc.) have the following meanings :

fragment m-n (in this case, Fragment 1-1)

m = fragment No. (in this case, Fragment 1)

n = transmission No. (in this case, 1st transmission)

Fig. 4.2.2-2 : Example of Fragmentation using continuous Frames

4.2.3 Transmitting other paging messages to other pagers during Fragmentation

During the course of sending one long message by Fragmentation, it is also possible to send other messages as shown in Figs. 4.2.3-1 and 4.2.3-2. In such instances, the requirements for sending messages by Fragmentation outlined in Section 4.2 must also be met.

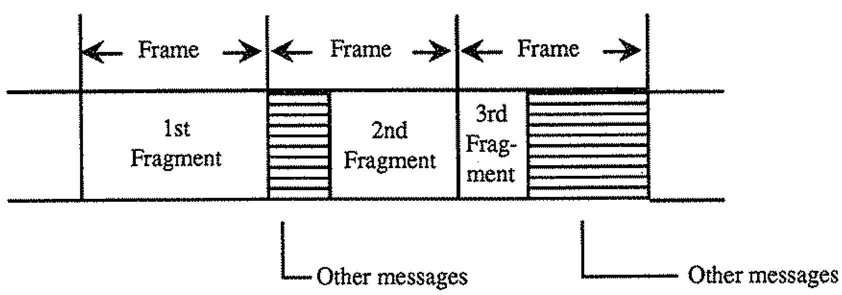


Fig. 4.2.3-1 : Transmitting other messages during Fragmentation [Example 1]

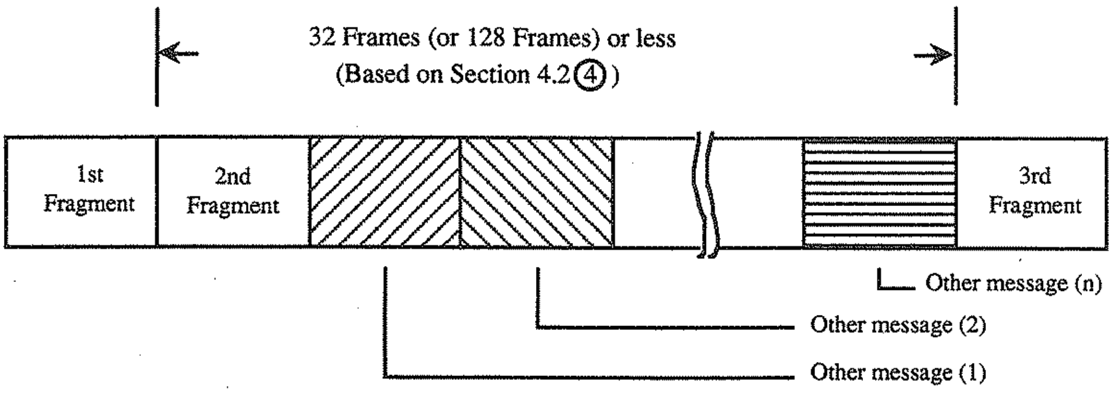


Fig. 4.2.3-2 : Transmitting other messages during Fragmentation [Example 2]

4.3 Reception of fragmented messages

Reception of a fragmented message in the case of the single transmission method is as described in the paragraph below.

In this example, the pager checks the Message Continued Flag contained in the received message, and when this flag is "1", it acknowledges that there are additional fragments remaining to be received. Accordingly, as long as the above-mentioned Message Continued Flag remains set to "1", the pager receives additional fragments. When it detects that the flag is set to "0", it acknowledges that the last fragment has been received and stops reception of the message.

In addition, the pager detects whether there are any missing fragments by checking Message Fragment Numbers and also recognizes which message a continuous fragment is received in by checking Message Numbers. In addition, the Fragment Checksum for each fragment is used by the pager to detect errors in fragments.

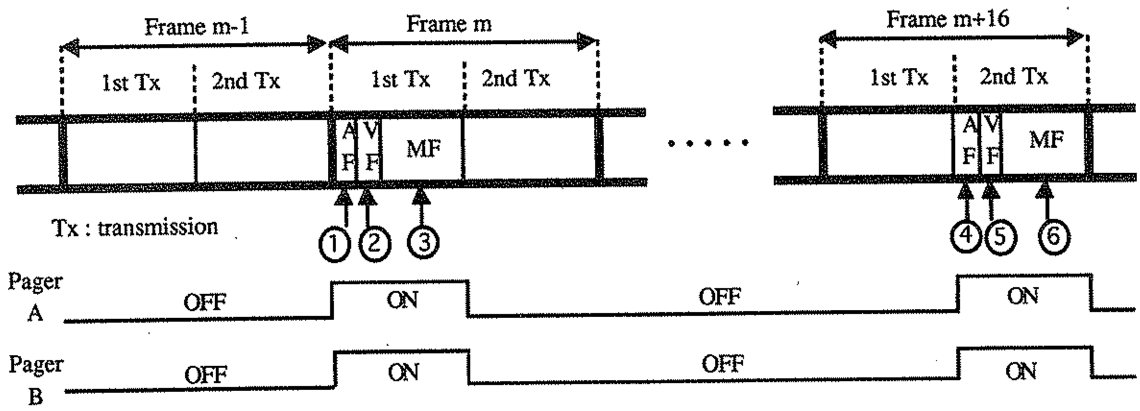
When the pager stops reception after the last fragment is received (where the Message Continued Flag sets to "0"), or in cases when the permissible transmission interval between each fragment is exceeded (based on Section 4.2 ④) and therefore the next fragment cannot be received, the pager reverts to the intermittent reception mode, wherein only Frames decided by the Collapse value are received.

Chapter 5 Group Messages

The methods for receiving common messages (Group messages) are outlined below.

5.1 Group messages using common addresses (group addresses)

Short Addresses or Long Addresses can be used as group addresses for individual pagers. When transmitting Group messages, the respective group addresses for the pagers in the respective groups are transmitted along with vectors which indicate the types, etc., of messages and the Group messages themselves. In addition to indicating the type of Group messages, vectors also indicate the number for the starting word of Group messages and the Group message word length. Fig. 5.1-1 below is an example of how Group messages are sent using group addresses.



① ········· Group address for the Pager A,B.
(The all pagers in the group receive Frame m.)
② ········· Common vector for the Pager A,B.
(Indicates the type of message, the number of the starting word and the message word length.)
③ ········· Group message.
④ ········· Group address for the Pager A,B.(Second transmission)
⑤ ········· Common vector for the Pager A,B.
(Indicates the type of message, the number of the starting word and the message word length. Second transmission.)
⑥ ········· Group message.(Second transmission.)

Fig. 5.1-1 : Example of transmitting Group messages using group addresses (when System Collapse cycle = 16 and the number of transmissions = 2).

5.2 Group messages using Temporary Addresses

Group message using Temporary Address is a method wherein the pagers in a certain group receive Group messages by the system transmitting a Temporary Address for all the pagers within the same group.

When this method is used, the address and Short Instruction Vector for each pager are transmitted first. By receiving the Short Instruction Vector, each pager is able to decode the

Temporary Address and the Frame where the Temporary Address is transmitted.(i.e., to decode those Frames designated by the 7 bits [$f_6 \sim f_0$] in Table 3.9.6-1). The assigned Temporary Address is only valid for the Frame in which the Temporary Address is transmitted. In cases when the Temporary Address is not detected within the designated Frame, the pager must automatically return to normal operation immediately. The Temporary Address is valid until the Group message ends. It is also possible to break down Group messages which stretch over several Frames. In addition, when the multiple transmission method is used, at the point where the first transmission of a Group message ends, other Group message can be transmitted (first transmission) by using the same Temporary Address. When the complete message is built, the pager automatically returns to normal operation.

Then all the pagers within the same group receive the Temporary Address with vector and message in the Frame designated by the Short Instruction Vector.

Before Group messages are transmitted, however, the multiple transmission which includes the Short Instruction Vector must be completed. The first transmission of the Group message must be started within 128 Frames from the first transmission of the Short Instruction Vector.

When the address for an individual pager is classified in a Single phase, the Temporary Address's phase is assigned to the same phase as the one used for the pertinent pager's address. Group messages are transmitted as needed in each phase on the same Frame.

When the address for an individual pager is classified in an Any phase, the Temporary Address is assigned to one of the usable phases from among the phases "a, b, c or d."

In cases when a Temporary Address is assigned to pagers within a group by means of using a Short Instruction Vector, the same Temporary Address must not be used until transmission of the Group message has ended.

Also, a second Temporary Address cannot be specified using the pertinent Temporary Address, and message numbers must not be used in Group messages.

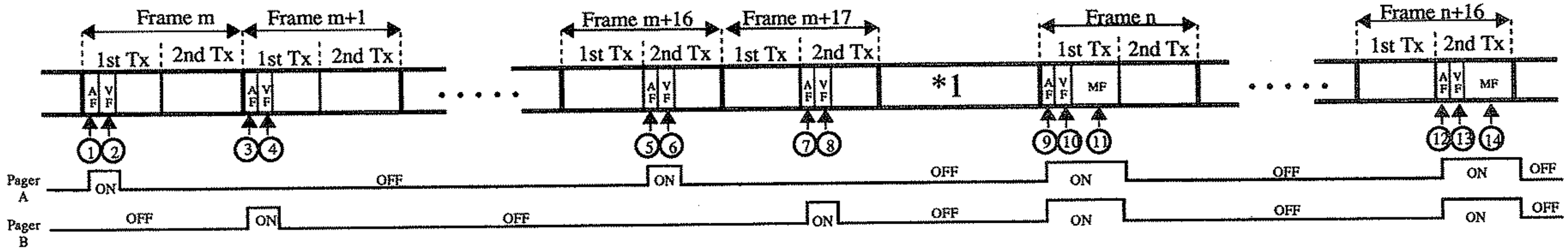
Also, there are two methods of transmission for Group messages, as described in Section 5.2.1 or 5.2.2. Pagers which receive Group messages using a Temporary Address must support at least one of the methods for transmitting Group messages.

5.2.1 The Frames of Group messages for which the transmitted Temporary Addresses don't depend on a dictated Collapse cycle by the infrastructure facilities.

The example for this case for the transmission of Group message is shown in Fig. 5.2.1-1. The Frame in which the Temporary Address is transmitted is any Frame except the first subsequent Frame after the multiple transmission for the page including the Short Instruction Vector is completed.

5.2.2 The Frames of Group messages for which the transmitted Temporary Addresses depend on a dictated Collapse cycle by the infrastructure facilities.

The example for this case for the transmission of Group message is shown in Fig. 5.2.2-1. The Frame in which the Temporary Address is transmitted is the Frame that the pager sets to the reception state at the System Collapse cycle after the multiple transmission for the page including the Short Instruction Vector is completed.



① ••• Address for pager A (Frame m).

② ••• Short Instruction Vector for pager A (which designates Frame n and Temporary Address for ⑨).

③ ••• Address for pager B (Frame m + 1).

④ ••• Short Instruction Vector for pager B (which designates Frame n and Temporary Address for ⑨).

⑤ ••• Address for pager A [second transmission].

⑥ ••• Short Instruction Vector for pager A (which designates Frame n and Temporary Address for ⑨ [second transmission]).

⑦ ••• Address for pager B [second transmission].

⑧ ••• Short Instruction Vector for pager B (which designates Frame n and Temporary Address for ⑨ [second transmission]).

⑨ ••• Temporary Address for each pager.

⑩ ••• Vector for each pager (indicates Group message type, start word No. and message word length).

⑪ ••• Group message for each pager.

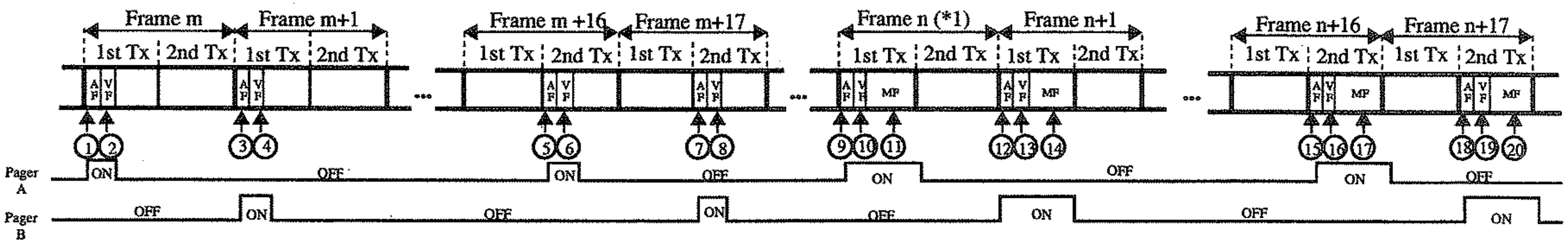
⑫ ••• Temporary Address for each pager [second transmission].

⑬ ••• Vector for each pager (indicates Group message type, start word No. and message word length [second transmission].

⑭ ••• Group message for each pager [second transmission].

*1 : For the Frame directly following Frame m+17, the Group message is not transmitted; also, n does not exceed 128 Frames from m.

Fig. 5.2.1-1 : Example of transmission of a Group message when the Frame in which the Temporary Address is transmitted does not depend on the System Collapse cycle [System Collapse cycle = 16, the number of transmissions = 2]



① ••• Address for pager A (Frame m).

② ••• Short Instruction Vector for pager A (which designates Frame n(*1) and Temporary Address for ⑨).

③ ••• Address for pager B (Frame m + 1).

④ ••• Short Instruction Vector for pager B (which designates Frame n+1 and Temporary Address for ⑫).

⑤ ••• Address for pager A [second transmission].

⑥ ••• Short Instruction Vector for pager A (which designates Frame n and Temporary Address for ⑨ [second transmission]).

⑦ ••• Address for pager B [second transmission].

⑧ ••• Short Instruction Vector for pager B (which designates Frame n+1 and Temporary Address for ⑫ [second transmission]).

⑨ ••• Temporary Address for pagers including pager A.

⑩ ••• Vector for pagers including pager A (indicates Group message type, start word No. and message word length).

⑪ ••• Group message for pagers including pager A

⑫ ••• Temporary Address for pagers including pager B .

⑬ ••• Vector for pagers including pager B (indicates Group message type, start word No. and message word length).

⑭ ••• Group message for pagers including pager B.

⑮ ••• Temporary Address for pagers including pager A [second transmission].

⑯ ••• Vector for pagers including pager A (indicates Group message type, start word No. and message word length [second transmission]).

⑰ ••• Group message for pagers including pager A [second transmission].

⑱ ••• Temporary Address for pagers including pager B [second transmission].

⑲ ••• Vector for pagers including pager B (indicates Group message type, start word No. and message word length [second transmission].

⑳ ••• Group message for pagers including pager B [second transmission].

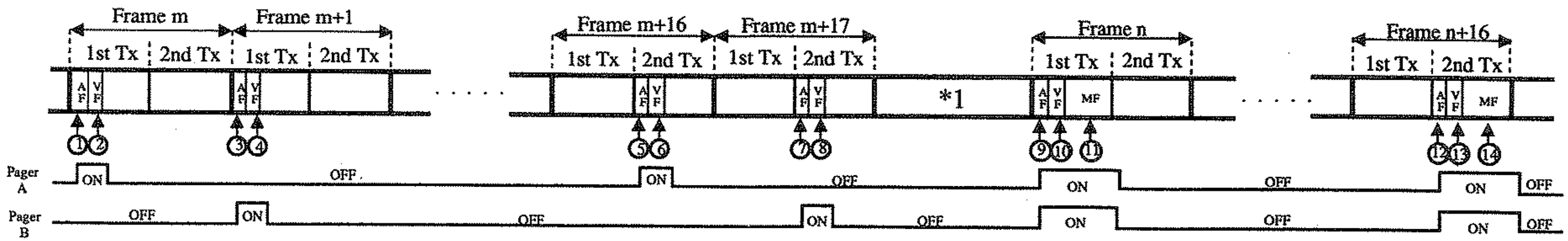
*1 : The value of n is decided depending on the System Collapse cycle [n = m+16+16 x p (p=1,2,3...)]; also, n does not exceed 128 Frames from m.

Fig. 5.2.2-1 : Example of transmission of Group message when the frame in which the Temporary Address is transmitted depends on the System Collapse cycle [System Collapse cycle = 16, the number of transmissions = 2]

5.3 Group messages using Temporary Addresses in subgroups

Each pager has a common address for each subgroup called a “Subgroup address”. A Subgroup address and a Short Instruction Vector are transmitted for each subgroup. All of the pagers in a subgroup receive a Temporary Address, vector and Group message in the Frame designated by a Short Instruction Vector. Transmission of Group messages using Temporary Addresses must meet all of the requirements outlined in Section 5.2.

Fig. 5.3-1 is an example of the method of transmitting Group messages by using Temporary Addresses for subgroups. (The Frames of Group messages for which the transmitted Temporary Addresses don't depend on the System Collapse cycle.)



① ••• Address for pagers in subgroup A (Frame m).

② ••• Short Instruction Vector for pagers in subgroup A (which designates Frame n and Temporary Address for ⑨).

③ ••• Address for pagers in subgroup B (Frame m+1).

④ ••• Short Instruction Vector for pagers in subgroup B (which designates Frame n and Temporary Address for ⑨).

⑤ ••• Address for pagers in subgroup A [second transmission].

⑥ ••• Short Instruction Vector for pagers in subgroup A (which designates Frame n and Temporary Address for ⑨ [second transmission]).

⑦ ••• Address for pagers in subgroup B [second transmission].

⑧ ••• Short Instruction Vector for pagers in subgroup B (which designates Frame n and Temporary Address for ⑨ [second transmission]).

⑨ ••• Temporary Address for pagers in all subgroups

⑩ ••• Vector for pagers in all subgroups (indicates Group message type, start word No. and message word length).

⑪ ••• Group message for pagers in all subgroups.

⑫ ••• Temporary Address for pagers in all subgroups [second transmission].

⑬ ••• Vector for pagers in all subgroups (indicates Group message type, start word No. and message word length [second transmission]).

⑭ ••• Group message for pagers in all subgroups [second transmission].

*1 : For the Frame directly following Frame m+17, the Group message is not transmitted; also, n does not exceed 128 Frames from m .

Fig. 5.3-1 : Example of transmission of Group message using Temporary Addresses in subgroups [System Collapse cycle= 16, the number of transmissions = 2]

Chapter 6 Multi-area/Roaming

When the Roaming Network bit in the Frame Information Word is set for n=1 on the pertinent channel, it indicates that Roaming Service is provided.

6.1 Simulcast System ID and Network ID

6.1.1 Simulcast System ID

The Simulcast System ID (hereinafter referred to as SSID) is used to identify the unit area for conducting simultaneous transmissions on a multiple number of Base stations along with a radio channel (herein after referred to as "the System" in Chapter 6).

The SSID is structured of two words. It has a different value on all of the Systems used nationally. The SSID is transmitted by using either Block Information Word 2, 3 or 4 and it is further divided into a 1st SSID word (SSID1; BIW000) and a 2nd SSID word (SSID2; BIW111).

As shown in Table 3.7.2-1, the word format type for the SSID1 (BIW000) is Block Information Word "000," and it includes Local channel ID [LID : 9 bits] and Coverage Zone [CZ : 5 bits]. The word format type for SSID2 (BIW111) is "111" and it includes the Country Code [CC: 10 bits] and Traffic Management Flag [TMF : 4 bits].

The SSID structure is shown in Table 6.1.1-1 below.

Table 6.1.1-1 : SSID structure

	Item		No. of bits	No of assign-ments	Description	Reference
SSID	SSID1 (BIW 000)	Local channel ID (LID)	9	512	Assigned so as not to be duplicated by multiple operators across all frequencies.	up to 16,384 Systems can be identified
		Coverage Zone (CZ)	5	32	32 Systems can be assigned per LID	
	SSID2 (BIW 111)	Country Code (CC)	10	1024	Indicates the ITU-T Country Code	440 (1B8HEX) for Japan
		Traffic Management Flag (TMF)	4	4	Enables making traffic uniform for a max. of 4 radio channels within the same unit area.	Identifies 4 channels for the same SSID1 and Country Code

6.1.1.1 SSID System Message transmission

Refer to Section 3.7.2 for SSID System Message transmission.

6.1.1.2 Traffic Management Flag

Four Traffic Management Flags, [T3,T2,T1,T0] are used by the SSID. One of the four (ranging from T3 ~ T0) is assigned to each address. The Traffic Management Flags are assigned to addresses (in cases of Long Addresses, first word of Long Addresses) in a manner in which the 2 LSB's become the flag numbers. For example, if the 2 LSB's for the address is "1 0", then the T2 flag is assigned. If a pager which supports Traffic Management Flag has multiple addresses, all addresses follow the same Traffic Management Flag bit. By use of Traffic Management Flag, the traffic for one System can be subdivided into 2,3 or 4 Systems.

Fig. 6.1.1.2-1 illustrates how the Traffic Management Flags are used. In a certain System

(System 1),when the Traffic Management Flags to be transmitted are set for [T3,T2,T1,T0] = [1,1,1,1], then all the pagers {①+②+③+④} which have a scan list containing the Local channel IDs, Coverage Zones and Country Codes identical to those used in the System can receive messages.

Next, cases when the traffic for System 1 is shared with System 2 are explained. System 1 for which the Traffic Management Flags are transmitted as [T3,T2,T1,T0]=[0,0,1,1] is allowed to page pagers of the pagers having the 2 LSB's of the address set for "00" or "01"{①+②}, from among the pagers which have a scan list containing the LID,CZ and CC identical to those used in the System. If the 2 LSB's of the address of pagers is set for "11" or "10", such pagers will be paged by another System (for example, System 2: F2 in the diagram) having identical LID,CZ and CC.

In addition, when traffic is subdivided into System 1,2,3 and 4, each System pages the pagers having the corresponding addresses for addresses ①,②,③ and ④.Based on the above explanation, it is obvious that each of the Traffic Management Flags T3 to T0 is set for "1" only once for the Systems into which traffic is divided. More precisely, in each of up to four Systems having an identical LID, CZ and CC, each of the Traffic Management Flags (T3, T2, T1, T0) must be set for "1" only once. With Systems 1 and 2 which transmit the identical LID, CZ, CC as shown in Fig. 6.1.1.2-1, for example, if Traffic Management Flag T0 is set for "1" in System 1, Traffic Management Flag T0 in System 2 must always be set for "0".

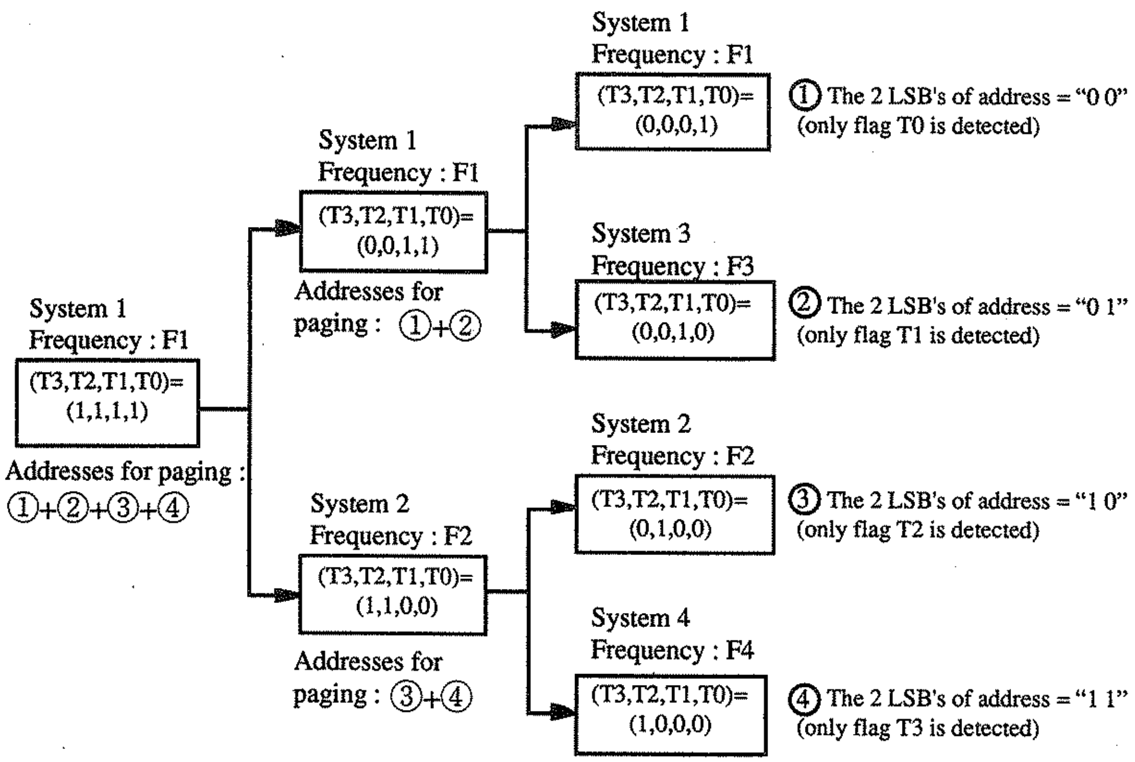


Fig. 6.1.1.2-1 : Example of system assignments based on Traffic Management Flags

6.1.1.3 Rules for SSID placement

In instances when the System supports Multi-area/Roaming, for Frames and phases which accord with the following rules, SSID1(BIW000) and SSID2(BIW111) must be placed in the any Block Information Word 2,3 or 4.

(1) In all Systems which support Multi-area/Roaming, all full Frames from Frames 0 through 3 must be transmitted. The shortening of Frames can not be allowed.

(2) In instances when the transmission speed is 6400bps, SSID1(BIW000) is placed in the order of phase “a” for Frame 0, phase “b” for Frame 1... phase “d” for Frame 3.

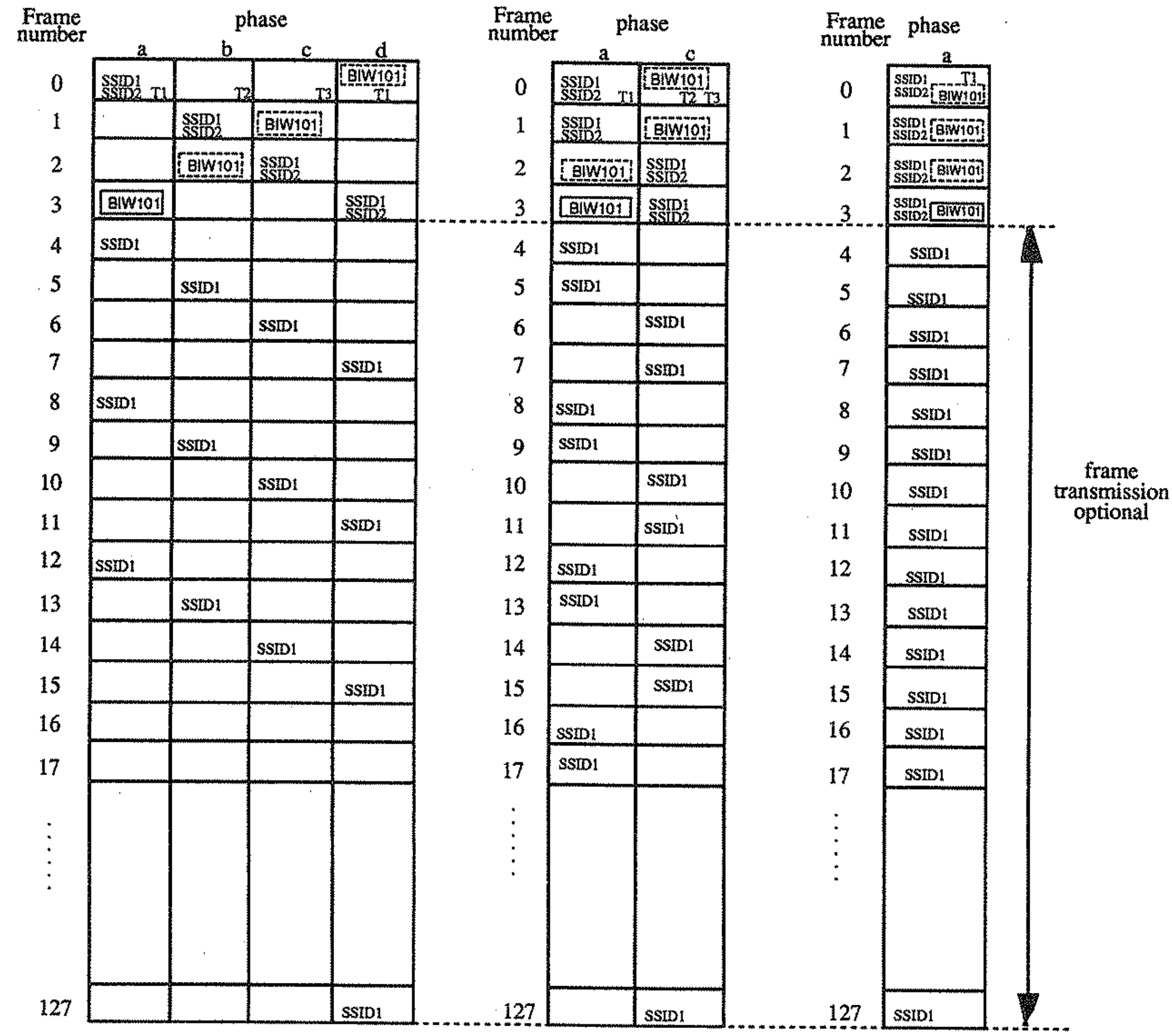
Transmission of Frames 4 through 127 is optional. In cases when the Frames are transmitted, SSID1(BIW000) is assigned in the order of phase “a” for Frame 4, phase “b” for Frame 5... phase “d” for Frame 127.

(3) In instances when the transmission speed is 6400bps, SSID2(BIW111) is assigned in the order of phase “a” for Frame 0, phase “b” for Frame 1, phase "c" for Frame 2, phase "d" for Frame 3.

(4) In instances when the transmission speed is 3200bps, phases “a” and “b” described in (2) and (3) above are assigned in phase "a" of the corresponding Frame, and phases “c” and “d” described in (2) and (3) above are assigned in phase "c" of the corresponding Frame.

Also, when the transmission speed is 1600bps, all of the phases described in (2) and (3) above are assigned to phase “a” of the corresponding Frames.

Fig. 6.1.1.3-1 below indicates the rules for SSID placement



(a) 6400bps (b) 3200bps (c) 1600bps

Note 1 : "T1, T2 and T3" in above indicate Block Information Word which relates to Time. The format type for Block Information Words is "001," "010" or "101." Also, in the case of 101: (A_3, A_2, A_1 and A_0) = either (0100 or 0101). In addition, in cases when the system supports transmission of Time information, all Time-related Block Information Words which are supported must be transmitted on Cycle 0, Frame 0 at minimum. (Refer to Section 3.7.2.)

Furthermore, in regards to phase placement for the respective phases, all supported Time-related Block Information Words (i.e. T_1, T_2 and T_3 in the figure) are placed on the same Cycle 0, Frame 0, and all Time related Block Information Words supported for the same phase must be placed in rotation at each hour. (In section (a) of the figure above, Phase a→T_1, Phase b→T_2, Phase c→T_3 and Phase d→T_1, for example, would be placed in the next Frame 0, Cycle 0 as Phase a→T_2, Phase b→T_3, Phase c→T_1 and Phase d→T_2; in section (b) of the figure above, Phase a→T_1, Phase c→T_2, T_3 would be placed in the next Frame 0, Cycle 0 as Phase a→T_2 and Phase c→T_3,T_1. In case of 1600bps if there is leeway in the number of placements for Block Information Words, more than two Time-related Block Information Words can be transmitted on Cycle 0, Frame 0.)

Note 2 : SSID1 and SSID2 in the above figure represents BIW000 and BIW111 respectively.

Note 3 : BIW101 in the above figure indicates that the word format type for the Block Information Word is "101" and (A3A2A1A0)=(0110). When Frame Offset is supported, BIW101 must be transmitted in Frame 3 at minimum. If it is possible to send the BIW101 in the Frame, it must be placed as indicated by the BIW101 (BIW101 encircled by dotted boxes) in the figure above.

Fig. 6.1.1.3-1 : SSID placement rules

6.1.2 Network ID

A Network ID (NID) is used in instances when a multiple number of Simulcast Systems are connected together to form one roaming network. In addition, when one radio frequency forms a part of multiple networks, several NIDs are transmitted by the System. In short, Roaming based on NID refers to a logical network. The NID is composed of Network Addresses and Short Message Vectors. As indicated in Table 3.9.2-1, the type of Short Message Vector is "0 0" and is composed of a 3-bit Network Address Multiplier, a 5-bit Service Area Identifier and a 4-bit Traffic Management Flag. Table 6.1.2-1 below shows the NID structure.

Table 6.1.2-1 : NID structure

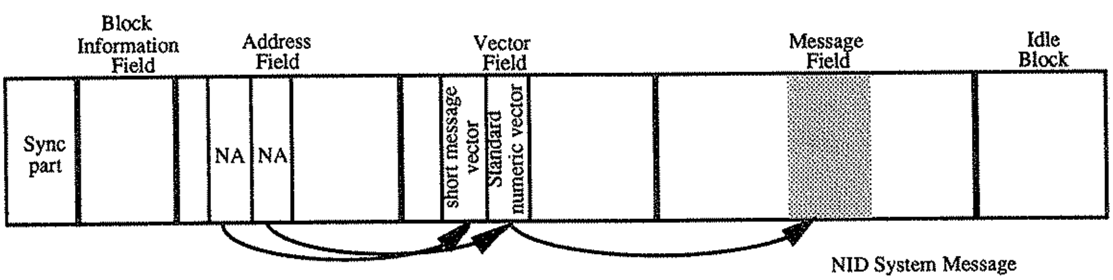
	Item		No. of bits	No. of assignments: Total number	No. of assignments: Hex	Description	Reference
NID	Network Address		21	4096	1F6800 1F77FF		Within the same area, the NID differs with each frequency.
	Short Message Vector	Multiplier	3	8		Extends the Network Address	
		Service Area Identifier	5	32		Used to Identify the Service Areas	
		Traffic Management Flag	4	4		Enables making traffic uniform for a max. of 4 RF channels within the same unit area.	Identifies 4 channels for the same Network Address, Multiplier and Service Area Identification

6.1.2.1 Transmission of the NID System Message

The NID System Message is transmitted in either a Numeric Message, Alphanumeric Message or HEX/Binary Message; however, transmission of the NID System Message is optional.

An NID and an identical Network Address which indicates related NID System Message are placed consecutively in the same Frame and the same phase and appear twice in the Address Field.

Fig. 6.1.2.1-1 below is an example of how the NID System Message is transmitted.



Note NA : Network Address

Fig. 6.1.2.1-1 : NID System Message transmission example (in case of single transmission)

6.1.2.2 NID Change Instruction

This pertains to transmission of the System Change Instruction related to NID using Network Addresses in the same manner as for the NID System Message transmission method described in Section 6.1.2.1. However, that transmission of this Change Instruction is optional. When a pager receives the NID Change Instruction, the pager adds this information to the scan list.

The transmission timing for Systems which support the transmission of this Change Instruction is Frames 0 through 7, using the two Cycles before and after the system has changed and the Cycle in which the change took place (i.e., a total of 5 Cycles). In addition, the phase shall be the phase used to NID transmission. (After the change has taken place, it is desirable that this Instruction is sent once an hour to allow all pagers to recognize the change.)

6.1.2.3 Traffic Management Flag

As shown in Table 3.9.2-1, four Traffic Management Flags on NID are used (F3,F2,F1,F0). One of the four Traffic Management Flags (ranging from F3 ~ F0) is assigned to each address. Assignment of Traffic Management Flags for the NID is performed in the same manner as described in Section 6.1.1.2; with the exception that assignment of the flags are performed on 4 NID Systems structured with identical Network Addresses, Multipliers and Service Area Identifiers.

6.1.2.4 Rules for NID placement

In instances where the System supports Multi-area/Roaming using NIDs, an NID must be assigned to the address field and vector field for Frames and phases which accord with the rules below.

(1) When the Frame number for the transmitted NID is F :

1) M = Modulo 8 of integer part of (radio frequency (kHz)/channel spacing (kHz))

For example, when the radio frequency is 280.0375MHz and channel spacing is 25kHz, then, M = 1,

and, whereas,

2) N= Modulo 8 of Network Address (=3 LSB's), and

3) C= Cycle number (0 ~ 14),

then,

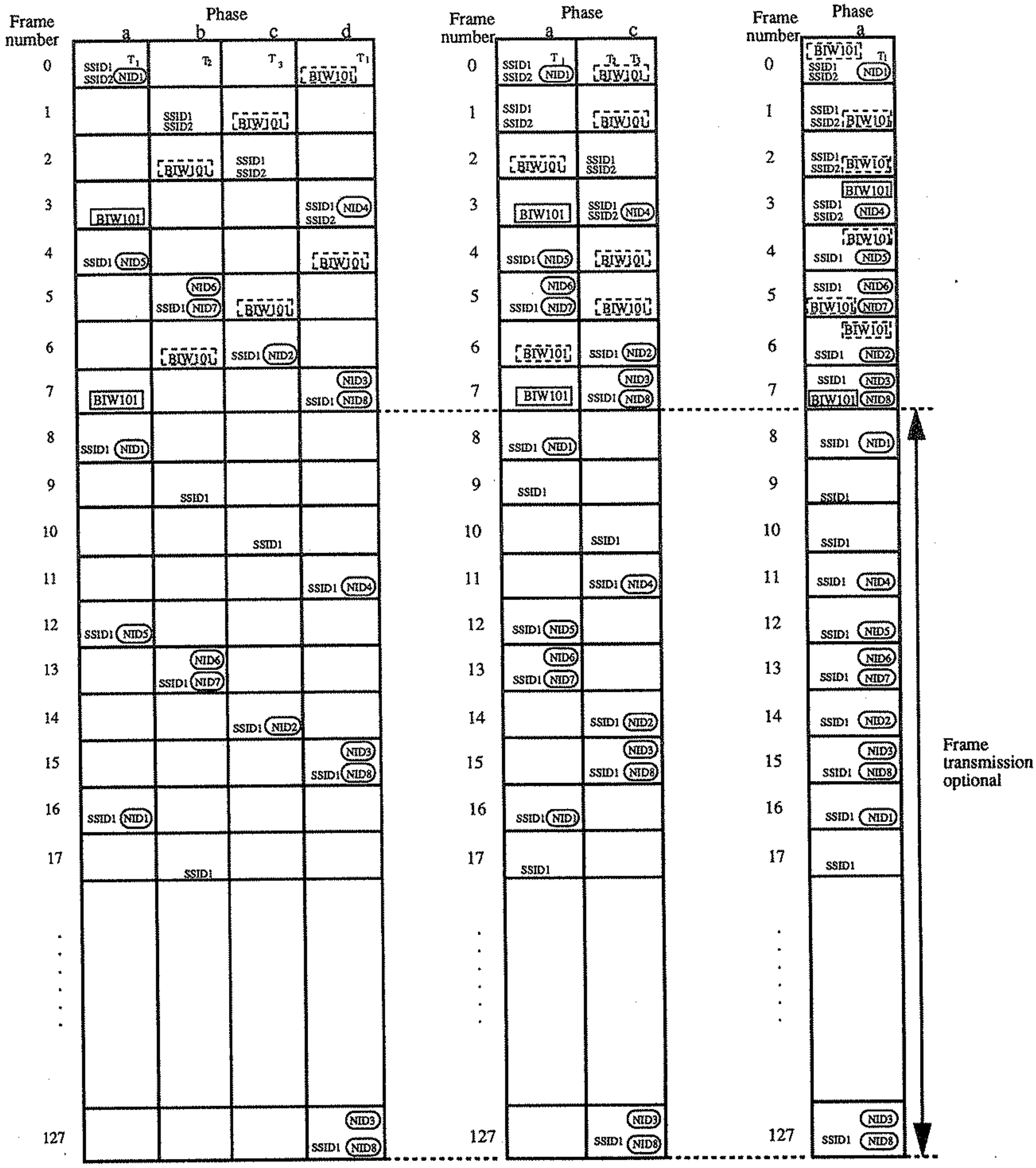
4) F= Module 8 of (M+N+C) is obtained.

(2) Also, within one System, the Frames running from Frames 0 through 7 must be transmitted. The shortening of Frames can not be allowed.

Transmission of Frames 8 through 127 is optional. In cases when the Frames are transmitted, however, the NID must be transmitted in Frames having Frame numbers equivalent those obtained by the module 8 of Frame numbers in (1) above.

(3) Placement of the phases occurring in the Frame number in (1) above is the same as that used for SSID placement.
(Carry On does not apply to NID placement.)

Fig. 6.1.2.4-1 below gives the rules for NID placement.



(a) 6400bps (b) 3200 bps (c) 1600bps

Note 1 :"T1, T2 and T3" in above indicate Block Information Word which relates to Time. The format type for Block Information Words is "001," "010" or "101." Also, in the case of 101: (A3, A2, A1 and A0) = either (0100 or 0101). In addition, in cases when the System supports transmission of Time information, all Time-related Block Information Words which are supported must be transmitted on Cycle 0, Frame 0 at minimum. (Refer to Section 3.7.2; also for placement of the respective phases, refer to Fig. 6.1.1.3-1, note 1.)

Note 2 : NID1 ~ NID 8 indicate that multiple NID exist in one System.

Note 3 : SSID1 and SSID2 in the above represents BIW000 and BIW111 respectively.

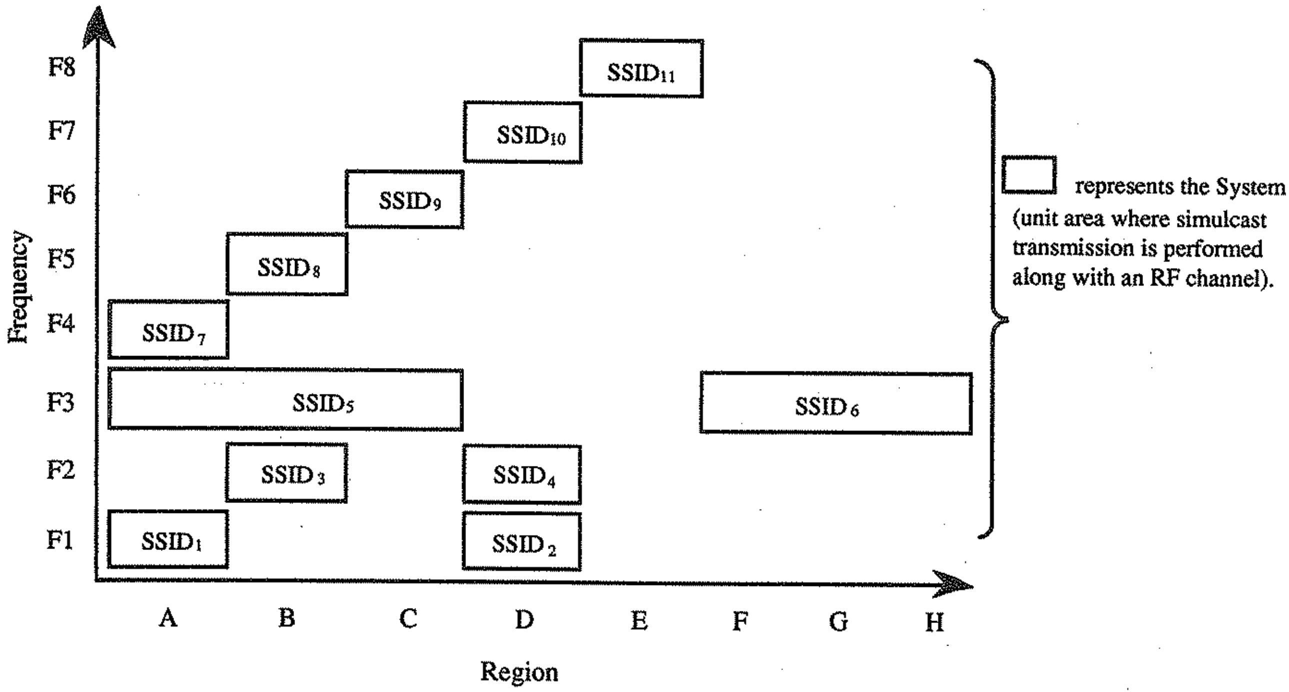
Note 4: BIW101 in the above figure indicates that the word format type for the Block Information Word is "101" and (A3A2A1A0)=(0110). When Frame Offset is supported, BIW101 must be transmitted in Frame 3 and Frame 7 at minimum. If it is possible to send the BIW101 in the Frame, it must be placed as indicated by the BIW101 (BIW101 encircled by dotted boxes) in the figure above.

Fig. 6.1.2.4-1 : Rules for NID placement

6.2 Application examples

6.2.1 Example of application of SSID

SSID is given different values for each System (unit area where simulcast transmission is performed along with a RF channel). Fig. 6.2.1-1 below is an example of how different SSID are assigned for each frequency in Region A. Also, note that different SSIDs are assigned for Region A and Region D which use the same F1 frequency.



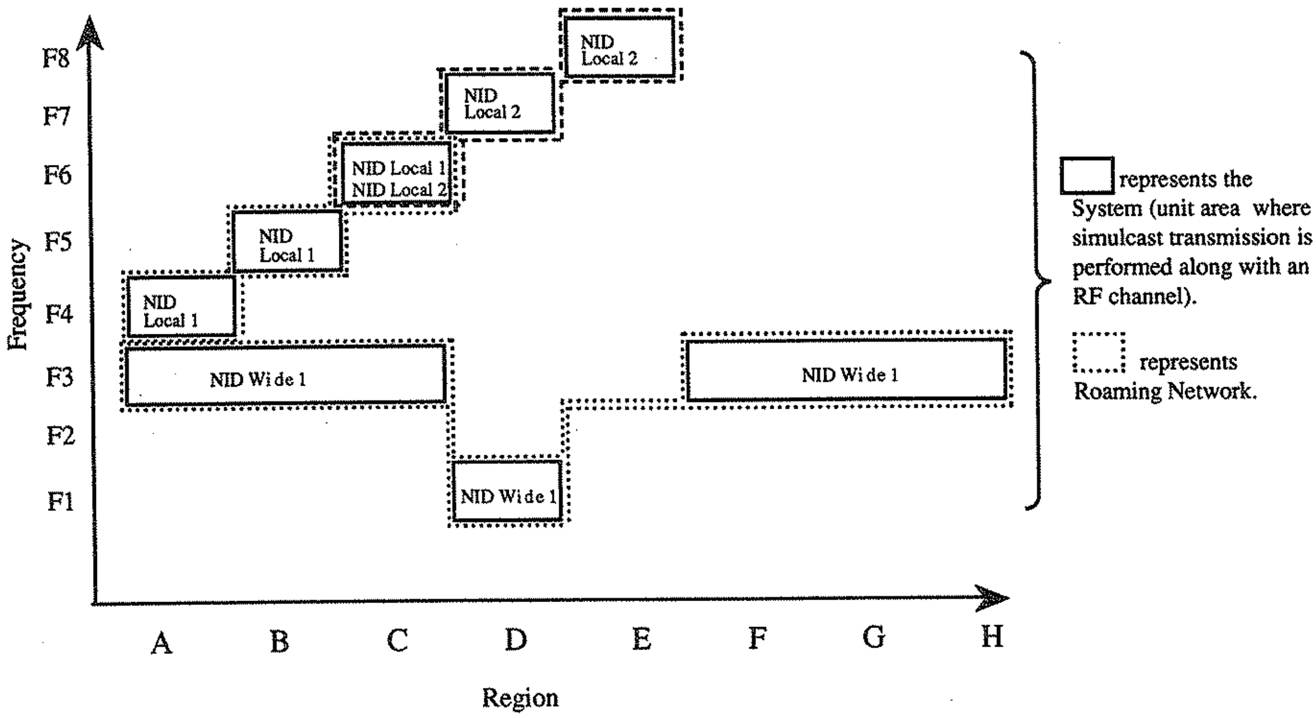
Note : $SSID_1 \sim SSID_{11}$ are composed of SSID1 (BIW000) and SSID2(BIW111) (refer to Section 6.1.1).

Fig. 6.2.1-1 : Example of SSID application

6.2.2 Example of application of NID

As shown in Fig. 6.2.2-1 below, in multiple Systems, by transmitting the same NID , it is possible to create a wider network covers a wider area in logical form.

A Roaming Network which covers Regions A, B and C is formed by NID Local 1. A roaming network which covers Regions C, D and E is formed by NID Local 2; also Region A,B,C,D,F,G and H are covered by NID Wide 1.



Note : NID Local 1, NID Local 2 and NID Wide 1 are composed of the Network Address and Short Message Vector. (Refer to Section 6.1.2)

Fig. 6.2.2-1 : Example of NID application

6.3 Scan list

Each pager has a scan list which lists various combinations of frequencies, SSIDs, NIDs, addresses, overlap or non-overlap.

Note : Inclusion of overlapping/non-overlapping areas on the scan list is optional.

Examples of Scan list are given below based on the application example in Section 6.2.

6.3.1 When Multi-area/Roaming is performed by SSID

When Multi-area/Roaming is performed for the areas shown in Fig. 6.2.1-1 and Region A (which uses frequency F1) represents the Home area, Multi-area/Roaming is performed for Region B (frequency F2), Region C (frequency F6), Region D (frequency F2), and wide region areas F, G and H (frequency F3). In this instance, the pager scan list appears as in the example shown in Table 6.3.1-1 below.

Note that although addresses have been omitted in the table, various Multi-area/Roaming combinations can be thought of for addresses.

Table 6.3.1-1 : Example scan list

No.	Frequency	Valid SSID	Valid NID	Overlap (Yes/No) *2
1	F1	$SSID_L$ *1 ($SSID_1$)	-	YES
2	F2	$SSID_3$, $SSID_4$	-	YES
3	F3	$SSID_6$	-	NO
4	F6	$SSID_9$	-	YES

Note : $SSID_1$, $SSID_3$, $SSID_4$, $SSID_6$ and $SSID_9$ are composed of SSID1(BIW000) and SSID2(BIW111) (refer to Section 6.1.1).

*1) $SSID_L$: indicates the Home area SSID.

*2) Overlap/non-overlap :

This indicates whether the areas shown on the scan list overlap with other areas shown on the scan list. How the areas shown in Table 6.3.1-1 overlap or not is shown in Fig. 6.3.1-1 below.

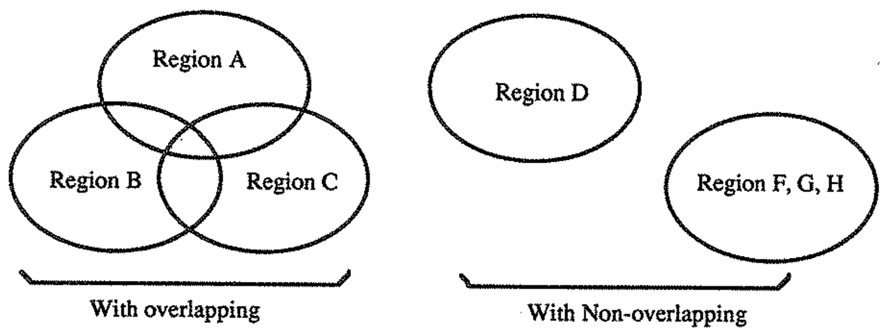


Fig. 6.3.1-1 : Examples of overlap/non-overlap areas

6.3.2 Combining Multi-area/Roaming with NID

The pager scan list appears as in the examples given in Tables 6.3.2-1 and 6.3.2-2 below, wherein Region A (which uses frequency F1) is the Home area and Multi-area/Roaming is performed using NID in Regions C, D and E.

Also note that although addresses have been omitted in the respective tables, various Multi-area/Roaming combinations can be thought of for addresses.

Table 6.3.2-1 : Scan list joining NID with SSID [Example 1]

No.	Frequency	Valid SSID	Valid NID	Overlap (Yes/No)
1	F1	$SSID_L$ ($SSID_1$)	-	YES
2	F6	-	NID Local 2	YES
3	F7	-	NID Local 2	NO
4	F8	-	NID Local 2	NO

Note : NID Local 2 is structured of the Network Address and the Short Message Vector (refer to Section 6.1.2).

Table 6.3.2-2 : Scan list joining NID with SSID [Example 2]

No.	Frequency	Valid SSID	Valid NID	Overlap (Yes/No)
1	F1	$SSID_L$ ($SSID_1$)	-	YES
2	Min. frequency Max frequency	-	NID Local 2	YES

Note that Multi-area/Roaming using SSID as described in Section 6.3.1 is also possible when using NID combinations as described in this section.

6.4 Procedures

The frequencies for use by pagers are set according to the scan list shown in Section 6.3. When a match up of the SSID or NID are detected, reception on the pertinent system starts.

Fig. 6.4-1 below outlines the example of the basic pager scanning procedure.

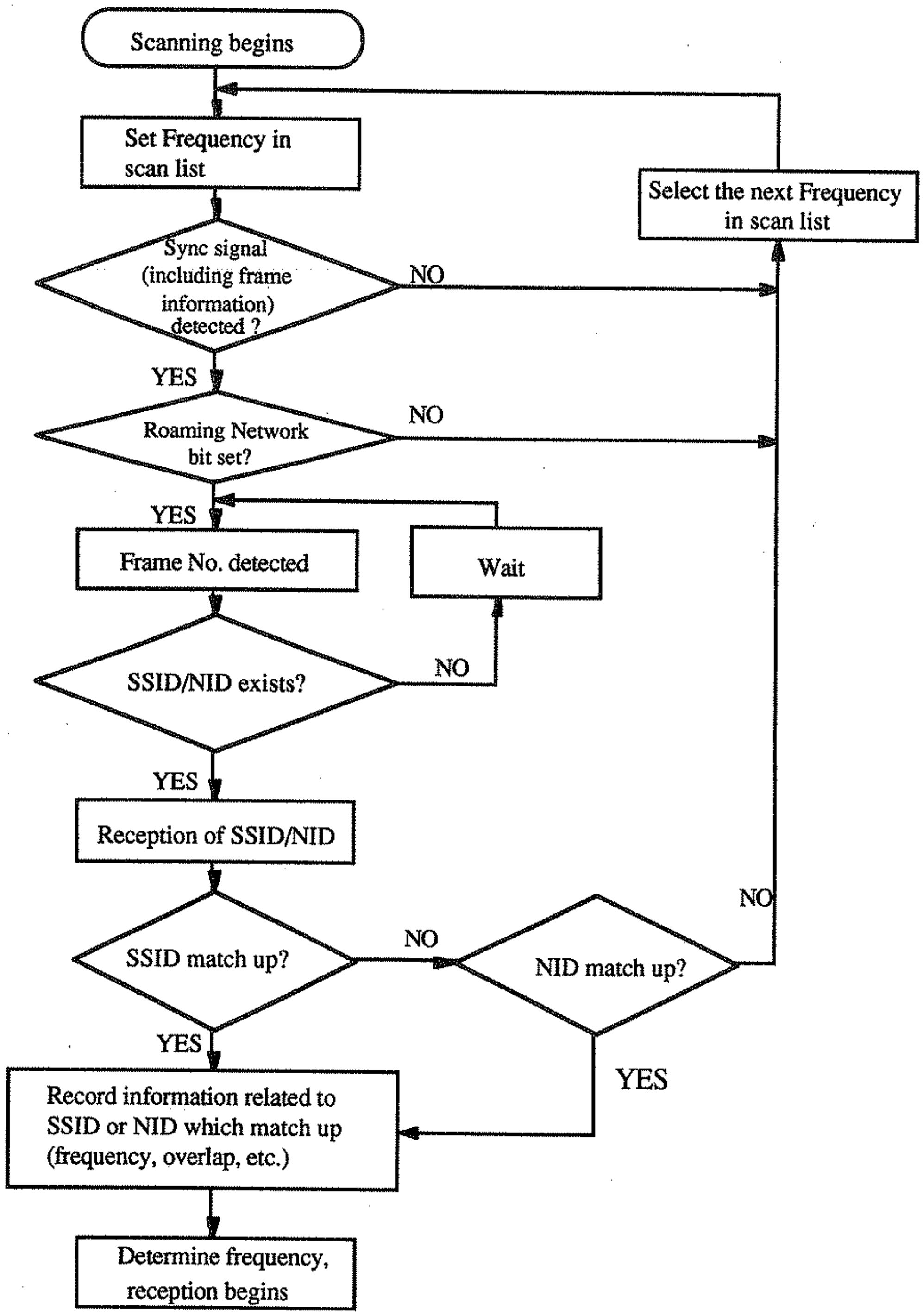


Fig. 6.4-1 : Example of pager scanning procedure

6.5 Requirements for equipment used in Multi-area/Roaming

The infrastructure facilities used to provide Multi-area/Roaming services shall be adjusted so that the Frame Timing deviation tolerance is within ± 1 ms based on the GPS (Global Positioning System) Time.

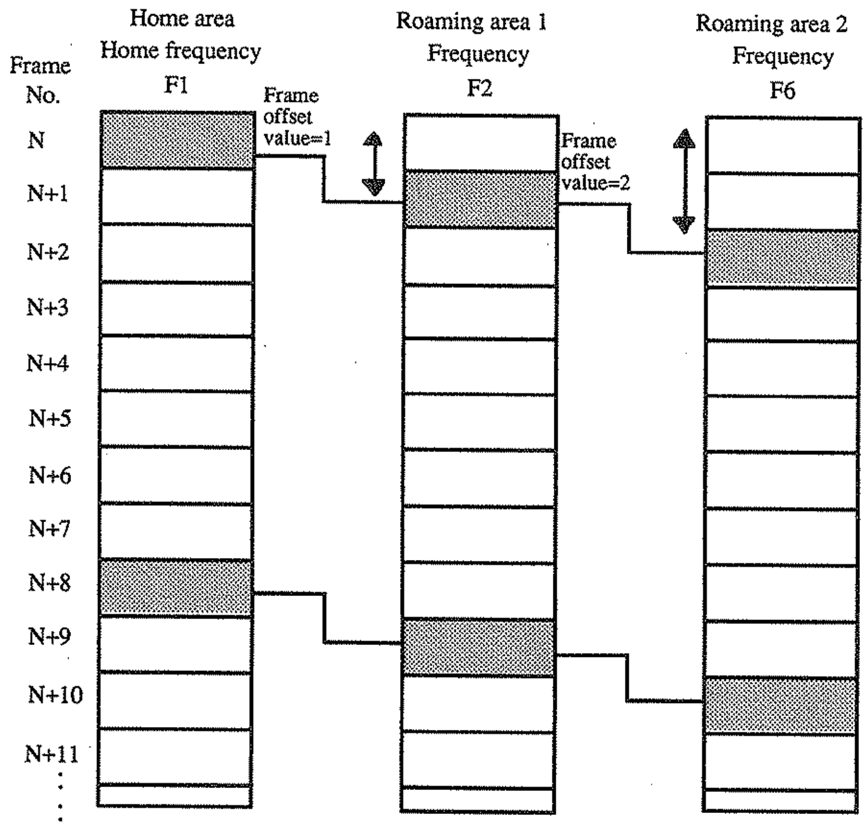
6.6 Application Example of Frame Offset

By using BIW101 ($A_3A_2A_1A_0$)=(0110), Frames to be monitered can be indicated by the offset value from the standard Frames based on the Collapse cycle. When Frames are offset, the Collapse cycle starts using the Frames which were added corresponding to the value of Frames Offset as standard.

Fig. 6.6-1 below is an example of transmission using Frame Offset.

The Frame Offset value is determined between Service Providers or Systems. When a System supports Frame Offset, messages must be transmitted based on the Frame Offset value and the maximum Carry On by BIW101 (A3A2A1A0) = (0110). Refer to Section 3.7.2.

When a System supports Frame Offset, System Messages related to the Operator Messaging Addresses, BIW101 and the Network Address (including Short Message Vectors for NID) cannot be transmitted in blocks 9 and 10 (Note, however, this does not apply in certain unavoidable cases, such as transmission of the 2nd, 3rd and 4th Subframes during multiple transmission).



Note 1 : In this example, 8 is used as the Collapse cycle.
Note 2 : The shaded parts in the example indicate the Frames to be monitered.

Fig. 6.6-1 : Transmission example using Frame Offset

6.7 Registration Acknowledgment Message (Option)

The Registration Acknowledgment Message is an optional function. When the paging area is changed based on the request of subscribers, the infrastructure facilities can notify the pager using this message that the area registration has been performed.

Transmission of the Registration Acknowledgment Messages is performed using Secure Messages.

Chapter 7 Mixing of Signaling with Existing Paging Systems

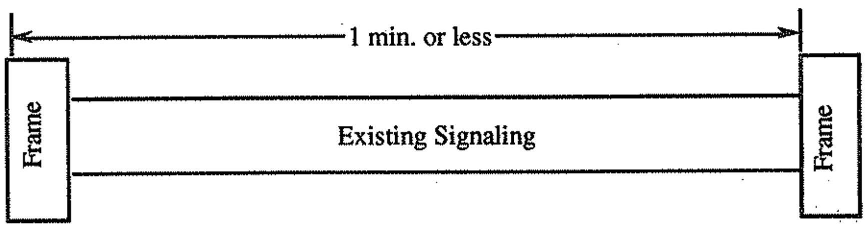
7.1 Common characteristics

When Mixing is performed with the POCSAG Radio Paging System (RCR STD-42, hereinafter referred to as the Existing Signaling), the rules in regard to the transmission of a Frame are applied, too.(Refer to Section 3.1.1)

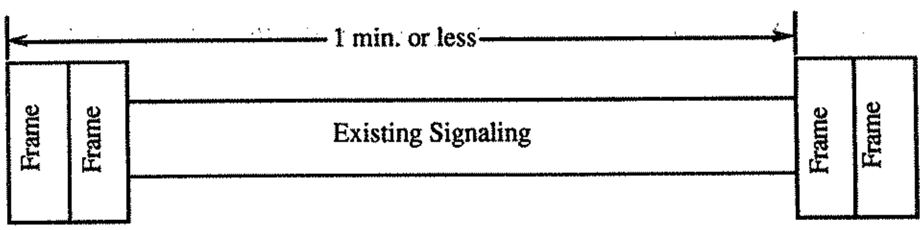
And in this case, if the Idle Frame transmission was not proper, channel filling pattern (1,0,1,0.... pattern of 2-level 1600bps) could be transmitted. For example, it starts at the end of the Existing Signaling and continues until the beginning of next Frame.

7.1.1 Mixing example when multiple transmission is not performed

When Mixing is performed with the Existing Signaling, in order to provide the most recent synchronization for the pagers, a minimum number of Frames can be transmitted once every minute or once every 4 minutes in case of shared channel (i.e., 2 Frames when the system Collapse value = 1, 4 Frames when system Collapse value = 2, etc.).



System Collapse value is set to 0 (Pager decodes all Frame)



System Collapse value is set to 1 (Pager decodes on every 2nd Frames)

Fig. 7.1.1-1 : Example of Mixing for Existing Signaling (In cases, 1 min. or less)

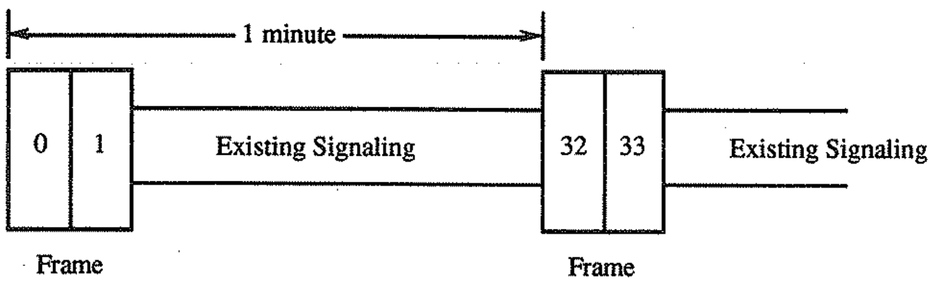
7.1.2 Mixing example when multiple transmission is used

When Mixing is performed with the Existing Signaling for multiple transmission, rules on Frame structure must accord with Section 3.4.2 and the System Collapse value must be set in accordance with the Frame transmission interval.

In addition, during Mixing, pagers which correspond to Frames that are not transmitted must not be assigned.

Also note that even when multiple transmission is not used, the method described above can still be used.

Frame transmission interval is 30 sec.	:	System Collapse value = 4
Frame transmission interval is 1 min.	:	System Collapse value = 5
Frame transmission interval is 4 min.	:	System Collapse value = 7



Example :

Frame transmission interval	=	1 minute
No. of Frames transmitted	=	2 Frames
System Collapse value	=	5

Also, Frames 2 ~ 31, 34 ~ 63, 66~ 95, 98 ~ 127 cannot be allocated.

Fig. 7.1.2-1 : Example of Mixing for multiple transmission

7.2 Mixing example with POCSAG signaling

7.2.1 Mixing example with 512bps POCSAG signaling

In order to activate the 512bps POCSAG signaling, a 750bps 1, 0 pattern must proceed the 576-bit preamble signal by at least 400 ms. Next, following the preamble signal, the batches which occupy the required number of POCSAG signaling are sent.

Fig. 7.2.1-1 below is an example of Mixing with the 512bps POCSAG signal.

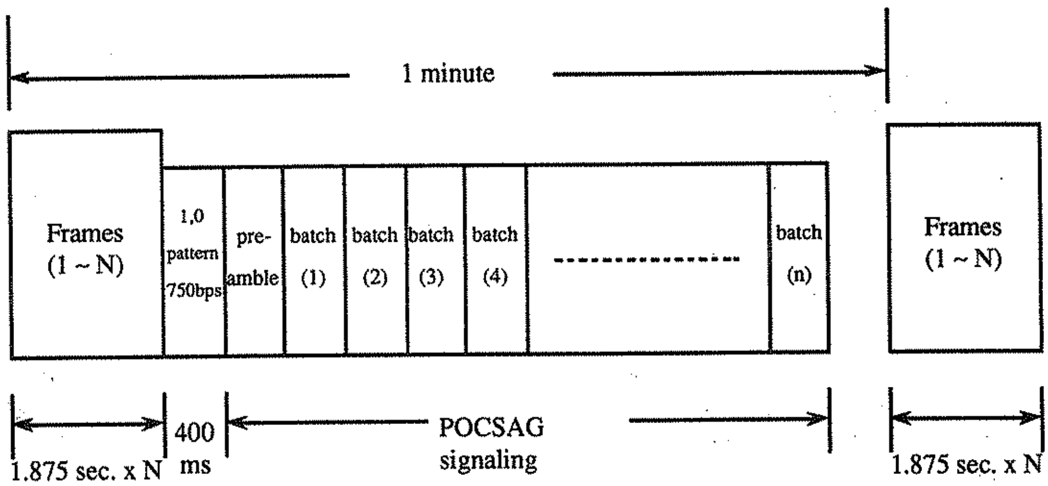


Fig. 7.2.1-1 : Example of Mixing with the 512bps POCSAG signaling

Example of Mixing, for transmissions at one Frame per minute, the following is obtained (in this case, the maximum values have been calculated without considering delay on signaling switching on the transmitter side) :

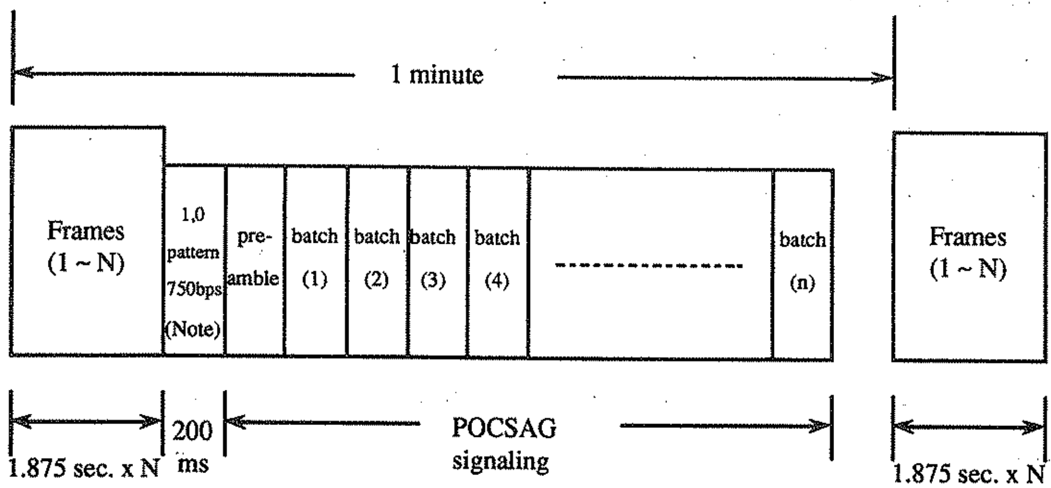
POCSAG	57.5 sec.	= 2 preambles (1.125 sec.) + 52 batches (1.0625 sec.)
1 Frame	1.875 sec.	
Total	59.375 sec.	

7.2.2 Mixing example with 1200bps POCSAG signaling

In order to activate the 1200bps POCSAG signaling, a 750bps (Refer to Note below) 1, 0 pattern must proceed the 576-bit preamble signal by at least 200 ms. Next, following the preamble signal, the batches which occupy the required number of POCSAG signaling are sent.

Fig. 7.2.2-1 below is an example of Mixing with the 1200bps POCSAG signaling.

Note : There are cases when 1500bps is used, depending on the country or region.



Note : There are cases when 1500bps is used, depending on the country or region.

Fig. 7.2.2-1 : Example of Mixing with 1200bps POCSAG signaling

Example of Mixing, for transmissions at one Frame per minute, the following is obtained (in this case, the maximum values have been calculated without considering delay on signaling switching on the transmitter side) :

POCSAG	55.84 sec.	= 3 preambles (0.48 sec.) + 120 batches (0.4533 sec.)
1 Frame	1.875 sec.	
Total	57.715 sec.	

7.3 Multi-area/Roaming while Mixing

Refer to Chapter 6 "Multi-area/Roaming" for Frame placement rules.

Chapter 8 Supplementary Services

This chapter lays down the regulations governing the supplementary services provided through this system.

8.1 Priority Call service

(1) Overview

A Priority Call service is the service which gives certain pagers priority over other pages.

(2) Method of providing the service

a. The Address designated for a Priority Call is positioned at the top of the Address Field to give it priority over other pages, and then is transmitted (refer to Section 3.8.1 (6)).

b. Block Information Word 1 indicates the number of words constituting a Priority Address in the Address Field (refer to Section 3.7.1) .

8.2 Group Call service

(1) Overview

With Group Call service, pagers are classified into groups and a common message is transmitted to the pagers within the pertinent groups. This service enables the Subscriber Information service (Refer to Section 8.9) to be provided.

(2) Method of providing the service

Refer to Chapter 5 "Group messages."

8.3 Multi-area/Roaming service

(1) Overview

On the user end, Multi-area/Roaming service enables pagers which have roamed into areas outside of their Home area to receive paging messages through registering the areas.

(2) Method of providing the service

Refer to Chapter 6 "Multi-area/Roaming."

8.4 Message Numbering service

(1) Overview

A Message Numbering Service is the service which adds message numbers to pages from the Infrastructure facility for each address separately.

(2) Method of providing the service

(a) The types of messages for the Message Numbering Service are Short Message

Vector (V(010) and t(10)) (refer to Section 3.9.2),Numbered Numeric Message (refer to Section 3.10.1.1),HEX/Binary Message (refer to Section 3.10.1.2) and Alphanumeric Message (refer to Section 3.10.1.3).

(b) Regarding the method to provide the Message Numbering Service, refer to the Message Number (N) for the messages types above.

(c) The Message Numbering service can not be provided for Secure Messages.

8.5 Source Indication service

(1) Overview

A Source Indication service is the service which transmits 8 types of Short Messages for identifying the Calling party.

(2) Method of providing the service

Information of the Source Indication service is transmitted by a Short Message Vector (refer to Section 3.9.2).

8.6 Special Format service

(1) Overview

A Special Format service is the service which converts the transmitted Numeric Message into the format specified in the ID-ROM of the pager.

(2) Method of providing the service

a. The information is sent by the Special Format Numeric Message (Section 3.10.1.1.1) which is designated by the Special Format Numeric Vector (Section 3.9.1).

b. On the pager side, for example, spaces, dashes, etc., are inserted into received message as specified by the ID-ROM of the pager.

8.7 Short Message service

(1) Overview

A Short Message service is the service which transmits Short Numeric Messages of 3-digits (for Short Addresses) or 8-digits (for Long Addresses).

(2) Method of providing the service

The information for Short Numeric Messages is transmitted by the Short Message Vector (refer to Section 3.9.2).

8.8 Real-time clock maintenance service

(1) Overview

A Real-time clock maintenance service is the service which adjustes the time of the clock for the pager according to the Time information sent from the Infrastructure facilities.

(2) Method of providing the service

Refer to Section 3.7.2 .

8.9 Subscriber Information service

(1) Overview

A Subscriber Information service is the service which allows the pager to receive various information messages.

(2) Method of providing the service

Refer to Chapter 5 “Group messages” for sending information messages to pagers within a certain group.

Chapter 9 Compatibility with Other Protocol

Excluding the country specific portions of the respective specifications, the FLEX-TD Radio Paging System specification defined by this Standard is compatible from a protocol standpoint with "FLEX™ Protocol Specification and FLEX™ Encoding and Decoding Requirements".

FLEX™ Protocol has been confirmed by PCIA* as meeting all technical and operational requirements for high speed paging codes. "FLEX™ Protocol Specification and FLEX™ Encoding and Decoding Requirements" are attached as the Reference Document.

* The PCIA (Personal Communications Industry Association) is the U.S. Association of Service Providers which is the recognized standardization body for paging-related standards and protocols in the U.S. market.

Chapter 10 Measurement Methods

This chapter describes the methods used for measuring the receiver characteristics of pagers. The measurement methods described here shall comply with IEC489-6. The number of transmission specified in each of the following sections accords with the definition given in Sections 3.4.2 and 3.6.

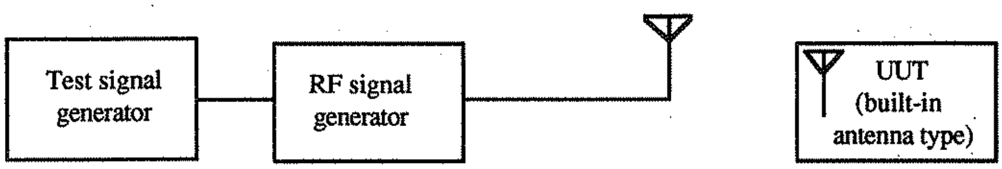
Also, in instances when the signaling speed is 3200 bps or 6400bps, in phases (except those being subject to measurement) the paging signal is transmitted at the same timing as the SCTS. The addresses for such paging signals are chosen so as to have an equal number of information bits 1 and 0 (for example, as with a repeated 1,0-bit pattern). Also, the numeric code for such messages shall be continuous 5's as shown in Table 3.10.2.1-1.

10.1 Built-in antenna type pager

10.1.1 Receiver sensitivity

10.1.1.1 Reference sensitivity (test site measurement)

(1) Measuring system diagram



(2) Test equipments Conditions

a. Generate NRZ signals which comply with the specified signaling format using the test signal generator and transmit addresses, vectors, messages (standard coded test signal hereinafter referred to as "SCTS") of the unit under test. Note that transmission at this point must be single transmission. An SCTS message field must be structured of 2 words. In the case of Tone-Only pagers, no messages are transmitted. (In the case of Tone-Only pagers utilizing the Tone-Only Address, neither vectors or messages are transmitted.)

b. The output signal from the RF signal generator must meet the base station transmitter requirements specified in Section 2.1.

c. For measurements of the built-in antenna type pager. Open site or a RF anechoic chamber must be used.

   The open site must comply with IEC 489-6 Appendix E. Note, however, measurements must be performed at an antenna height which is not affected by the height pattern.

   The anechoic chamber shall be a 6-sided anechoic chamber. However, when 5-sided anechoic chamber is used, measurements must be performed at an antenna height which is not affected by the height pattern.

d. Reference sensitivity for On-Body type pagers must be front sensitivity and the "Salty" which complies with IEC 489-6 Appendix H must be used as simulated man test device.

e. Reference sensitivity for other types of pagers must be set at maximum directivity under the normal usage conditions.

(3) Conditions for the UUT (Unit Under Test)

Set a pager under test to a test frequency.

(4) Test procedure

a. Set the center frequency of the RF signal generator to the test frequency.

b. Set the electric field strength to a value where the page success rate decreases to approx. 50%.

c. Increase electric field strength with 2-dB steps until SCTS can be decoded three times consecutively.

Record the electric field strength value when the SCTS was decoded three times consecutively for the first time.

d. Next, decrease the electric field strength by 1dB, then record this value.

e. Transmit the SCTS repeatedly and if any of the 1st, 2nd or 3rd SCTS could not be decoded, increase the electric field strength by 1dB and record this value.

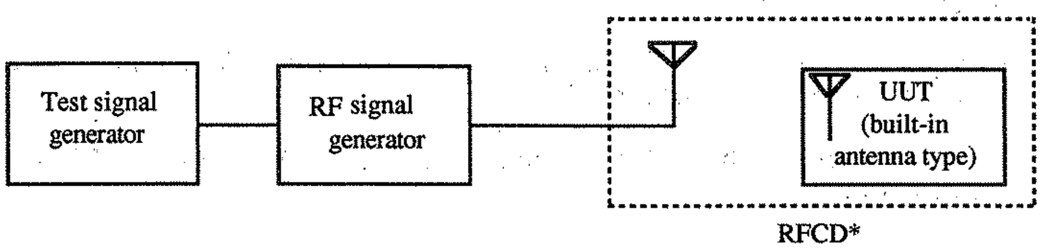
When all of the 1st, 2nd and 3rd SCTS can be decoded, decrease the electric field strength by 1dB, then record this value.

Repeat the procedure in step e) above until the no. of recorded values reaches 20.

f. The average value of all the recorded values is the reference sensitivity.

10.1.1.2 Reference sensitivity (Radio Frequency Coupling Device Measurement)

(1) Measuring system diagram



* RFCD : Radio Frequency Coupling Device

(2) Test equipments Condition

a. Generate NRZ signals which comply with the signaling format from the test signal generator and transmit the SCTS to the UUT. Transmissions at this point is single transmission. The SCTS message field must be structured of 2 words. However, In case of Tone-Only pagers, no messages are transmitted. (In case of Tone-Only pagers utilizing the Tone-Only Address, neither vectors or messages are transmitted.)

b. The output signal from the RF signal generator must meet the base station transmitter requirements specified in Section 2.1.

c. Correlate the RFCD at the frequency to be measured using the pager (the same type as the UUT) which was used for measuring reference sensitivity in Section 10.1.1.1.

(3) Conditions for the UUT

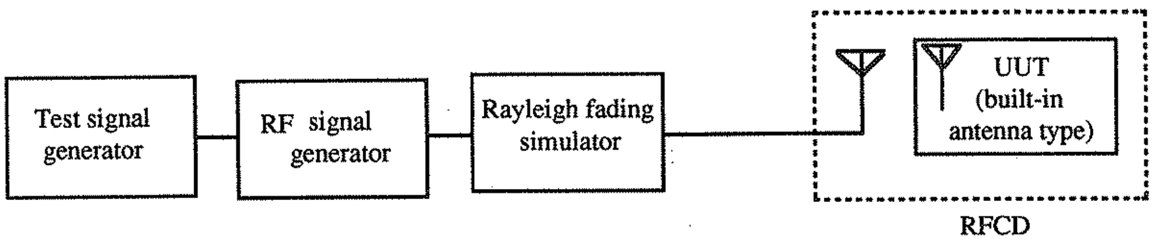
Set a pager under test to a test frequency.

(4) Test procedure

The measuring procedure must accord with Section 10.1.1.1 (4).

10.1.1.3 Sensitivity under fading condition

(1) Measuring system diagram



(2) Test equipments conditions

a. Transmit the SCTS from the test signal generator. The number of transmission must be two. The SCTS message field must be structured of 2 words. However, In case of Tone-Only pagers, no messages are transmitted. (In case of Tone-Only pagers utilizing the Tone-Only Address, neither vectors or messages are transmitted.)

b. The output signal from the RF signal generator must meet the base station transmitter requirements specified in Section 2.1.

c. Use a fading simulator which complies with IEC Pub. 489-6 Appendix C with Rayleigh fading of a maximum Doppler frequency of 1 Hz.

d. For the measurement environment, use the RFCD which is correlated by using the pager used for measurement for reference sensitivity in Section 10.1.1.1.

(3) Conditions for UUT

Set a pager under test to a test frequency.

(4) Test procedure

a. Set the center frequency of the RF signal generator to the test frequency.

b. Set the electric field strength to a value where the page success rate decreases to approx. 50%.

c. Increase the electric field strength with 2-dB steps until SCTS can be decoded three times consecutively for the first time.

d. Record the electric field strength when the SCTS can be decoded 3 times consecutively.

e. Next, decrease the electric field strength by 1dB and record this value.

f. Transmit the SCTS repeatedly and if any of the 1st, 2nd or 3rd SCTS could not be decoded, increase the electric field strength by 1dB and record this value.

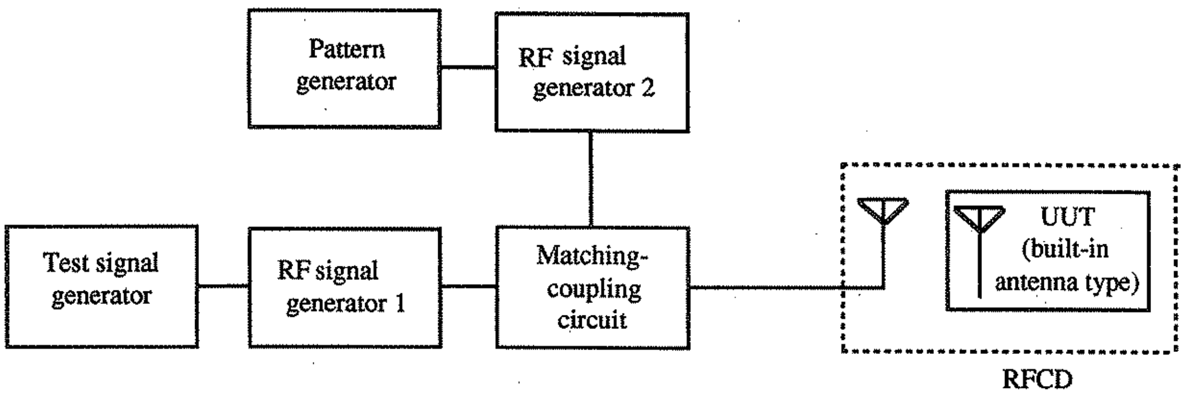
When all of the 1st, 2nd and 3rd SCTS can be decoded, decrease the electric field strength by 1dB, then record this value.

Repeat the procedure in step f) above until the no. of recorded values reaches 40.

g. The average value of all the recorded values is the sensitivity under fading condition.

10.1.2 Adjacent channel selectivity

(1) Measuring system diagram



(2) Test equipments conditions

a. Transmit SCTS from the test signal generator. Transmission at this point is single transmission. The SCTS message field must be structured of 2 words. However, In case of Tone-Only pagers, no messages are transmitted. (In case of Tone-Only pagers utilizing the Tone-Only Address, neither vectors or messages are transmitted.)

b. Transmit a binary pseudo noise series signal (ITU-T O.151) having a coding length of 32,767 bits continuously from the pattern generator.

c. The output signals from the RF signal generators 1 and 2 must meet the base station transmitter requirements specified in Section 2.1.

RF signal generator 2 is modulated at 3200 bps/2FSK.

d. As measurement environment use the RFCD correlated by the pager which was used for measuring reference sensitivity in Section 10.1.1.1 .

(3) Conditions for UUT

Set a pager under test to a test Frequency.

(4) Test procedure

a. Set the center frequency of RF signal generator 1 to the test frequency (fw).

b. Measure and record reference sensitivity without interference signal from RF signal generator 2.

c. Set the signal level of signal generator 1 to (reference sensitivity + 3dB).

d. Set the center frequency of RF signal generator 2 to the specified frequency. (set the center frequency to fw+25kHz or fw-25kHz respectively and perform steps e) thru g) below.)

e. Set the signal level of RF signal generator 2 to a value where the page success rate decreases approx. 50%.

f. Transmit SCTS repeatedly and decrease the signal level of RF generator 2 with 2-dB steps until SCTS can be decoded three times consecutively.

Record the signal level when the SCTS is decoded three times consecutively for the first time.

Next, increase the signal level of RF signal generator 2 by 1dB and record the signal level at this point.

g. Transmit the SCTS repeatedly and if any of the 1st, 2nd or 3rd SCTS could not be decoded, decrease the signal level for RF signal generator 2 by 1dB and record this value.

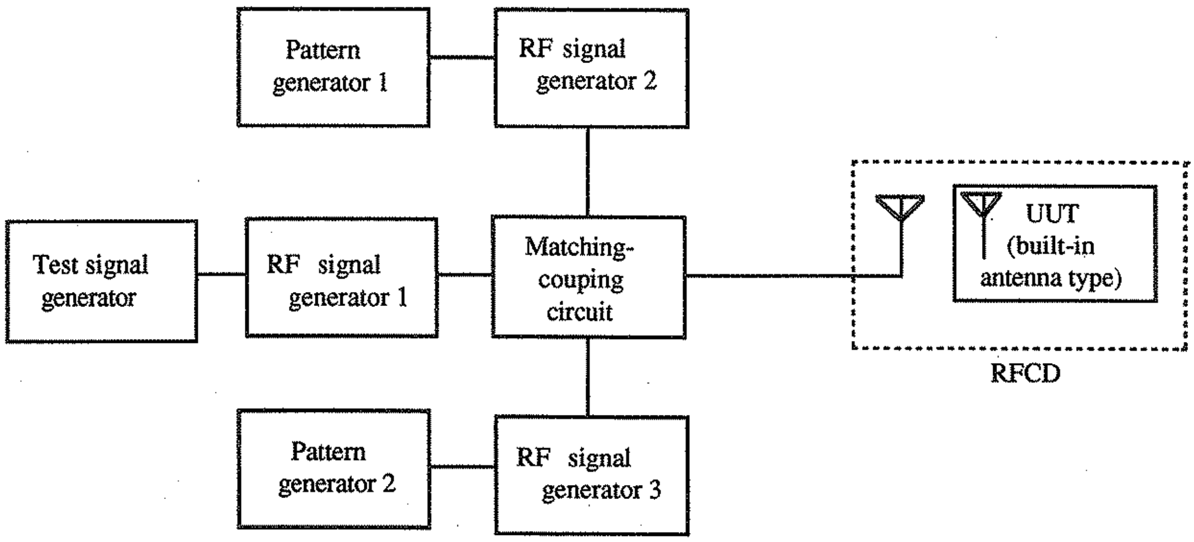
When all of the 1st, 2nd and 3rd SCTS can be decoded, increase the signal level of RF signal generator 2 by 1dB and record the signal level at this point.

Repeat the procedure in step g) above until the no. of recorded values reaches 40.

h. Obtain the ratio in dB unit between the average value (interference level) of all the signal levels recorded against the reference sensitivity and defines as adjacent channel selectivity.

10.1.3 Intermodulation characteristics

(1) Measuring system diagram



(2) Test equipment conditions

a. Transmit SCTS from the test signal generator. Transmission at this point is single transmission.

The SCTS message field must be structured of 2 words. However, in case of Tone-Only pagers, no messages are transmitted. (In case of Tone-Only pagers utilizing the Tone-Only Address, neither vectors or messages are transmitted.)

b. Transmit a binary pseudo noise series signal (ITU-T O.151) having a coding length of 32,767 bits continuously from the pattern generators. Also, set pattern generators 1 and 2 so that the respective pattern generators have different phase.

c. The output signals from the RF signal generators 1,2 and 3 must meet the base station transmitter requirements specified in Section 2.1.

RF signal generator 2 and 3 are modulated at 3200 bps/2FSK.

d. As measurement environment use the RFCD correlated by the pager which was used for measuring reference sensitivity in Section 10.1.1.1.

(3) Conditions for UUT

Set a pager under test to a test frequency.

(4) Test procedure

a. Set the center frequency of RF signal generator 1 to the test frequency (fw) and set the signal level for RF signal generator 1 (desired signal) so that the electric field strength at the location of the UUT is 50dBμV/m.

b. Set RF signal generators 2 and 3 to the specified frequency.

(In case of 3rd-order intermodulation, set the signal generators to the frequency listed in Table 10.1.3-1 and perform the procedures in steps c) thru g). In case of 2nd-order intermodulation for direct-conversion type pagers, set the signal generators to the frequency listed in Table 10.1.3-2 and perform the procedures in steps c) thru g).

Table 10.1.3-1 : Set frequencies for 3rd-order Intermodulation

Item no.	Combination of frequencies	
1	fw -50kHz	fw -100kHz
2	fw +50kHz	fw +100kHz

Table 10.1.3-2 : Set frequencies for 2nd-order Intermodulation

Item no.	Combination of frequencies	
1	fw -50kHz	fw +50kHz
2	fw -50kHz	2fw -50kHz
3	fw +50kHz	2fw +50kHz

c. Set the signal level of RF signal generators 2 and 3 to a value where the page success rate decreases approx. 50%.

d. Transmit SCTS repeatedly and decrease the signal level of RF generators 2 and 3 with 2-dB steps until SCTS can be decoded three times consecutively.

   Record the signal level when the SCTS is decoded three times consecutively for the first time.

e. Next, increase the signal level of RF signal generators 2 and 3 by 1dB and record the signal level at this point.

f. Transmit the SCTS repeatedly and if any of the 1st, 2nd or 3rd SCTS could not be decoded, decrease the signal level of RF signal generators 2 and 3 by 1dB and record this value.

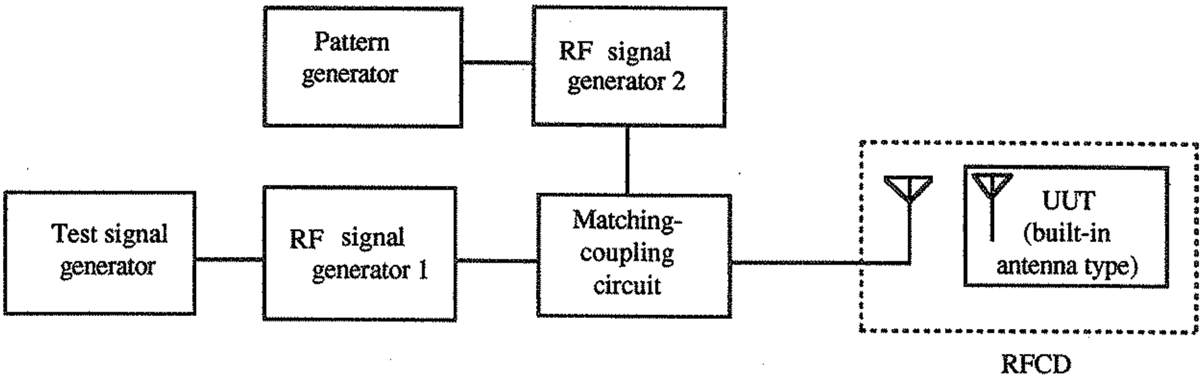
   When all of the 1st, 2nd and 3rd SCTS can be decoded, increase the signal level of RF signal generators 2 and 3 by 1dB and record the signal level at this point.

   Repeat the procedure in step f) above until the no. of recorded values reaches 40.

g. Obtain the ratio in dB unit between the average value (interference level) of all the signal levels recorded against the reference sensitivity and defines as intermodulation characteristics.

10.1.4 Spurious response

(1) Measuring system diagram



(2) Test equipments conditions

a. Transmit SCTS from the test signal generator. Transmissions at this point is single transmission. The SCTS message field must be structured of 2 words. However, In case of Tone-Only pagers, no messages are transmitted. (In case of Tone-Only pagers utilizing the Tone-Only Address, neither vectors or messages are transmitted.)

b. Transmit a binary pseudo noise series signal (ITU-T O.151) having a coding length of 32,767 bits continuously from the pattern generators.

c. The output signals of the RF signal generators 1 and 2 must meet the base station transmitter requirements specified in Section 2.1.

RF signal generator 2 is modulated at 3200 bps/2FSK.

d. As measurement environment, use the RFCD correlated by the pager which was used for measuring reference sensitivity in Section 10.1.1.1

(3) Conditions for UUT

Set a pager under test to a test frequency.

(4) Test procedure

a. Set the center frequency of RF signal generator 1 to the test frequency (fw).

b. Measure and record reference sensitivity without interference signal from RF signal generator 2.

c. Set the signal level of RF signal generator 1 to (reference sensitivity + 3dB).

d. Set the signal level of RF signal generator 2 to the specified frequency. (spurious reception frequency (*).)

e. Set the signal level of RF signal generator 2 to a value where the page success rate decreases approx. 50%.

f. Transmit SCTS repeatedly and decrease the signal level of RF generator 2 with 2-dB steps until SCTS can be decoded three times consecutively.

Record the signal level when the SCTS is decoded three times consecutively for the first time.

g. Next, increase the signal level of RF signal generator 2 by 1dB and record the signal level at this point.

h. Transmit the SCTS repeatedly and if any of the 1st, 2nd or 3rd SCTS could not be decoded, decrease the signal level of RF signal generator 2 by 1dB and record this value.

When all of the 1st, 2nd and 3rd SCTS can be decoded, increase the signal level of RF signal generators 2 by 1dB and record the signal level at this point.

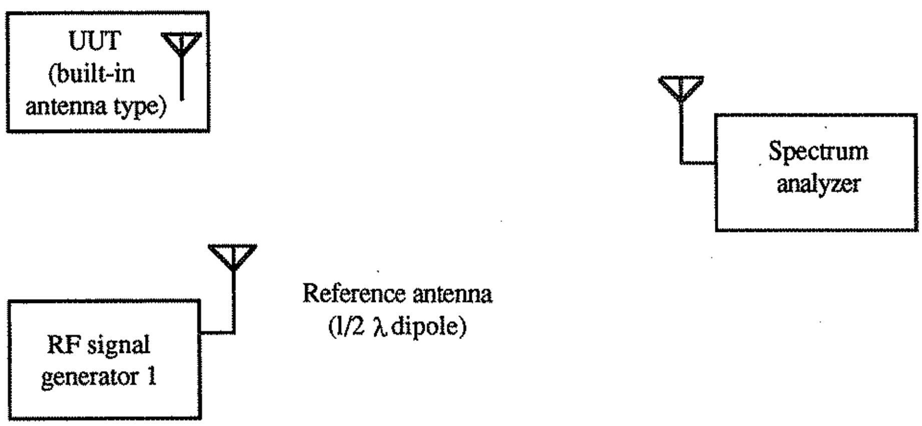
Repeat step h) above until the No. of recorded values reaches 40.

i. Obtain the ratio between the average value (interference level) of all the signal levels recorded against the reference sensitivity in dB unit and defines as spurious response.

(*) As one of a method for setting the spurious reception frequency, obtain the IF frequency for the UUT using a measuring receiver which is capable of receiving IF frequency to detect the spurious reception frequency.

10.1.5 Limitation of spurious emission

(1) Measuring system diagram



(2) Test equipments conditions

a. Use an open site or an anechoic chamber equivalent to the open site.

The open site must comply with IEC489-6 Appendix K or L.

b. The measurement antenna height must be variable within 1 to 4 m from the ground.

c. The reference antenna height must be 1.5m from the ground.

d. Place the UUT on the turntable and set the height at 1.5m to the bottom from the ground.

e. The distance between the UUT and the reference antenna must be 3m.

(3) Conditions for UUT

a. Set a pager under test to a test frequency.

b. Set the reception mode for continuous reception.

(4) Test procedure

a. Place the UUT on the turntable and search for the spectrum required for testing conducted spurious emission.

b. Use the spectrum analyzer to measure the power for each spectrum searched in a) above. During this measurement, turn the turntable and vary the measurement antenna height within a range of 1 to 4m and switch the polarization plane vertically and horizontally, then record the maximum value.

c. Replace the UUT with the reference antenna which is fed by the RF signal generator.

d. Set the output for the RF signal generator to 4000μμW (-54dBm). However, the actual output value must be a value added with the reference antenna gain and cable loss calibration.

e. Set the RF signal generator frequency to the conducted spurious emission from the UUT.

f. Measure the spurious emission from the reference antenna using the spectrum analyzer. During this measurement, vary the measurement antenna height within a range of 1 to 4m and change the polarization plane vertically and horizontally, then record the maximum value.

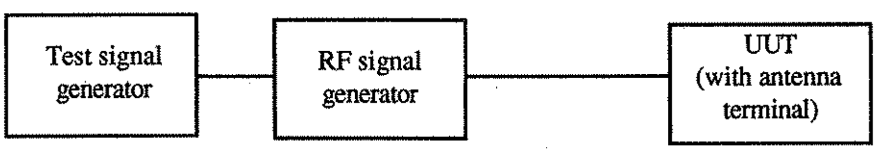
g. Compare the value recorded in step b) to the value recorded in step f) for rating whether it is satisfactory or not.

10.2 Pager with antenna terminal

10.2.1 Receiver sensitivity

10.2.1.1 Reference sensitivity

(1) Measuring system diagram



(2) Test equipments Conditions

a. Generate an NRZ signal which complies with the specified signaling format using the test signal generator and transmit addresses, vectors, messages (SCTS) of the UUT. Note that transmission at this point must be single transmission. An SCTS message field must be structured of 2 words. In case of Tone-Only pagers, no messages are transmitted. (In case of Tone-Only pagers utilizing the Tone-Only Address, neither vectors or messages are transmitted.)

b. The output signals from the RF signal generator must meet the base station transmitter requirements specified in Section 2.1.

(3) Conditions for UUT

a. Set a pager under test to a test frequency.

(4) Test procedure

a. Set the center frequency of the RF signal generator to the test frequency.

b. Set the signal level to a point where the page success decreases to approx. 50%.

c. Increase the signal level with 2-dB steps until SCTS can be decoded three times consecutively.

d. Record the signal level after the SCTS was decoded three times consecutively.

e. Next, decrease the signal level by 1dB, then record this value.

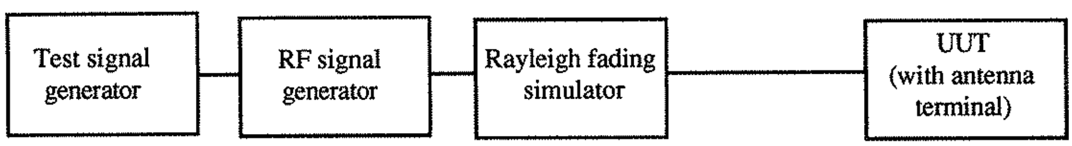
f. Transmit the SCTS repeatedly and if any of the 1st, 2nd or 3rd SCTS could not be decoded, increase the signal level by 1dB and record this value. When all of the 1st, 2nd and 3rd SCTS can be decoded, decrease the signal level by 1dB, then record this value.

Repeat the procedure in step f) above until the no. of recorded values reaches 20.

g. The average value of all the recorded values is the reference sensitivity.

10.2.1.2 Sensitivity under fading condition

(1) Measuring system diagram



(2) Test equipments conditions

a. Transmit the SCTS from the test signal generator. The number of transmission must be two. The SCTS message field must be structured of 2 words. However, In case of Tone-Only pagers, no messages are transmitted. (In case of Tone-Only pagers utilizing the Tone-Only Address, neither vectors or messages are transmitted.)

b. The output signals from the RF signal generator must meet the base station transmitter requirements specified in Section 2.1.

c. Use a fading simulator which accord with IEC Pub. 489-6 Appendix C with Rayleigh fading at a maximum Doppler frequency of 1 Hz.

(3) Conditions for UUT

a. Set a pager under test to a test frequency.

(4) Test procedure

a. Set the center frequency of the RF signal generator to the test frequency.

b. Set the signal level to a value where the page success rate decreases to approx. 50%.

c. Increase the signal level with 2-dB steps until SCTS can be decoded three times consecutively for the first time.

d. Record the signal level when the SCTS can be decoded 3 times consecutively.

e. Next, decrease the signal level by 1dB and record this value.

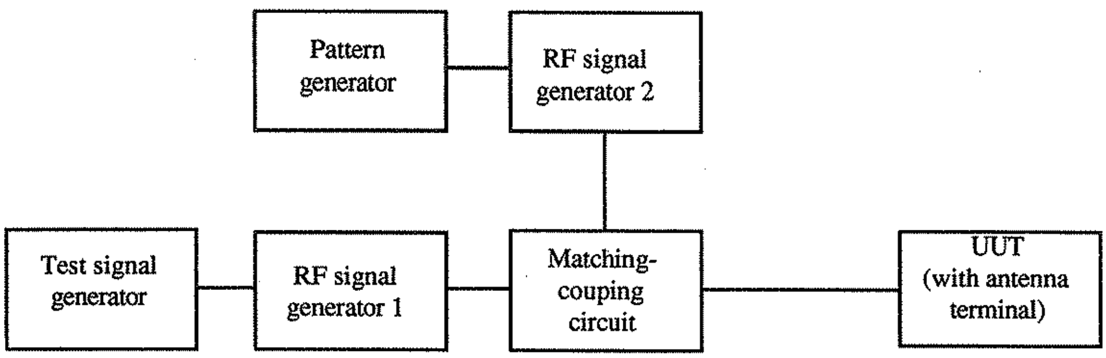
f. Transmit the SCTS repeatedly and if any of the 1st, 2nd or 3rd SCTS could not be decoded, increase the signal level by 1dB and record this value. When all of the 1st, 2nd and 3rd SCTS can be decoded, decrease the signal level by 1dB, then record this value.

Repeat the procedure in step f) above until the no. of recorded values reaches 40.

g. The average value of all the recorded values is the sensitivity under fading condition.

10.2.2 Adjacent channel selectivity

(1) Measuring system diagram



(2) Test equipments conditions

a. Transmit SCTS from the test signal generator. Transmission at this point is single transmission. The SCTS message field shall be 2 words. However, In case of Tone-Only pagers, no messages are transmitted. (In case of Tone-Only pagers utilizing the Tone-Only Address, neither vectors or messages are transmitted.)

b. Transmit a binary pseudo noise series signal (ITU-T O.151) having a coding length of 32,767 bits continuously from the pattern generator.

c. The output signals from the RF signal generators 1 and 2 must meet the base station transmitter requirement specified in Section 2.1. RF signal generator 2 is modulated at 3200 bps/2FSK

(3) Conditions for UUT

a. Set a pager under test to a test frequency.

(4) Test procedure

a. Set the center frequency of RF signal generator 1 to the test frequency (fw).

b. Measure reference sensitivity without interference signal from RF signal generator 2.

c. Set the signal level of RF signal generator 1 to (reference sensitivity + 3dB).

d. Set the center frequency of RF signal generator 2 to the specified frequency level. (set the center frequency to fw+25kHz or fw-25kHz respectively and perform steps e) thru g) below.

e. Set the signal level of RF signal generator 2 to a value where the page success rate decreases approx. 50%.

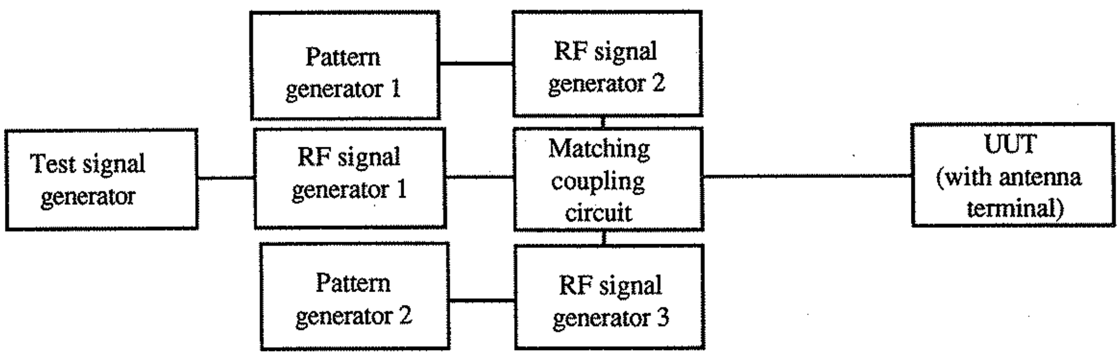
f. Transmit SCTS repeatedly and decrease the signal level of RF generator 2 with 2-dB steps until SCTS can be decoded three times consecutively.
Record the signal level when the SCTS is decoded three times consecutively for the first time. Next, increase the signal level of RF signal generator 2 by 1dB and record the signal level at this point.

g. Transmit the SCTS repeatedly and if any of the 1st, 2nd or 3rd SCTS could not be decoded, decrease the signal level of RF signal generator 2 by 1dB and record this value.
When all of the 1st, 2nd and 3rd SCTS can be decoded, increase the signal level of RF signal generator 2 by 1dB and record the signal level at this point.
Repeat the procedure in step g) above until the no. of recorded values reaches 40.

h. Obtain the ratio in dB unit between the average value (interference level) of all the signal levels recorded against the reference sensitivity and defines as adjacent channel selectivity.

10.2.3 Intermodulation characteristics

(1) Measuring system diagram



(2) Test equipments conditions

a. Transmit SCTS from the test signal generator. Transmissions at this point is single transmission.

The SCTS message field must be structured of 2 words. However, in case of Tone-Only pagers, no messages are transmitted. (In case of Tone-Only pagers utilizing the Tone-Only Address, neither vectors or messages are transmitted.)

b. Transmit a binary pseudo noise series signal (ITU-T O.151) having a coding length of 32,767 bits continuously from the pattern generators. Also, set pattern generators 1 and 2 so that the respective pattern generators have a different phase.

c. The output signals from the RF signal generators 1, 2 and 3 must meet the base station transmitter requirements specified in Section 2.1. RF signal generators 2 and 3 are modulated at 3200 bps/2FSk

(3) Conditions for UUT

a. Set a pager under test to a test frequency.

(4) Test procedure

a. Set the center frequency of RF signal generator 1 to the test frequency (fw) and set the signal level of RF signal generator 1 (desired signal) so that the signal level at the location of the UUT is 40dBμV.

b. Set RF signal generators 2 and 3 to the specified frequency.

(In case of 3rd-order intermodulation, set the signal generators to the frequency listed in Table 10.1.3-1 and perform the procedures in steps c) thru g). In case of 2-order intermodulation for direct-conversion type pagers, set the signal generators to the frequency listed in Table 10.1.3-2 and perform the procedures in steps c) thru g).

c. Set the signal level of RF signal generators 2 and 3 to a value where the page sucess rate decreases approx. 50%.

d. Transmit SCTS repeatedly and decrease the signal level of RF generators 2 and 3 with 2-dB steps until SCTS can be decoded three times consecutively. Record the signal level when the SCTS is decoded three times consecutively for the first time.

e. Next, increase the signal level of RF signal generators 2 and 3 by 1dB and record the signal level at this point.

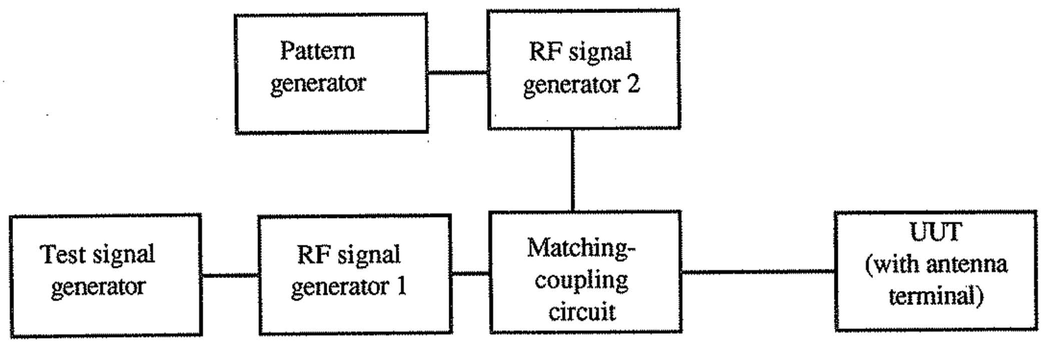
f. Transmit the SCTS repeatedly and if any of the 1st, 2nd or 3rd SCTS cannot be decoded, decrease the signal level of RF signal generators 2 and 3 by 1dB and record this value. When all of the 1st, 2nd and 3rd SCTS can be decoded, increase the signal level of RF signal generators 2 and 3 by 1dB and record the signal level at this point.

Repeat step f) above until the no. of recorded values reaches 40.

g. Obtain the ratio in dB unit between the average value (interference level) of all the signal levels recorded against the reference sensitivity and defines as intermodulation characteristics.

10.2.4 Spurious response

(1) Measuring system diagram



(2) Test equipments conditions

a. SCTS from the test signal generator. Transmission at this point is single transmission.

The SCTS message field must be structured of 2 words. However, in case of Tone-Only pagers, no messages are transmitted. (In case of Tone-Only pagers utilizing the Tone-Only Address, neither vectors or messages are transmitted.)

b. Transmit a binary pseudo noise series signal (ITU-T O.151) having a coding length of 32,767 bits continuously from the pattern generators.

c. The output signals from the RF signal generators 1 and 2 must meet the base station transmitter requirements specified in Section 2.1. RF signal generator 2 is modulated at 3200 bps/2FSK.

(3) Conditions for UUT

a. Set a pager under test to a test frequency.

(4) Test procedure

a. Set the center frequency of RF signal generator 1 to the test frequency (fw).

b. Measure reference sensitivity without interference signal from RF signal generator 2.

c. Set the desired signal level of RF signal generator 1 to (reference sensitivity + 3dB).

d. Set the signal of RF signal generator 2 to the specified frequency (spurious reception frequency (*).)

e. Set the signal level of RF signal generator 2 to a value where the page success rate decreases approx. 50%.

f. Transmit SCTS repeatedly and decrease the signal level of RF generator 2 with 2-dB steps until SCTS can be decoded three times consecutively.

Record the signal level when the SCTS is decoded three times consecutively for the first time.

Next, increase the signal level of RF signal generator 2 by 1dB and record the signal level at this point.

h. Transmit the SCTS repeatedly and if any of the 1st, 2nd or 3rd SCTS could not be decoded, decrease the signal level of RF signal generator 2 by 1dB and record this value.

When all of the 1st, 2nd and 3rd SCTS can be decoded, increase the signal level of RF signal generators 2 by 1dB and record the signal level at this point.

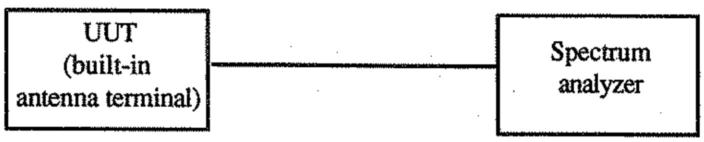
Repeat the procedure in step h) above until the no. of recorded values reaches 40.

i. Obtain the ratio in dB unit between the average value (interference level) of all the signal levels recorded against the reference sensitivity and defines as spurious response.

(*) As one of a method for setting the spurious reception frequency, obtain the IF frequency for the UUT using a measuring receiver which is capable of receiving IF frequency and specify the spurious reception frequency.

10.2.5 Limitation of spurious emission

(1) Measuring system diagram



(2) Test equipments conditions

a. Settings for the spectrum analyzer

Sweep range	:	0Hz
Resolution bandwidth	:	Approx. 100kHz
Y-axis scale	:	10dB/div.
Input level	:	Maximum amplitude must be 70 to 90% of the full scale
Sweep mode	:	Single sweep
Sweep trigger	:	Video trigger. Generally positive voltage but adjustments required.
Sweep time	:	Approx. 20 msec.
Detection mode	:	Sample mode

(3) Conditions for UUT

a. Set a pager under test to a test frequency.

b. Set the reception mode for continuous reception.

(4) Test procedure

a. Search for the spectrum to be tested in the conducted spurious emitted from UUT.

b. Use the spectrum analyzer and measure the power for each spectrum searched in step a) above.

Chapter 11 Glossary of Terms

1. GPS (Global Positioning System) Time

GPS Time refers to the time based on the Atomic Time on the GPS satellite. This is characterized by not requiring leap time adjustments, such as UTC (Universal Time Coordinated).

2. NID (Network IDentification)

NID (Network ID) is the ID used for identifying the pertinent network when a multiple number of Simulcast Systems are connected together to form one roaming network.

3. RFCD (Radio Frequency Coupling Device)

RFCD refers to radio frequency coupling devices which are used as tools (TEM cells, etc.) for connection between a receiver with built-in antenna and the terminal of a measuring instrument.

4. SSID (Simulcast System Identification)

SSID is the ID used for identifying the System (i.e. unit area where simulcast transmission is performed along with an RF channel).

5. SCTS (Standard Coded Test Signal)

SCTS refers to a standard test signal which is encoded by the signaling format specified by this Standard.

6. Coverage Zone

The Coverage Zone is one of the information elements composing the SSID. Up to 32 systems can be identified for each LID.

7. Collapse cycle

One of the 128 Frames is preassigned to the address of each pager. Accordingly, if a the pager receives messages only in the preassigned Frame, it will receive only once every 128 Frames (once every 4 minutes). With this assignment method, the battery saving ratio is maximized, however, the paging delay is extended. Thus, when it is desirable to shorten the paging delay, the pager receiving cycle can be changed.

8. Service Area Identifier

The Service Area Identifier is one of the information elements which composes the NID. Up to 32 Service Areas can be identified by the Service Area Identifier in each combination of Network Address and Multiplier.

9. Cycle

One Cycle is structured of 128 Frames; 15 Cycles running from Cycle 0 through Cycle 14 is transmitted per hour.

10. Subframe

A Frame is divided into multiple Subframes corresponding to the number of words decided based on the number of transmissions. Accordingly, one Frame is divided into two Subframes in case the number of transmissions equals to 2, into three Subframes in case the number of transmissions equals to 3 and into four Subframes in case the number of transmissions equals to 4.

11. Signature

Signature is used for HEX/Binary Messages and Alphanumeric Messages. This is obtained by specified binary calculation in relation to the entire message (including all fragments).

12. System event

A System event designates when a significant change has been made in the transmission conditions for the infrastructure facilities, including a change of frequencies, the addition of new frequencies, change of the Channel Set Up Instruction and so forth.

13. System Message

A System Message consists of information to be transmitted from a Infrastructure facility to all pagers or to all roaming pagers and so forth.

14. Traffic Management Flag (TMF)

The Traffic Management Flag is one of the information elements composing the SSID or NID. It can equally disperse traffic over a maximum of 4 channels in the same unit area.

15. Phase

A Frame is composed of a multiplexed 1600bps data stream. A Frame is non-multiplexed at 1600bps, 2-channel multiplexed at 3200bps and 4-channel multiplex at 6400bps. The respective channel for a Frame is referred to as a "Phase."

16. Multiple transmission

The Infrastructure facility is allowed to select the number of transmissions ranging from single thru four transmission for the same paging signal. Transmissions are performed at a transmission repeating interval that corresponds to the Collapse cycle specified by the Infrastructure facility.

17. Fragments

When transmitting a long message, the message can be divided into several sub-messages for transmission. These sub-messages are called "Fragments."

18. Frame

One Frame is structured of 11 blocks for paging signal and includes a 115 ms Sync signal. Frames are numbered from 0 thru 127.

19. Carry On

In pagers which receive a certain Frame according to the Collapse cycle, the term Carry On indicates that information to be transmitted only in the pertinent Frame will also be transmitted in the subsequent Frame(s). Carry On is not allowed during multiple transmission.

20. Frame Information Word

A Frame Information Word is a 32-bit word that is placed in the sync signal for each Frame and is transmitted using 1600bps 2FSK modulation. It includes such information as the Frame number, the Cycle number and no. of times for transmissions.

21. Blocking Length

Blocking Length indicates the bits per character in HEX/Binary Messages.

22. Block

A block refers to an interleave unit of 160 ms. The number of BCH (32, 21) can be changed from 8 words to 32 words, but the interleave length remains identical regardless of the transmission speed.

23. Block Information Word

A Block Information Word is a word which is placed in the first block of each Frame (or Subframe in case of multiple transmission). Block Information Word 1 indicates the information required for the pager to receive messages, such as the number of Block Information Words, the number of Priority addresses, the start of the Vector Field, the System Collapse cycle value and so forth. Also, in cases when the Infrastructure facility supports Multi-area Roaming, Block Information Word 2, 3, 4 are used to send information, such as the Simulcast System ID (SSID) or Time related information and so forth, if necessary.

24. Home area

The Home area refers to the basic area the pager is registered in from among the areas in which it receives Multi-area Roaming service. If no area change instruction is given by the user, normally the Infrastructure facility assumes that the user is located in the Home area.

Attached Document

Appendix A CAPCODE

1. CAPCODE

Addresses, Frame numbers, the Collapse cycles and phases are the parameters required to page individual pagers. Also, from the standpoint of system operation, CAPCODE is used as the unified method for handling all of these parameters together. CAPCODE is a term designating either Short or Long Addresses. A Short Address (1 word) is indicated by a 7 decimal digit field and a Long Address (2 words) is indicated by a 9 decimal digit field (however, 10 decimal digit field can be used for Long Addresses which are combinations of Long Addresses Set 1-3, 1-4, 2-3). Also, when information indicated by alphabetical characters is attached to a 7-digit or 9-digit address field, such information is used to indicate the CAPCODE type.

"Extended CAPCODE" is used to attach information which indicates functions used to facilitate a pager's Roaming .

A 10 decimal digit field is used in the Address Field for an Extended CAPCODE, regardless of whether the address is a Short Address or Long Address.

For roaming inside Japan, either Short or Long Addresses are used.

For International roaming, however, use of Long Addresses is desirable.

The different combinations of CAPCODE forms are given below :

	Short Address	Long Address	Extended CAPCODE
1)	fffbU1234567	fffbU123456789	RfffbU1234567890
2)	U1234567	U123456789	RU1234567890
3)	bA1234567	bA123456789	RbA1234567890
4)	A1234567	A123456789	RA1234567890

fff : The Frame number assigned to the address (0 ~ 127)

b : pager Collapse cycle (0 ~ 7)

U ~ Z : Indicates that the information which is attached to the CAPCODE (f f f b) is required. In some cases, this information is omitted. In such instances, the Frame number and the pager Collapse cycle depend on information memorized on the Infrastructure facility side and in the pager.

A ~ L : Indicates that the Frame number and phase-related information are included in the number field which indicates the address field. When b is not attached, a Collapse value of 4 (at 16-Frame intervals) is used as the pager's Collapse cycle value.

P,Q,R,S : 2nd alpha character information

Indicates the following information related roaming capabilities of the pager unit is included in the alphabet field :

Frame Offset capable (1 : Yes ; 0 : No)
Function which can follow TMF on system side (1 : Yes 0 : No)

P : 0 0 Types not having roaming functions or Frame Offset; or not having a TMF function

Q : 0 1 Types not having a Frame Offset function, but which are capable of following TMF information on the system side.

R : 1 0 Types capable of following Frame offset information for Block Information Word (BIW101) and not having a TMF function

S : 1 1 Types capable of following Frame Offset information for Block Information Word (BIW101) and also following TMF information on the system side

2. Scope of CAPCODE address

In cases where the CAPCODE address indicates decimal numbers, for Short Addresses or 1-word addresses, number configuration from 1 thru 2,031,614 are used; for Long Addresses, number configurations from 2,101,249 or higher are used.

3. Standard rules for embedding Frames and phases

Ordinarily from a system standpoint, it is highly desirable that pagers are distributed over 4 phases in each 128 frame. When distribution of Frames and phases begins, the address assignment sequence is performed automatically by inserting the information into 7, 9 or 10-digit decimal number CAPCODEs.

The standard method for extracting Frames and phases is to first convert 7, 9 and 10-digit decimal numbers into binary. With "bit 0" as the LSB, 00, 01, 10 and 11 which follow "bits 2 and 3" define phase 0, phase 1, phase 2 and phase 3, respectively. In addition, "bits 4 ~ 10" are assigned in order from Frame 000 thru Frame 127.

The pager will follow TMF, bit 0 and bit 1 represent which of the TMF.

Also, as a method for extracting Frames and phases, 7, 9 and 10-digit decimal number addresses are calculated by modulo arithmetic (base10),

thus :

Phase = modulo 4 (INT [address/4])
Frame = modulo 128 (INT [address/16])

This definition is characterized in that when Addresses are assigned in sequential order, Phases are increased for each 4 consecutive Addresses, while Frames are increased for each 16 Address assignments.

Rules for assigning Frame and Phase to addresses (for Short Addresses)

Example :In the case, 1,020,927 (Decimal)

Binary 0 1111 1001 0011 1111 1111

represent
Frame number
(Frame 000-127)

Phase 0(a)=00
Phase 1(b)=01
Phase 2(c)=10
Phase 3(d)=11

Table A-1 : Range of CAPCODE Address

CAPCODE address		Description
	000 000 000	Unused
000 000 001	001 933 312	Short Address
001 933 313	001 998 848	Illegal
001 998 849	002 009 087	Reserved for future use
002 009 088	002 025 471	Information Service Address
002 025 472	002 029 567	Network Address
002 029 568	002 029 583	Temporary Address
002 029 584	002 029 599	Operator Messaging Address
002 029 600	002 031 614	Reserved for future use
002 031 615	002 101 248	Unused
002 101 249	102 101 250	Long Address 1-2 (100M Uncoordinated)
002 101 251	402 101 250	Long Address 1-2 (300M By Country)
402 101 251	1 075 843 072	Long Address 1-2 (675M Global)
1 075 843 073	2 149 584 896	Long Address 1-3 (1,074M Global)
2 149 584 897	3 223 326 720	Long Address 1-4 (1,074M Global)
3 223 326 721	3 923 326 750	Long Address 2-3 (700M By Country)
3 923 326 751	4 280 000 000	Long Address 2-3 (357M Reserved)
4 280 000 001	4 285 000 000	Info.Svc.Adr.,Long Adr. 2-3 (5M Global)
4 285 000 001	4 290 000 000	Info.Svc.Adr.,Long Adr. 2-3 (5M By Country)
4 290 000 001	4 291 000 000	Info.Svc.Adr.,Long Adr. 2-3 (1M Per Country for World Wide Use)
4 291 000 001	4 297 068 542	Info.Svc.Adr.,Long Adr. 2-3 (6M Reserved)
4 297 068 543 or over		Reserved for future Use (Not Defined and Reserved)

Note 1) Global : Address is coordinated to be unique world-wide.
Note 2) By Country : Administrated within each Country or Region (can be reused within each country or Region.)
Note 3) Country for World-Wide Use: 1000 addresses are assigned to each Country Code. For example, in the case of Japan, as the Country Code is "440". 4,290,<u>440</u>,001 through 4,290,441,000 are assigned.

corresponding to Country Code

Note 4) Reserved : Reserved for future Use.

4. Definition for alphabet characters attached to CAPCODE

The alphabetical prefix indicates the type of a pager for which an Address is assigned among Single Phase, Any Phase and All Phase. It also indicates the 1st, 2nd, 3rd or 4th Addresses for a pager which has multiple Addresses when these Addresses comply with the standard rules in the following table, and defines the standard for determining which Address is to be assigned to which Frame and which Phase.

"A" indicates a pager with Single Phase for which the standard rules for deciding Phase and Frame is applied. "B" is almost identical with "A", except that "1" is subtracted from the CAPCODE before the standards rule is applied. In the same manner "C" and "D" respectively indicate that "2" and "3" are subtracted from the CAPCODE.

"E" thru "H" and "I" thru "L" indicate Any phase and All phase pagers respectively. By changing the method of subtraction, all the Addresses for a pager having multiple Addresses are assigned to the same Frame.

If the standards rule is not defined, "U" thru "X" indicate Single Phase pagers, and Phases 0 thru 3 are assigned to indicate the Frame and the pager Collapse cycle. "Y" and "Z" are for Any or All Phase pagers having Addresses which are not standard.

Standard Rule	No Rules (Non-Standard Form)
A- Single Phase Subtract 0	U- Single phase, Phase 0
B- Single Phase Subtract 1	V- Single phase, Phase 1
C- Single Phase Subtract 2	W- Single phase, Phase 2
D- Single Phase Subtract 3	X- Single phase, Phase 3
E- Any Phase Subtract 0	Y- Any Phase
F- Any Phase Subtract 1	
G- Any Phase Subtract 2	
H- Any Phase Subtract 3	
I- All Phase Subtract 0	Z- All Phase
J- All Phase Subtract 1	
K- All Phase Subtract 2	
L- All Phase Subtract 3	

5. Conversion from CAPCODE to a binary Address

5.1 Conversion from a short CAPCODE to a binary Address

To convert a Short Address CAPCODE into a binary address, 32,768 is added to a 7-digit decimal CAPCODE (for example, CAPCODE: 0000001 is 32,769 in decimal and CAPCODE :1,933,312 is 1,966,080 in decimal) This resultant number is then converted to a 21 binary number which becomes the information bits of the (31,21) BCH code word. (The LSB calculated becomes the first bit on the channel followed by the remaining information bits and the 10 parity bits.) The 32 overall every parity bit is added to make the 32 bit Address code word.

5.2 Conversion from a long CAPCODE to a binary Address

5.2.1 Long Address Set 1-2 (2,101,249 to 1,075,843,072)

To convert a Long Address CAPCODE into a binary Address, first 2,068,481 is subtracted from a 9-digit decimal CAPCODE. Next, the subtraction result is divided by 32,768, then "1" is added to the remainder to obtain the 1st Long Address word (Equivalent to the subtraction result of modulo 32,768 plus 1). The value is converted into a 21-bit binary number which will be the information bits for generating the BCH (31, 21) code word. The LSB is transmitted first (for example, CAPCODE: 2,101,249 is the 1st Long Address is 1, and the 2nd Long Address is 2,097,150).

The 2nd Long Address word is decided by the integral portion of the value obtained as a result of dividing by 32,768 during the first calculation. Next, this value is subtracted from 2,097,151 (equivalent to 1's complement of the value in binary) and then is converted into a 21-bit binary, which will become the information bits when generating the BCH(31,21) code word.

5.2.2 Long Address Set 1-3 or 1-4 (1,075,843,073 to 3,223,326,720)

As the conversion method for the Long Address 1st word, the same calculation method used for a Long Address word combining Long Address Set 1-2 is used. In the conversion method for the 2nd Long Address word, 2,068,481 is first subtracted from the decimal CAPCODE, then the obtained value is divided by 32,768 and then 1,933,312 is added to the value obtained from the integral portion of the result of this division to obtain the 2nd Long Address word.

The value obtained is converted into a 21-bit binary number which will be the information bits for generating a BCH (31, 21) code word. The LSB is transmitted first.

5.2.3 Long Address Set 2-3 (3,223,326,721 to 4,297,068,542)

The conversion method for the 1st Long Address word is to subtract 2,068,479 from the CAPCODE. Next, 2,064,383 is added to the remainder obtained by dividing the result of the above calculation by 32,768.

The conversion method for the 2nd Long Address word is first subtracted 2,068,479 from the decimal CAPCODE and then the obtained value is divided by 32,768 and the integral portion of the value obtained by this division is added with 1,867,776 to obtain the 2nd Long Address word.

The value obtained is converted into a 21-bit binary number which will be the information bits for generating a BCH (31, 21) code word. The LSB is transmitted first.

6. Conversion from binary to CAPCODE

When a value for an Address code word is given, this value can be converted into a CAPCODE by performing this inverse of the above process. A Short Address word is converted into a decimal number, then, 32,768 is subtracted to obtain a 7-digit CAPCODE. (Decimal address : 32,769 is indicated by '0000001' in the form of the CAPCODE).

For a two word Long Address, the 1st Long Address word is first converted from binary to decimal. Next, the complement of the 2nd Long Address word is obtained (or subtracting 2,097,151 in decimal) and converted into decimal. This value is multiplied by 32,768, then 2,068,480 is added to it and then it is added to 1st Long Address word. The result of this calculation becomes a 9-digit address portion for the CAPCODE (if Long Address 1 is 1 (decimal) and Long Address 2 is 2,097,150 (decimal), for example, the CAPCODE is 2,101,249).

If a pager has one individual Address only and the pager Collapse cycle is 4 (16-Frame interval), A, E or I is attached as prefix for 7- or 9-digit addresses. (A is attached for Single Phase pagers and E or I is attached for Any Phase pagers or All Phase pagers respectively.)

If a pager has two Addresses and both addresses are individual Addresses, A, E and I are attached as prefixes for the 1st address, and B, F, J are attached as prefixes for the 2nd address. B, F, J indicate that the pertinent address is the 2nd address, and also indicate that they accompany to the 1st address.

<Example calculation method>

(1) Example of conversion from a CAPCODE to a decimal address :

1) In case of Short Address :

Address = CAPCODE + 32,768
For example, the address of the CAPCODE: 0000001 is
Short Address = 1 + 32,768 = 32,769

2) In case of Long Address Set 1-2 :

It can be done,
Calculate first, (CAPCODE -2,068,481)/32,768= Quotient ....Remainder
Then, 1st Long Address word (Long Address 1)= Remainder +1
2nd Long Address word (Long Address 2)=2,097,151-Quotient

Example (a)CAPCODE: 2,101,249 is;
(2,101,249-2,068,481)/32,768=1....0 (Quotient is 1 and Remainder is 0)
Long Address 1=0+1=1
Long Address 2=2,097,151-1=2,097,150

Example (b)CAPCODE: 999,999,999 is;
(999,999,999-2,068,481)/32,768=30,454....14,846
Long Address 1=14,846+1=14,847
Long Address 2=2,097,151-30,454=2,066,697

3) In case of Long Address Set 1-3 and 1-4 :

It can be done,
Calculate first, (CAPCODE -2,068,481)/32,768= Quotient ....Remainder
Then, 1st Long Address word (Long Address 1)= Remainder +1
2nd Long Address word (Long Address 3 or 4)=Quotient+1,933,312

Example (c)The address of the CAPCODE: 1,075,843,073 is;
(1,075,843,073-2,068,481)/32,768=32,769....0
Long Address 1=0+1=1
Long Address 3=32,769+1,933,312=1,966,081

Example (d)The address of the CAPCODE: 2,149,584,896 is;
(2,149,584,896-2,068,481)/32,768=65,536....32,767
Long Address 1=32,767+1=32,768
Long Address 3=65,536+1,933,312=1,998,848

4) In case of Long Address Set 2-3 :

It can be done,
Calculate first, (CAPCODE -2,068,479)/32,768= Quotient ....Remainder
Then, 1st Long Address word (Long Address 2)= Remainder +2,064,383
2nd Long Address word (Long Address 3) =Quotient+1,867,776

Example (e)The address of the CAPCODE: 3,223,326,721 is;
(3,223,326,721-2,068,479)/32,768=98,305....2
Long Address 2=2+2,064,383=2,064,385
Long Address 3=98,305+1,867,776=1,966,081

(2) Example of conversion from a decimal address to a CAPCODE :

1) In case of Short Address :

CAPCODE = Short Address - 32,768
For example, the CAPCODE of the decimal address: 32,769 is
CAPCODE = 32,769 - 32,768 = 0000001

2) In case of Long Address :

CAPCODE = Long Address 1 +(2,097,151-Long Address 2)× 32,768+2,068,480
For example, the Long Address 1=1(Dec.), and Long Address 2=2,097,150(Dec.) is
CAPCODE=1+(2,097,151-2,097,150)× 32,768+2,068,480=2,101,249

Annex

Annex 1 : Subscriber Data Registration Standard for the FLEX-TD Radio Paging System

Note : Disclosure of this standard is specified in accordance with the "Regulation for Disclosure of Subscriber Data Registration Standard for the FLEX-TD Radio Paging System" approved in the Standard Assembly.

Annex 2 : Standard Specification for External Interfaces for the FLEX-TD Pagers

1. Overview

1.1 Overview

This standard defines the external interface for the FLEX-TD pagers (referred to as "pagers" in the following).

1.2 External interface

The external interface is specified by physical and electrical characteristics for connecting the pagers with external data communications devices to interface information received by the pager.

1.3 Configuration of external interface

Fig. 1.3-1 below shows the external interface configuration.

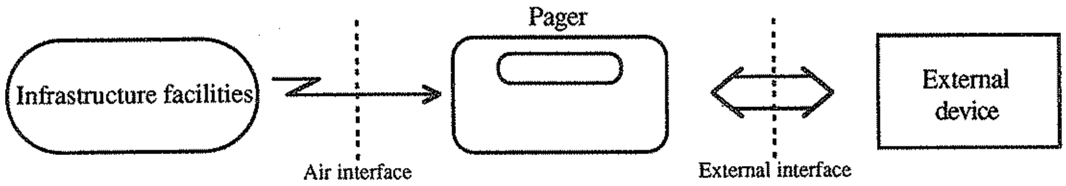


Fig. 1.3-1 : Configuration of external interface

2. Serial interface

2.1 Overview of the Serial interface

This interface consists of a pager and an external device for interfacing the information received by the pager.

Fig. 2.1-1 below gives an overview of the Serial interface.

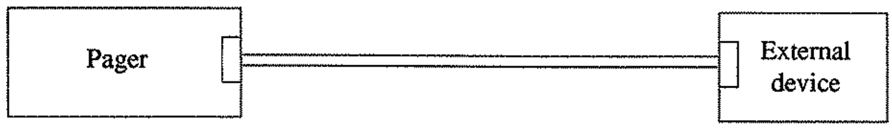


Fig. 2.1-1: Serial interface

2.2 Pagers

Pagers handles received data, etc., for input/output with external devices.

2.3 Technical requirements for Serial interface

2.3.1 Scope of application

Two types of serial interfaces are defined, on the physical requirement.

2.3.2 Physical requirements

The following two types of serial interfaces are defined.

(1) Type I (3-wire)

Type I consists of SI (serial input), SO (serial output) and GND (ground).

(2) Type II (4-wire)

Type II consists of SI (serial input), SO (serial output), GND (ground) and VCC (power source).

2.4 Electrical requirements

2.4.1 GND (ground)

Negative polarity ground must be used and GND must be electrical potential reference.

2.4.2 SO (serial output)

The SO for the pager must be an open collector or an open drain.

Space	:	sink current 1 mA or more (V_{SO}<0.4V)
Mark	:	leak current 10 μA or less (V_{SO}=5V)
Breakage Voltage	:	15V or more

2.4.3 SI (serial input)

An input terminal having a pull-up resistor must be used.

Pull-up resistance is 10kΩ to 100 kΩ.

2.4.4 VCC (power source)

VCC is a power supply line from the external device to the pager.

VCC: 5V or less

2.5 Protocol

Synchronization method	:	start-stop synchronization protocol (full duplex or half-duplex)
Transmission speed	:	1200bps, 2400bps, 4800bps, 9600bps
Data bit	:	8 bits
Stop bit	:	1 bit
Parity	:	None

2.6 Communication procedure

This standard does not specify communication procedures, however, compatibility of external device to be connected to the pager should be sufficiently considered.

3. PCMCIA interface

3.1 Overview of the PCMCIA interface

The PCMCIA interface connects the pager and external device.

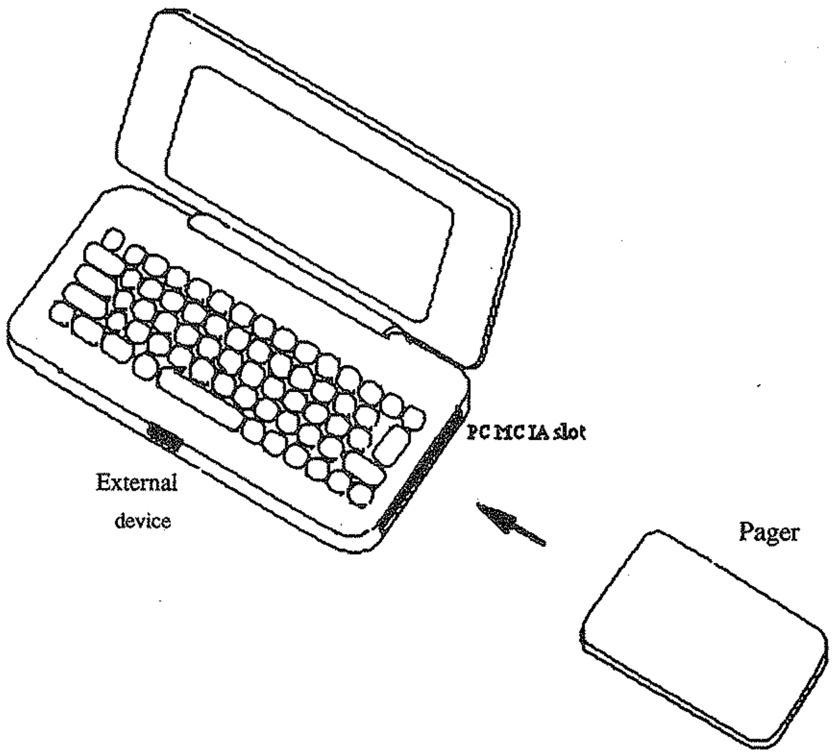


Fig. 3.3-1 : PCMCIA interface

3.1.1 External devices

External devices interface with the pager by inserting the pager into the device's PCMCIA slot.

3.1.2 Pagers

Pagers handle received data for input/output with external devices.

3.2 Technical requirements for the PCMCIA interface.

3.2.1 Reference

The PCMCIA interface, in principle, accord with the standard which is currently disclosed, and shall accords with revisions of the pertinent standard in the future.

3.2.2 Physical requirements

Physical requirements accord with the physical specifications, included in the PC Card Guidelines or the PCMCIA PC Card Standard by Japan Electronic Industry Development Association (JEIDA).

3.2.3 Electrical requirements

Electrical requirements accord with the electrical/interface specifications, included in the PC Card Guidelines or PCMCIA PC Card Standard by Japan Electronic Industry Development Association (JEIDA).

3.2.4 Protocol

This standard does not specify protocols, however, compatibility with external devices to be connected with the pager should be sufficiently considered.

Reference Document A

FLEX™ Protocol Specification
and
FLEX™ Encoding and Decoding Requirements

Issue :G1.8
Document Number :FLEX™-93001
Date : May 7,1996

Note : This reference material is version of the specification which was available at the time this Standard (RCR STD-43A) was established.

FLEX

FLEX™ Protocol Specification

and

FLEX™ Encoding and Decoding Requirements

Issue: G1.8
Document Number: FLEX™-93001
Date: May 7, 1996

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TABLE OF CONTENTS

1. FLEX™ OVERVIEW

1.1. PURPOSE

The major market need which drove the development of the FLEX™ signal protocol is the paging Service Provider's desire for greater channel capacity. (Prior to June 1993 this protocol was identified as WASP - Wide Area Signal Protocol). FLEX™ supports up to five times the traffic of a 1200 bps POCSAG channel when running at the 6400 bps rate. The Multi-speed format allows initial use at low speed (1600 bps) using much of a system's existing infrastructure. In order to maintain the simulcast and fading performance of slower speed codes like Motorola's GSC code, the protocol includes word interleaving to provide 10 mS fade protection and a modulation change to four level FM at 3200 bps and 6400 bps. Greatly improved battery life is achieved through the use of synchronous time slots in which latency in the delivery of messages can be extended to improve battery life. From a subscriber capacity standpoint, the special two word "Long Address" set supports over 3.5 billion users (additional 1.5 billion addresses held in reserve) while the one word "Short Address" set serves close to two million users.

The code is also designed to support both local and nationwide roaming users. Channel identification of the local provider is provided within the protocol along with means to allow scanning pagers to identify channels which belong to nationwide networks. This information will allow roaming pagers to be capable of quickly identifying the presence of their subscribed systems.

The FLEX™ protocol has established the means for future design flexibility by allowing new system features to be added through the use of Frame Sync code words "A5", "A6", ..., through "A15" and additional Block Information Words which can be defined as needed.

1.2. SCOPE

The intent of this document is to ensure that the FLEX™ protocol and the related features and services are implemented in a consistent manner among various manufacturers.

Section 2 gives a general system overview. Section 3, "FLEX™ Protocol Definition", describes the over the air paging information as it appears on the channel. Section 4, "FLEX™ Encoding and Decoding Requirements", specifies the transmission rules for implementing FLEX™ in a paging terminal or other encoding device, and provides decoding requirements for implementing FLEX™ in a pager. Section 5, gives insight into FLEX™ terminology and Section 6 contains the revision history.

This specification is intended for internal use by licensees of the FLEX™ protocol.

1.3. DOCUMENTS OF INTEREST

"FLEX™ Benchmarking" [1]

"FLEX™ Battery Life Performance" [1]

"Mixing Coding Formats on a Channel" [1]

"Mixing Coding Formats on a Multi-channel Transmitter System" [1]

"Telocator Network Paging Protocol" [2] Version 3.7: July 27, 1995

1.4. RECOMMENDED RELATED DOCUMENTATION

"The FLEX™ Protocol's Operational Capabilities for Multi-Frequency, Multi-Area Use".

"Secure Instructions to FLEX™ Pagers"

Available to qualified organizations (e.g. licensees and paging operators evaluating FLEX™) under a Non-Disclosure Agreement with Motorola.

1.5. COMMENTS

1. The Text and Figures that appear in this document are all part of this specification. If there is an apparent conflict between the Text and an associated Figure, please contact Marianne Lloyd[1].

2. Constructs (e.g., bits, bytes, words, op-codes, values) that are defined by this protocol document shall be used as they are defined in this protocol document. All undefined constructs and all constructs designated as "Reserved", or words of similar import, by this document shall not be used for information signaling purposes. Motorola's express written approval is required for use of such undefined or "Reserved" constructs for any purpose including non-published implementations.

[1] For more information on Motorola's new FLEX paging code, contact Marianne Lloyd: Telephone (407) 739-8281; FAX (407) 739-2519

[2] For more information contact The Personal Communications Industry Association (PCIA formerly Telocator) at 500 Montgomery Street, Suite 700, Alexandria, VA 22314-1561. Telephone (703) 739-0300.

2. GENERAL DESCRIPTION

2.1. SYSTEM OVERVIEW

The FLEX™ code is a synchronous time slot protocol tied to an accurate time reference. When Frame 0 is synchronized with the start of each hour the pager can derive real time from the current Frame and Cycle number thus providing the user accurate time within the hour with no need for adjustment. (User sets hour and date or system provider can optionally choose to send time and date setting commands.)

Each address in a pager is assigned a base Frame in the set of 128 Frames appearing on the channel during each 4 minute period of time. A user can trade battery life for the more frequent delivery of messages. FLEX™ has defined the concept of collapsing the Frame number to less than the 7 binary bits normally required to convey a Frame number. This masking of a specific number of Frame number bits allows delivery latency to be traded for battery life. It is also valuable to force the concentration of FLEX™ paging traffic into very small periods of time to facilitate mixing with other codes. As an example, all pagers in the system can be instructed, in the Block Information Word (BIW) sent at the beginning of each Frame, to respond only to the 4 least significant bits in the Frame number field. This results in pagers being operative for receiving messages once every 16 Frames (30 seconds). Similarly, the pager code plug will individually instruct specific pagers to Collapse their assigned Frame number. When the code plug assigned "pager Collapse" value is smaller than the "system Collapse" value it will take precedence and the pager will be receptive more often than the system value. If the system value is the smaller it will set the battery saving cycle.

Battery savings is also derived from the organization of fields within each Frame. The active addresses are grouped together in a defined area at the beginning of each Frame allowing the pager to immediately battery save at the end of this field when its address is not detected.

Once a pager acquires synchronization to the channel it expects to find its assigned Frame within a very tight time window. Even if signal is lost, the pager continues to look in the expected windows possibly for up to 60 minutes (time-out varies with system clock stability via programmed code plug value) as might be the case during a subway ride. For this reason the terminal must maintain timing even through power failures so that when power is restored, paging will begin synchronous with the signal existing prior to the power outage.

The higher speed of FLEX™ creates tighter requirements on the time equalization of each transmitter link in order to minimize simulcast time offsets. It is recommended that the paging data be buffered at the transmitter site and re-clocked using an accurate timing source (possibly from a satellite). The use of 4-level FM doubles the modulation symbol length (when compared to 2-level FM) helping reduce the effect of simulcast distribution errors and the effect of propagation timing differences between multiple signals within the capture range of the receiver.

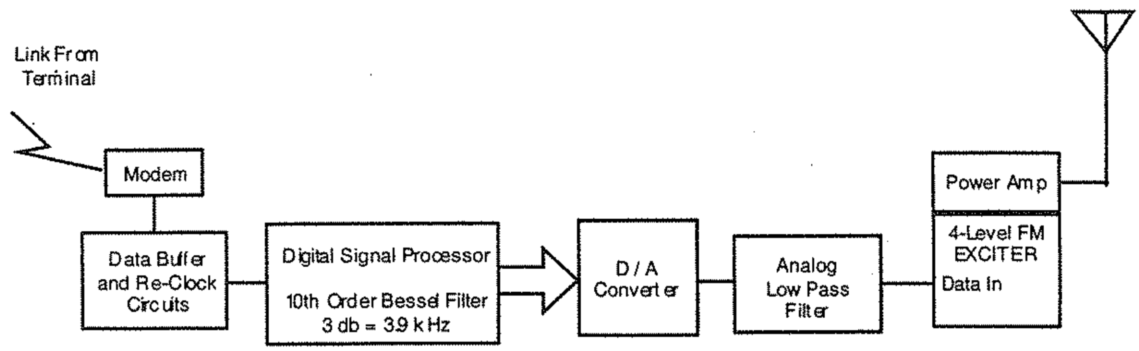
The multiple speed feature of FLEX™ is accomplished by multiplexing one, two, or four 1600 bps channels of traffic. If group calls are to be set up, the system provider should attempt to assign all potential members to the same Frame for battery saving reasons. If members of the group have "single phase" pagers then their phases must match or the message will have to be repeated on each traffic multiplex phase.

A roaming overlay is defined to support smaller systems using Simulcast System IDentification (SSID) in which a portion is embedded in each Frame of the protocol. Larger Global roaming systems use a Network IDentification (NID) to mark RF channels which are members of a Global, Nationwide, or Regional network.

Future high tier products will be capable of decoding all 4 phases simultaneously as may be required when message and information services share the same channel. Most alphanumeric pagers will be capable of 1600 bps reception on "any phase" while even higher tier data intensive products will be capable of 6400 bps message reception using "all phases".

3. FLEX™ PROTOCOL DEFINITION

3.1. MODULATION



A low speed FLEX™ system intended to operate at 1600 bps requires few changes to an existing base station designed for 1200 / 2400 POCSAG operation. The deviation for FLEX™ should be set to ± 4800 Hz, however, if the channel is mixed with another protocol and only 2-FM is to be used, the pager will tolerate less deviation with little effect on sensitivity. When FLEX™ 4-FM is required then ± 4800 Hz must be used. See table below.

2-Level FM		**4-Level FM** (Gray Coded)	
"1"	Carrier + 4800 Hz	"10"	Carrier + 4800 Hz
		"11"	Carrier + 1600 Hz
		"01"	Carrier - 1600 Hz
"0"	Carrier - 4800 Hz	"00"	Carrier - 4800 Hz

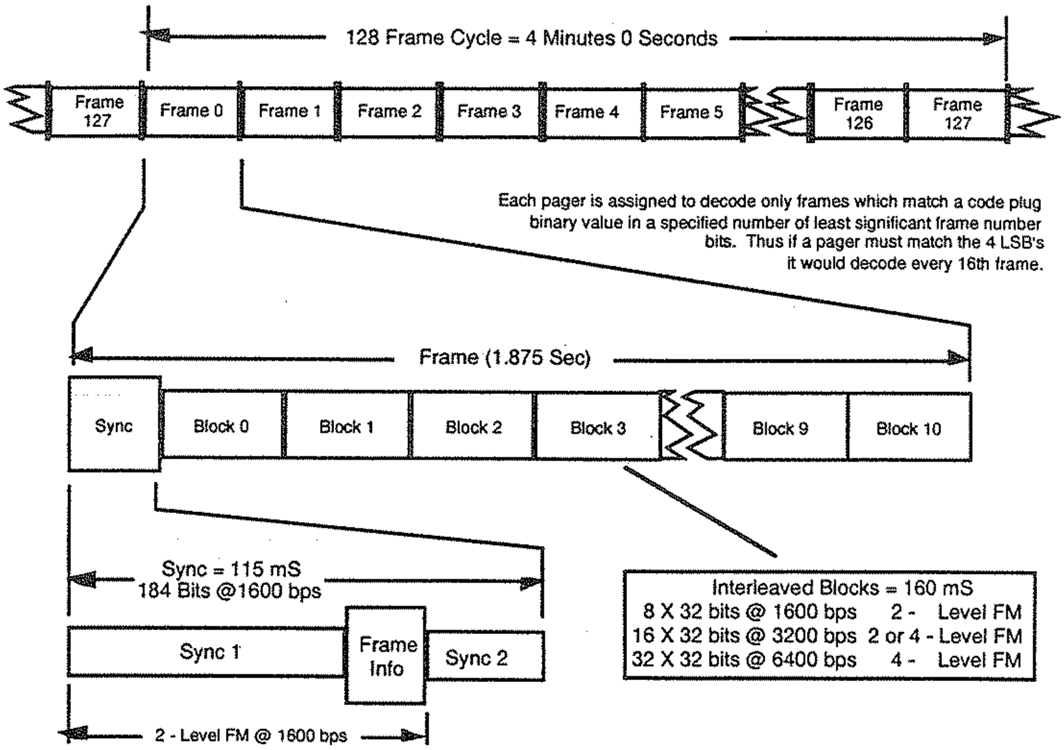
Deviation difference between 4-FM symbols is 3200 Hz ± 60 Hz
Binary to 4-FM Conversion Order - Symbol MSB followed by Symbol LSB.
2-FM only - systems deviation may be adjusted within the range of ±4.0 to ±4.8 kHz

Higher speed FLEX™ systems designed to operate at 3200 bps and 6400 bps require an upgraded base station and high speed communication links to each base station. The DSP filter in the figure above is required to meet adjacent channel splatter requirements while maintaining good simulcast performance.

When converting the binary data stream to 4 Level FM the first bit out becomes the most significant bit (MSB) of the 4 level symbol with the following bit the least significant bit (LSB) of the symbol. Thus for the FLEX™ protocol operating at 6400 bps, Phase "a" is always the symbol MSB with phase "b" the LSB. The same is true for phase "c" and "d".

The frequency difference between adjacent symbols shall be 3200 ± 60 Hz. The 2-level modulation within the FLEX™ sync portion must be held to the same accuracy as the "00" and "10" symbols in order to provide the means to derive accurate 4-level symbol thresholds.

3.2. FLEX™ FRAME STRUCTURE



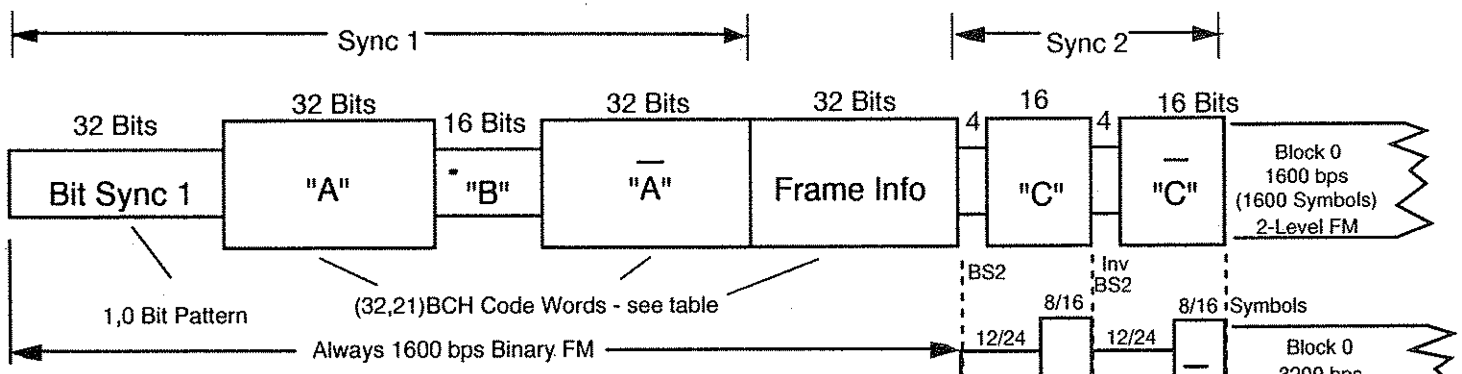
FLEX™ Frames are transmitted at 32 Frames per minute (1.875 sec per Frame). A FLEX™ Cycle is defined to be 128 Frames (4 minutes) with each Frame numbered from 0 to 127. An hour is divided into 15 FLEX™ Cycles numbered 0 through 14. The Frame Information Word contains the 7 bit Frame number and the 4 bit Cycle number. It is recommended that Frame 0, Cycle 0 be synchronized to GPS time on the hour. For roaming systems this is a requirement.

The Sync 1 portion of each Frame is transmitted at 1600 bps providing means for obtaining Frame timing, 1600 bps symbol timing, and an indication of the speed for the remainder of the Frame. The Frame Information Word (FIW) carries 11 bits indicating Frame and Cycle numbers, 5 bits to indicate a standard FLEX™ operation with Low Traffic Flags for the indication of the time multiplex phases with low traffic (address field does not extend past Block 0) or the 5 bits indicates the presence of a Time Diversity system and its structure, 1 bit to indicate the channel supports roaming subscribers and a 4 bit Checksum to ensure quality of the received information.

The Sync 2 portion of the Frame is designed to provide synchronization at the Frame's block speed allowing proper de-multiplexing and decoding of the message blocks.

3.3. SYNC STRUCTURE

The structure of the FLEX™ synchronization signal is illustrated in the following figure.

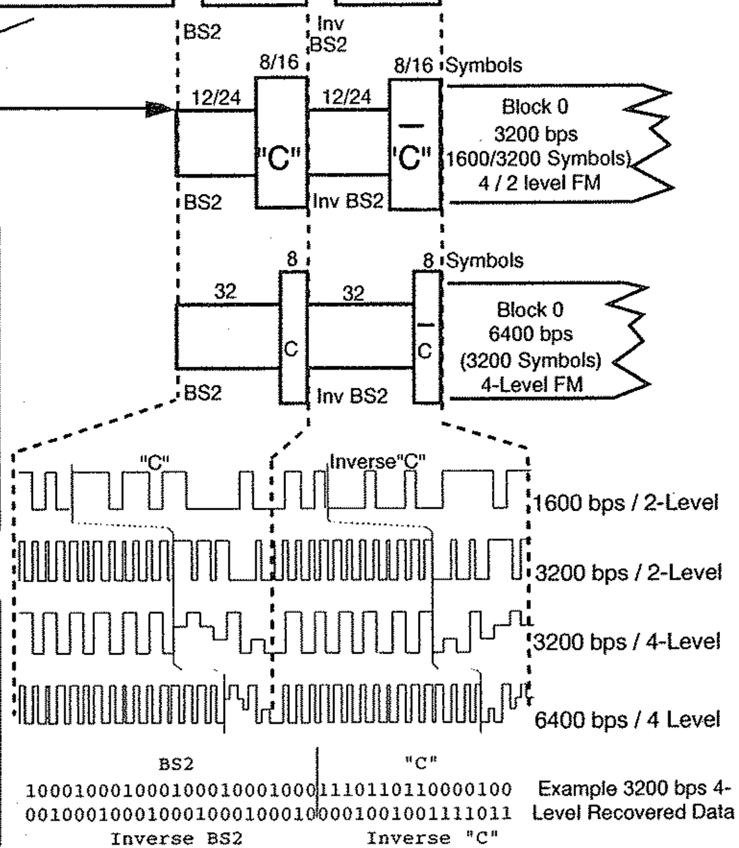


Frame Speed		"A" Binary Pattern
A1	1600/2FM	0111100011110011 0101100100111001
A2	3200/2FM	1000010011100111 0101100100111001
A3	3200/4FM	0100111110010111 0101100100111001
A4	6400/4FM	0010000101011111 0101100100111001
A5	Future	1101110101001011 0101100100111001
•		
A15	Future	1111000110011101 0101100100111001
Ar	Re-Sync	1100101100100000 0101100100111001

Sample Bit Stream for 1600 bps Frame Speed

BS1	1010101010101010 1010101010101010
A1	0111100011110011 0101100100111001
B	0101010101010101
Inv A1	1000011100001100 1010011011000110
Frame Info	iiiiiiiiiiiiiiii iiiiipppppppppP
BS2	1010
C	1110110110000100
Inv BS2	0101
Inv C	0001001001111011

LSB on left is transmitted 1st.



Sync 2 - The "C" waveforms are defined as either 2-level or 4-level symbols depending on the desired speed and modulation in the data blocks.

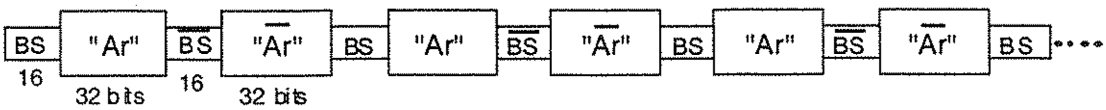
The sample bit stream table found in the above figure shows exactly the binary wave form which must appear on the channel for 1600 bps FLEX™ Frames. For FLEX™ 3200 bps sent as binary 2-level FM, the A2 and the inverse A2 words are substituted for the "A1" and inverse "A1" patterns shown in the table. The Sync 2 pattern is changed to the example shown in the lower right of the figure (24 bits of comma followed by the 16 bit "C" pattern transmitted at 3200 bps). When 3200 bps 4-level is chosen the A3 and inverse A3 words are chosen to replace "A1" and a 4-level modulator is required to transmit the "C" pattern as shown in lower right of the figure. Note also that the comma now is a pattern made up of the 4-level 10, and 00 symbols. At 6400 bps, the same process is used as just described substituting A4 in Sync 1 and modifying Sync 2 to 32 BS2 symbols (4-level) and 8 symbols for the "C" pattern. In the future, FLEX™ compatible systems will use the A1 through A15 sync words and variations in the "B" word pattern. When a pager receives one of these other Sync word transmissions, battery saving may begin immediately after the first detection of A5 through A15 or in the case of a pager not programmed to detect A5 through A15, the absence of a detection of A1 through A4 in the expected time window may result in a return to the battery save mode.

The "C" pattern is used to facilitate the re-synchronization to the data blocks which may be sent at different speeds and with different modulation from the 1600 bps Sync 1. The "C" pattern transmitted always decodes to the same bit pattern independent of speed or modulation. ("C" = 1110110110000100 with 1st bit transmitted on the left) The Bit Sync 2 pattern surrounding the "C" pattern is intended to look like full deviation comma on the channel. This results in decoded bit patterns of 1,0,1,0,1,0,1,... for 2-level modulations, 10,00,10,00,10,00... for 4 level modulations.

Table of "A" Patterns

	1 2 3 4 5 6 7 16	17 32
A 1	0 1 1 1 1 0 0 0 1 1 1 1 0 0 1 1	0 1 0 1 1 0 0 1 0 0 1 1 1 0 0 1
A 2	1 0 0 0 0 1 0 0 1 1 1 0 0 1 1 1	0 1 0 1 1 0 0 1 0 0 1 1 1 0 0 1
A 3	0 1 0 0 1 1 1 1 1 0 0 1 0 1 1 1	0 1 0 1 1 0 0 1 0 0 1 1 1 0 0 1
A 4	0 0 1 0 0 0 0 1 0 1 0 1 1 1 1 1	0 1 0 1 1 0 0 1 0 0 1 1 1 0 0 1
A 5	1 1 0 1 1 1 0 1 0 1 0 0 1 0 1 1	0 1 0 1 1 0 0 1 0 0 1 1 1 0 0 1
A 6	0 0 0 1 0 1 1 0 0 0 1 1 1 0 1 1	0 1 0 1 1 0 0 1 0 0 1 1 1 0 0 1
A 7	1 0 1 1 0 0 1 1 1 0 0 0 0 0 1 1	0 1 0 1 1 0 0 1 0 0 1 1 1 0 0 1
A 8	0 1 1 0 0 0 1 1 0 1 0 0 0 0 0 1	0 1 0 1 1 0 0 1 0 0 1 1 1 0 0 1
A 9	0 0 0 1 1 0 1 1 1 1 1 0 0 0 1 0	0 1 0 1 1 0 0 1 0 0 1 1 1 0 0 1
A 1 0	0 0 1 0 1 1 0 0 1 0 0 0 0 1 1 0	0 1 0 1 1 0 0 1 0 0 1 1 1 0 0 1
A 1 1	1 0 1 0 0 1 0 1 1 1 1 0 1 0 0 0	0 1 0 1 1 0 0 1 0 0 1 1 1 0 0 1
A 1 2	1 0 0 1 0 0 1 0 1 0 0 0 1 1 0 0	0 1 0 1 1 0 0 1 0 0 1 1 1 0 0 1
A 1 3	0 1 1 0 1 1 1 0 1 0 0 1 1 0 0 0	0 1 0 1 1 0 0 1 0 0 1 1 1 0 0 1
A 1 4	1 0 1 1 1 1 1 0 0 1 0 1 1 0 1 0	0 1 0 1 1 0 0 1 0 0 1 1 1 0 0 1
A 1 5	1 1 1 1 0 0 0 1 1 0 0 1 1 1 0 1	0 1 0 1 1 0 0 1 0 0 1 1 1 0 0 1
A r	1 1 0 0 1 0 1 1 0 0 1 0 0 0 0 0	0 1 0 1 1 0 0 1 0 0 1 1 1 0 0 1

3.4. EMERGENCY RE-SYNCHRONIZATION TRANSMISSION



In emergency cases where the FLEX™ time reference backup systems fail or some other critical component is known to have failed it may become necessary for the infrastructure to force all pagers to re-synchronize. (Note: FLEX™ is intended to be a synchronous paging system requiring no preamble, thus when a pager synchronizes to the Frame timing it receives over the air, all subsequent transmissions must follow with the same timing or the pager will miss messages.) The above re-synchronization pattern must be continuously transmitted on the channel for a length of time equal to or greater than the system Collapse cycle. Thus if the system Collapse is set to 7 (longest case) the transmission must be 4 minutes long to ensure that a pager operating at the full system Collapse value would have at least one opportunity to receive the reset instruction. If at the other extreme the system had been running with a system Collapse of "0" which forces all pagers to receive every Frame, only a 1.875 second length of re-synchronization pattern would be required (or several Frames for all pagers to have multiple opportunities) .

The re-synchronization pattern follows the definition of the "A" Synchronization portion of the Sync Structure described in the previous section. The "A" pattern is chosen to be the "Ar" pattern previously defined with 16 bits of comma separating the normal and inverted "Ar" words. The comma leading into the inverted "A" pattern is the inverse of the comma leading into the normal "A" pattern. There are no constraints as to how the transmission starts or ends just that the total length be at least equal to the length of the battery saving strobe period of the worst case pager in the system.

3.5. INTERLEAVED BLOCK STRUCTURE

Each FLEX™ block occupies 160 mS of transmission time independent of the designated Frame speed. As is illustrated below additional information tracts (or multiplex phases) are combined together increasing the information per block in proportion to the selected speed.

1600 BPS Block (8 Words X 32 Bits)

	1 2 3 4 5 6 7 . . . . 21 Information	. . . . . . 31 Parity	32 Ck
Word 0a	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	P
Word 1a	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	P
Word 2a	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	P
Word 3a	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	P
Word 4a	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	P
Word 5a	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	P
Word 6a	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	P
Word 7a	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	P

3200 BPS Block (16 Words X 32 Bits)

Word 0a	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	P
Word 0c	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	P
Word 1a	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	P
Word 1c	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	P
•			
•			
•			
Word 6a	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	P
Word 6c	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	P
Word 7a	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	P
Word 7c	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	P

6400 BPS Block (32 Words X 32 Bits)

Word 0a	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	P
Word 0b	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	P
Word 0c	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	P
Word 0d	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	P
Word 1a	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	P
•			
•			
•			
Word 6d	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	P
Word 7a	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	P
Word 7b	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	P
Word 7c	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	P
Word 7d	i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	P

The above figures represent a data stream on the channel which is generated by transmitting columns starting at the upper left and proceeding to the lower right. The 3200 and 6400 bps block construction can be viewed as shown above where the code word interleaving and multiple 1600 bps data stream multiplexing are combined into one operation. It could just as correctly be viewed as multiple interleaved data streams multiplexed together.

3.5.1. Block Size

All blocks are 160 mS in time. As the channel bit rate increases so to does the multiplex degree.

1600 bps	- 8 Words	8 X 32 =	256 bits	Multiplex degree 1
3200 bps	- 16 Words	16 X 32 =	512 bits	Multiplex degree 2
6400 bps	- 32 Words	32 X 32 =	1024 bits	Multiplex degree 4

3.5.2. Block Transmission

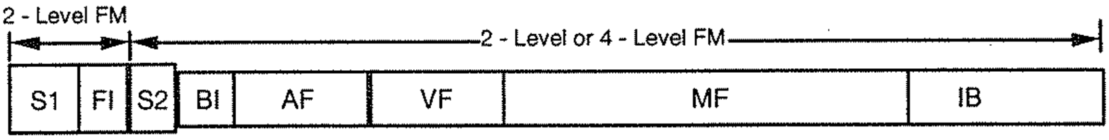
All words are (31,21)BCH codewords (with 32nd even parity bit) arranged in rows starting at Word 0a, Word 0b, 0c, 0d, 1a, - - - - , 7a, 7b, 7c, 7d. Transmission takes place by columns starting at bit 1 of word 0a. This binary bit stream is either modulated directly (binary FSK), or in the case of 3200 and 6400 bps 4-level, it is first passed through a 2 bit symbol converter. The symbol conversion is synchronized so that the first two bits of the block are always paired together to form a four level symbol (bit 1 of word 0a and 0c for 3200 bps and bit 1 of word 0a and 0b for 6400 bps). For example, at 6400 bps, bit 1 of word 0a becomes the MSB of the symbol with bit 1 of word 0b the LSB; at 3200 bps, bit 1 of word 0a becomes the MSB of the symbol with bit 1 of word 0c the LSB. (Refer to Section 3.5 for illustrations)

3.5.3. Block Reception

Each receiver extracts (de-multiplexes) its assigned sample phase ("a", "b", "c", or "d") from the bit stream forming an 8 X 32 array in memory. The 32 bit BCH code words are now identifiable and can be processed through a 2 bit error correcting algorithm. Error status is noted for each word and the information bits are extracted for further processing. Stored within the Subscriber Unit is the assigned phase value of 0, 1, 2, or 3. At 6400 bps, 0 maps into phase "a", 1 = "b", 2 = "c" and 3 = "d". At 3200 bps, 0 & 1 map into "a" and 2 & 3 map into "c". At 1600 bps the multiplex assignment is not a factor in the decoding parameters.

3.6. TRANSMISSION ORDER

The following figure represents field ordering within a FLEX™ Frame. It should be noted that field boundaries are not restricted to block boundaries.



Synchronization 1 - Consists of 112 bits at 1600 bps modulated with 2- level FM. Fifteen different patterns have been defined for present and future applications. Each pattern provides overall system synchronization and specifies the type of data and data modulation which follows directly. Detection of the 5th, through 15th "A" Sync code word types indicates that no data is present for a paging receiver which is responsive to the 1st through 4th "A" Sync code words - i.e. the pager should battery save for the remainder of this Frame.

Frame Information - This is a 32 bit code word transmitted at 1600 bps modulated with 2 - level FM. It identifies the Frame Number 0 - 127 (7 bits), the Cycle Number 0 - 14 (4 bits), 5 bits to indicate standard FLEX™ operation with Low Traffic Flags for the indication of time multiplex phases with low traffic (address field does not extend past Block 0), 1 bit to indicate the channel supports roaming subscribers and a 4 bit Checksum to ensure quality of the received information.

Synchronization 2 - Detection of this pattern provides timing information for synchronization to a higher speed Frame. It consists of a 40 bit (40 Symbol) pattern transmitted at 1600 bps 2-FM if the Frame speed is 1600 bps, an 80 bit (80 Symbol) pattern transmitted at 3200 bps if the Frame speed is 3200 2-FM, an 80 bit (40 Symbol) pattern transmitted at 3200 bps 4 - Level FM if the Frame speed is 3200 bps 4-FM, or a 160 bit (80 Symbol) pattern if the Frame speed is 6400 bps.

Block Information - The first 1, 2, 3, or 4 words of the first interleaved Block contain Frame and system structure information. The typical case is a 1 word field with 2 bits indicating the start of the Address Field, 6 bits defining the start of the Vector Field, 2 bits to indicate traffic overflow into the next Frame(s) (Carry On), 3 bits indicating number of low order Frame number bits to be examined (System Collapse) and 4 bits indicating the number of priority addresses at the beginning of the Address Field. Words 2, 3, and 4 contain information for calendar and time setting in addition to required information for roaming systems.

Address Field - The Address Field starts directly after the Block Information Words and consist of short addresses (1 word) and long addresses (2 words). Addresses which are limited to Tone Only operation should be placed at the end of the Address Field since an associated vector is not required. Priority addresses are placed at the beginning of the field.

Vector Field - The Vector Field starts at the location indicated in the Block Information Word and maintains a 1 to 1 relationship with the Address Field. The Vector word points to the start word of the associated message and indicates the message length in code words.

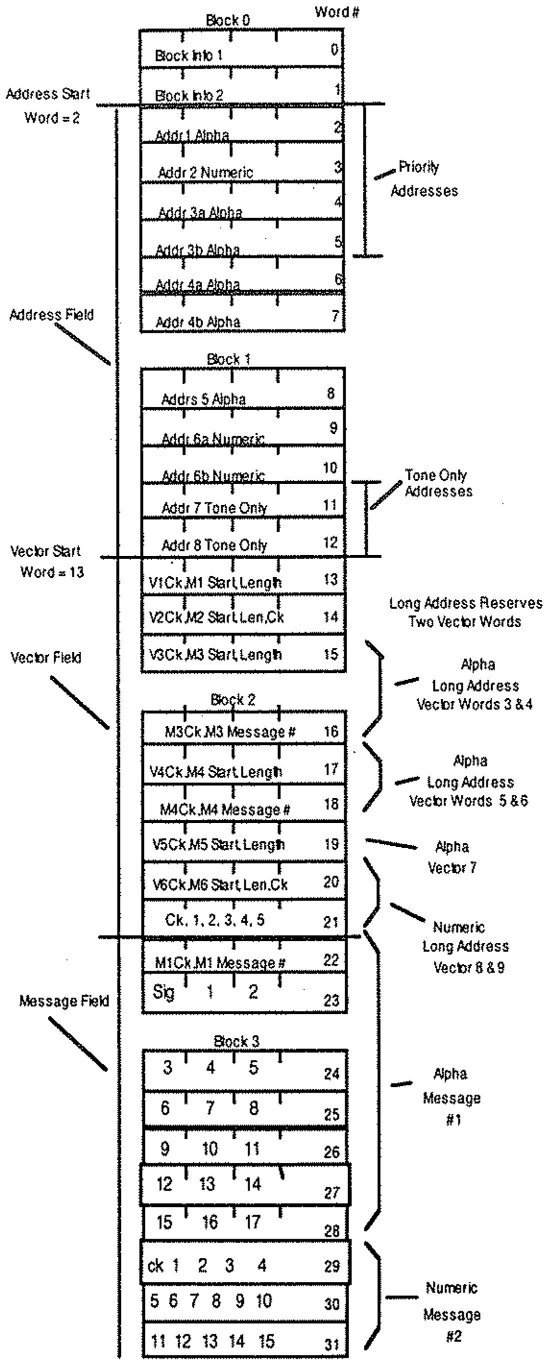
Message Field - Contains the message words specified by the Vector Field.

Idle Blocks - Unused Blocks should be filled with alternating all 1's and all 0's code words to produce a 1,0 pattern on the channel at 1600 bps. When transmitting 4 - level FM the unused Blocks should be filled with the proper patterns to result in the same 1600 bps binary waveform on the channel. (1,0,1,0 bit pattern at 1600 bps at 2 FSK; 1,1, 0, 0, 1, 1, 0, 0 bit pattern at 3200 bps at 2FSK; 10, 00, 10, 00 symbol pattern at 3200 bps at 4FSK; 10, 10, 00, 00, 10, 10, 00, 00 symbol pattern at 6400 bps at 4 level FSK)

The following figures and associated text represent the construction of a FLEX™ Frame with a mix of message types.

Example - This diagram represents a mix of pages on just one phase of a FLEX™ Frame transmission. An additional 1 or an additional 3 phases may be time multiplexed into this represented data when the channel speed is raised to 3200 or 6400 bps.

Block Information Field - This field is usually 1 word but may be up to 4 words when additional information is carried. Two information bits specify the beginning (and number of Block Information Words) of the Address Field. Six information bits specify the beginning of the Vector Field.



Address Field - By knowing the beginning of the Address Field and knowing the beginning of the Vector Field the pager can determine how many Address words on the channel must be decoded in the Frame in order to determine if a message is present. When an Address is detected, the position in the Address Field is matched to the same position in the Vector Field to determine which Vector holds the pointers to the associated message. A special priority Address Field is defined to occupy up to the first 15 Addresses in the Address Field. Four bits in the Block Information Word identify this boundary.

Address Ordering is as follows:

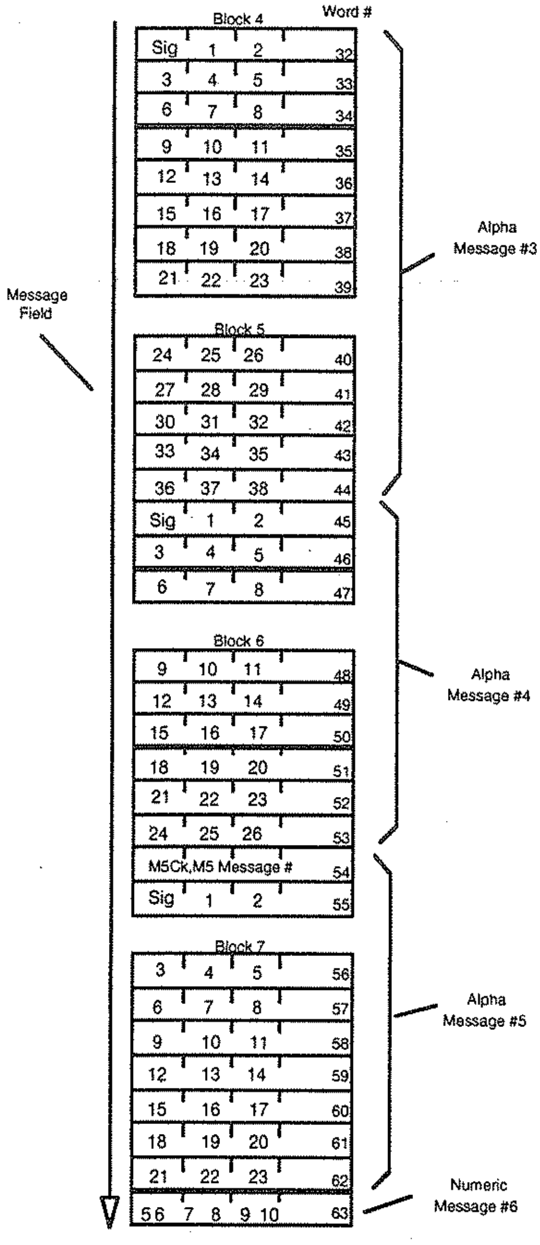
a) Priority Addresses - First 0 - 15 Addresses

b) Addresses with associated Vectors

c) Tone Only Addresses which do not require Vectors. (Code plug must specify TO address - not a Tone Only function).

Long two-word Addresses - are not treated in any special manner in the Address Field. The extra word reserved in the Vector Field becomes the first word of the message - the Vector points to the rest of the message.

Vector Field - Vectors are defined as single (31,21) BCH + even parity bit code words (in the case of a long two word address the Vector is also two words) where the first 4 bits are defined to be check bits followed by 3 Vector type bits. The remaining 14 bits (14 + 21 bits long address) carry the message start pointer, the message length (in codewords) or other information depending on the Vector type. See word definitions for complete definition.



Vector Types:

$V_2V_1V_0$

0 0 0	Secure Message Vector
0 0 1	Short Instruction Vector
0 1 0	Short Message Vector
0 1 1	Numeric Vector
1 0 0	Num. Vector with Format
1 0 1	Alphanumeric Vector
1 1 0	HEX / Binary Vector
1 1 1	Num. Vector with Message #

Calculation of the Vector Word Position:

V (word #) = Addr (word #) - Addr Start (word #) + Vector Start (word #)

The data field portion of each message starts with a Checksum as defined in the Code Word definitions of FLEX™. Depending on the type of page the Checksum and even the first few characters may be located in the Vector portion (as in case of two vector words being assigned for long addresses). The Checksum covers the total message field including fill bits and fill characters completing the last BCH word.

Unused blocks are filled with the all 1's and all 0's Idle code words in the proper order to create the Bit Sync 1 pattern on the channel. (Binary 1,0 pattern at 1600 bps - blocks start with fill pattern and then are written over as the Frame is filled with traffic.) This pattern at the 6400 bps channel speed is equivalent to symbol transmissions of 10, 10, 00, 00, 10, 10, 00, 00 • • • • • etc., where gray coded 4-level FM symbols are used. "10" is the extreme positive deviated symbol and "00 is the extreme negative deviated symbol.

Message location in the message field does not have to be assigned in any particular order relative to the address order. Several addresses can be vectored to the same message.

3.7. ADDRESS FIELD RANGE DEFINITION

Type	HEX	Binary	Decimal	Quantity
Idle Word	000000	0 0000 0000 0000 0000 0000	0	1
Long Address 1	000001	0 0000 0000 0000 0000 0001	1	
	008000	0 0000 1000 0000 0000 0000	32,768	32,768
Short Address	008001	0 0000 1000 0000 0000 0001	32,769	
	1E0000	1 1110 0000 0000 0000 0000	1,966,080	1,933,312
Long Address 3	1E0001	1 1110 0000 0000 0000 0001	1,966,081	
	1E8000	1 1110 1000 0000 0000 0000	1,998,848	32,768
Long Address 4	1E8001	1 1110 1000 0000 0000 0001	1,998,849	
	1F0000	1 1111 0000 0000 0000 0000	2,031,616	32,768
Short Addresses (Reserved)	1F0001	1 1111 0000 0000 0000 0001	2,031,617	
	1F27FF	1 1111 0010 0111 1111 1111	2,041,855	10,239
Info Svc Address	1F2800	1 1111 0010 1000 0000 0000	2,041,856	
	1F67FF	1 1111 0110 0111 1111 1111	2,058,239	16,384
Network Addr's	1F6800	1 1111 0110 1000 0000 0000	2,058,240	
	1F77FF	1 1111 0111 0111 1111 1111	2,062,335	4,096
Temporary Addr's	1F7800	1 1111 0111 1000 0000 0000	2,062,336	
	1F780F	1 1111 0111 1000 0000 1111	2,062,351	16
Operator Messaging Addresses	1F7810	1 1111 0111 1000 0001 0000	2,062,352	
	1F781F	1 1111 0111 1000 0001 1111	2,062,367	16
Short Addresses (Reserved)	1F7820	1 1111 0111 1000 0010 0000	2,062,368	
	1F7FFE	1 1111 0111 1111 1111 1110	2,064,382	2,015
Long Address 2	1F7FFF	1 1111 0111 1111 1111 1111	2,064,383	
	1FFFFE	1 1111 1111 1111 1111 1110	2,097,150	32,768
Idle Word	1FFFFF	1 1111 1111 1111 1111 1111	2,097,151	1

2,097,152 Total

Addresses are always transmitted starting with the LSB to MSB followed by the BCH parity bits and the 32nd overall even parity bit.

The designation of a Long Address CAPCODE to a subscriber unit is defined to be two Long Address words sequentially transmitted. Each pairing of Long Address Words creates over 1 billion combinations. The combinations of 1-2, 1-3, 1-4, 2-3 and 2-4 create over 5 billion CAPCODEs.

3.8. CODE WORD DEFINITIONS

3.8.1. Basic Code Word Structure

1 2 3 4 5 6 7 8 9 10 21	22 31	32
$d_{01}d_{02}d_{03}d_{04}d_{05}d_{06}d_{07}d_{08}d_{09}d_{10}d_{11}d_{12}d_{13}d_{14}d_{15}d_{16}d_{17}d_{18}d_{19}d_{20}d_{21}$	$P_{22}P_{23}P_{24}P_{25}P_{26}P_{27}P_{28}P_{29}P_{30}P_{31}$	P_{32}
Information	Parity	Ck
$x_0\ x_1\ x_2\ x_3\ \ a_0\ a_1\ a_2\ a_3\ b_0\ b_1\ b_2\ b_3\ c_0\ c_1\ c_2\ c_3\ d_0\ d_1\ d_2\ d_3\ \ e_0$	$P_{22}P_{23}P_{24}P_{25}P_{26}P_{27}P_{28}P_{29}P_{30}P_{31}$	P_{32}

Data LSB

First bit transmitted
(Same format as POCSAG)

Certain words requiring extra error
detection employ a 4 bit check
character defined by
X = ones complement(A+B+C+D+E)
where X is the 4 LSB's of the result.

Overall even parity
check (Same as
POCSAG)

All (31,21) BCH + even parity bit code words received in the FLEX™ code protocol are processed through a 2 bit error corrector. The 8 word interleaved block structure provides for correction of 16 consecutive errors in the received data stream (32 consecutive bit errors at 3200 bps and 64 consecutive bit errors at 6400 bps in the time multiplexed data stream). Since employing the maximum error correction may in some cases (low S/N and extreme cases of fading) result in an unacceptable error rate out of the decoder, the FLEX™ protocol utilizes Checksums embedded in the data stream. The Checksum used in the Frame Information Word, the Block Information Word, and all Vector Words is calculated by forming 4-bit fields as shown in above figure and calculating the binary sum. The result is 1's complemented (each bit inverted) and the 4 LSB's of the result are transmitted as the Checksum. (This definition eliminates the transmission of the all 0's code word since all zeros in the information field results in a Checksum equal to 1111.) Checksums used elsewhere are based on the same concept but are tailored to the specific need.

Example: Calculate the Checksum for the following information bits 5-21

xxxx 1010 0011 1001 1100 1

Rearrange each 4 bit field by moving LSB's to the right:

```
  0101
  1100
  1001
  0011
     1
011110
```

1's complement of the result = 100001

The 4 LSB's = 0001

Rearranging LSB to the left for transmission = 1000 1010 0011 1001 1100 1

3.8.2. BCH Generator Polynomial

The (31,21) BCH code word with 32nd bit added to provide an overall even parity check is the same word as defined for the POCSAG code. Its use in FLEX™ is intended to follow POCSAG protocol as much as possible.

Each code word has 21 information bits, which correspond to the coefficients of a polynomial having terms from X^30 down to X^10. This polynomial is divided, Modulo-2, by the generating polynomial G(x) = X^10 + X^9 + X^8 + X^6 + X^5 + X^3 + X^0. The check bits correspond to the coefficients of the terms from X^9 to X^0 in the remainder polynomial found at the completion of this division. The complete block, consisting of the information bits followed by the check bits, corresponds to the coefficients of a polynomial which is integrally divisible in modulo-2 fashion by the generating polynomial.

To the 31 bits is added a 32nd bit to provide an even parity check of the whole code word.

3.8.3. Frame Information Word

1 2 3 4 5 6 7 21	31	32
Information	Parity	Ck.
x_0 x_1 x_2 x_3 c_0 c_1 c_2 c_3 f_0 f_1 f_2 f_3 f_4 f_5 f_6 n_0 r_0 t_0 t_1 t_2 t_3	p p p p p p p p p p	P
0 0 1 1 1 1 0 0 0 0 1 1 1 1 0 0 0 0 0 0 1	0100010101	1

Example: Cycle 3, Frame 60, no roaming support, standard FLEX™, low traffic in phase d

c - Cycle Number (0 - 14) c_3 c_2 c_1 c_0 15 Cycles per Hour
f - Frame Number (0 - 127) f_6 f_5 f_4 f_3 f_2 f_1 f_0 128 Frames per Cycle
n - Roaming Support - Yes when n = 1; No when n = 0
r - Repeat Paging / Time Diversity Indicator -
If r = 1, t_3 t_2 t_1 t_0 are reserved.
If r = 0, t_3 t_2 t_1 t_0 are Low Traffic flags for each phase in the Frame
t - Definition dependent on value of "r".
When r = 0, (t_3 t_2 t_1 t_0) are Low Traffic Flags for phases (d,c,b,a)
At 3200 bps t_3=t_2 and t_1=t_0 Representing the 2 phases in the Frame.
At 1600 bps t_3=t_2=t_1=t_0 Representing the one phase in the Frame.
t = 1 - Indicates Address Field contained within Block 0
t = 0 - Indicates Address Field extends past Block 0
These flags give an early indication that the traffic is light and all addresses are contained within Block 0. The infrastructure will not set a flag to 1 even when traffic is low if a Carry On or Collapse change condition exists.
x - Standard 4 bit Checksum
Frames are to be transmitted in real time with leading edge of Bit Sync 1 of Cycle 0 Frame 0 synchronized with the beginning of the hour.

3.8.4. Block Information Word (BIW) 1

1	2	3	4	5	6	7	.	.	.	.	.	.	.	.	.	.	.	.	.	21	 31	32
Information																					Parity	Ck
x_0	x_1	x_2	x_3	p_0	p_1	p_2	p_3	a_0	a_1	v_0	v_1	v_2	v_3	v_4	v_5	c_0	c_1	m_0	m_1	m_2	p p p p p p p p p p	P
0	1	0	1	0	1	0	1	0	1	0	0	1	1	1	1	1	0	0	1	1	1011110010	0

Example: Addresses start at Word #3, Vectors start at Word #60, carry on into next 1 Frames, System Collapse of 6, first 10 addresses are priority.

p - Number of priority address words (long addresses count as 2 words) at beginning of address field (0-15) $p_3\ p_2\ p_1\ p_0$

a - End of Block Info. Field (0-3) $a_1\ a_0$ = (00, 01, 10, & 11 indicating Address Field to start at word 1, 2, 3, or 4)

v - Vector Field Start Word (1 - 63) $v_5\ v_4\ v_3\ v_2\ v_1\ v_0$ When no Vectors are needed, the default value should be set to the word position just following the last Tone Only Address or if no Tone Only Addresses exist the word position just following the last Block Information Word.

c - Flag for traffic "Carry On" $c_1\ c_0$ = (00, 01,10,11). Traffic carried into next zero, one, two, or three Frames. Flag applies only to pagers assigned to this Frame, not pagers instructed to Carry On in previous Frame. Carry On value must be the same in all phases of the same Frame.

m - System Frame ID Collapse Mask (0 - 7). All Frames carry the same value.

$m_2\ m_1\ m_0$
0 0 0 - 2^0 = 1 Frame Latency (pager decodes all Frames)
0 0 1 - 2^1 = 2 Frames Latency (pager decodes every 2nd Frame)
•
1 1 1 - 2 ^7 = 128 Frames Latency (No Collapse)

x - Standard 4 bit Checksum

3.8.5. Block Information Word (BIW) 2, 3, 4 (As required)

The 2nd , 3rd, and 4th optional BIW words located in the first interleaved block of a FLEX™ Frame contain Simulcast System IDentification, Time and System Information.

1 2 3 4 5 6 7 21	 31	32
Information	Parity	Ck
$x_0x_1x_2x_3\ f_0\ f_1\ f_2\ s_0\ s_1\ s_2\ s_3\ s_4\ s_5\ s_6\ s_7\ s_8\ s_9\ s_{10}\ s_{11}\ s_{12}\ s_{13}$	p p p p p p p p p p	P
1 1 0 1 1 0 0 1 0 1 0 0 1 1 1 1 1 0 0 1 1	1111100011	0

Example: Date format, 5th Year, 31 Day, 12th Month (December 31, 1999)

f - Word Format Type $f_2\ f_1\ f_0$
s - Data
x - Standard 4 bit Checksum

$f_2\ f_1\ f_0$	$s_{13}s_{12}s_{11}s_{10}s_9\ s_8\ s_7\ s_6\ s_5\ s_4\ s_3\ s_2\ s_1\ s_0$	
0 0 0	$i_8\ i_7\ i_6\ i_5\ i_4\ i_3\ i_2\ i_1\ i_0\ C_4\ C_3\ C_2\ C_1\ C_0$	512 Local IDs, 32 Coverage Zones
0 0 1	$m_3\ m_2\ m_1\ m_0\ d_4\ d_3\ d_2\ d_1\ d_0\ Y_4\ Y_3\ Y_2\ Y_1\ Y_0$	Month, Day, Year
0 1 0	$S_2\ S_1\ S_0\ M_5\ M_4\ M_3\ M_2\ M_1\ M_0\ H_4\ H_3\ H_2\ H_1\ H_0$	Second, Minute, Hour
0 1 1	Reserved for Future Use	
1 0 0	Reserved for Future Use	
1 0 1	$I_9\ I_8\ I_7\ I_6\ I_5\ I_4\ I_3\ I_2\ I_1\ I_0\ A_3\ A_2\ A_1\ A_0$	System Information, Type
1 1 0	Reserved for Future Use	
1 1 1	$c_9c_8c_7c_6c_5c_4c_3c_2c_1c_0\ T_3\ T_2\ T_1\ T_0$	Country Code, Traffic Management Flags

Unused bits are set to 0.

Note: BIW 1 is always sent as the initial BIW in a Frame. There is no mandatory sending order of the additional BIW's (2, 3, or 4) contained within each Frame.

The RF channel when part of an SSID FLEX™ roaming system, must communicate the Simulcast System IDentification (SSID): BIW 000 (Local ID, Coverage Zone) and BIW 111 (Country Code, Traffic Management Flags) utilizing the placement structure as described in the following Section 3.9.1.

When Time is supported on an RF channel, at least one "Time" BIW (001, 010 or 101) must appear in each phase transmitted in Frame 0 Cycle 0. See Section 3.9.1

SSID - Local IDentification (LID) / Coverage Zone / Country Code / Traffic Management Flags - An LID along with the Coverage Zone, Country Code and Traffic Management Flags define a specific simulcast coverage area. When an RF channel supports roaming through the use of an SSID, BIW 000 must be placed in every Frame transmitted and BIW 111 must be present in the mandatory Frames 0 through 3. The mandatory Frames cannot be blocked due to channel sharing or the mixing with other protocols on the channel. Thus, a shared transmitter can only support one roaming channel.

The 4 Traffic Management Flags indicate a possible assignment of any combination of 4 groups of traffic to an RF channel. Each roaming subscriber unit, after finding an RF channel which matches its programmed LID, Coverage Zone and Country Code responds to only one of the 4 Traffic Management Flags. When one or more of the transmitted Traffic Management Flags are set to "0", subscriber units assigned to those traffic groups must find another RF channel with the same LID, Coverage Zone and Country Code information with its assigned Traffic Flag set to 1. The 2 least significant bits (LSBs) of the primary subscriber unit address used on the RF channel determines which Traffic Flag is to be monitored. In the case where the primary address is a Long Address, the 2 LSBs of the first code word are used to determine which Traffic Flag is to be monitored. (This is the same as the two LSBs of the Cap Code converted to binary.)

Date / Local Time / Local Time Zone - The 3 Block Information Words (001, 010, and 101) are used to provide Date, Local Time and Local Time Zone information in the FLEX™ protocol. These BIW's are not required to be transmitted. When the Service Provider supports Time, one, two or all three of these BIW's must be transmitted as described in the following Section 3.9.1. Time can optionally be sent in other Frames to facilitate more frequent updates

The Date (Month, Day, Year) BIW 001 information has the following definitions: Month field is 4 bits (0001 - 1100, Jan. - Dec.), Day field is 5 bits (00001 - 11111, 1-31), and the Year field is 5 bits (00000 - 11111, 1994 through 2025). (Note: Use Modulo arithmetic so each product will have a 32 year life span.)

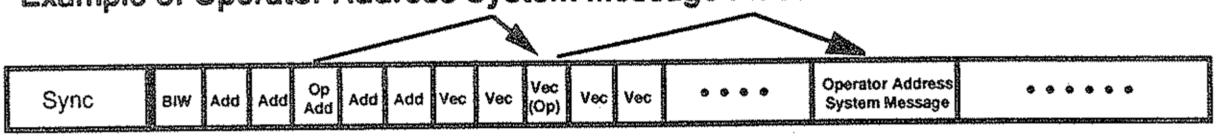
The Time (Second, Minute, Hour) BIW 010 information has the following definitions: The Hour field is 5 bits (00000 - 10111, 0 - 23 hours), Minute field is 6 bits (000000 - 111011, 0 - 59 minutes) and Seconds field is 3 bits (000 - 111; 0 to 7 in 1/8 minute or 7.5 Second increments). The Time transmitted in the BIW reflects the Present Local Time at the leading edge of the first bit of Bit Sync 1 of Frame 0 for the current Cycle.

The Local Time Zone (Seconds Adjust, Daylight Savings, Local Time Zone) BIW 101 and the A_3 A_2 A_1 A_0 bits given as 0100 or 0101 are utilized to provide time accuracy to within 1 second. Bits S_5 S_4 S_3 are used to add to the seconds sent in BIW 010. This allows the Local Time reference to be corrected to within 1 second in increments of 1/64 of a minute. The L_0 bit indicates that the time transmitted is Daylight Savings Time or Standard Time (L_0 bit set to 1 indicates Standard Time and the bit set to 0 to indicates Daylight Savings Time). The Local Time Zone data bits, z_4 z_3 z_2 z_1 z_0, are defined in Section 5.14 (Time Zone Information). The 'r' bit is reserved. (Local Time refers to the Time Zone transmitted)

System Message - The 4 bits (A_3 A_2 A_1 A_0) in BIW 101 are used to indicate the type of System Message or Information to be contained in this Frame. Only one BIW 101 System Message with data in the Message Field is allowed per Frame per phase. If the System Message has a corresponding Operator Messaging Address, both the BIW 101 and the Operator Messaging Address and its message must be sent. The Operator Messaging Address method allows subscriber units to receive System Messages utilizing the same means as personal messages.

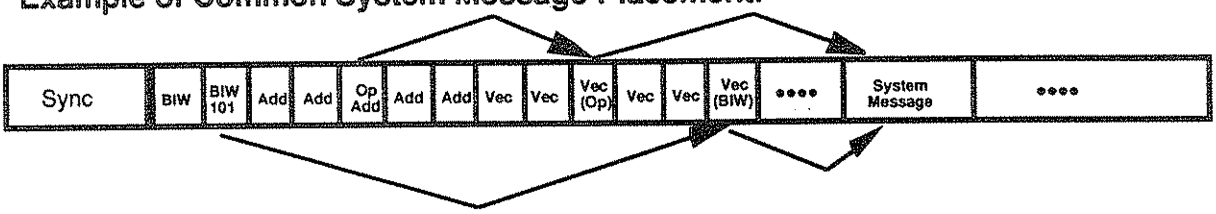
From the table in Section 3.7, Address Field Range Definition, sixteen unique addresses have been set aside to allow the operating system to send "Operator Messaging Addresses". This Addressing event followed by the expected vector and subsequent messaging is the preferred means to receive System Messages. This is illustrated in the following figure.

Example of Operator Address System Message Placement:



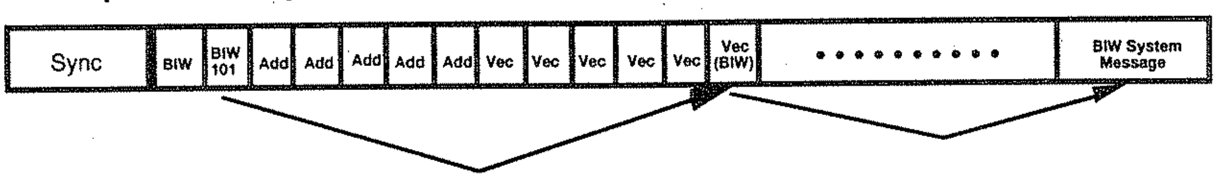
When the system operator sends a BIW 101 System Message that has a corresponding Operator Messaging Address, both the BIW System Vector placed at the end of the Vector Field and the Operator Messaging Vector point to the same message in the same phase. This is illustrated in the following figure. When the BIW System Message is sent, Tone Only addresses cannot be included in the same phase as the BIW 101 System Message.

Example of Common System Message Placement:



It is also possible to send the needed System Messaging by separating the BIW101 System Message from the Operator Address Messaging. The figure below just shows how the BIW System Message might appear in one FLEX™ Cycle. The Operator Addressing Message would appear in the following cycle as illustrated above. Tone Only addresses cannot be included in the same phase as the BIW 101 System Message.

Example of BIW System Message Placement:



Operator Messaging Addresses - System Messages and Instructions:

	Operator Messaging Address
Message for all Subscriber Units	1 1111 0111 1000 0001 0000
Message for Home Subscribers Units	1 1111 0111 1000 0001 0001
Message for all Roaming (non-Home) Units	1 1111 0111 1000 0001 0010
Message for SSID Subscriber Units	1 1111 0111 1000 0001 0011
Time Message for all Subscriber Units	1 1111 0111 1000 0001 0100
Reserved (9 Addresses)	•
	•
Instruction for SSID Subscriber Units	1 1111 0111 1000 0001 1110
System Event Notification	1 1111 0111 1000 0001 1111

BIW 101 System Messages:

	A_3	A_2	A_1	A_0
Message for all Subscriber Units (Operator Messaging Address: 1 1111 0111 1000 0001 0000) (I9 - I0 Reserved)	0	0	0	0
Message for Home Subscribers Units (Operator Messaging Address: 1 1111 0111 1000 0001 0001) (I9 - I0 Reserved)	0	0	0	1
Message for all Roaming (non-Home) Units (Operator Messaging Address: 1 1111 0111 1000 0001 0010) (I9 - I0 Reserved)	0	0	1	0
Message for SSID Subscriber Units (Operator Messaging Address: 1 1111 0111 1000 0001 0011) (I9 - I0 Reserved)	0	0	1	1
Message for all Subscriber Units plus Time Instruction (Operator Messaging Address: 1 1111 0111 1000 0001 0100) (Seconds Adjust, Reserved Bit, Daylight Savings, Local Time Zone) (S_5 S_4 S_3 r L_o z_4 z_3 z_2 z_1 z_0 0 1 0 0)	0	1	0	0
Time Instruction (Seconds Adjust, Reserved Bit, Daylight Savings, Local Time Zone) (S_5 S_4 S_3 r L_o z_4 z_3 z_2 z_1 z_0 0 1 0 1)	0	1	0	1
Channel Set Up Instruction (BIW Message, NID Message, Maximum Carry On, Frame Offset) (B_0 N_0 O_1 O_0 F_5 F_4 F_3 F_2 F_1 F_0 0 1 1 0)	0	1	1	0
Reserved for Future Use	0	1	1	1
•				
•				
	1	1	1	1

Note: The information bit in BIW101 which are not used are reserved and set to zero (System Message types A = 0000, 0001, 0010, and 0011)

Message for all Subscriber Units - BIW 101; $A_3\ A_2\ A_1\ A_0$ = 0000
Messages may be of any length and type, however, Secure Message Vectors are not allowed.

Message for Home Subscriber Units - BIW 101; $A_3\ A_2\ A_1\ A_0$ = 0001
Messages may be of any length and type, however, Secure Message Vectors are not allowed. This message is intended to be ignored by subscriber units which have roamed into this area.

Message for all Roaming Subscriber Units - BIW 101; $A_3\ A_2\ A_1\ A_0$ = 0010
Messages may be of any length and type, however, Secure Message Vectors are not allowed. This message is intended to be ignored by subscriber units which are not capable of roaming and by roaming units which have this area identified as their home area.

Message for SSID Subscriber Units - BIW 101 / $A_3\ A_2\ A_1\ A_0$ = 0011
Messages may be of any length and type, however, Secure Message Vectors are not allowed. This message is intended for pagers which have this SSID identified in their memories (Home or Roaming Pagers).

Message for all Subscriber Units plus Time Instruction - BIW 101; $A_3\ A_2\ A_1\ A_0$ = 0100 See System Message and Time definitions previously stated. Messages may be of any length and type, however, Secure Message Vectors are not allowed.

Time Instruction - BIW 101; $A_3\ A_2\ A_1\ A_0$ = 0101
See Time definitions previously stated.

Channel Set Up Instruction - BIW 101; $A_3\ A_2\ A_1\ A_0$ = 0110
The BIW System Message bit, B_0, set = 1 indicates that this RF channel is generating System Messages. The NID System Message bit, N_0, set = 1 indicates that the RF channel is generating System Messages associated with NID's. The 2 bit Maximum Carry On field, $O_1\ O_0$, indicates the maximum Carry On which will be applied to traffic targeted for multi-frequency roaming pagers. Normal traffic carried within the Frame may see larger values of "Carry On". The 6 Frame Offset bits, $F_5\ F_4\ F_3\ F_2\ F_1\ F_0$, are used to indicate the Frame Offset value to be applied to the roaming traffic (values from 1 through 63 Frames are valid). A Frame offset value of zero is a default value. It does not represent a valid Frame Offset value.

Instruction for SSID Subscriber Units - Operator Messaging Address (... ... 1110)
This Instruction is defined in Section 3.9.6.

System Event Notification - Operator Messaging Address (... ... 1111)
This Operator Messaging Address along with the Short Instruction Vector, Instruction Type 001, must be transmitted in a minimum of all Frames for the duration of one System Collapse Cycle. This Notification is used to pre-alert pagers to a forthcoming system event that will be transmitted within the next 4 FLEX™ Cycles. This allows efficient operation of pagers to receive necessary system information without continuously sampling the channel.

Events for which this notification is used include the following:

- the splitting away of at least one SSID TMF flag to another frequency
- the addition of a new coverage zone to an LID in which a class of users have pagers which have been programmed to accept this expanded coverage area.
- the splitting away of at least one NID TMF flag.
- the general addition of a new frequency to be used in association with an NID.
- any change in the channel set up instruction. An example might be the addition of a new frequency and coverage area which requires a realignment of frame offset values through out the system.

3.8.6. Address Word Definitions

Addresses are sent LSB 1st (opposite of POCSAG). This assumes that addresses are assigned in consecutive order resulting in the first address bit on the channel being closer to a random distribution.

3.8.6.1. Short Address

1 2 3 4 5 6 7 . . . . 21 Information	31 Parity	32 Ck
d_0 d_1 d_2 d_3 d_4 d_5 d_6 d_7 d_8 d_9 d_{10} d_{11} d_{12} d_{13} d_{14} d_{15} d_{16} d_{17} d_{18} d_{19} d_{20}	p p p p p p p p p p	P

d - Short Address Information bits -

d_{20} $d_{19}d_{18}d_{17}d_{16}$ $d_{15}d_{14}d_{13}d_{12}$ $d_{11}d_{10}d_9d_8$ $d_7d_6d_5d_4$ $d_3d_2d_1d_0$ Range from

0 0000 1000 0000 0000 0001 thru 1 1110 0000 0000 0000 0000

3.8.6.2. Long Two Word Address

1 2 3 4 5 6 7 . . . . 21 Information		31 Parity	32 Ck
d_0 d_1 d_2 d_3 d_4 d_5 d_6 d_7 d_8 d_9 d_{10} d_{11} d_{12} d_{13} d_{14} d_{15}	0 0 0 0 0	p p p p p p p p p p	P
e_0 e_1 e_2 e_3 e_4 e_5 e_6 e_7 e_8 e_9 e_{10} e_{11} e_{12} e_{13} e_{14} e_{15}	1 1 1 1 1	p p p p p p p p p p	P

For Example, with Long Address combination 1-2:

d - Long Address First Word Information bits -

$d_{15}d_{14}d_{13}d_{12}$ $d_{11}d_{10}d_9d_8$ $d_7d_6d_5d_4$ $d_3d_2d_1d_0$ Range from

0000 0000 0000 0001 thru 1000 0000 0000 0000

e - Long Address Second Word Information bits -

$e_{15}e_{14}e_{13}e_{12}$ $e_{11}e_{10}e_9e_8$ $e_7e_6e_5e_4$ $e_3e_2e_1e_0$ Range from

0111 1111 1111 1111 thru 1111 1111 1111 1110

Use of a Long address results in a corresponding double vector. By definition the first word of the message resides in this 2nd vector word. Now the vector pointer indicates the position of the first word of the remaining message and the message size / length field indicates the number of message words total (subtract 1 to find number of words in the message field).

3.8.6.3. Network Address

1 2 3 4 5 6 7 . . . . 21 Information	31 Parity	32 Ck
d_0 d_1 d_2 d_3 d_4 d_5 d_6 d_7 d_8 d_9 d_{10} d_{11} d_{12} 1 1 0 1 1 1 1 1	p p p p p p p p p p	P

d - Network Address Information bits -

d_{20} $d_{19}d_{18}d_{17}d_{16}$ $d_{15}d_{14}d_{13}d_{12}$ $d_{11}d_{10}d_9d_8$ $d_7d_6d_5d_4$ $d_3d_2d_1d_0$ Range from

1 1111 0110 1000 0000 0000 thru 1 1111 0111 0111 1111 1111

Network Addresses appear in specific Frames and phases. The 12 bits in the Short Message / Tone Only Vector further define the Network ID. See Section 3.9 for full details.

3.8.7. Vector Word Definitions

3.8.7.1. Numeric Vector

1 2 3 4 5 6 7 21	31	32
Information	Parity	Ck
x_0 x_1 x_2 x_3 V_0 V_1 V_2 b_0 b_1 b_2 b_3 b_4 b_5 b_6 n_0 n_1 n_2 K_0 K_1 K_2 K_3	p p p p p p p p p p	P
0 0 0 1 1 1 0 1 1 1 0 0 0 0 1 1 0 0 1 1 1	0 1 1 0 1 0 0 1 1 1	1

Example: Numeric vector type, message starts at word #7 and is 4 words in length, the first 4 LSB's of the message Checksum are 1110

V - Vector Type V_2 V_1 V_0
- 0 1 1 - Standard Numeric Vector
- 1 0 0 - Special Format Numeric Vector (rule defined in code plug).
- 1 1 1 - Numbered Numeric Vector

b - Word number range of message start (3 - 87 Decimal)
n - Number of words in message = n n n +1 (n n n = 0 to 7 Decimal)
K - Beginning check bits of message
x - Standard 4 bit Checksum

Note: Long address results in a second vector word which becomes the first message word. Remaining message words in the message field are reduced by 1. When the messages are 4 or less Numeric characters, the "b" field will equal the word position of the second vector word and the "n n n" field will equal 0 (the number of words in message equals 1).

3.8.7.2. Short Message / Tone Only Vector

1 2 3 4 5 6 7 21	31	32
Information	Parity	Ck
x_0 x_1 x_2 x_3 V_0 V_1 V_2 t_0 t_1 d_0 d_1 d_2 d_3 d_4 d_5 d_6 d_7 d_8 d_9 d_{10} d_{11}	p p p p p p p p p p	P
$d_{12}d_{13}d_{14}d_{15}$ $d_{16}d_{17}d_{18}d_{19}$ $d_{20}d_{21}d_{22}d_{23}$ $d_{24}d_{25}d_{26}d_{27}$ $d_{28}d_{29}d_{30}d_{31}$ d_{32}	p p p p p p p p p p	P

Note: Second word bits d_{12} - d_{32} are present only when this vector is used with a long address.
V - Vector Type $V_2V_1V_0$ 010 Short Message / Tone Only
t - Message Type

t_1t_0	$d_{11}d_{10}d_9d_8$ $d_7d_6d_5d_4$ $d_3d_2d_1d_0$	
00	$c_3c_2c_1c_0$ $b_3b_2b_1b_0$ $a_3a_2a_1a_0$	- 3 Numeric Characters with Short Address or 8 Numeric Characters with Long Add.
	$T_3T_2T_1T_0$ $M_2M_1M_0$ $A_4A_3A_2A_1A_0$	or 12 bits defined with Network Address as indicated in Section 3.9.
01	$s_8s_7s_6s_5$ $s_4s_3s_2s_1$ s_0 $S_2S_1S_0$	- 8 Sources plus 9 or 30 Unused Bits
10	s_1 s_0 R_0 $N_5N_4N_3N_2N_1N_0$ $S_2S_1S_0$	- 8 Sources, 0-63 Message Number, Message Retrieval Flag, and 2 or 23 Unused bits
11		- Spare Message Type

x - Standard 4 bit Checksum (does not check 2nd code word).

The 12 bits defined in the Short Message Vector, complete the definition of a Network ID. Short Message Type (t_1t_0= 00) is used to represent the Service Area, a Multiplier, and Traffic Management Flag associated with the Network Address. (Multiplier = 3 bits $M_2M_1M_0$, Service Area = 5 bits $A_4A_3A_2A_1A_0$, and TMF = 4 bits $T_3T_2T_1T_0$,)

Unused bits are set to 0, unused numeric characters are set to "space" (HEX C). In the case of "long addressing" there will be two vectors allowing bits d_{12} through d_{31} to represent 5 additional numeric characters with d_{32} (spare bit) set to 0. Normal "short addressing" results in a 1 word "Short Message / Tone Only Vector".

3.8.7.3. HEX / Binary Vector

1 2 3 4	5 6 7		21	31	32
		Information		Parity	Ck
x_0 x_1 x_2 x_3	V_0 V_1 V_2	b_0 b_1 b_2 b_3 b_4 b_5 b_6	n_0 n_1 n_2 n_3 n_4 n_5 n_6	p p p p p p p p p p	P

V - Vector Type $V_2V_1V_0$ = 110 - HEX Message Vector

b - Word Number of message start $b_6b_5b_4b_3b_2b_1b_0$ (3 - 87 Decimal)

n - Number of message words in this Frame $n_6n_5n_4n_3n_2n_1n_0$ (3 to 85 Decimal)

Note: Long address results in second vector word which becomes the first message word. Remaining message words in the message field is reduced by 1.

x - Standard 4 bit Checksum

3.8.7.4. Alphanumeric Vector

1 2 3 4 5 6 7			21	31	32
		Information		Parity	Ck
x_0 x_1 x_2 x_3	V_0 V_1 V_2	b_0 b_1 b_2 b_3 b_4 b_5 b_6	n_0 n_1 n_2 n_3 n_4 n_5 n_6	p p p p p p p p p p	P

V - Vector Type $V_2V_1V_0$ = 101 - Alpha Message Vector

b - Word Number of message start (3 - 87 Decimal)

n - Number of message words in this Frame (2 to 85 Decimal)

Note: Long address results in second vector word which becomes the first message word. Remaining message words in the message field is reduced by 1.

x - Standard 4 bit Checksum

3.8.7.5. Secure Message Vector

1 2 3 4 5 6 7			21	31	32
		Information		Parity	Ck
x_0 x_1 x_2 x_3	V_0 V_1 V_2	b_0 b_1 b_2 b_3 b_4 b_5 b_6	n_0 n_1 n_2 n_3 n_4 n_5 n_6	p p p p p p p p p p	P

V - Vector Type $V_2V_1V_0$ = 000 - Secure Message Vector

b - Word Number of message start (3 - 87 Decimal)

n - Number of message words in this Frame (2 to 85 Decimal)

Note: Long address results in second vector word which becomes the first message word. Remaining message words in the message field is reduced by 1.

x - Standard 4 bit Checksum

3.8.7.6. Short Instruction Vector

1 2 3 4 5 6 7. . . . . 21 Information	31 Parity	32 Ck
$x_0\ x_1\ x_2\ x_3$ $V_0\ V_1\ V_2$ $i_0\ i_1\ i_2$ $d_0\ d_1\ d_2\ d_3\ d_4\ d_5\ d_6\ d_7\ d_8\ d_9\ d_{10}$	p p p p p p p p p p	P
$d_{11}d_{12}d_{13}d_{14}$ $d_{15}d_{16}d_{17}d_{18}$ $d_{19}d_{20}d_{21}d_{22}$ $d_{23}d_{24}d_{25}d_{26}$ $d_{27}d_{28}d_{29}d_{30}$ d_{31}	p p p p p p p p p p	P

Note: Second word bits d_{11} - d_{31} are present only when this vector is used with a long address. All unused bits set to "0".

V - Vector Type $V_2V_1V_0$ = 001 Short Instruction Vector
i - Defines instruction type
d - Definition depends on vector function
x - Standard 4 bit Checksum

Note: As of date of this release all bits in the second word are unused and should be set to "0". All unused spare bits should also be set to "0".

	$i_2\ i_1\ i_0$	$d_{10}d_9d_8d_7d_6d_5d_4d_3d_2d_1d_0$	
Temp. Address Activation	0 0 0	$a_3a_2\ a_1a_0\ f_6f_5f_4f_3f_2f_1f_0$	4 Addr, 7 Frame
System Event	0 0 1	$d_{10}d_9d_8d_7d_6d_5d_4d_3d_2d_1d_0$	11 Event Flags
Reserved	0 1 0		
Reserved	0 1 1		
Reserved	1 0 0		
Reserved	1 0 1		
Reserved	1 1 0		
Reserved for Test	1 1 1		

Temporary Addresses - The FLEX™ protocol specifies sixteen addresses which may be temporarily activated in a specific future Frame (If the designated Frame is equal to the present Frame the pager is to interpret this as the next occurrence of this Frame 4 minutes in the future.) These temporary addresses are similar to the Golay Sequential Code Activation Code Word which allows several activated pagers to receive a common message. The temporary address is valid for one message starting in the specified Frame and remaining valid throughout the following Frames to the completion of the message. The subscriber unit will not respond to any Carry On operation for temporary addresses that may be in effect in the originally specified Frame. If the message is not found in the specified Frame (Frame defined by a full 7 bit Frame number) the pager returns to normal operation.

The temporary Base Address is defined to be 1 1111 0111 1000 0000 0000 (MSB to LSB). Temporary addresses are calculated from the base address by adding binary 0000 (decimal 0) through binary 1111 (decimal 15) to the base.

System Event - The 11 Event Flags define the specific event or events to take place within the next 4 FLEX Cycles as indicated by the System Event Notification described in Section 3.8.5.

d_0- SSID TMF split,

d_1 - NID TMF split,

d_2 -Channel Set-Up Instruction change with BIW 101 (... ... 0 1 1 0)

d_3 - Add new frequency to the NID frequency list.

d_4 - Add new frequency for an LID new Coverage Zone

d_5 to d_{10}- All Reserved and default to 0.

3.8.8. Message Field Definitions

3.8.8.1. Numeric Data Message

Standard (V = 011) or Special Format (V = 100) 4, 10, 15, 20, 25, 31, 36, or 41 Characters

1 2 3 4 5 6 7 . . . . 21 Information	. . . . 31 Parity	32 Ck
1st Word		
$K_4\ K_5\ a_0\ a_1\ a_2\ a_3\ b_0\ b_1\ b_2\ b_3\ c_0\ c_1\ c_2\ c_3\ d_0\ d_1\ d_2\ d_3\ e_0\ e_1\ e_2$	p p p p p p p p p p	P
2nd Word		
$e_3\ f_0\ f_1\ f_2\ f_3\ g_0\ g_1\ g_2\ g_3\ h_0\ h_1\ h_2\ h_3\ i_0\ i_1\ i_2\ i_3\ j_0\ j_1\ j_2\ j_3$	p p p p p p p p p p	P
3rd Word		
$k_0\ k_1\ k_2\ k_3\ l_0\ l_1\ l_2\ l_3\ m_0\ m_1\ m_2\ m_3\ n_0\ n_1\ n_2\ n_3\ o_0\ o_1\ o_2\ o_3\ q_0$	p p p p p p p p p p	P
4th Word		
$q_1\ q_2\ q_3\ r_0\ r_1\ r_2\ r_3\ s_0\ s_1\ s_2\ s_3\ t_0\ t_1\ t_2\ t_3\ u_0\ u_1\ u_2\ u_3\ v_0\ v_1$	p p p p p p p p p p	P
5th Word		
$v_2\ v_3\ w_0\ w_1\ w_2\ w_3\ y_0\ y_1\ y_2\ y_3\ z_0\ z_1\ z_2\ z_3\ A_0\ A_1\ A_2\ A_3\ B_0\ B_1\ B_2$	p p p p p p p p p p	P
6th Word		
$B_3\ C_0\ C_1\ C_2\ C_3\ D_0\ D_1\ D_2\ D_3\ E_0\ E_1\ E_2\ E_3\ F_0\ F_1\ F_2\ F_3\ G_0\ G_1\ G_2\ G_3$	p p p p p p p p p p	P
7th Word		
$H_0\ H_1\ H_2\ H_3\ I_0\ I_1\ I_2\ I_3\ J_0\ J_1\ J_2\ J_3\ V_0\ V_1\ V_2\ V_3\ L_0\ L_1\ L_2\ L_3\ M_0$	p p p p p p p p p p	P
8th Word		
$M_1\ M_2\ M_3\ O_0\ O_1\ O_2\ O_3\ P_0\ P_1\ P_2\ P_3\ Q_0\ Q_1\ Q_2\ Q_3\ T_0\ T_1\ T_2\ T_3\ U_0\ U_1$	p p p p p p p p p p	P

Numbered (V = 111) 2, 8, 13, 18, 23, 29, 34, or 39 Numeric Characters

1 2 3 4 5 6 7 . . . . 21 Information	. . . . 31 Parity	32 Ck
1st Word		
$K_4\ K_5\ N_0\ N_1\ N_2\ N_3\ N_4\ N_5\ R_0\ S_0\ a_0\ a_1\ a_2\ a_3\ b_0\ b_1\ b_2\ b_3\ c_0\ c_1\ c_2$	p p p p p p p p p p	P
2nd Word		
$c_3\ d_0\ d_1\ d_2\ d_3\ e_0\ e_1\ e_2\ e_3\ f_0\ f_1\ f_2\ f_3\ g_0\ g_1\ g_2\ g_3\ h_0\ h_1\ h_2\ h_3$	p p p p p p p p p p	P
3rd Word		
$i_0\ i_1\ i_2\ i_3\ j_0\ j_1\ j_2\ j_3\ k_0\ k_1\ k_2\ k_3\ l_0\ l_1\ l_2\ l_3\ m_0\ m_1\ m_2\ m_3\ n_0$	p p p p p p p p p p	P
4th Word		
$n_1\ n_2\ n_3\ o_0\ o_1\ o_2\ o_3\ q_0\ q_1\ q_2\ q_3\ r_0\ r_1\ r_2\ r_3\ s_0\ s_1\ s_2\ s_3\ t_0\ t_1$	p p p p p p p p p p	P
5th Word		
$t_2\ t_3\ u_0\ u_1\ u_2\ u_3\ v_0\ v_1\ v_2\ v_3\ w_0\ w_1\ w_2\ w_3\ y_0\ y_1\ y_2\ y_3\ z_0\ z_1\ z_2$	p p p p p p p p p p	P
6th Word		
$z_3\ A_0\ A_1\ A_2\ A_3\ B_0\ B_1\ B_2\ B_3\ C_0\ C_1\ C_2\ C_3\ D_0\ D_1\ D_2\ D_3\ E_0\ E_1\ E_2\ E_3$	p p p p p p p p p p	P
7th Word		
$F_0\ F_1\ F_2\ F_3\ G_0\ G_1\ G_2\ G_3\ H_0\ H_1\ H_2\ H_3\ I_0\ I_1\ I_2\ I_3\ J_0\ J_1\ J_2\ J_3\ V_0$	p p p p p p p p p p	P
8th Word		
$V_1\ V_2\ V_3\ L_0\ L_1\ L_2\ L_3\ M_0\ M_1\ M_2\ M_3\ O_0\ O_1\ O_2\ O_3\ P_0\ P_1\ P_2\ P_3\ Q_0\ Q_1$	p p p p p p p p p p	P

Data sent LSB 1st

K - 6 bit Message Checksum (First 4 bits are in the vector word): This Checksum is calculated by initializing the message Checksum field (K) to zero and summing the information bits of each code word in the message, (including control information and termination characters and bits in the last message word) to a Checksum register. The information bits of each word are broken into three groups: the first is the 8 bits comprising bits 1 through 8, the second group comprises bits 9 through16 and the third group comprises bits 17 through 21. Bits 1, 9 and 17 are the LSB's of each group. The binary sum is calculated, the result is shortened to the 8 least significant bits. The 2 most significant bits are shifted right 6 bits and summed with the least significant 6 bits to form a new sum. This resultant sum is 1's complemented with the 6 LSB's of the result being transmitted as the message Checksum.

N - Message Number: When the system supports message retrieval the infrastructure will assign message numbers (for each paging address separately) starting at 0 and progressing up to a maximum of 63 in consecutive order. The actual maximum roll over number is defined in the pager code plug to accommodate values set in the system infrastructure. When message numbers are not received in order, the subscriber should assume a message has been missed. The subscriber or the pager may determine the missing message number(s) allowing a request to be made for retrieval. When a normal unnumbered numeric message is received (message retrieval flag is equal to 0) it is not to be included in the missed message calculation. The message retrieval number displayed to the user is to be 1 + N so that the user perceives messages numbered from 1 to N + 1.

R- Message Retrieval Flag: When this bit is set to 1, the pager expects to see messages numbered in order (each address numbered separately). Detection of a missing number indicates a missed message. A message received with R = 0 is allowed to be out of order and shall not cause the pager to indicate that a message has been missed.

S- Special Format: In the numbered message format this bit set to 1 indicates that a special display format should be used.

Message Fill Rules: For numeric messages of 36 characters or less (34 characters if numbered) fewer than 8 code words on the channel are required. Only code words containing the numeric message are to be transmitted. The "space" character (Hex C) should be used to fill any unused 4-bit characters in the last word and zeros to fill any remaining partial characters. The Checksum is correspondingly shortened to include only the code words comprising the shortened message along with the "space" and fill characters used to fill in the last word.

Special Format Numeric: Spaces and dashes as specified by the code plug are inserted into the received message. This feature in certain markets saves the transmission of an additional word on the channel. As an example in the U.S. market a 10 character (area code plus telephone number) fits into two message words, if the dashes or parentheses were to be included in the message a 3rd message word on the channel would be required. The actual placement is code plug definable and can vary between markets.

3.8.8.2. HEX / Binary Message

Vector type V=110 First Only Fragment

1 2 3 4 5 6 7 21	 31	32
Information	Parity	Ck
1st Word		
$K_0\ K_1\ K_2\ K_3\ K_4\ K_5\ K_6\ K_7\ K_8\ K_9\ K_{10} K_{11}\ C_0\ F_0 F_1\ N_0\ N_1\ N_2\ N_3\ N_4\ N_5$	p p p p p p p p p p	P
2nd Word		
$R_0\ M_0\ D_0\ H_0\ B_0\ B_1\ B_2\ B_3\ s_0\ s_1\ s_2\ s_3\ I_0\ S_0\ S_1\ S_2\ S_3\ S_4\ S_5\ S_6\ S_7$	p p p p p p p p p p	P
3rd Word		
$a_0\ a_1\ a_2\ a_3\ b_0\ b_1\ b_2\ b_3\ c_0\ c_1\ c_2\ c_3\ d_0\ d_1\ d_2\ d_3\ e_0\ e_1\ e_2\ e_3\ f_0$	p p p p p p p p p p	P
4th Word		
$f_1\ f_2\ f_3\ g_0\ g_1\ g_2\ g_3\ h_0\ h_1\ h_2\ h_3\ i_0\ i_1\ i_2\ i_3\ j_0\ j_1\ j_2\ j_3\ k_0\ k_1$	p p p p p p p p p p	P
5th Word		
$k_2\ k_3\ l_0\ l_1\ l_2\ l_3\ m_0\ m_1\ m_2\ m_3\ n_0\ n_1\ n_2\ n_3\ o_0\ o_1\ o_2\ o_3\ q_0\ q_1\ q_2$	p p p p p p p p p p	P
6th Word		
$q_3\ r_0\ r_1\ r_2\ r_3\ s_0\ s_1\ s_2\ s_3\ t_0\ t_1\ t_2\ t_3\ u_0\ u_1\ u_2\ u_3\ v_0\ v_1\ v_2\ v_3$	p p p p p p p p p p	P
•		
•		
•		
nth Word		
i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	P

Vector type V=110 All Other Fragments

1 2 3 4 5 6 7 21	 31	32
Information	Parity	Ck
1st Word		
$K_0\ K_1\ K_2\ K_3\ K_4\ K_5\ K_6\ K_7\ K_8\ K_9\ K_{10} K_{11}\ C_0\ F_0\ F_1\ N_0\ N_1\ N_2\ N_3\ N_4\ N_5$	p p p p p p p p p p	P
2nd Word		
$a_0\ a_1\ a_2\ a_3\ b_0\ b_1\ b_2\ b_3\ c_0\ c_1\ c_2\ c_3\ d_0\ d_1\ d_2\ d_3\ e_0\ e_1\ e_2\ e_3\ f_0$	p p p p p p p p p p	P
3rd Word		
$f_1\ f_2\ f_3\ g_0\ g_1\ g_2\ g_3\ h_0\ h_1\ h_2\ h_3\ i_0\ i_1\ i_2\ i_3\ j_0\ j_1\ j_2\ j_3\ k_0\ k_1$	p p p p p p p p p p	P
4th Word		
$k_2\ k_3\ l_0\ l_1\ l_2\ l_3\ m_0\ m_1\ m_2\ m_3\ n_0\ n_1\ n_2\ n_3\ o_0\ o_1\ o_2\ o_3\ q_0\ q_1\ q_2$	p p p p p p p p p p	P
5th Word		
$q_3\ r_0\ r_1\ r_2\ r_3\ s_0\ s_1\ s_2\ s_3\ t_0\ t_1\ t_2\ t_3\ u_0\ u_1\ u_2\ u_3\ v_0\ v_1\ v_2\ v_3$	p p p p p p p p p p	P
•		
•		
•		
nth Word		
i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	P

K - 12 bit Fragment Checksum: This Checksum is calculated by initializing the Fragment Checksum field (K) to zero and calculating a sum over the information bits of each code word in the message fragment (including control information and termination characters / bits in the last fragment word). This sum requires that the information bits of each word be broken into three groups: the first is the 8 bits comprising bits 1 through 8, the second group comprises bits 9 through 16 and the third group comprises bits 17 through 21. Bits 1, 9 and 17 are the LSB's of each group. The binary sum is calculated over all code words in the fragment, the 1's complement of the sum is determined and the 12 LSB's of the result is placed into the Fragment Checksum field to be transmitted at the beginning of the fragment.

C - 1 bit Message Continued Flag: When set to 1, indicates fragments of this message are to be expected in any or possibly all of the following Frames until a fragment with C0 = 0 is found.

F - 2 bit Message Fragment Number: This is a modulo 3 message fragment number which is incremented by 1 in successive message fragments. The initial fragments starts at 11 and each following fragment is incremented by 1 modulo 3. (11, 00, 01, 10, 00, 01, 10, 00 etc.). The 11 state (after the initial fragment) is skipped in this process to avoid confusion with the single fragment of a non-continued message. The final fragment is indicated by the Message Continued Flag being reset to 0.

N - Message Number: When the system supports message retrieval the infrastructure will assign message numbers (for each paging address separately) starting at 0 and progressing up to a maximum of 63 in consecutive order. The actual maximum roll over number is defined in the pager code plug to accommodate values set in the system infrastructure. When message numbers are not received in order, the subscriber should assume a message has been missed. The subscriber or the pager may determine the missing message number(s) allowing a request to be made for retrieval. When a normal unnumbered numeric message is received (message retrieval flag is equal to 0) it is not to be included in the missed message calculation. This number is also used to identify fragments of the same message. Multiple messages to the same address must have separate message numbers. An exception to this rule is the header message tied to a transparent message each with the same message number. The message retrieval number displayed to the user is to be 1 + N so that the user perceives messages numbered from 1 to N + 1.

R - Message Retrieval Flag: When this bit is set to 1, the pager expects to see messages numbered in order (each address numbered separately). Detection of a missing number indicates a missed message. A message received with R = 0 is allowed to be out of order and shall not cause the pager to indicate that a message has been missed.

M - 1 bit Mail Drop Flag; When set to 1, indicates the received message can be processed uniquely.

D - 1 bit Display Direction Field: D0 = 0 - Display left to right, D0 = 1 - Display right to left (valid only when data sent as characters i.e. Blocking Length not equal 0001)

H - 1 bit Header Message: H0 = 1 Indicates that this message is a header to a following transparent message of the same message number. H0 = 0 implies message is not a header

B - 4 bit Blocking Length: Indicates bits per character. B3B2B1B0 = 0001 = 1 bit per character (binary / transparent data), 1111 =15 bits per character, 0000 =16 bits per character. Data with blocking length other than 1 is assumed to be displayed on a character by character basis. (default value = 0001) Note: The preceding figures show B = 4 bit blocking length.

I - Status Information Field Enabler. If this bit is set = to 1, the first 8 bits of the data field (3rd word of the first fragment a0 a1 a2 a3 b0 b1 b2 b3) identify the method of encoding used on the remaining data in the message. When the bit is set to 0, standard HEX / Binary Messaging is in effect. At the present time, the use of these 8 Status Information Field bits and their associated definitions with the I bit set = 1 are Reserved.

s - 4 bit Field Reserved for future use: Default value = 0000

S - 8 bit Signature Field: The signature is defined to be the 1's complement of the binary sum over the total message taken 8 bits at a time prior to formatting into fragments. It would be equivalent to a binary sum starting with the first 8 bits directly following the signature field (b3 b2 b1 b0 a3 a2 a1 a0 + d3 d2 d1 d0 c3 c2 c1 c0 etc.) and continuing all the way to the last valid data bit in the last word of the last fragment. The 8 least significant bits of the result are inverted (1's complement) and transmitted as the message signature. (Note: This sum does not include any termination bits and should be calculated directly on the message as received by the terminal. The device generating the signature should be able to calculate before the fragmenting boundaries are determined.)

Fields R through S are only transmitted in the first fragment of a message. The fields K through N make up the first word of every fragment in a multi-fragment message.

Message Content: Starting with the first character of the 3rd word in the message (2nd word in the remaining fragments), each 4 bit field represents 1 of any of the 16 possible combinations with no restrictions (data may be binary).

Fragment Termination: Unused bits in the last message word of a fragment are filled with all 0's or all 1's depending on the last valid data bit. This choice is always the opposite polarity of the last valid data bit. For first fragments and inner fragments of a multi-fragment message, the message is interrupted (stopped) on the last full character boundary in the last code word in the fragment. Any unused bits follow the just stated rule. The final fragment follows the above rules except when the last character is all 1's or all 0's and it exactly fills the last code word. In this case, an additional word must be sent of opposite polarity of all 1's or all 0's to signify the position of the last character thus allowing that last character to be an all 1's or an all 0's character pattern. (This is always the case when a binary message ends in the last bit of the last word.)

Message Header: (H =1) This is a displayable tag associated with a transparent / non-displayable data message. The tag and the associated message are complete in themselves. The pager will associate the header message with the data file based on the two having the same message number and being sent in sequence (header first followed by data file).

3.8.8.3. Alphanumeric Message

Vector type V=101 First Only Fragment

1 2 3 4 5 6 7 21	 31	32
Information	Parity	Ck
1st Word		
K_0 K_1 K_2 K_3 K_4 K_5 K_6 K_7 K_8 K_9 C_0 F_0 F_1 N_0 N_1 N_2 N_3 N_4 N_5 R_0 M_0	p p p p p p p p p p	P
2nd Word		
S_0 S_1 S_2 S_3 S_4 S_5 S_6 a_0 a_1 a_2 a_3 a_4 a_5 a_6 b_0 b_1 b_2 b_3 b_4 b_5 b_6	p p p p p p p p p p	P
3rd Word		
c_0 c_1 c_2 c_3 c_4 c_5 c_6 d_0 d_1 d_2 d_3 d_4 d_5 d_6 e_0 e_1 e_2 e_3 e_4 e_5 e_6	p p p p p p p p p p	P
4th Word		
f_0 f_1 f_2 f_3 f_4 f_5 f_6 g_0 g_1 g_2 g_3 g_4 g_5 g_6 h_0 h_1 h_2 h_3 h_4 h_5 h_6	p p p p p p p p p p	P
5th Word		
i_0 i_1 i_2 i_3 i_4 i_5 i_6 j_0 j_1 j_2 j_3 j_4 j_5 j_6 k_0 k_1 k_2 k_3 k_4 k_5 k_6	p p p p p p p p p p	P
• • •		
nth Word		
i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	P

Vector type V=101 Other Fragment

1 2 3 4 5 6 7 21	31	32
Information	Parity	Ck
1st Word		
K_0 K_1 K_2 K_3 K_4 K_5 K_6 K_7 K_8 K_9 C_0 F_0 F_1 N_0 N_1 N_2 N_3 N_4 N_5 U_0 V_0	p p p p p p p p p p	P
2nd Word		
a_0 a_1 a_2 a_3 a_4 a_5 a_6 b_0 b_1 b_2 b_3 b_4 b_5 b_6 c_0 c_1 c_2 c_3 c_4 c_5 c_6	p p p p p p p p p p	P
3rd Word		
d_0 d_1 d_2 d_3 d_4 d_5 d_6 e_0 e_1 e_2 e_3 e_4 e_5 e_6 f_0 f_1 f_2 f_3 f_4 f_5 f_6	p p p p p p p p p p	P
4th Word		
g_0 g_1 g_2 g_3 g_4 g_5 g_6 h_0 h_1 h_2 h_3 h_4 h_5 h_6 i_0 i_1 i_2 i_3 i_4 i_5 i_6	p p p p p p p p p p	P
5th Word		
j_0 j_1 j_2 j_3 j_4 j_5 j_6 k_0 k_1 k_2 k_3 k_4 k_5 k_6 l_0 l_1 l_2 l_3 l_4 l_5 l_6	p p p p p p p p p p	P
• • •		
nth Word		
i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	P

Data sent LSB 1st

K - 10 bit Fragment Checksum: This Checksum is calculated by initializing the fragment Checksum (K) to zero and summing the information bits of each code word in the message fragment (including control information and termination characters and bits in the last message word) to a Checksum register. The information bits of each word are broken into three groups: the first is the 8 bits comprising bits 1 through 8, the second group comprises bits 9 through 16 and the third group comprises bits 17 through 21. Bits 1, 9 and 17 are the LSB's of each group. The binary sum is calculated, the 1's complement of the sum is determined and the 10 LSB's of the result is transmitted as the message Checksum.

C -1 bit Message Continued Flag: When set (=1) indicates fragments of this message are to be expected in following Frames.

F - 2 bit Message Fragment Number: This is a modulo 3 message fragment number which is incremented by 1 in successive message fragments. Initial fragments start at 11 and increment 1 for each successive fragment. The 11 state (after the start fragment) is skipped in this process to avoid confusion with an initial fragment of a non-continued message. The final fragment is indicated by Message Continued Flag being reset (= 0).

N - Message Number: When the system supports message retrieval the infrastructure will assign message numbers (for each paging address separately) starting at 0 and progressing up to a maximum of 63 in consecutive order. The actual maximum roll over number is defined in the pager code plug to accommodate values set in the system infrastructure. When message numbers are not received in order, the subscriber should assume a message has been missed. The subscriber or the pager may determine the missing message number(s) allowing a request to be made for retrieval. When a normal unnumbered numeric message is received (message retrieval flag is equal to 0) it is not to be included in the missed message calculation. This number is also used to identify fragments of the same message. Multiple messages to the same address must have separate message numbers. The message retrieval number displayed to the user is to be 1 + N so that the user perceives messages numbered from 1 to N + 1.

R - Message Retrieval Flag: When this bit is set to 1, the pager expects to see messages numbered in order (each address numbered separately). Detection of a missing number indicates a missed message. A message received with R = 0 is allowed to be out of order and shall not cause the pager to indicate that a message has been missed.

M - 1 bit Mail drop Flag: When set to 1, indicates the received message can be processed uniquely.

S - 7 bit Signature Field: The signature is defined to be the 1's complement of the binary sum over the total message (all fragments) taken 7 bits at a time (on alpha character boundary) starting with the first 7 bits directly following the signature field. ($a_6\, a_5\, a_4\, a_3\, a_2\, a_1\, a_0$, $b_6\, b_5\, b_4\, b_3\, b_2\, b_1\, b_0$, etc.) The 7 least significant bits of the result is transmitted as the message signature.

U, V - Fragmentation control bits: This field exists in all fragments except the first fragment. It is used to support character position tracking in each fragment when symbolic characters (characters made up of 1, 2, or 3 ASCII characters) are transmitted using the Alphanumeric message type. The default value is 0,0.

Message Content: Starting with the 2nd character of the 2nd word in the message (1st character of the 2nd word in all remaining fragments), each 7 bit field represents Standard ASCII (ISO 646-1983E) characters with options for certain International characters.

Message Termination: The ASCII character ETX ($03) should be used to fill any unused 7-bit characters in a word. In the case where symbolic characters are being transmitted special rules for fragment and message termination are defined in Section 3.8.8.6.

3.8.8.4. Secure Message

Vector type V=000 All Fragment

1 2 3 4 5 6 7 . . . . 21 Information	. . . . 31 Parity	32 Ck
1st Word		
K_0 K_1 K_2 K_3 K_4 K_5 K_6 K_7 K_8 K_9 C_0 F_0 F_1 N_0 N_1 N_2 N_3 N_4 N_5 t_0 t_1	p p p p p p p p p p	P
2nd Word		
a_0 a_1 a_2 a_3 a_4 a_5 a_6 b_0 b_1 b_2 b_3 b_4 b_5 b_6 c_0 c_1 c_2 c_3 c_4 c_5 c_6	p p p p p p p p p p	P
3rd Word		
d_0 d_1 d_2 d_3 d_4 d_5 d_6 e_0 e_1 e_2 e_3 e_4 e_5 e_6 f_0 f_1 f_2 f_3 f_4 f_5 f_6	p p p p p p p p p p	P
4th Word		
g_0 g_1 g_2 g_3 g_4 g_5 g_6 h_0 h_1 h_2 h_3 h_4 h_5 h_6 i_0 i_1 i_2 i_3 i_4 i_5 i_6	p p p p p p p p p p	P
5th Word		
j_0 j_1 j_2 j_3 j_4 j_5 j_6 k_0 k_1 k_2 k_3 k_4 k_5 k_6 l_0 l_1 l_2 l_3 l_4 l_5 l_6	p p p p p p p p p p	P
• • •		
nth Word		
i i i i i i i i i i i i i i i i i i i i i	p p p p p p p p p p	P

Data sent LSB 1st

K - 10 bit Fragment Checksum: This Checksum is calculated by initializing the fragment Checksum (K) to zero and summing the information bits of each code word in the message fragment (including control information and termination characters and bits in the last message word) to a Checksum register. The information bits of each word are broken into three groups: the first is the 8 bits comprising bits 1 through 8, the second group comprises bits 9 through 16 and the third group comprises bits 17 through 21. Bits 1, 9 and 17 are the LSB's of each group. The binary sum is calculated, the 1's complement of the sum is determined and the 10 LSB's of the result is transmitted as the message Checksum.

C -1 bit Message Continued Flag: When set (=1) indicates fragments of this message are to be expected in following Frames.

F - 2 bit Message Fragment Number: This is a modulo 3 message fragment number which is incremented by 1 in successive message fragments. Initial fragments start at 11 and increment 1 for each successive fragment. The 11 state (after the start fragment) is skipped in this process to avoid confusion with an initial fragment of a non-continued message. The final fragment is indicated by Message Continued Flag being reset (= 0).

N - Message Number: This number is used to identify fragments of the same message. Multiple messages to the same address must have separate message numbers. The number ranges from 0 to 63.

t - 2 bit Secure Message Type Field.

$t_1\ t_0 = 0, 0$ represents 7 bit ASCII data being transmitted
$t_1\ t_0 = 1, 0$ represents binary data format (1 character = 1 bit)
$t_1\ t_0 = 0, 1$ represents data with defined fields
$t_1\ t_0 = 1, 1$ reserved

Message Content:

For $t_1\ t_0 = 0\ 0$, the message is delivered over the network as if it were made up of ASCII characters. Starting with the first character of the 2nd word in the message (and 1st character of all remaining fragments), each 7 bit field represents Standard ASCII (ISO 646-1983E) characters with options for certain International characters.

Often Secure messages start with specific operation codes therefore the 1st 7 bits of a general message should start with an alphabetic or numeric character. Other characters should be considered reserved for possible operation code use.

Message Termination:

For ASCII message type $t_1\ t_0 = 0\ 0$, the ASCII character ETX ($03) should be used to fill any unused 7-bit characters in the last word (in the last fragment).

For Binary message type $t_1\ t_0 = 1\ 0$, unused bits in the last message word of the message are filled with all 0's or all 1's depending on the last valid data bit. The choice is always the opposite polarity of the last valid data bit. When the message ends exactly in the last bit of the last message word an additional word must be sent of opposite polarity all 1's or all 0's to signify the position of the last bit.

For data with defined fields type $t_1\ t_0 = 0\ 1$, no special termination is required.

3.8.8.5. Full Bandwidth Message Protocol (Future)

In the future it will be desired to deliver messages over the RF channel at the full 6400 bps rate. An extension of the FLEX™ protocol will be defined providing the assembly of messages at the full 6400 bps rate (as opposed to the single phase rate of 1600 bps). It is expected that this capability would be used for special applications only since it does not have an effect on channel capacity just the latency in receiving long data files.

3.8.8.6. Alphanumeric Message Rules for Symbolic Characters Sets

In the past, paging protocols have supported symbolic characters like Chinese, Kanji, etc. using a 7 bit ASCII protocol. When the FLEX™ alphanumeric mode is used to carry this same signaling format, special fragmenting rules are required to maintain character boundaries so performance will be optimized under poor signal conditions. The following rules allow character positions within a fragment to be determined when prior fragments are missing.

ENHANCED FRAGMENTATION RULES:

1) The pager must recognize <NUL> characters only at the end of fragments where they are used as fill characters. The pager must remove these characters so that the displayed message is not affected. In all other positions the NUL character must be considered a result of channel errors. (This provides a method to end each fragment with a complete character and does not disrupt a pager which is not capable of following all of the EF (Enhanced Fragmenting) rules.)

2) The last fragment is to be completed by filling unused character positions with <ETX> characters or <NUL> characters. (Original FLEX™ alphanumeric message definition (<ETX>) plus the new <NUL> requirement.) When the message ends exactly in the last character position in the last BCH codeword, no additional <ETX> characters are required.

3) The U and V bits in the message header are available in all fragments following the initial fragment to aid in decoding. In the first fragment the pager must assume the message starts in the default character mode.

For the second and remaining fragments the definition of the (U,V) field is as follows:

U_0	V_0	
0	0	EF not supported in Infrastructure
0	1	Reserved (for a second alternate character mode)
1	0	Default Character Mode
1	1	Alternate Character Mode

When the EF field is 0 0, the pager will decode messages allowing characters to be split between fragments. When the U,V field is not 0 0, each fragment will start on a character boundary with the character mode defined by the above table.

Note: It is required that the encoding device dissect the message in order to control character boundaries within each fragment.

3.9. FLEX™ ROAMING STRUCTURE

The FLEX™ paging protocol defines two methods for supporting roaming pagers. The first method is called SSID (Simulcast System IDentification) roaming and is based on the pager identifying each simulcast area which is to be included in the desired roaming area. The pager, in this case, contains a channel scan list with the information required to find and identify each simulcast system.

The second method is referred to as NID (Network IDentification) roaming and is based on the pager examining RF channels for the presence of a marker (NID) carried in the address and vector fields indicating that the channel is affiliated with the desired roaming network. This type of roaming is better suited for large, possibly global, coverage areas where it would be impractical to store every possible Simulcast System IDentification making up the desired total coverage area.

Roaming Terms:
The Simulcast System IDentifier (SSID) together with the Network IDentifier (NID) represent the basic building blocks used in FLEX™ Multi-Area Roaming.

Simulcast System IDentifier
A Simulcast System IDentifier (SSID) is composed of a Local IDentifier (LID) (9 bits), a Coverage Zone (5 bits), a Country Code (10 bits) and Traffic Management Flags (4 bits). These components when combined with an RF frequency, define a specific simulcast coverage area. The 9 bit LID is unique within the same Country Code not to be reassigned to another operator in any paging RF band. The pager's memory resource is the only limit to the number of SSID's a pager can store. RF channel frequency information combined with an SSID identifies one unique simulcast area on the Earth. Placement of SSID information in the FLEX™ structure is defined in Section 3.9.1.

Network IDentifier
A Network IDentifier (NID) is composed of a Network Address (from the set of 4096), and 12 information bits carried in a Short Message Vector. The 12 bits are divided into fields as follows: Service Area Identifier (5 bits), a Multiplier (3 bits) and Traffic Management Flags (4 bits). Placement of NID information in the FLEX™ structure is defined in Section 3.9.1.

A RF channel may combine roaming traffic from several different Service Providers by carrying their respective NID's. An NID is unique across an RF band. This allows the pager to scan (if necessary) all frequencies within the subscriber unit's RF range for the channel carrying its assigned NID.

3.9.1. SSID and NID Requirements to Support Multi-Frequency Roaming.

Simulcast System IDentification (SSID) Placement Rules - When a Service Provider supports roaming and possibly the transmission of real time and calendar information the following placement rules are to be followed as illustrated in the following tables below:

1) GPS (or a Universal Time reference which is synchronized to within ±1 millisecond of GPS) must be used to align the leading edge of the 1st bit of Bit Sync 1 of Frame 0 to the 4 Minute Timing Marks. Frame 0, Cycle 0 is transmitted at the top of the GPS hour. The GPS time requirement forces all RF channels in a roaming system to be time aligned (worst case +/- 2 mS time offset between any two channels with each channel aligned to within +/-1mS of GPS time).

2) The Roaming Support bit (n_0) in the Frame Information Word must be set to 1 when the channel obeys Rule 1) and obeys roaming information placement rules.

PHASE

Frame	A	B	C	D
0	BIW000 BIW111 T1	T2	T3	BIW101 T1
1		BIW000 BIW111	BIW101	
2		BIW101	BIW000 BIW111	
3	BIW101			BIW000 BIW111
4	BIW000			
5		BIW000		
6			BIW000	
7				BIW000
8	BIW000			
9		BIW000		
10			BIW000	
11				BIW000
12	BIW000			
13		BIW000		
14			BIW000	
15				BIW000
16	BIW000			
17		BIW000		
18			BIW000	
19				BIW000
⋮				
127				BIW000

3) If a system supports an SSID only, FLEX™ Frames 0, 1, 2, & 3 must be transmitted (7.5 Second minimum transmission at beginning of each 4 Minute FLEX™ cycle).

4) SSID information must follow, at a minimum, what is shown in the Figure (BIW 000 in all Frames transmitted, BIW 111 in Frames 0, 1, 2, 3). The phase placement is determined by Modulo 4 of the Frame number where Phase a = 0, b = 1, c = 2 and d = 3.

5) Protocol mixing, Channel ID Licensing signals (FCC, etc.) and Channel Sharing with another operator may take place only during the time periods aligned with Frames 4 through 127 to ensure the presence of the mandatory Frames 0 through 3.

6) Time, if supported, and other information is expected to appear in the Block Information Words. Time when supported must appear in each Phase transmitted in Frame 0 Cycle 0 rotating through the supported time related BIWs. In order to meet this requirement at 1600 bps, the BIW101 Channel Set Up Instruction is allowed to be removed from Frame 0 creating space for one time BIW. Time should rotate within each phase and across phases so the "Any" Phase pager may obtain a complete set of time information from Frame 0 at 6400 and 3200 bps. At 1600 bps, it may take 3 hours to completely update time. ("T" in the Figure represents time placed in the BIW field). If additional BIW positions are available, Time BIWs can be utilized to fill the open BIW positions allowing faster Time information delivery.

7) When supported, Frame Offsetting information must follow what is shown in the preceding figure. The BIW 101 locations in the rectangles represent the A_3 A_2 A_1 A_0

field set to 0110 providing Channel Set Up Instructions for the RF channel. The phase placement is determined by the 1's complement of Modulo 4 of the Frame number where Phase a = 0, b = 1, c = 2 and d = 3. When the system operates at 3200 BPS, the standard transfer of phase information described in Section 3.5.2 is used (Phase b is combined into Phase a, Phase d is combined into Phase c). In a 1600 BPS system, the Frame Offsetting BIW must be placed in each of the mandatory Frames if a BIW position is available. However, this Frame Offsetting BIW must be placed in Frame 3.

In cases where a channel is shared, the above FLEX™ requirements must be followed in order for the channel to provide roaming services.

NID (Network Identification) Requirements to Support Multi-Frequency Roaming - NIDs are markers placed in the FLEX™ protocol to identify the Roaming Network affiliations of each particular RF channel. The NID consists of a special network address located in the address field followed by the Short Message Vector in the vector field. The Subscriber Unit looks in predetermined Frames and phases on each FLEX™ RF channel to identify which RF channels support the desired network roaming service. The NID is generally used to group many simulcast areas together forming Regional, National, or Global Networks. The Subscriber Unit typically would be assigned only one NID while an individual RF channel could support many networks by carrying the required different NID's in the proper Frames.

PHASE

Frame	A	B	C	D
0	BIW000 BIW111 T1 NID 1	T2	T3	BIW101 T1
1		BIW000 BIW111	BIW101	
2		BIW101	BIW000 BIW111	
3	BIW101			BIW000 BIW111
4	BIW000			BIW101
5		BIW000	BIW101	
6		BIW101	BIW000 NID 2	
7	BIW101			BIW000
8	BIW000 NID 1			
9		BIW000		
10			BIW000	
11				BIW000
12	BIW000			
13		BIW000		
14			BIW000 NID 2	
15				BIW000
16	BIW000 NID 1			
17		BIW000		
18			BIW000	
19				BIW000
⋮				
127				BIW000

In most cases, an RF channel supporting NID's will already carry SSID information, however, if no SSID support is to be carried on the RF channel rules 1), 2), 6) and 7) must still be observed in addition to the following rules:

8) When NID roaming is supported Frames 0 through 7 must be transmitted in every FLEX™ cycle (15 Seconds minimum transmission at the beginning of each 4 Minute FLEX™ cycle).

9) Protocol mixing, Channel ID Licensing signals (FCC, etc.) and/or Channel Sharing with another Service Provider must be confined to Frames 8 through 127 to ensure the presence of mandatory Frames 0 through 7.

10) Each NID is located in a specific Frame in the range of Frames 0 through 7. The phase placement is determined by Modulo 4 of the Frame number where Phase a = 0, b = 1, c = 2 and d = 3. (Carry On does not apply to NID placement.)

11) NIDs must appear in other Frames which are optionally transmitted when Modulo 8 of the Frame number is the same as the NID expected Frame. This means that on a shared channel with two or more FLEX™ operators, each must support the transmission of both operator's NIDs.

12) The expected placement of an NID is determined by the following set of rules:
 a) Each RF channel is represented by a number (M) in the range of 0 through 7 where; M = Modulo 8 of Integer [(Freq. kHz) / (25 kHz)]
 b) N = Modulo 8 of Network Address (same as 3 LSB's)
 c) C = Modulo 8 of the FLEX™ Cycle Number (0 through 14)
 d) Expected Frame = F = Modulo 8 of Sum N+M+C.
 (The formula in Rule 12 makes it possible to search 8 consecutive RF channels for the same NID in the 15 second (8 Frame) period at the beginning of each 4 minute period of time. It also causes the NID to shift one Frame each cycle thus alleviating possible shadow problems in the coverage overlap / straddle areas.)

13) When supported, Frame Offsetting information must follow what is shown in the preceding figure. The BIW 101 locations in the rectangles represent the A_3 A_2 A_1 A_0 field set to 0110 providing Channel Set Up Instructions for the RF channel. The phase placement is determined by the 1's complement of Modulo 4 of the Frame number where Phase a = 0, b = 1, c = 2 and d = 3. When the system operates at 3200 BPS, the standard transfer of phase information described in Section 3.5.2 is used (Phase b is combined into Phase a, Phase d is combined into Phase c). In a 1600 BPS system, the Frame Offsetting BIW must be placed in each of the mandatory Frames if a BIW position is available. However, this Frame Offsetting BIW must be placed in Frame 7.

3.9.2. System Message Transmission

Sending System Messages Using the BIW

A System Message must be initiated in Frame 0 when a BIW position is open for System Messaging. If a BIW position in Frame 0 is not available, the first Frame transmitted after Frame 0 which has an available BIW position is to be used for the System Messaging. Pagers which desire to receive System Messages will look in Frame 0 for the possibility of a System Message. After receiving a System Message, the subscriber unit may choose to ignore future messages or to look much less frequently (for example, maybe just once a day). This choice would depend on the type of subscriber unit and a choice made by the user.

The method of transmission is to place BIW 101 in the Block Information Word field and add an extra Vector at the end of the Vector Field. The Vector then points to the System Message following all the rules for Vectors (all Vector types are valid except the Secure Vector). The Message Retrieval Flag (R bit) must be set to zero for BIW System Messages. If a fragmented message is to be transmitted, the BIW 101 must be re-stated in a following Frame with the next message fragment. Except for BIW 101 acting as an address, rules for normal fragmented messages apply.

When the BIW System Message has a corresponding Operator Messaging Address, both the BIW 101 and the Operator Messaging Address and its message must be sent. The Operator Messaging Address method allows subscriber units to receive System Messages utilizing the same means as personal messages.

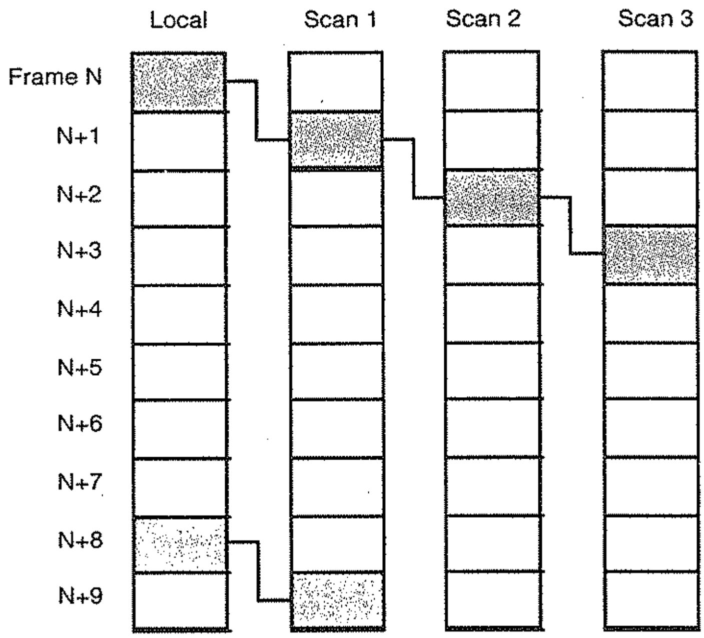
Sending an Operator Messaging Address System Message As indicated in Section 3.8.5, System Messages and Instructions shall be delivered in Frame 0 using these addresses in the same manner as a normal FLEX™ Address, Vector and Messaging event. This isrequired for delivering System Messages.

Sending a NID System Message
Each Network Address by definition must be transmitted at a minimum once in the range of Frames 0 through 7. When a message is to be sent, the Network Address must appear twice, consecutively (next to each other in the same phase) in the address field, within the mandatory Frames as defined by the NID placement rules. The first Network Address is used to define an NID and the second Network Address may initiate an associated System Message. Short Message Vectors are not allowed for use as a System Message as the message and address combination could be interpreted as an additional NID.

This message could be as simple as a "Welcome Message" or in the future it might deliver channel information which could assist a roaming subscriber assigned to that particular NID. The Message Retrieval Flag (R bit) must be set to zero for NID System Messages.

3.9.3. Frame Offsetting Example

When the desired roaming coverage pattern contains separate simulcast areas which overlap, it is desirable for the pager to detect the degraded performance which occurs at the fringe of one coverage area and start examining the other potential frequencies in order to prepare for a switch to another channel. When these conditions are anticipated by the Service Provider, a pager's Frame assignment can be altered on each scanned RF frequency to allow monitoring of several RF channels through time multiplexing at the FLEX™ Frame rate. As one channel emerges as the dominate strong signal, most likely, the other channels can be dropped.



In some cases, the pager may be required to monitor all assigned frequencies in the overlap areas even if some signals are weak.

3.9.4. Registration Acknowledgment Message

Registration is an optional feature in FLEX™. The subscriber conveys his desire to temporarily change his Coverage Area by interacting with the terminal database. An optional Registration Acknowledgment Message may be transmitted to the subscriber unit to let the subscriber know that the system has accepted his request.

The Registration Acknowledgment Message uses a Secure Message of the ASCII Character type ($t_1\ t_0 = 0\ 0$). This message is transmitted using the Primary Subscriber Unit address in response to the subscriber requesting service to be temporarily changed, modifying areas of coverage.

Registration Acknowledgment - Secure Message

Vector type V=000 $t_1\ t_0 = 0\ 0$

1 2 3 4 5 6 7 . . . . 21 Information	22 31 Parity	32 Ck
1st Word K0 K1 K2 K3 K4 K5 K6 K7 K8 K9 C0 F0 F1 N0 N1 N2 N3 N4 N5 t0 t1 2nd Word 1 0 1 1 1 1 0 r0 r1 r2 r3 r4 r5 r6 r7 r8 r9 r10 r11 r12 r13		

Data sent LSB 1st

The K, C, F, N , t Fields in the 1st Word are all defined in Section 3.8.8.4.
The 2nd Word definitions are:
Bits 1 - 7 – Operation Code for Registration Ack. ("=" Hex 3D)
Bits 8-21 – Reserved (default to ETX characters)

3.9.5. Registration Instruction

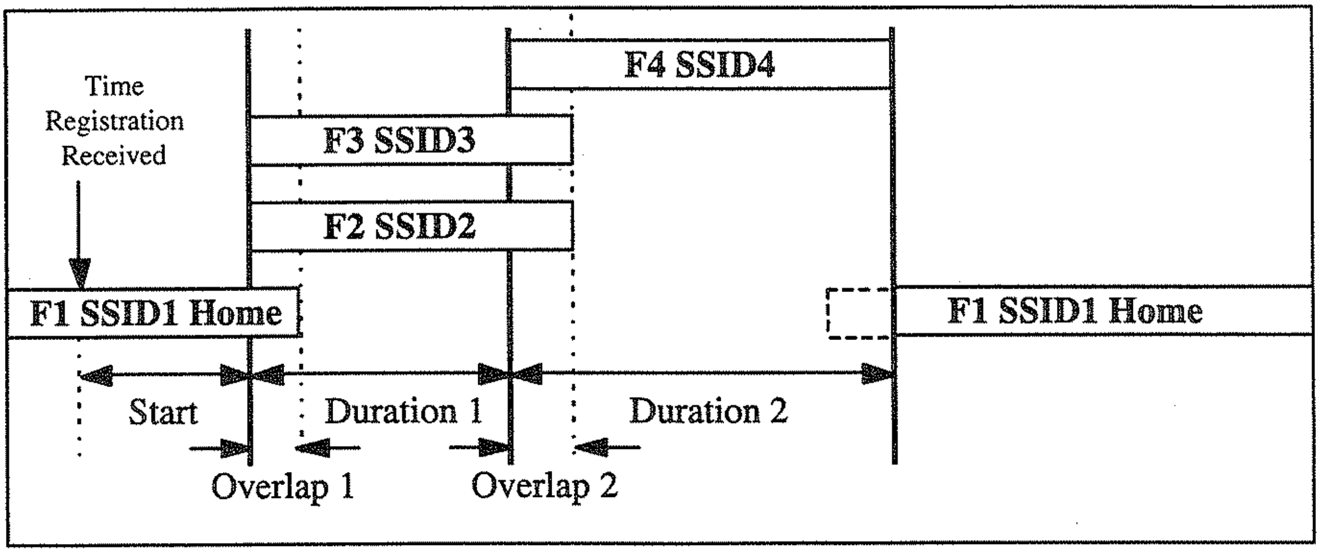
The Registration Instruction is an operator option allowed only in certain countries[1]. When used, it provides the function of the previous Registration Acknowledgment Message plus it aids the pager in determining which channel is carrying the desired traffic.

The following figure illustrates the registration process as seen by the pager through the information provided in the Registration Instruction. The subscriber contacts the service provider by telephone and describes the areas he intends to visit, the approximate time of arrival and duration of stay in each area. A message is sent to the pager using the secure message for providing the information shown in the figure.

As can be seen in the figure, each "Start" of new coverage may represent 1 or more coverage areas. The overlap time is the time to hold the previous coverage area in the registered status after the new coverage area becomes registered. This overlap might typically be on the order of 4 hours but could be extended up to 64 hours. Expiration of the final "duration" results in the pager returning control to the scan list stored in the pager's memory.

[1] The registration instruction may not be allowed in certain countries. Please check with the Motorola licensing manager. Refer to page ii.

Registration Example



Detailed description of the Secure Instructions are available in the Document entitled "Secure Instructions to FLEX™ Pagers" available to qualified organizations (e.g. licensees and paging operators evaluating FLEX™) under Non-Disclosure Agreement with Motorola. See Notice page ii

3.9.6. System SSID Change Instruction

Several types of Information may be communicated to the subscriber unit concerning system changes that have recently occurred or are about to occur.

Types of changes indicated:
- An up-coming traffic split to a new RF Channel using TMF's
- An on-going indication of a split that has occurred in the past
- A Coverage Area addition for subscriber units which have the indicated coverage area already included in the pager scan list. The Service Provider must anticipate this coverage addition at the time the pager is programmed. The LID, Country Code, and Coverage Zones (to be activated in the future) are programmed in the pager. At the time when the coverage area is available or when the decision as to which RF frequency is to be used all pagers may be delivered the information through the System SSID Change Instruction. Reception of the RF frequency activates the scan list entry.

The System SSID Change Instruction uses Operator Messaging Address 1110 which will be monitored by all multi-frequency subscriber units which have chosen to monitor this channel because of the SSID.

The System SSID Change Instruction is mandatory for those systems which use TMF splitting. These messages are sent in the first 8 frames of a FLEX™ cycle unless the system only supports SSIDs and frame 4 through 7 are not transmitted. The instruction is placed in the same phase as the SSID 2 Cycles before and 2 Cycles after the Cycle which contained the change (this is a total of 5 Cycles). After the change has taken place, this message is recommended to be sent once an hour (at the discretion of the Service Provider) to allow all subscriber units to recognize the change.

Detailed description of the Secure Instructions are available in the Document entitled "Secure Instructions to FLEX™ Pagers" available to qualified organizations (e.g. licensees and paging operators evaluating FLEX™) under Non-Disclosure Agreement with Motorola. See Notice page ii

3.9.7. System NID Change Instruction

The use of the System NID Change Instruction is optional. When utilized, they are sent in the mandatory frames 2 Cycles before and 2 Cycles after the Cycle which contains the change (a total of 5 Cycles). After the change has taken place, this message is recommended to be sent once an hour (at the discretion of the Service Provider) to allow all subscriber units to recognize the change. The indicated RF frequency is equal to the value transmitted times 1.25 kHz. The LSB is transmitted first in all fields.

This instruction is similar to the System SSID Change Instruction in that it gives an early indication of a traffic management channel split or informs the subscriber unit that a new NID Service area has become available. This System Instruction uses a Secure Message of the type t_1 t_0 = 0 1. The Instruction is initiated by the Network Address of the affected NID (second of 2 consecutive addresses initiates the message) and is transmitted in the mandatory frames. The System NID Change Instruction data is described in the following table.

Detailed description of the Secure Instructions are available in the Document entitled "Secure Instructions to FLEX™ Pagers" available to qualified organizations (e.g. licensees and paging operators evaluating FLEX™) under Non-Disclosure Agreement with Motorola. See Notice page ii

3.9.8. Roaming System Design Elements

In order to provide a basic understanding of the principles involved in the design of a multi-frequency roaming system, the following material briefly describes the Encoding process. Additional material may be found in the FLEX™ System Management Documentation paper "The FLEX™ Protocol's Operational Capabilities for Multi-Frequency, Multi-Area Use".

Each subscriber unit contains a list of potential RF frequencies along with associated SSIDs and NIDs. Addresses associated with these SSIDs and NIDs are stored in the subscriber unit and identified as being active at "Home" or in "All" coverage areas. All addresses in the pager must be associated with one Traffic Management Flag (TMF). The TMF choice is determined by the Primary Individual address active at "Home".

Coverage Classifications
The "Home" is typically identified by a SSID or a set of SSIDs (an LID, Coverage Zone, Country Code and Traffic Management Flag). The Encoding Device sends messages to this SSID or this set of SSIDs when applicable.

Coverage areas away from "Home" typically will be based on an NID and will fall into two classifications.

"Roaming Coverage Type 1" - this type of coverage support results in the Encoding Device sending messages to the desired area plus all other Coverage Areas which overlap the desired area and transmit the same NID (Network Address, Multiplier, Service Area and Traffic Management Flag).

"Roaming Coverage Type 2" - this type of coverage support results in the Encoding Device sending messages only to the desired area which transmits the required NID (Network Address, Multiplier, Service Area and Traffic Management Flag).

The above Coverage Classification definitions identify the development needs of the FLEX™ roaming subscriber unit.

4. FLEX™ ENCODING AND DECODING REQUIREMENTS

4.1. PURPOSE

The purpose of this section is to compliment the entire document with respect to encoding requirements for implementing FLEX™ in Encoding Systems and decoding requirements for implementing FLEX™ in Decoding Systems, such as a pager. The intent is to ensure that features and services dependent wholly or partially on FLEX™ are implemented in an inter-operable manner among various manufacturers.

The following Sections will be highlighted as Rules or Recommendations. All are considered as Rules unless otherwise noted. The definitions of these two items are as follows:

Rule: A rule is a mandatory attribute that must be followed to be compliant with a version of the specification.

Recommendation: A recommendation is a suggested attribute considered to be highly desirable. In some cases, a recommendation may optimize the enablement of future enhancements to the specification.

4.2. SCOPE

These encoding and decoding specifications apply to all Encoding Systems or Devices and Decoding Systems or Devices claiming compliance to the FLEX™ specifications Document Number: FLEX™-93001. These systems and devices include the pager (subscriber unit), paging terminal or paging encoder. Rules and Recommendations are included in this Section to compliment the operational means of the entire document in order to format a FLEX™ data stream properly for RF transmission and to decode it successfully.

4.3. FLEX™ ENCODING RULES

4.3.1. General FLEX™ Encoder Rules

4.3.1.1. The stability of the Encoder clock used to establish time positions of FLEX™ Frames must be no worse than ±25 ppm (including worst case temperature and aging effects).

4.3.1.2. Once a FLEX™ transmission has been initiated to FLEX™ Decoders on a channel, the FLEX™ Encoder must maintain Frame synchronization continuously thereafter to the specified stability of timing.

4.3.1.3. If the Encoder loses FLEX™ Frame synchronization timing, the Emergency Re-synchronization pattern must be sent before any new FLEX™ messages may be transmitted. This pattern must be sent continuously

duration that exceeds the longest Decoder battery save cycle used in the coverage area of the system where synchronization was lost.

4.3.2. Frame Management Rules

4.3.2.1. Transmission of a Frame may be terminated prior to the end of the Frame (shortened early) only after all whole Blocks containing data have been transmitted.

4.3.2.2. Whenever a Frame is shortened early, it must not terminate prior to the end of the first Block where the Block Information Word(s) is (are) found.

4.3.2.3. Frames may be skipped to provide access to protocol signaling other than FLEX™ on the channel.

4.3.2.4. A pager Collapse value (battery save cycle) must be assigned to each individual and radio group address. This value defines the maximum interval between Frame searches, without taking into account the system Collapse value.

4.3.2.5. The pager Collapse value (battery save cycle) for each individual and radio group address that is stored in the Encoding system and acted upon at the Encoder must be the same value stored in the Decoding System or Device (pager / subscriber unit).

4.3.2.6. The system Collapse value must be the same for all phases and Frames.

4.3.2.7. Changes to the System Frame ID Collapse Mask in Block Information Word 1 requires the 4 Low Traffic Flags in the Frame Information Word to be cleared (set to 0) in every Frame (starting with the Frame in which the change was made) for a duration that exceeds the longest Decoder battery save cycle used in the coverage area of the changed system.

4.3.2.8. The 4 Low Traffic Flags in the Frame Information Word must be cleared (set to 0) in any Frame where the Carry On feature is used (i.e. when the two Carry On bits are not "00").

4.3.3. Pager Synchronization Acquisition Rules

4.3.3.1. Minimum channel activity required to support FLEX is at least 1 full Frame per minute (32 Frames) or in the case of shared channel operation at least 1 full Frame per 4 minutes (128 Frames). The FLEX encoder and the FLEX pager must support both conditions. A full Frame is defined to be 1.875 seconds long, with idle code filling any unused portion of the Frame. Once a full Frame is sent within the specified time period, additional Frames may be shortened.

4.3.3.2. RECOMMENDATION: It is recommended that idle time on the channel be filled with FLEX™ idle Frames. When there is not enough time to send a complete idle Frame, as may occur on a mixed protocol signaling channel, an alternating 1,0 fill pattern at 1600 bps can be sent. For example, a channel fill pattern should be started at the end of the POCSAG transmission and continued until the FLEX™ Frame begins.

4.3.4. Transmission Phase Selection Rules

4.3.4.1. Individual and radio group addresses which have been assigned to a Single Phase Decoder must be assigned to one of the four available phases (a, b, c, or d).

4.3.4.2. All individual and radio group addresses assigned to a Single Phase Decoder must be assigned to the same phase.

4.3.4.3. Address assignments to Single or Any phase Decoders and phase assignment to single phase Decoders must be stored in the Encoder and must be the same value as stored in the Decoder code plug for each individual and radio group address.

4.3.4.4. Individual and radio group addresses which have been assigned to Single Phase Decoders must always be sent in the assigned phase of the Decoder.

4.3.4.5. Individual and radio group addresses which have been assigned to Any Phase Decoders can be sent in any available phase.

4.3.4.6. Phase assignments of dynamic group addresses (using the Short Instruction Vector) must be consistent with Rules 4.3.4.1, 4.3.4.2 and 4.3.4.5.

4.3.5. Message Addressing Rules

4.3.5.1. Each individual and radio group address must be assigned to one of the 128 available Frames of a FLEX™ cycle.

4.3.5.2. An individual or radio group address must be assigned to only one Frame.

4.3.5.3. The Frame assignment for each individual and radio group address that is stored in the Encoding System and acted upon at the Encoder must be the same value stored in the Decoder.

4.3.5.4. A maximum of 2 occurrences of an identical individual or radio group address is allowed in any Frame for unfragmented messages. This rule applies across all phases in a multi-phase Frame. For example, for Decoders that support Any Phase addressing, an Any Phase address may appear once in two different phases in a single multi-phase Frame.

4.3.5.5. Once an individual, Operator Messaging, NID or radio group address is used to begin transmitting a fragmented message, that same address must not be used to start a new fragmented transmission until the first fragmented transmission has been completed.

4.3.5.6. For the duration of time that an individual or radio group address is being used to send a fragmented message, that same address must not appear more than once in any Frame to send an unfragmented message.

4.3.5.7. Once a specific dynamic group address (temporary address) is assigned to a group, it must not be reused until its associated message has been transmitted in its entirety. Given this constraint, the same dynamic group address can only appear once in any Frame.

4.3.5.8. A dynamic group address cannot be used to set up a second dynamic group.

4.3.6. Message Fragmenting Rules

4.3.6.1. Messages using any of the three defined Numeric Vectors (011, 100, 111) cannot be fragmented, and thus must be contained completely within a single Frame.

4.3.6.2. Fragments of the same message must be sent at a frequency of at least 1 fragment every 32 Frames (at least one per minute). In special cases, the frequency of fragments may be extended to 1 fragment every 128 Frames (at least one fragment every 4 minutes). These special cases include but are not limited to channels that support roaming, channels that are shared between multiple Service Providers and channels containing a repeat format. The Encoder and Subscriber Unit must support both conditions.

4.3.6.3. Enhanced Message Fragmenting for Symbolic Character transmission requires that the Encoder track character boundaries within each fragment in order to avoid character splitting.

4.3.7. Message Retrieval Numbering Rules

4.3.7.1. Message numbering is an optional feature.

4.3.7.2. Message numbers must be assigned sequentially in ascending order.

4.3.7.3. Message number sequences must be maintained independently for each individual and radio group address.

4.3.7.4. Message numbers are not used (retrieval message number disabled) in conjunction with a dynamic group address.

4.3.7.5. Rule Deleted

4.3.7.6. When a missed message is re-transmitted from message retrieval storage, the message must have $R_0 = 0$ to avoid creating an out of sequence message which may cause the Decoder to indicate a missed message.

4.4. FLEX™ DECODING RULES

4.4.1. General FLEX™ Decoding Rules

4.4.1.1. FLEX™ Decoders may implement either Single Phase addressing or Any Phase addressing.

4.4.1.2. Rule Deleted.

4.4.1.3. FLEX™ Decoders that support the Numeric Vector type 011 must also support the short message vector type 010, with message type t_1t_0 set to 00.

4.4.1.4. FLEX™ Decoders that support the Alphanumeric Vector type 101 must support the Numeric vector type 011 and the short message vector type 010, with message type t_1t_0 set to 00. "Any" Phase and "All" Phase Decoders which support the Alphanumeric Vector type 101 must also support the instruction type 000 of the Short Instruction Vector type 001.

4.4.1.5. FLEX™ Decoders must be capable of decoding Frames at all of the following combinations of data rate and modulation modes: 1600 bps, 2 level; 3200 bps, 2 level; 3200 bps, 4 level; 6400 bps, 4 level.

4.4.1.6. FLEX decoders must be designed to accept the 1 Frame per 4 minute RF channel activity described in Rule 4.3.3.1 and tolerate 4 minute fragment separation times.

4.5. MULTI-FREQUENCY FLEX™ ROAMING RULES

4.5.1. Multi-Frequency Roaming FLEX™ Encoder Rules

4.5.1.1. GPS Time Coordination (or other universal time standard adjusted to

±1 mS of GPS) is required of all Roaming channels with the beginning of Frame 0 aligned with the 4 Minute Time Marks. Channels for multi-frequency roaming must transmit the Frame Information Word with bit n_0 set to 1 in every Frame.

4.5.1.2. When SSID's are transmitted on the channel, Frames 0 through 3 must be transmitted in their entirety. When no traffic exists, Idle Words must be used to fill Frame Blocks.

4.5.1.3. When NID's are included on the channel, Frames 0 through 7 must be transmitted in their entirety. When no traffic exists, Idle Words must be used to fill Frame Blocks.

4.5.1.4. SSID's and NID's when transmitted appear in the Phase defined by the formula: Phase = Modulo 4 (Frame #) where the resultant 0, 1, 2, 3 corresponds to Phases a, b, c, d respectively.

4.5.1.5. When FLEX™ is transmitted at 3200 bps, the SSID and NID information carried respectively in the Block Information field and the address field in Phase a is combined with information in Phase b for transmission in Phase a. Likewise, same information in Phase c is combined with information in Phase d for transmission in Phase c.

4.5.1.6. When FLEX™ is transmitted at 1600 bps, data in all Phases are combined for transmission in Phase a.

4.5.1.7. SSID Block Information Word 000 (BIW 000) must appear in every FLEX™ Frame transmitted on RF channels supporting SSID's.

4.5.1.8. SSID Block Information Word 111 (BIW 111) must appear in FLEX™ Frames 0 through 3 on RF channels supporting SSID's.

4.5.1.9. NID's must appear in FLEX™ Frame Numbers (F) on a RF channel supporting the NID determined by the following placement rule: Modulo 8 (F) = Modulo 8 (M+N+C) where M is the integer portion of the nominal radio frequency in kHz divided by 25 kHz, N is the Network Address portion of the NID, and C is the current FLEX™ Cycle number. (This does not force additional Frames to be transmitted outside of the mandatory Frames.)

4.5.1.10. Rule Deleted

4.5.1.11. Protocol mixing is allowed during Frames 4 through 127 on channels only supporting SSID's. Protocol mixing is allowed during Frames 8 through 127 on channels supporting NID's. (Protocol mixing is defined as FLEX™ signaling replaced by an alternate protocol.)

4.5.1.12. When a multi-frequency roaming Channel is Shared, FLEX™ must be transmitted during Frames 0 through 3 (or 0 through 7 when NID's are present) and a single SSID representing all sharing parties must be transmitted. All Frames transmitted must contain the Frame Information Word with n_0 set to 1 and carry SSID and NID information representing all parties sharing the channel.

4.5.1.13. The LID (9 bits) portion of the SSID must not be assigned to a different Service Provider within the same Country Code. This applies across all frequencies in all frequency bands.

4.5.1.14. Within a Coverage Zone, for a specific Country Code, each of the Traffic Management Flags associated with an LID and Coverage Zone combination must appear on one and only one RF channel set to a "1" to indicate the associated traffic management group is supported on that RF channel.

4.5.1.15. Throughout a Service Area, each of the four Traffic Management Flags associated with an NID and Service Area must appear on an RF channel set to a "1" to indicate the associated traffic management group is supported on that RF channel.

4.5.1.16. When a system utilizes Frame Offset multi-frequency reception, the FLEX™ Encoding System must process messages to designated addresses with the "maximum Carry On" value broadcast in the BIW 101 Channel Set Up Instruction.

4.5.1.17. When a system utilizes Frame Offset multi-frequency reception, the FLEX™ Encoding System must process messages to designated addresses with the "Frame Offset" value broadcast in the BIW 101 Channel Set Up Instruction.

4.5.1.18. When a system utilizes Frame Offset multi-frequency reception, System Messages and System Instructions (and their fragments) based on Operator Messaging Addresses, BIW's and NID Addresses, must not extend into Blocks 9 or 10 of a Frame except when unavoidable in system where r_0 is set to "1" in the Frame Information Word.

4.5.1.19. When a system utilizes Frame Offset multi-frequency reception, the Short Message Vector portion of an NID must not extend into Blocks 9 or 10 of a Frame except when unavoidable in system where r_0 is set to "1" in the Frame Information Word.

4.5.1.20. The Operator Messaging Address along with the Short Instruction Vector, Instruction Type 001, must be transmitted in a minimum of all Frames for the duration of one System Collapse Cycle. The System Event must take place within the next 4 FLEX™ Cycles of the first System Event Notification.

4.5.1.21. When system messages are to be transmitted, the encoder must use the Operator Message Address. In addition the encoder must be capable of transmitting BIW101 system messages when earlier pager designs are supported in the system.

4.5.2. Roaming FLEX™ Decoding Rules

4.5.2.1. FLEX™ Decoders must support 4 minute FLEX™ rules for the fragmentation of messages. (See Rule 4.3.6.2)

4.5.2.2. Rule Deleted.

4.5.2.3. RECOMMENDATION: Multi-Frequency roaming subscriber units should support the "Frame Offset" value broadcast in the BIW 101 Channel Set Up Instruction on designated addresses.

4.5.2.4. RECOMMENDATION: Multi-Frequency roaming subscriber units should support the "maximum Carry On" value broadcast in the BIW 101 Channel Set Up Instruction on designated addresses.

4.5.2.5. Recommendation: New subscriber unit designs should implement the Operator Message Address method for receiving system messages.

5. APPENDIX

5.1. ACRONYMS AND ABBREVIATIONS

BER	Bit Error Rate
BIW	Block Information Word
BPS	Bits Per Second
BSR	Battery Save Ratio
FCC	Federal Communications Commission
FIW	Frame Information Word
FLEX™	Motorola's High Speed Paging Protocol
FM	Frequency Modulation
FSK	Frequency Shift Keying
GPS	Global Positioning System
GSC	Golay Sequential Code
ISO	International Organization for Standardization
LID	Local IDentification
MBE	Message Bit Efficiency
NID	Network IDentification
PCIA	Personal Communications Industry Association
POCSAG	Post Office Code Standardisation Advisory Group
RCC	Radio Common Carrier
RF	Radio Frequency
SSID	Simulcast System IDentification
TDM	Time Division Multiplexing
TNPP	Telocator Network Paging Protocol

5.2. GLOSSARY OF TERMS

Address Classification – Refers to the scope of phase assignment for an address. The three available address classifications are Single Phase, Any Phase and All Phase.

Address Code Word – An address code word is a code word whose information portion contains a numeric value assigned as a specific address type.

Address Falsing – Address falsing occurs when an address code word is incorrectly detected as valid.

Address Field - The portion of a Frame that immediately follows the Block Information Field of each Frame. The Address Field always precedes the Vector and Messaging Field within the Frame.

Address Latency Time – The time delay incurred from the instant the entire page is available to the encoding device to the instant in time the first bit of the page goes out on the channel. Address latency time is independent of message length.

Address Mode –Refers to the scope of the address type. Serves as an indicator of whether the message associated with the address type is directed to a single recipient or multiple recipients. The three address modes are Individual, Radio Group and Dynamic Group.

Address Type – A group of address code words which identifies the major paging service categories. The six address types are Short, Long, Information Services, Network Identification, Operator Message Addresses and Temporary Addresses.

All Phase Address Classification – An address that can be assigned to multiple phases within its Frame for the purpose of spreading a single message across more than one phase resulting in the possible reception of messages at the full 6400 bps rate. (precise definition reserved for the future)

Any Phase Address Classification – An address that can be arbitrarily assigned to any phase at the time of transmission. Message reception is limited to a single phase per Frame at 1600 bps.

Base Frame - The single frame which is assigned to an address. The base frame value falls in the range of 0 through 127. Collapse values are applied to this frame number value to determine the actual frames which are to be monitored by the pager.

Battery Save Ratio – The battery save ratio (BSR) is a measure of the protocol's ability to minimize the number of bits that must be examined in order to detect an address match. The BSR can be expressed in the following terms:

$$BSR = \frac{\text{total number of bits sent per unit of time}}{\text{total number of bits examined per unit time}}$$

The effective "total number of bits examined per unit time" attributed to a pager would also include the bits occurring while the receiver is on but in the process of warming up while the BSR attributed to the code would assume zero receiver warm time.

Block Information Word (BIW) - A BIW contains information about the structure of the Frame dealing with priority address field length, BIW Field length, Vector Field start position, Frame Carry On Flag status and Collapse Mask Identification. Unique BIW's are used to identify the Time, Local IDentification (LID), Coverage Zone, Country Code, Traffic Management Flags and System Message Field that are provided to properly support a FLEX™ systems Roaming Channel.

Channel Fill Pattern – Interleaved all 1's or all 0's code words resulting in a 1600 bps 1,0,1,0... pattern on the RF channel.

Code Word – A FLEX™ code word is defined as being a member of the set of BCH (31,21) code words with a 32nd even parity added to provide a minimum distance of six.

Collapse - The effective collapse value is the lesser of the pager collapse and the system collapse. The effective collapse value modifies the frame number by indicating to the pager that a specific number of least significant bits are don't care bits. If the effective number is 3 then when the frame number is converted to binary, all 8 combinations of 3 bits are valid resulting in the pager monitoring 8 of the 128 frames in a FLEX 4 minute cycle.

Country Code -Most countries in the world have a specific Country Code assignment identified in the CCITT (ITU-T) Standard E.212, Annex A. These assignments are utilized as part of the SSID information that make up a FLEX™ roaming subscriber unit profile.

Coverage Zone - A specific geographical area that is designated to support FLEX™ signaling. This BIW information is used to verify a FLEX™ roaming subscriber unit is operating on a suitable RF channel that contains the subscriber unit's messaging.

Dynamic Group Address Mode -The dynamic group address mode enables an unlimited number of recipients to receive the same message. Using a Short or Long individual address, each group member is sent an instruction to meet in a future Frame to receive a message and to use a pre-assigned temporary address shared by all group members. Although this mode (sometimes referred to as Terminal Group Call) is usually less efficient in the use of air time than the Radio Group Address mode, it easily allows members of the group to change.

Fading Sensitivity – Fading sensitivity is defined as the probability of decoding a page without uncorrectable errors in the presence of Raleigh fading at a specific fade rate.

False Dial Rate –The false dial rate is the rate at which a telephone number is dialed incorrectly, the false dial rate is in the range of 1% to 3%. Some paging systems employ error detection by adding an extra check digit to the dialed number. This is a large source of false page reception.

Falsing – Erroneously identifying data on the communications channel as the anticipated bit sequence. The data could be address, synchronization, message etc.

FLEX™ Cycle - A FLEX™ cycle is composed of 128 unique FLEX™ Frames (0 to 127) that are sent on the RF channel over each 4 minute time period.

FLEX™ Frame – A FLEX™ Frame consists of synchronization information and 11 interleaved blocks of BIW's, Address, Vector and Messaging information. A subscriber unit's Frame is the one it is assigned to as well as any Frame it examines as defined by its Collapse value and the "System Collapse" mask. There are 128 unique FLEX™ Frames which compose a FLEX™ Cycle that are scheduled to be sent on the RF channel every 4 minutes.

Fragmented Message – A message is considered fragmented when the address and associated message are not completely contained in a single Frame. All dynamic group messages using temporary addresses are considered to be fragmented regardless of message length. Messages sent using individual or radio group addresses that span more than one Frame are fragmented messages. The fragmentation process is considered to start with the first fragment (or first short instruction vector) and ends when the last fragment is received.

Frame 0 – A FLEX™ Frame that is to be synchronized with a universal time reference such that each Frame 0 begins at the top of the hour and follows exactly every 4 minutes later.

Frame Information Word (FIW)- A BCH (31,21) code word plus an even parity bit is contained within the Synchronization portion of each FLEX™ Frame. For roaming subscriber units to properly recognize a Frame supporting roaming traffic, there is a single bit in the FIW that is called a Roaming Support Bit. When this bit is set to "1" the FIW identifies this RF channel as supporting roaming traffic and is GPS synchronized. When this bit is set to "0", the FIW identifies this RF channel as one that does not support roaming traffic. The FIW also indicates the FLEX™ systems Cycle Number, Frame Number and capability of the Frame to support Time Diversity operations or the indication of Low Traffic Flags for each phase in the Frame.

Frequency BandsplitA frequency bandsplit is defined to be within every 100Mhz: 0 to less than 100 MHz, 100 MHz to less than 200 MHz, 200 MHz to less than 300 MHz, etc. and finally 900 MHz to less than 1000 MHz.

Global Position System (GPS) A network of satellites in geostationary orbits to provide exact location and time attributes for communication systems that need accurate position and time references. GPS Time is carried by these satellites, as well as Universal Time Coordinated (UTC). Both GPS Time and UTC are based on International Atomic Time (TAI), which is defined as originating on January 1, 1958. UTC differs from TAI by corrections for movements in the celestial bodies and variations in Earth's rotation. These corrections are referred to as Leap-Seconds. GPS Time and TAI have no such Leap-Second corrections. Leap-Seconds would require Re-Synchronization in a synchronous system.

Idle Frame – An idle Frame is a minimum FLEX™ Frame completely filled with 11 idle blocks, with the first block containing a valid Block Information Word.

Individual Address Mode –The individual address mode enables an individual subscriber to be the only recipient of a message by sending a unique Short or Long address followed by the message.

Local IDentification (LID) –Each FLEX™ simulcast area includes in the transmitted BIW field one LID number. When combined with Coverage Area, Country Code, Traffic Management Flags and RF channel information a specific SSID is identified. Each country is allocated a total of 512 LID numbers, 32 Coverage Zones associated with up to 4 possible Traffic Management Flags.

Mail Drop Message Mode – An optional user selectable message mode whereby received messages of a particular nature can be processed uniquely.

Message Field- The portion of the FLEX™ Frame that contains the actual messaging directed to an addressed subscriber unit. Details for the messaging field (position, message length, etc.) are given by the associated Vector field.

Minimum Frame – A minimum FLEX™ Frame contains Synchronization information and the first block with a valid Block Information Word.

Network Address -The Network Address is a specific assigned address. It appears on the RF channel within the Address Field in predicted frames. There are 4096 Network Addresses (2,058,240 to 2,062,335).

Network IDentification (NID)- The NID uniquely identifies the roaming network on specific RF channel(s), in a frequency bandsplit, to which a subscriber unit might subscribe. The NID consists of a Network Address combined with the associated Short Message / Tone Only Vector which utilizes a 3 bit (8 times) multiplier field resulting in over 32,000 assignable networks. Each of these potential networks can have up to 32 identifiable Service Areas. This Network Address is not an individual or a radio group address.

Operator Messaging Address - The Operator Messaging Address is not an individual or a radio group address.

Page – The information on the channel directed to the recipient, includes address and message information.

Present Local Time - The present local time represents the actual time in the associated time zone. It is intended that the time to be displayed on the subscriber unit is the time contained in the BIW codewords.

Primary Subscriber Unit AddressThe address programmed in the Subscriber Unit which determines the Subscriber Unit's characteristics for a given RF channel (i.e. Traffic Management Flag response, phase, support for channel set up BIW, frame offset, and maximum carry on). These characteristics do not necessarily extend to information addresses. The address may also identify the Frame, and Collapse Cycle characteristics.

Private Message Mode –The default message mode of messages received by the paging device. Private messages do not go to a pre-assigned spot, instead they are deposited in the next available message slot.

Radio Group Address Mode -The radio group address mode enables an unlimited number of recipients to receive the same message by sending one Short or Long address common to all group members, followed by the message. This method is very efficient in the use of air time but requires a pre-arrangement of the groups and thus is more difficult to change. Many times there is a battery life impact when the individual address and the group address are in different Frames.

RF Channel – The medium over which FLEX™ is broadcast.

Roaming Support Bit- A bit assigned within the FIW that indicates to a FLEX™ roaming subscriber unit that this RF channel supports roaming traffic and is GPS synchronized. When this bit is equal to 1, the channel is supporting roaming traffic. When the bit is equal to 0, the RF channel does not support roaming traffic.

Secondary Addresses - Additional addresses in a subscriber unit other than the Primary Address. These addresses have their own base frame and collapse values which may be different from the values for the Primary Address.

Short Message / Tone Only Vector - This specific vector is used along with a Network Address to identify a roaming network. The Vectors 3 multiplier bits, 5 service area bits and 4 TMF bits are associated with the Network Address to form the NID.

Single Phase Address Classification -An address that is specifically assigned in advance to one of four phases. This address would only appear in its assigned phase.

Simulcast Transmissions-Provides wide area radio coverage by simultaneously sending synchronized data from multiple transmitters.

Simulcast System ID(SSID) - An identification given to a single simulcast area which contains the Local ID, Coverage Zone, Country Code, and Traffic Management Flag assignment on a specific RF channel to which the subscriber units responds.

Source – Additional information associated with tone alert pages that can be used to identify the calling party.

Subscriber Unit Active Frames-This is the collection of all Frames in the 128 Frame FLEX cycle which must be monitored by a specific pager. It is the summation of all assigned addresses with their respective base frames modified by the lesser of the pager collapse (which may vary address to address) and the system collapse. If the pager's addresses are Roaming capable the frame values may be offset by the Frame Offset value transmitted in the Channel Set Up Block Information Word carried in the mandatory frames.

System Collapse Cycle- The number of Frames specified by the Collapse Value transmitted in the BIW of every Frame. The number of Frames is 2^{CV}, and thus is 1, 2, 4, 8, 16, 32, 64, or 128, respectively for collapse values from 0 to 7.

System Message -The indication of a System Message for a roaming subscriber unit is given by BIW 101 or by Operator Messaging Addresses. System Messages are used to convey channel characteristics.

System Vector -A system vector is defined as any of the valid FLEX™ vector word definitions other than the Secure Vector.

Symbol – A symbol is a signal element used during the modulation, transmission and demodulation of the protocol. A symbol may represent one or more bits of data.

Traffic Management Flag (TMF)- A TMF bit position (flag field is part of an NID and SSID) is assigned to every subscriber unit that is part of a FLEX™ roaming coverage area. A subscriber unit responds to the TMF shift in the bit assignment (normally the bit is set to 1; the need for an RF channel shift is activated when the subscriber unit's TMF bit is set to 0) so that it will begin to search alternate RF channels which contain its designated SSID information with the designated TMF again set to 1. The 4 available TMF's positions allow the Service Provider to modify their system's RF channel traffic profile as necessary.

Traffic Management Group (TMG) – The two least significant bits of the FLEX™ address normally determine the TMG an address belongs to. The TMG is used to match the corresponding Traffic Management Flag (TMF) in deciding whether traffic for the address is present on the channel or not.

Unfragmented Message – A message that is started and completed in a single Frame. By definition, all messages using the Numeric Vector are unfragmented messages as they must be sent within one Frame.

Universal Coverage Zone - One of the 32 Coverage Zones within the SSID, will be used to indicate a Universal Coverage Zone. This Coverage Zone designation identifies an arrangement that allows an individual Service Provider to temporarily modify their transmitter system signaling configuration into a unique simulcast coverage area. Another Coverage Zone must be transmitted when the temporary arrangement has been terminated.

Vector Field- The portion of a Frame that immediately follows the Address Field of each Frame. The Vector field always precedes the Messaging field within the Frame and details the location and number of message code words for the corresponding address within this frame.

5.3. NUMERIC CHARACTER SET

The following tables define the characters to be displayed in the FLEX™ Numeric message mode.

Standard Character Set (People's Republic of China Option Off)

Character	B_3	B_2	B_1	B_0
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
Spare	1	0	1	0
U	1	0	1	1
Space	1	1	0	0
-	1	1	0	1
]	1	1	1	0
[	1	1	1	1

Alternate Character Set (People's Republic of China Option On)

Character	B_3	B_2	B_1	B_0
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
A	1	0	1	0
B	1	0	1	1
Space	1	1	0	0
C	1	1	0	1
D	1	1	1	0
E	1	1	1	1

5.4. ALPHANUMERIC CHARACTER SET

The following table represents the characters to be displayed in the FLEX™ alphanumeric message mode. Control characters that are not acted upon by the pager are ignored in the display process (do not require display space) but are stored in memory for possible down load to an external device.

Characters Used in Alphanumeric Messages - ISO 646-1983E

				B_7	0	0	0	0	1	1	1	1
				B_6	0	0	1	1	0	0	1	1
				B_5	0	1	0	1	0	1	0	1
B_4	B_3	B_2	B_1	HEX	0	1	2	3	4	5	6	7
0	0	0	0	0	NUL	DLE	SP	0	@	P	`	p
0	0	0	1	1	SOH	DC1	!	1	A	Q	a	q
0	0	1	0	2	STX	DC2	"	2	B	R	b	r
0	0	1	1	3	ETX	DC3	#	3	C	S	c	s
0	1	0	0	4	EOT	DC4	$	4	D	T	d	t
0	1	0	1	5	ENQ	NAK	%	5	E	U	e	u
0	1	1	0	6	ACK	SYN	&	6	F	V	f	v
0	1	1	1	7	BEL	ETB	'	7	G	W	g	w
1	0	0	0	8	BS	CAN	(	8	H	X	h	x
1	0	0	1	9	TAB	EM	)	9	I	Y	i	y
1	0	1	0	A	LF	SUB	*	:	J	Z	j	z
1	0	1	1	B	VT	ESC	+	;	K	[	k	{
1	1	0	0	C	FF	FS	,	<	L	\	l	|
1	1	0	1	D	CR	GS	-	=	M	]	m	}
1	1	1	0	E	SO	RS	.	>	N	^	n	~
1	1	1	1	F	SI	US	/	?	O	_	o	DEL

FLEX™ products are expected to provide options to re-map certain characters in the above table to special characters required in each international market. Specifically ASCII HEX characters 23, 24, 40, 5B, 5C, 5D, 5E, 5F, 60, 7B, 7C, 7D, 7E, and 7F are candidates for re-map.

5.4.1. Simplified Chinese Character Set

The CCD character set recommended for People's Republic of China follows the GB2312-80 Information Exchange Chinese Encoding Character Set (Basic Set).

5.5. TRAFFIC LEVELING USING "CARRY ON" FIELD

When incoming traffic levels are on the average less than the channel capacity and the distribution among Frames is not uniform resulting in an overflow condition in a particular Frame, the "Carry On" field (in the Block Information Word) may be used to instruct each member (pager with address assigned to this Frame - not "Carried On" into Frame) of the overloaded Frame to also decode the following 1, 2 or 3 Frames. Since pagers are being instructed to decode Frames which would normally be ignored, degraded battery life might be expected. This effect is expected to be small however because occurrence of this problem is expected only in a small portion of the busy hour which is in itself a small portion of the day.

The terminal could take traffic from the overloaded Frame and fill in excess capacity in the following 1, 2, or 3 Frames or it could (preferred approach) give priority to the "Carry On" traffic and displace the traffic in the following Frame. When traffic is displaced, the following Frames may become overloaded and require a "Carry On " condition. This will continue until a Frame is encountered with sufficient excess capacity to satisfy the "Carry On " condition.

5.6. LONG MESSAGE FRAGMENTATION

The longest message which will fit into a Frame is 88 code words less one Block Information Word, an Address Word, a Vector Word, and the 1 overhead word in the message or 84 code words total. Three alpha characters per word yields a maximum 252 character message (251 characters in 1st fragment) in a Frame assuming no other traffic. Messages longer than this value must be sent as several fragments. Furthermore in systems with a mixture of traffic types it is recommended that short messages be given priority over the longer alphanumeric and data traffic thus message fragmentation is used as a tool to redistributed traffic to Frames that are lightly loaded.

The pager is instructed to expect additional fragments when the "continue bit" in the message header is set. This causes the pager to examine every following Frame for an additional fragment until the last fragment with the continue bit reset is found. The only requirement relating to the placement in time of the remaining fragments is that no more than 32 Frames / 1 minute (or 128 Frames / 4 minutes see Section 4.3.6.2) may pass between segment receptions. On reception of the last fragment, the pager returns to the battery saving mode in which only assigned Frames are decoded.

Each fragment contains a Checksum character to detect errors in the fragment, a fragment number 0, 1 or 2 to detect missing fragments, a message number to identify which message the fragment is a part, and the continue bit which either indicates that more fragments are in queue or that the last fragment has been received.

5.7. GROUP MESSAGING TECHNIQUES

The FLEX™ protocol offers several methods of forming groups of pagers for the purpose of receiving common messages. Each method offers a different trade-off between pager battery life, the amount of traffic incurred on the channel to complete the group call and the encoder complexities in setting up the group.

At the extremes, the system could repeat the message to each pager in the group (sometimes referred to as terminal group call) or the system could send the message only once if all members of the group had previously set up their pagers to receive the same common group address. The common group address approach usually results in pagers monitoring more Frames (personal address Frame and the Frame assigned for the group address) resulting in a reduction in battery life.

FLEX™ offers several intermediate possibilities. The first dynamic group call approach assigns a "Temporary Address" over the air to each pager using the personal address. The instruction to do this is very short (only 2 code words on the channel - address word and a vector word) thus the benefit over a terminal group call is greatest when the message is long. The assigned temporary address is active in a specified Frame in the future and is valid until the message is completed (message may be fragmented over several Frames). In the case of a group call to "single phase" pagers, the message may have to be repeated in each phase.

A more efficient variation of the above dynamic group call is to code plug assign common addresses to sub-groups. Now the system can send a message to the full group (all sub-groups combined) by applying the dynamic group call approach to each sub-group address. When the sub-groups are defined to be pagers which have their personal addresses in the same Frame as the sub-group address then there is no battery life penalty for the additional address. This approach allows a single or any combination of sub-groups to be paged efficiently.

5.8. CHANNEL SHARING USING "COLLAPSE FUNCTION"

Ideally, the FLEX™ pager is designed to monitor time slots (Frames) separated in time by an exact value representative of the users desires in the trade off between message delivery latency and battery life. Thus a small pen or watch pager user might choose time slots separated by as much as 4 minutes in time in order to achieve long battery life. The user of a belt pager might choose a time value which gives quicker delivery (say 15 seconds) between time slots since battery life might not be as important to him as is the timely response to a call. Basically each user can be provided the latency which fits his needs.

The above scenario is realizable if the channel is dedicated to the FLEX™ protocol or even if the channel carries other traffic but the FLEX™ protocol takes priority. When this is not the case there is no assurance that when the one opportunity to send a message to the small pager operating on a 4 minute cycle occurs that the channel will be available. The Collapse concept was designed to solve this problem during the initial implementation of FLEX™ on an existing channel.

There are two types of Collapse defined in the FLEX™ protocol. The first is dictated by the user and is programmed into the code plug ("pager Collapse" value). This value is the desired time slot spacing. The second Collapse value is the one dictated by the system ("system Collapse") and transmitted in the Block Information Word of every Frame. This value initially will instruct the pagers desiring the long battery save cycle to look more often. When the "system Collapse" value is equal to 0 all pagers will monitor every Frame (many Frames will be missing due to channel sharing with the existing protocol). When the "system Collapse" field equals 1, each pager will monitor every other Frame with the choice being the Frames that match the LSB of their assigned Frame. Likewise, when the Collapse value is 2, pagers will match the 2 LSBs of their assigned Frame and thus monitor every 4th Frame on the channel. When FLEX™ dominates the channel the Collapse value will be increased to 7 resulting in the monitoring of 1 of 128 Frames if the pager code plug value is this large. In most cases, the pager code plug value will dictate a smaller battery save cycle. (Smaller of the two Collapse values dominates). Note: the Collapse value referenced here is the exponent of 2 which results in the desired battery save cycle. i.e. 2^7 = 128 Frame Cycle.

A word of warning may be appropriate here relating to an unexpected degradation in pager battery life in a lightly loaded system which does not service every pager frequently. For example, if the "system Collapse" were set to 1 and normal traffic loads were being processed, two adjacent Frames would be sent at least once every minute. During very light traffic conditions (i.e. middle of the night), it is possible that the 1 Frame per minute requirement could be met by transmitting only the odd (or only the even) Frame every minute. An even (or odd) pager would never see a synchronous Frame, or the time between even (or odd) Frames could be so long that the pager would cycle in and out of synchronization, consuming additional battery energy. To avoid this situation in lightly loaded systems, a minimum Frame should be sent for each supported Frame frequently (2 Frames for Collapse 1 every 2 minutes, 4 Frames for Collapse 2 every 4 minutes, 8 Frames for Collapse 3 every 8 minutes, 16 Frames for Collapse 4 every 16 minutes) to provide synchronization updates to the pager.

5.9. MESSAGE NUMBERING AND MESSAGE RETRIEVAL

Message numbering is offered in the Numeric, HEX / Binary, and Alphanumeric message formats. The use of this feature is product and system dependent. Possible uses are:

1) To provide the means for identifying fragments of the same message in the reconstruction process.
2) To allow detection of a missed message when a message number is skipped. The system provider may provide a retrieval service.
3) Possibly to assist the user in time ordering his messages through display of the number as part of the message.

The HEX / Binary and Alphanumeric formats have a signature field in the first message word (1st fragment only). This field is intended to help in the duplicate message detection process since the signature is algorithmically derived from the callers entered message.
In the case of the Numeric message, the numbered numeric vector type must be chosen. This choice indicates that the first two characters (8 bits) of the numeric message represent a 6 bit number (0-63) along with a 7th bit to indicate active message retrieval and an 8th bit to indicate that special formatting is desired for this message.

5.10. REAL TIME CLOCK MAINTENANCE

It is recommended that the FLEX™ Frame timing be synchronized to a GPS time source with Frame 0 Cycle 0 synchronized to the start of each hour. Every Frame 0 Cycle 0 will contain at least 1 "Time" BIW in each phase transmitted to convey Minute Hour and Date if the optional transmission of time is supported.

5.11. SIMULCAST CONTROL REQUIREMENTS

As in most simulcast systems, reception begins to degrade rapidly when two signals being received simultaneously have magnitude differences less than the capture ratio of the receiver and the time offset between the two signals approach 1/4 of the symbol duration. The FLEX™ goal is to time equalize the simulcast transmitters to within a few microseconds and reserve most of the allowable differential delay for path differences.

5.12. NATIONWIDE ROAMING / CHANNEL ACQUISITION

Roaming networks are a collection of simulcast systems brought together through the use of SSID's and NID's. The smaller scanning system coverage area will be identified by the pager via a scanning list of subscribed SSID's (LID, Coverage Zone, Country Code, and Traffic Management Flag Set). The larger coverage areas will take advantage of a Network ID which is carried in the address field of all local systems which are participating in the larger network. The pager will use a frequency scan list which contains the information to qualify or disqualify each channel. In each geographic location, the pager will use the scan information to choose the appropriate channel to monitor. In the case where more than one correct choice exists, the pager may monitor several channels assuming the system was set up with Frame Offsets which anticipate this condition.

5.13. EMERGENCY SYSTEM RE-SYNCHRONIZATION

In the unlikely case of the infrastructure detecting a loss or an uncontrolled change in the system clock a system wide reset may be desirable. The timing source must be battery backed up to allow a synchronous restart after a power outage thus making the need for re-synchronizing very, very infrequent. The pattern described in section 3.4 is transmitted long enough for all pagers to detect at least one "Ar" code word and start a continuous search for a valid FLEX™ Frame. The pager should look for at least one minute after the last "Ar" pattern is detected.

Since it is also possible for the system timing to have jumped to a time position out of the pager's range but not be detected by the infrastructure it may be advisable to have a battery operated monitor FLEX™ receiver tied to the infrastructure signifying the detection of each FLEX™ sync pattern as it is transmitted.

5.14. TIME ZONE INFORMATION

Part of the Local ID carried in the block information field (optional information now but in future may become required in nationwide roaming) is made up of a 5 bit time zone field. The following table is used to convert the 5 bit field to specific time zones.

Zone Field $z_4\ z_3\ z_2\ z_1\ z_0$	Relative Hours to Greenwich	Time Zone
10000	-----	RESERVED
10001	+5 Hr 45 Min	Nepal
10010	+6.5	Burma, Corcos Is.
10011	+9.5	Central Australia
10100	-3.5	Newfoundland
10101	-11	Midway Is.
10110	-10	Hawaii
10111	-9	Alaska
11000	-8	Pacific
11001	-7	Mountain
11010	-6	Central
11011	-5	Eastern
11100	-4	Atlantic
11101	-3	Greenland
11110	-2	S. Sandwich Is.
11111	-1	Azares, Cape Verde
00000	0	Greenwich Meridian
00001	+1	France, Germany, Italy
00010	+2	Egypt, Greece
00011	+3	Iraq, Saudi Arabia, Turkey
00100	+4	Oman
00101	+5	Pakistan
00110	+6	B.I.O.T.
00111	+7	Laos, Thailand, Cambodia
01000	+8	China, Hong Kong, Taiwan
01001	+9	Japan, Korea
01010	+10	Northern Mariana Is., Tasmania
01011	+11	New Caledonia
01100	+12	New Zealand
01101	+3.5	Iran
01110	+4.5	Afghanistan
01111	+5.5	India, Sri Lanka

5.15. FLEX™ CAPCODE

The FLEX™ CAPCODE is defined to represent either a "Short" or a "Long" address. The short address is defined in this protocol specification as one code word and is represented by a 7 decimal digit field (see table below). The long address is defined in the protocol specification to be two words on the RF channel and is represented by a 9 decimal digit field (Long Addresses in set 1-3, 1-4, 2-3 and 2-4 require 10 digits). An Alpha "CAPCODE type" character always precedes the 7, 9, or 10 digit address field providing information as to the type of address and distinguishes FLEX™ CAPCODEs from the CAPCODEs of other paging protocols.

An "Extended" CAPCODE has been defined to accommodate the additional information required when subscriber units roam between systems on a local or global basis. If the system in which the subscriber unit is roaming requires capabilities of this Extended CAPCODE to ensure proper message delivery then it must use it. The address field has been extended to 10 digits which may represent both short and long addresses. Local roaming may use either short or long addresses while global roaming would be expected to use long addresses. The 10 digit Address Field identifies over 5 billion long addresses. In this CAPCODE form, a second alpha character using the letters P, Q, R and S identify different roaming capabilities of the subscriber unit to which the address is assigned.

The letters "U through Z" indicate that additional information is required and act as a separator to the field containing a single digit "b" battery cycle field (pager Collapse) or a 4 digit "fffb" field combining the battery cycle digit with a 3 digit "f" Frame number field. This form may be shortened as in 2) below when label space limits the number of characters printed (this form indicates that the subscriber unit or the system data base must be accessed in order to determine the assigned Frame and battery cycle).

The alpha letters "A" through "L" indicate that the rules are used to derive the Frame and phase information from the address field and that the standard battery cycle of 4 (16 Frame cycle) is to be used, as shown in 4) below. The battery cycle "b" field must be included when it is not equal to 4 (the FLEX™ standard) as in 3) below. The twelve possible forms of the FLEX™ CAPCODE are shown below:

	Short	Long	Extended
1)	fffbU1234567	fffbU123456789	RfffbU1234567890
2)	U1234567	U123456789	RU1234567890
3)	bA1234567	bA123456789	RbA1234567890
4)	A1234567	A123456789	RA1234567890

The "fff" field is a number from "000" to "127" indicating the base FLEX™ Frame to which the address is assigned. The "b" field is a number from "0" to "7" indicating the battery cycle. In the forms using the letters "A" through "L", "b" is not displayed unless it is a value other than 4. (The FLEX™ standard battery cycle value is 4 where 2^4 = 16 Frames = 30 second between active Frames.) The convention of using 7 digits to represent Short addresses, 9 digits to represent some of the Long addresses in set 1-2, and 10 digits to represent the balance of long addresses was chosen to help differentiate between the different types of addresses. The range of the decimal address field consists of the numbers 1 through 5,370,810,366 where Short and other single code word addresses fall below 2,031,615 and Long addresses are above 2,101,248.

The convention in displaying a CAPCODE is to use the shortest form possible thus even though the non-standard form could represent a standard assignment, the standard form is chosen to indicate the fact that it is a standard assignment. All forms except 2) above contain all the information required to send a message to a subscriber unit. Again the form 2) should be avoided when possible since it requires retrieval of the missing information from the subscriber unit or from the system data base.

The following address range table defines the address usage assignment:

CAPCODE Assignment Table

CAPCODE Address Value		Description
000,000,000		Not Used - Illegal
000,000,001	001,933,312	Short Addresses
001,933,313	001,998,848	Illegal
001,998,849	002,009,087	Reserved for Future Use
002,009,088	002,025,471	Information Service Addresses
002,025,472	002,029,567	Network Addresses
002,029,568	002,029,583	Temporary Addresses
002,029,584	002,029,599	Operator Messaging Addresses
002,029,600	002,031,614	Reserved for Future Use
002,031,615	002,101,248	Not Used - Invalid
002,101,249	102,101,250	Long Address. Set 1-2 (100M Uncoordinated)
102,101,251	402,101,250	Long Address Set 1-2 (300M By Country)
402,101,251	1,075,843,072	Long Address Set 1-2 (675M Global)
1,075,843,073	2,149,584,896	Long Address Set 1-3 (1,074M Global)
2,149,584,897	3,223,326,720	Long Address Set 1-4 (1,074M Global)
3,223,326,721	3,923,326,750	Long Address Set 2-3 (700M By Country)
3,923,326,751	4,280,000,000	Long Address Set 2-3 (357M Reserved)
		Long Address Set 2-3 (17M Info Service)
4,280,000,001	4,285,000,000	5M Global;
4,285,000,001	4,290,000,000	5M by Country;
4,290,000,001	4,291,000,000	1M Total 1K / Country for World-Wide Use;
4,291,000,001	4,297,068,542	6M Reserved
		Additional Addresses Not Defined and Reserved

"Global" - Address is coordinated to be unique World-Wide.

"By Country" - The 1 billion Long Addresses are reused within each Country and coordinated with adjacent countries along borders. The set is divided into 200 sets of 5 million each and released for use one set at a time. Sets used in adjacent countries should be avoided. Set 1 is defined to be 102,101,251 through 107,101,250, set 60 is defined to be 397,101,251 through 402,101,250. Set 61 begins at 3,223,326,751 and continues through 3,228,326,750, likewise set number 200 ranges from 3,918,326,751 through 3,923,326,750.

"Country for World-Wide Use" - 1000 Addresses are assigned to each Country for World-Wide Use following the Country Code numbers in Section 5.16 (For example, Information Service CAPCODEs for Greece are determined by adding the range 202,000 through 202,999 to the base 4,290,000,001, resulting in resulting in CAPCODEs 4,290,202,001 - 4,290,203,000.)

"Reserved" - See definitions in Section 1.5 Comments.

"Information Service Addresses" - Rules governing the use of these addresses will be forthcoming in release G1.9 of FLEX™. Operators should take this into account when establishing new information services.

5.15.1. Standard Frame and Phase Embedding Rule

Maximum battery life in a FLEX™ subscriber unit is achieved when all of the addresses assigned to a pager are in the same Frame. For Single Phase subscriber units, it is a requirement that all of the assigned addresses be in the same phase.

Normally, it is very desirable to spread the population of FLEX™ subscriber units on a system across all four phases of all 128 Frames. Frame and phase spreading can be performed automatically as addresses are assigned sequentially by embedding that information into the 7, 9, and 10 digit FLEX™ address.

The standard procedure for deriving the phase and Frame values from the CAPCODE starts by separating the 7, 9, or 10 digit decimal address portion (field to the right of the Alpha character) and performing a decimal to binary conversion. The least significant bit is labeled "bit 0"; in order the following "bits 2 and 3" specify phases 00, 01, 10, or 11 for phase 0,1,2,3 (a,b,c,d), and "bits 4-10" represent Frames "000" through "127". For roaming capable subscriber units "bits 0 and 1" represent which of the 4 Traffic Management Flags (TMF) the address will follow.

The Frame and phase can also be derived from the 7, 9, or 10 digit decimal address by using modulo arithmetic (base 10) where Phase = Modulo 4 (Integer (Addr/4)) and Frame = Modulo 128 (Integer (Addr/16))

This definition has the property that when addresses are assigned in order, the phase will increment after assigning 4 consecutive addresses while the Frame will increment after 16 addresses have been assigned.

5.15.2. CAPCODE Alpha Character Definition

The alpha character in the FLEX™ CAPCODE indicates the type of subscriber unit to which the address is assigned ("Single phase", "Any phase", or "All phase"), indicates if the address is the first, second, third or fourth address in the subscriber unit (when addresses are assigned in order following standard rules) and specifies the rules to follow in determining which phase and Frame the address is active.

Standard Rules	**No Rules (Non-Standard Form)**
A - Single Phase Subtract 0	U - Single Phase, Phase 0
B - Single Phase Subtract 1	V - Single Phase, Phase 1
C - Single Phase Subtract 2	W - Single Phase, Phase 2
D - Single Phase Subtract 3	X - Single Phase, Phase 3
E - Any Phase Subtract 0	Y - Any Phase
F - Any Phase Subtract 1	
G - Any Phase Subtract 2	
H - Any Phase Subtract 3	
I - All Phase Subtract 0	Z - All Phase
J - All Phase Subtract 1	
K - All Phase Subtract 2	
L - All Phase Subtract 3	

The alpha character "A" represents a “Single phase” subscriber unit using the standard rules for embedding Phase and Frame. A letter "B" is similar to "A" except 1 is subtracted from the CAPCODE before applying the standard rule. Likewise, the letter "C" and "D" indicates that 2 or 3 is to be subtracted before applying the rule. (These rules modify the standard rule and are intended to simplify the order entry process for multiple address subscriber units. It is assumed that addresses will be assigned in sequential order i.e. the salesman will indicate that a certain range of addresses are to be used. When a quantity of 4 address subscriber units are ordered with the requirement that addresses assigned to each subscriber unit be in the same phase and Frame, the subtraction of 1, 2, or 3 ensures that the calculation for each additional address is referenced to the first address thus assigning all A, B, C, and D addresses to the same Frame and phase).

"E through H" and "I through L" represent "Any" and "All" phase subscriber units where the subtract rule is modified to ensure that all addresses of a multiple address subscriber unit are in the same Frame.

For the cases where no rule is defined, the letters "U through X" indicate “Single phase” subscriber units assigned to phases 0 through 3 (phase a, b, c, or d) with the Frame and battery cycle displayed explicitly. "Y" and "Z" indicate non-standard addresses for "Any" and "All" phase subscriber units.

The “Extended” CAPCODE defines a second Alpha Character to take on the following meanings relative to the level of roaming capability.

Frame Offset Capable (1 - Yes, 0 - No)

Follows TMF (1 - Yes, 0 - No)

P	00	Non-Roaming or a single frequency roaming Subscriber Unit
Q	01	No Frame Offset, Follows the TMF’s (Traffic Management Flags)
R	10	Frame Offset BIW 101; Does not follow TMF’s
S	11	Frame Offset BIW 101; Follows TMF’s

5.15.3. Interim or "Phantom" TNPP FLEX™

This initial form of TNPP supporting FLEX™ in systems which already contain POCSAG will be limited to the standard CAPCODE rule (no pre-subtraction alphas B,C,D,F,G,H supported). This means that if multiple address subscriber units are desired they must be chosen so the simple rule applies. For example, a 4 address “Single phase” subscriber unit must have its first address evenly divisible by 4 in order that the standard rule will result in the next 3 address being in the same Phase and Frame. Likewise, a 16 address “Any phase” subscriber unit must have a first address which is evenly divisible by 16 so that the next 16 addresses will be in the same Frame.

5.15.4. TNPP Revision 3.7 and Beyond

TNPP version 3.7 and later include support for FLEX™. Please contact the PCIA to obtain the latest revision.

5.15.5. CAPCODE to Binary Conversion

Short CAPCODE - To convert a short address CAPCODE, the number 32,768 is added to the 7 digit decimal CAPCODE address (or to any CAPCODE less than 2,031,615). This resultant number is then converted to a 21 bit binary number which becomes the information bits of the (31,21)BCH code word transmitted over the air. (The LSB calculated becomes the first bit on the channel followed by the remaining information bits and the 10 parity bits.) The 32nd overall even parity bit is added to make the 32 bit address code word.

Long CAPCODE 2,101,249 to 1,075,843,072 - Long address set 1-2 is in this range. To convert, the number 2,068,481 is subtracted from the CAPCODE address. This "Resultant" number is then divided by 32,768 with the remainder plus 1 equal to the 1st long address word (same as "Resultant" Modulo 32768 plus 1). This value is converted to a 21 bit binary number which becomes the information bits in the (31,21)BCH code word generation (even parity bit is added to extend to 32 bit codeword).Again, LSB is the first bit on the channel.

The 2nd long address word is determined by first calculating the Integer portion of the "Resultant" divided by 32,768. This value is then subtracted from 2,097,151 (Equivalent to 1's complement of the value in binary) and converted to a 21 bit binary number which becomes the information bits in the (31,21)BCH code word generation. LSB is the first bit on the channel.

Long CAPCODE 1,075,843,073 to 3,223,326,720 - Long address sets 1-3 and 1-4 are in this range. The 1st long address word is calculated following the same rules as for long addresses in set 1-2. The 2nd long address word is determined by subtracting 2,068,481 from the CAPCODE, the resultant number is divided by 32,768 with the integer portion added to 1,933,312. This number is then converted to the 21 binary information bits of the (31,21) BCH code word which is transmitted. LSB is the first bit on the channel.

Long CAPCODE 3,223,326,721 to 4,297,068,542 - Long address set 2-3 is in this range. The first word is determined by subtracting 2,068,479 from the CAPCODE, then determining the remainder after dividing by 32,768 (modulo 32,768). This value is then added to 2,064,383 with the resultant converted to the 21 binary information bit required to specify the (31,21) BCH word. The 2nd word is determined by subtracting 2,068,479 from the CAPCODE and finding the integer portion after dividing by 32,768. This value is then added to 1,867,776 and converted to the 21 binary information bits of the (312,21) BCH code word which is transmitted over the air. LSB is the first bit on the channel.

5.15.6. Binary to CAPCODE Conversion

Given address code word values which are transmitted over the air, the CAPCODE can be calculated by performing the inverse of the above process. As an example, the short address code word is converted to decimal and the number 32,768 is subtracted to arrive at the 7 digit address portion of the CAPCODE. For a two word long address in set 1-2, first convert address word 1 from binary to decimal. The 2nd address word is then complemented (or subtracted from 2,097,151 decimal) and converted to decimal. This value is multiplied by 32,768, added to 2,068,480 and then added to address word 1. The result is the address portion of the FLEX™ CAPCODE.

If the pager contains only a single individual address and the user is content with the recommended 30 second battery cycle then the letter "A", "E", or "I" is added as a prefix to the 7, 9 or 10 digit address. ("A" Single Phase Pager, "E" Any phase pager, and "I" All phase pager)

If the pager were to be a two address pager where both addresses are individual addresses then "A", "E", or "I" would again preface the address field of the first address. "B", "F", or "J" would preface the second address. The "B, F, J" indicates that the address is a second address and it is to have the properties of the first address. This rule eliminates the need for an order entry operator or a salesman to calculate a starting address which would allow standard rules to always apply.

In other cases especially where a group address is to be included it is very likely that the "U" through "Z" forms of the CAPCODE will be used so that phase and Frame can be explicitly chosen to provide best battery life (and same phase operation in the case of the single phase products).

In the case of a roaming pager, the proper alpha character (P, Q, R or S) must be added into the left most position of the Extended CAPCODE form.

5.16. LIST OF COUNTRY CODES

The following list of Country Codes is adapted from the CCITT (ITU-T) Standard E.212 Annex A and are used in the Block Information Word field for roaming channel management. (Reference BIW Word Format Type 111 in Section 3.8.5)

Zone 2

Number	Country or Area
202	Greece
204	Netherlands (Kingdom of the)
206	Belgium
208	France
212	Monaco
214	Spain
216	Hungarian People's Republic
220	Yugoslavia (Socialist Republic of)
222	Italy
226	Romania (Socialist Republic of)
228	Switzerland (Confederation of)
230	Czechoslovak Socialist Republic
232	Austria
234	United Kingdom of Great Britain
238	Denmark
240	Sweden
242	Norway
244	Finland
250	Union of Soviet Socialist Republics
260	Poland (People's Republic of)
262	Germany (Federal Republic of)
266	Gibraltar
268	Portugal
270	Luxembourg
272	Ireland
274	Iceland
276	Albania (Socialist People's Republic of)
278	Malta (Republic of)
280	Cyprus (Republic of)
284	Bulgaria (People's Republic of)
286	Turkey

Zone 3

Number	Country or Area
302	Canada
308	St. Pierre and Miquelon
310	United States of America
330	Puerto Rico
332	Virgin Islands (USA)
334	Mexico
338	Jamaica
340	French Antilles
342	Barbados
344	Antigua
346	Cayman Islands
348	British Virgin Islands
350	Bermuda
352	Grenada
354	Montserrat
356	St. Kitts

Zone 3

Number	Country or Area
358	St. Lucia
360	St. Vincent and the Grenadines
362	Netherlands Antilles
364	Bahamas (Commonwealth of the)
366	Dominica
368	Cuba
370	Dominican Republic
372	Haiti (Republic of)
374	Trinidad and Tobago
376	Turks and Caicos Islands

Zone 4

Number	Country or Area
404	India (Republic of)
410	Pakistan (Islamic Republic of)
412	Afghanistan (Democratic Republic of)
413	Sri Lanka (Democratic Socialist Republic of)
414	Burma (Socialist Republic of the Union of)
415	Lebanon
416	Jordan (Hashemite Kingdom of)
417	Syrian Arab Republic
418	Iraq (Republic of)
419	Kuwait (State of)
420	Saudi Arabia (Kingdom of)
421	Yemen Arab Republic
422	Oman (Sultanate of)
423	Yemen (People's Democratic Republic of)
424	United Arab Emirates
425	Israel (State of)
426	Bahrain (State of)
427	Qatar (State of)
428	Mongolian People's Republic
429	Nepal
430	United Arab Emirates (Abu Dhabi)
431	United Arab Emirates (Dubai)
432	Iran (Islamic Republic of)
440	Japan
450	Korea (Republic of)
452	Viet Nam (Socialist Republic of)
454	Hong Kong
455	Macao
456	Democratic Kampuchea
457	Lao People's Democratic Republic
460	China (People's Republic of)
467	Democratic People's Republic of Korea
470	Bangladesh (People's Republic of)
472	Maldives (Republic of)

Zone 5

Number	Country or Area
502	Malaysia
505	Australia
510	Indonesia (Republic of)
515	Philippines (Republic of the)
520	Thailand
525	Singapore (Republic of)
528	Brunei
530	New Zealand
535	Guam
536	Nauru (Republic of)
537	Papau New Guinea
539	Tonga (Kingdom of)
540	Solomon Islands
541	Vanuatu
542	Fiji
543	Wallis and Futuna Islands
544	American Samao
545	Gilbert & Ellice Islands
546	New Caledonia and Dependencies
547	French Polynesia
548	Cook Islands
549	Western Samoa

Zone 6

Number	Country or Area
602	Egypt (Arab Republic of)
603	Algeria (People's Democratic Republic of)
604	Morroco (Kingdom of)
605	Tunisia
606	Libya (Socialist People's Libyan Arab Jamahiriya)
607	Gambia (Republic of the)
608	Senegal (Republic of)
609	Mauritania (Islamic Republic of)
610	Mali (Republic of)
611	Guinea (Republic of)
612	Ivory Cost (Republic of the)
613	Upper Volta (Republic of)
614	Niger (Republic of the)
615	Togolese Republic
616	Benin (People's Republic of)
617	Mauritius
618	Liberia (Republic of)
619	Sierra Leone
620	Ghana
621	Nigeria (Federal Republic of)
622	Chad (Republic of the)
623	Central African Republic
624	Cameroon (Republic of)
625	Cape Verde (Republic of)
626	Sao Tome and Principe (Democratic Republic of)
627	Equatorial Guinea (Republicof)

Zone 6

Number	Country or Area
628	Gabon Republic
629	Congo (People's Republic of the)
630	Zaire (Republic of)
631	Angola (People's Republic of)
632	Guinea Bissau (Republic of)
633	Seychelles
634	Sudan (Democratic Republic of the)
635	Rwanda (Republic of)
636	Ethiopa
637	Somali Democratic Republic
638	Republic of Djibouti
639	Kenya (Republic of)
640	Tanzania (United Republic of)
641	Uganda (Republic of)
642	Burandi (Republic of)
643	Mozambique (People's Republic of)
645	Zambia (Republic of)
646	Madagascar (Democratic Republic of)
647	Reunion (French Department of)
648	Zimbabwe (Republic of)
649	Namibia
650	Malawi
651	Lesotho (Kingdom of)
652	Bostwana (Republic of)
653	Swaziland (Kingdom of)
654	Comoros (Islamic Federal Republic of the)
655	South Africa (Republic of)

Zone 7

Number	Country or Area
702	Belize
704	Guatemala (Republic of)
706	El Salvador (Republic of)
708	Honduras (Republic of)
710	Nicaragua
712	Costa Rica
714	Panama (Republic of)
716	Peru
722	Argentine Republic
724	Brazil (Federative Republic of)
730	Chile
732	Colombia (Republic of)
734	Venezuela (Republic of)
736	Bolivia (Republic of)
738	Guyana
740	Ecuador
742	Guiana (French Department of)
744	Paraguay (Republic of)
746	Suriname (Republic of)
748	Uruguay (Eastern Republic of)

6. REVISION MANAGEMENT & HISTORY

6.1. REVISION MANAGEMENT

Revisions will be made by Motorola as required and history will be documented.

The following revisions have been made since the introduction of version G1.3 on 2/3/93. For the most part the changes are listed in the order that they occur in this document. Minor changes made only to clarify descriptive material or to correct word processor errors are not listed.

6.2. REVISION HISTORY

G1.4 Changes - Released 11/15/93.

- Protocol name changed from WASP to FLEX - 6/23/93 Telocator Announcement Changed Local and Nationwide address types to Short and Long Addresses to reflect the character of the address not how it is used.
- Now using name "single", "any" and "all" phase in Section 2.1 and other sections of this document to describe the three basic types of FLEX pagers.
- Added the definition of the Re-Sync "A" pattern to the table and drawing in Section 3.3. Also corrected the "C" pattern mentioned in the text.
- Added Section 3.4 describing the addition of an Emergency Re-Synchronization transmission to the FLEX definition.
- The address field range definition table modified: a) each long address word range increased slightly to make field size a multiple of 1024 (CAPCODE issue). b) Short addresses moved so range adjacent to long address 1 word (CAPCODE issue). c) an information service address field identified and reserved for future use. d) temporary addresses expanded from 8 to 16 (simplified short instruction vector for temporary addressing when it became apparent that single phase pager would not be capable of changing phase) e) reserved addresses moved so CAPCODE addresses are a continuous set of numbers with only one break between the Short and Long address ranges.
- Added default value for "n" reserved bits in the Frame Information Word and defined "v" field in the Block information word to be set to "0" if no vector exist.
- Clarified the use of the second vector word in the Long addressing form. Vector length field is number of code words including the word rotated into the 2nd vector position.
- Modified the Short Message Tone Only Vector message number field to match that being used with Alpha and HEX message forms.
- Added section 3.8.7.5 Secure Message Vector and section 3.8.8.4 Secure message. This definition is the same as the definition for an Alpha message except for the removal of the signature field. The system might grant access to this type message only when security/password measures have been met.
- Modified 3.8.7.6 Short Instruction Vector for change in the temporary address definition from 8 to 16 addresses all in the same set (eliminated the 2 bit phase field). Clarified the future Frame field to indicate the full 7 bit Frame identification. If future Frame indicated is the same number as the present Frame the pager is to assume the intended Frame is 4 minutes in the future.
- Modified the Numbered Numeric Message definition in section 3.8.8.1 to follow approach used in Alpha and HEX.
- Several modifications to the HEX/Binary message format in section 3.8.8.2. a) expanded the fragment check character field so future applications of this format might use a standard 12 bit CRC character. b) changed message numbering to a 0-63 range with a 1 bit retrieval active flag. c) added a 2 bit type field for use with messages which read right to left or may contain a text header followed by non-displayable data. d) added a two bit blocking length field to indicate bits per character. e) added an 8 bit signature field (separate from message number). f) re-ordered bits in the first fragment word so that mail drop, message retrieval, message type, blocking length, and the signature field are sent only once at the beginning of the message in the first fragment of long messages. g) reserved 5 bits in message header for future use.

- Alpha message section 3.8.8.3 modified to include the new definition of message numbering and retrieval. Added 7 bit signature to occur only once per message in the beginning of the message of the first fragment.
- Updated section 5.9 Message Numbering in the appendix to reflect the changes made to the rest of the document.
- Modified Section 5.3 Numeric Character Set changing the line feed 1010 character to a spare character. It was determined that the line feed was of little value in a numeric product and should not be part of a requirement.
- Added section 5.13 Emergency System Re-Synchronization to the appendix to give an overview of the need for this addition to the FLEX protocol.
- Modified the time display functions of FLEX by specifying the information be available over the air every 4 minutes in Frame "0000000". Added section 5.14 to explain possible use of zone field to assist time display while roaming modified local channel ID definition (Sect 3.8.5) to include time zone.
- Added Section 5.15 FLEX CAPCODE to describe the relationship between the CAPCODE and the FLEX code words transmitted over the air.

G1.5 Changes - Released 2/1/94.

- The separate "FLEX Signaling Protocol Encoding and Decoding Requirements Document" Document Number FLEX - 93003 Version 1.1 was added to the "FLEX Protocol Specification Document". The combined document name was changed to "FLEX PROTOCOL SPECIFICATION and ENCODING AND DECODING REQUIREMENTS". The combined document number stayed the same as the original protocol document (FLEX - 93001) with the version updated to G1.5.
- 3.1 Modulation - allowable deviation for 2FM only systems extended to ±4.0 to ±5.6 kHz.
- 3.8.3. Frame Information Word - Defined one of the reserved bits to be a repeat format indicator r0. When r0 = 1 the channel contains repeat paging and the t3 t2 t1 t0 bits are reserved to describe the particular format. When r0 = 0, the t3 t2 t1 t0 field resumes it prior definition as low traffic indicators.
- 3.8.4 Block Information Word - changed the default value for the vector field when no vectors exist from 000000 to the word position directly following the address field. In the case of no addresses it is set to the word position directly after the last block information word.
- 3.8.5 Block Information Word 2,3,4 - Added sentence indicating that the Local Channel ID could appear more often than just Frame 0000000.
- 3.8.6.2 Long Two Word Address - Corrected error in the binary range of the long address second word.
- 3.8.8.1 Numeric Data Message - Redefined the message check character to follow rules set for alpha and HEX. The 6 digit character numeric check character is derived from the 10 character Alpha check character.
- 4.3.3.1 Modified to allow for FLEX inactivity up to 4 minute in length under shared channel conditions.
- 4.3.6.2 Modified to allow fragment spacing up to 4 minutes on shared channel.

G1.6 Changes - Released 4/8/94.

- The Revision Management & History section 3.9 was relocated to the end of the document and renumbered section 6.
- 3.6 Transmission Order - The description of the Frame Information Word was corrected to reflect the definition is section in 3.8.3.
- 3.8.5 Block Information Word 2,3,4. Added to " Real Time" description that the GPS or UTC minute time mark be aligned with the leading edge of the first sync bit.
- 4.3.2.7 Clarified wording.
- 5.6 Long Message Fragmentation. Added text to indicate option allowing 4 minutes between fragments.
- 5.8 Channel Sharing Using "Collapse Function" - added battery life warning for lightly loaded systems that skip Frames due to no traffic.
- 5.15 FLEX CAPCODE - Changed boundary between illegal and long addresses in the CAPCODE Assignment Table.
- 5.15.5 CAPCODE to Binary Conversion - Corrected error in the translation numbers by adding 1024. The constant used in the calculation of long address word one was changed from 2,067,457 to 2,068,481. Now Frame and phase calculations can be performed on either the binary code words or the decimal CAPCODE.
- 5.15.6 Binary to CAPCODE Conversion - The constant used in the calculation using long address word one was changed from 2,067,456 to 2,068,480. Other changes include minor clarification of text.

G1.7 Changes - Released April 6, 1995.

- 3.1 Modulation - The deviation difference between 4FM symbols was relaxed to 3200 +/- 60 Hz from +/- 16 Hz to more closely match reasonable base station specifications. The maximum deviation for 2FM only FLEX systems was reduced from 5.6 kHz to 4.8 kHz to improve receiver performance.
- 3.2 FLEX Frame Structure - Removed reference to the possibility of time offset FLEX Frames and added reference to the new requirement that channels that support roaming must align Frame 0 with the 4 minute marks of a real time source. Referenced the new definition of a Roaming Support bit in the Frame Information Word.
- 3.3 Added drawing and references to additional "A" Sync words.
- 3.6 Transmission Order - Changed Frame Information, Block Information, and Idle Blocks paragraphs to further clarify definition.
- 3.7 Address Field Range Definition - Moved addresses from high end of the Short Address field for use in future roaming systems (Long Address 3, Long Address 4 and Short Address Reserved for a total of 75,775 addresses reserved).
- 3.8.3 Frame Information Word - Added Roaming Network Flag.
- 3.8.4 Block Information Word - Clarified the priority address field as being address word count not address count. Clarified the default field value for the vector field when no vectors are required.
- 3.8.5 Block Information Word 2,3,4 - Redefined the 000 word to include a 5 bit field for Coverage Zones, Time Zone moved to new 101 word which also allows system messages to be transmitted, 011 word was deleted (no longer allow time offsetting of Frames), and added 111 word to include Country Code and Traffic Management Flags. Removed text describing Frame Offset and added new paragraph describing Real Time / Month, Day, Year/ Time Zone use. Also described System Message Field within BIW 101. Sending of time changed to a "must" to allow accurate time stamping and time setting in pagers.
- 3.8.6.3 Network ID Address - Added definition of Network ID.
- 3.8.7.1 Numeric Vector - Added definition for b field value when Long Address and short message result in no detached message (message fits in second vector word).
- 3.8.7.2 Short Message / Tone Only Vector - Added R_0 retrieval flag field to type 10 vector to match other message formats. Added reference to 00 vector type being used with Network ID (NID) to expand definition - see Section 3.8.8.6.
- 3.8.8.1 Numeric Data Message - Clarified R_0 definition to be same as other message formats.
- 3.8.8.2 HEX / Binary Message - Clarified the fragment check sum. Defined the D and H field from what was the T field. Clarified the B field meaning. Clarified the S Signature definition. Clarified Message Number field. Changed the fragmenting rules. Added paragraph describing Message Header.
- 3.8.8.3 Alphanumeric Message - Corrected typing errors in F field definition and in S field definition. Clarified Message Number field.
- 3.8.8.6 Alphanumeric Message Rules for Symbolic Characters Sets - Added new section of termination rules for ASCII based symbolic character sets using the FLEX Alphanumeric message mode.
- 3.9 FLEX Roaming Structure - New Section
- 4.3.2.1, 4.3.2.4, 4.3.2.5, 4.3.2.8, 4.3.3.1, 4.3.4.3, 4.3.5.2, 4.3.5.3, 4.4.1.1, Minor change in choice of words to describe rules.
- 4.3.5.8 New Rule added limiting use of Dynamic address
- 4.3.7.5 Rule deleted - Short message fragment number is 11, this allows short message to be distinguished from long message fragment thus rule not necessary.
- 4.3.7.6 New rule to cover over the air message retrieval.
- 4.4.1.2 Rule change - Tone Only pager now not required to support dynamic addressing.
- 4.5 Roaming FLEX Multi-Frequency Roaming Rules- New Section
- 5.1 Appendix - added several new acronyms.
- 5.2 Glossary of Terms - Added several new terms and definitions.
- 5.3 Numeric Character Set - Added optional character set mainly for use in Peoples Republic China.
- 5.7 Group Messaging Techniques - Re-write of section.
- 5.14 Time Zone Information - Modified text to align with new method of transmission in Block Information field BIW Word 101.
- 5.15 FLEX CAPCODE - Modified table of CAPCODE ranges to reserve addresses for future global roaming.
- 5.16 List of Country Codes - New Section.

G1.8 Changes - Released May 7, 1996.

Version G1.8 attempts to take the more general view of "Encoding Devices" and "Decoding Devices". Any remnants of phrases like "pagers", "subscriber units" etc. should be read as "Decoding Devices". Likewise "terminals" etc. should be read as "Encoding Devices".

- Page ii - Marianne Lloyd is the new reference person identified for License Inquiries.
- 1.1 Purpose - Clarified wording: ... FLEX™ protocol has established the means for future design flexibility by allowing ... .
- 1.3 Telocator Network Paging Protocol reference up-issued to Version 3.7; new address and phone number listed; Marianne Lloyd is the new contact person identified for FLEX™ paging code information.
- 1.4 "RECOMMENDED FLEX™ SYSTEM MANAGEMENT DOCUMENTATION" Section added.
- 1.5 "COMMENTS" Section added.
- 2.1 System Overview - Clarified wording: ... the pager code plug will individually ... in the 2nd paragraph on Page 3; ... (SSID) in which a portion is embedded ... on Page 4.
- 3.2 FLEX™ Frame Structure - Clarified wording: synchronized to GPS time ...; ... 5 bits for indication ... and ... the 5 bits indicate the system ... in the 2nd paragraph.
- 3.3 Sync Structure - Clarified wording: ...FLEX™ compatible systems will use the ... in the 1st paragraph on Page 8.
- 3.4 Emergency Re-Synchronization Transmission - Clarified system Collapse relationship to pager operation during Re-synchronization; Deleted last paragraph since GPS has no seconds adjustments.
- 3.5.3 Block Reception - Clarified wording: ... further processing. Stored within the Subscriber Unit is the assigned phase value of 0, 1, 2, or 3. At 6400 bps ... .
- 3.6 Clarified wording in Address Field on Page 12: ... (1 word) and long addresses ... ; ...end of the address field since ... .
- 3.6 Transmission Order - Clarified wording in last paragraph on Page 14: ... all 0's Idle code words ...
- 3.7 Address Field Range Definition - Expanded wording for Long Address 3 and Long Address 4 and removed (Reserved) notation; removed (Reserved) on Info Svc Address; Created Operator Messaging Addresses field for 16 addresses from Short Address (Reserved) field; renamed Reserved Addr's to Short Addresses (Reserved). Reworded 2nd paragraph below Address Field Range Definition table.
- 3.8.3 Frame Information Word - Clarified wording on r - Repeat Paging Indicator bit: ... for Time Diversity operations.
- 3.8.5 Block Information Word (BIW) 2, 3, 4 - This section has been rewritten and now includes expanded System Message delivery means through BIW 101 and Operator Messaging Addresses.
- 3.8.6.2 Added the "For Example" statement.
- 3.8.7.2 Renamed the 'F' bits to 'T' bits to be an identical reference with the definitions of Traffic Management Flags in the BIW 111.
- 3.8.7.3 Minimum number of message words in this Frame changed to 3.
- 3.8.7.4 Minimum number of message words in this Frame changed to 2
- 3.8.7.5 Minimum number of message words in this Frame changed to 2
- 3.8.7.6 Short Instruction Vector - Clarified wording in the Temporary Addresses paragraph with the addition of: "The subscriber unit will not respond to any Carry On operation for temporary addresses that may be in effect in the originally specified Frame." Added System Event structure for Instruction Type 0 0 1.
- 3.8.8.1 In the N - Message Number definition the last sentence was added: "The message retrieval number displayed to the user is to be 1 + N so that the user perceives messages numbered from 1 to N + 1."
- 3.8.8.2 - In the N - Message Number definition the last sentence was added: "The message retrieval number displayed to the user is to be 1 + N so that the user perceives messages numbered from 1 to N + 1." Clarified wording on Mail Drop Flag M. Clarified the reference in B - 4 bit Blocking Length on Note: " ... preceding figures ... ". Introduced the I - Status Information Field Enable. Changed 'long' to 'multi-fragment' in the Fields R through S definition.
- 3.8.8.3 - In the N - Message Number definition the last sentence was added: "The message retrieval number displayed to the user is to be 1 + N so that the user perceives messages numbered from 1 to N + 1." Clarified wording on Mail Drop Flag on Page 34.
- 3.8.8.4 Secure Message - Established the t - 2 bit Secure Message Type Field along with the revisions to the definitions for Message Content and Message Termination.
- 3.9 Changed 'simulcast system' to 'Simulcast System Identification' in the 2nd paragraph. Revised descriptions for the Roaming Terms, Simulcast System Identifier and Network Identifier paragraphs.

- 3.9.1 SSID and NID Placement Rules for Roaming: Rule 1 - Added the GPS information from the paragraph under Rule 6 in Issue G1.7 to Rule 1. Clarified wording: Rule 2. Clarified wording: Rule 4 ... 'at a minimum' ... and '... Modulo 4 ...'; Rule 5 ... 'Channel ID Licensing signals (FCC, etc.)' ... ; Rule 6 - Rewritten for clarity. Added the new Rule 7 as part of SSID Placement Rules. Rules 8 through 13 were Rules 7 through 12. All have been updated. In Rule 10, '(Carry On does not apply to NID placement.)' was added.
- 3.9.2 System Message Transmission - Section rewritten for both Sending a SSID System Message and Sending a NID System Message.
- 3.9.3 Frame Offsetting Example - replaced paragraphs below the figure with a single sentence.
- 3.9.4 New Section 'Registration and Registration Acknowledgment Message ' introduced.
- 3.9.5 New Section 'Registration Instruction' introduced.
- 3.9.6 New Section 'System SSID Change Instruction' introduced.
- 3.9.7 New Section 'System NID Change Instruction' introduced.
- 3.9.8 New Section 'Roaming System Design Elements' introduced.
- 4 FLEX™ Encoding and Decoding Requirements - The Purpose (4.1) and Scope (4.2) Sections were rewritten to identify Encoding Systems and Decoding Systems' as more descriptive terms and stated the definitions for Rules and Recommendations.
- 4.3 FLEX Encoding Rules: Generic use of 'pagers' has been replaced by 'decoders'; 'terminal data base' with 'Encoding System'. The terminology within all Rules / Recommendations was enhanced or clarified except for: 4.3.2.6, 4.3.3.1, 4.3.5.6, 4.3.5.8, 4.3.6.2, 4.3.6.3, 4.3.7.1, 4.3.7.4, 4.5.1.6 4.5.1.11 and 4.5.1.12. The following rules were deleted: 4.4.1.2, 4.5.1.10 and 4.5.2.2. The following are New Rules: 4.4.1.6, 4.5.1.16, 4.5.1.17, 4.5.1.18, 4.5.1.19, 4.5.1.20, 4.5.1.21, 4.5.2.3 and 4.5.2.4.
- 5 Appendix - additional Acronyms and Abbreviations were made; additions were placed into the Glossary of Terms.
- 5.6 - Added "(251 characters in 1st fragment)"
- 5.8 - Clarified meaning in last sentence: "To avoid this situation in lightly loaded systems, a minimum Frame should be sent for each supported Frame frequently (2 Frames for Collapse 1 every 2 minutes, 4 Frames for Collapse 2 every 4 minutes, 8 Frames for Collapse 3 every 8 minutes, 16 Frames for Collapse 4 every 16 minutes) to provide synchronization updates to the pager."
- 5.10 Real time Maintenance wording Clarified: ... synchronized to a GPS time source ... .
- 5.12 - Corrected LID to properly state it as an SSID in the 2nd line.
- 5.13 - Corrected "a" to "at" for the end of the 6th line.
- 5.15 FLEX™ CAPCODE through 5.15.5 CAPCODE to Binary Conversion - this section was clarified and expanded to better represent the details needed to implement FLEX™ Roaming. The CAPCODE Assignment Table was revised and expanded to identify all combinations of Long Address sets and their uses.
- 5.15.2 "Extended" CAPCODE definition added along with a Table.
- 5.15.4 TNPP Revision is now 3.7.
- 5.15.5 Binary to CAPCODE Conversion - this section has been rewritten.
- 5.15.6 Binary to CAPCODE Conversion - this section has been rewritten.
- 5.16 LIST OF COUNTRY CODES reformatted for ease of reading.

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STANDARD

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