

RECOMMENDATION ITU-R M.584-2

CODES AND FORMATS FOR RADIO PAGING

(Question ITU-R 12/8)

(1982-1986-1997)

Summary

This Recommendation describes codes and formats which may be used to provide radio paging.

The ITU Radiocommunication Assembly,

considering

- a) this Recommendation which describes codes and formats presently used by some of administrations;
- b) Recommendation ITU-R M.539;
- c) that the studies necessary to define the requirements for new radio-paging systems are ongoing;
- d) that some administrations need to implement, or intend to implement, radio paging systems offering higher transmission speeds, to increase data throughput and subscriber handling capability;
- e) that, among other things, standard code(s) and format(s) are necessary to permit radio paging;
- f) that the codes and formats described in the annexes are presently used for radio paging,

recommends

- 1** that future work should allow for possible future changes in these codes and formats;
- 2** that studies should continue in order to meet the evolving requirements for paging systems.

ANNEX I

Radio-paging code No. 1**1 Code and format**

This code is sometimes referred to as POCSAG. A transmission consists of a preamble followed by batches of complete codewords, each batch commencing with a synchronization codeword (SC). The format of the signals is illustrated in Fig. 1. Transmission may cease at the end of a batch when there are no further calls.

1.1 Preamble

Each transmission starts with a preamble to aid the pagers to attain bit synchronization and thus help in acquiring word and batch synchronization. The preamble is a pattern of reversals, 101010... repeated for a period of at least 576 bits, i.e. the duration of a batch plus a codeword.

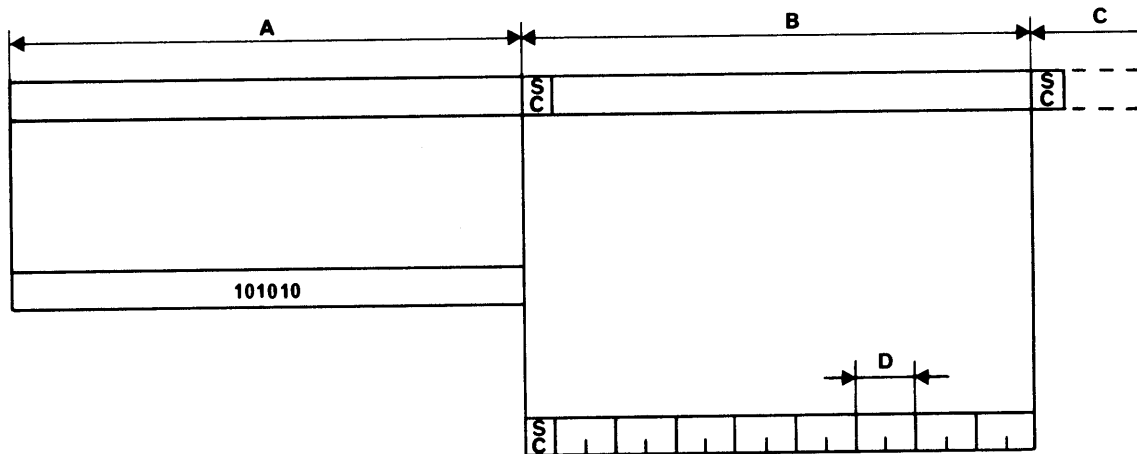


FIGURE 1 – Signal format

- A: preamble. Duration at least 576 bits = the duration 1 batch + 1 codeword
- B: first batch
- C: second and subsequent batches
- D: one frame = 2 codewords
- SC: synchronization codeword

Note. – 1 batch = synchronization codeword + 8 frames = 17 codewords.

D01-sc

1.2 Batch structure

Codewords are structured in batches which comprise a synchronization codeword followed by 8 frames, each containing 2 codewords. The frames are numbered 0 to 7 and the pager population is divided into 8 groups. Thus each pager is allocated to one of the 8 frames according to the 3 least significant bits (LSB) of its 21 bit identity (see § 1.3.2), i.e. 000 = frame 0, 111 = frame 7, and only examines address codewords in that frame. Therefore each pager's address codewords must be transmitted only in the allocated frame.

Message codewords for any receiver may be transmitted in any frame but follow, directly, the associated address codeword. A message may consist of any number of codewords transmitted consecutively and may embrace one or more batches but the synchronization codeword must not be displaced by message codewords. Message termination is indicated by the next address codeword or idle codeword. There is at least one address or idle codeword between the end of one message and the address codeword belonging to the next message.

In any batch, wherever there is no meaningful codeword to be transmitted, an idle codeword is transmitted.

The last codeword in any transmission should be an idle codeword.

1.3 Types of codewords

Codewords contain 32 bits which are transmitted with the most significant bit first.

The structure of a codeword is illustrated in Fig. 2.

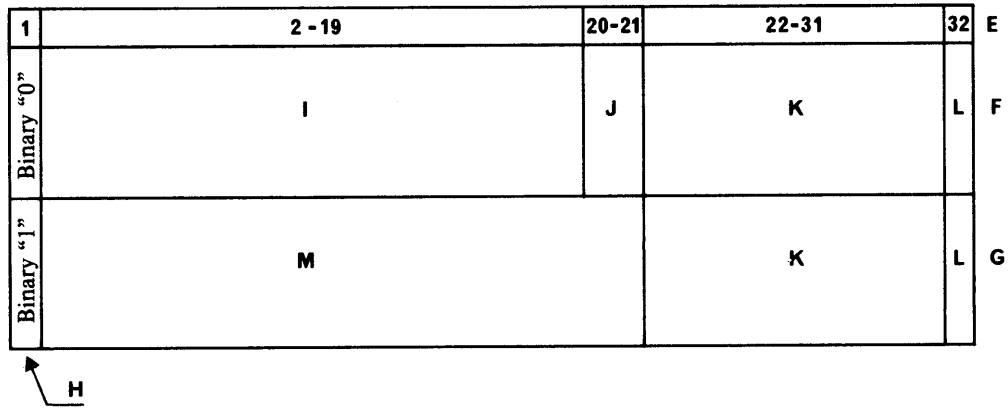


FIGURE 2 – Form of address and message codewords

- E: bit number
- F: address codeword
- G: message codeword
- H: flag bit
- I: address bits (2-19)
- J: function bits
- K: check bits
- L: even parity bit
- M: message bits (2-21)

D02-sc

1.3.1 Synchronization Codeword

The synchronization codeword is shown in Table 1:

TABLE 1

Bit No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Bit	0	1	1	1	1	1	0	0	1	1	0	1	0	0	1	0
Bit No.	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Bit	0	0	0	1	0	1	0	1	1	1	0	1	1	0	0	0

1.3.2 Address Codewords

The structure of an address codeword is illustrated in Fig. 2.

Bit 1 (the flag bit) of an address codeword is always a zero. This distinguishes it from a message codeword.

Bits 2-19 are address bits corresponding to the 18 most significant bits of a 21 bit identity assigned to the pager.

For information regarding the least significant bits see § 1.2.

Bits 20 and 21 are the two function bits which are used to select the required address from the four assigned to the pager. Hence the total number of addresses is 2²³ (over 8 million).

Bits 22 to 31 are the parity check bits (see § 1.4) and the final bit (bit 32) is chosen to give even parity.

1.3.3 Message Codewords

The structure of a message codeword is shown in Fig. 2. A message codeword always starts with a 1 (the flag bit) and the whole message always follows directly after the address codeword. The framing rules of the code format do not apply to a message and message codewords continue until terminated by the transmission of the next address codeword or idle codeword. Each message displaces at least one address codeword or idle codeword and the displaced address codewords are delayed and transmitted in the next available appropriate frame. Although message codewords may

continue into the next batch, the normal batch structure is maintained, i.e., the batch will consist of 16 codewords, preceded by a synchronization codeword. At the conclusion of a message any waiting address codewords are transmitted, starting with the first appropriate to the first free frame or half frame.

Message codewords have 20 message bits, viz bit 2 to bit 21 inclusive and these are followed by the parity check bits obtained according to the procedure outlined in § 1.4 below.

1.3.4 Idle Codeword

In the absence of an address codeword or message codeword, an idle codeword is transmitted. The idle codeword is a valid address codeword, which must not be allocated to pagers and has the following structure as shown in Table 2:

TABLE 2

Bit No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Bit	0	1	1	1	1	0	1	0	1	1	0	0	1	0	0	1
Bit No.	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Bit	1	1	0	0	0	0	0	1	1	0	0	1	0	1	1	1

1.4 Codeword Generation (31: 21 BCH + Parity)

Each codeword 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 $x^{10} + x^9 + x^8 + x^6 + x^5 + x^3 + 1$. 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 of the block is added one additional bit to provide an even bit parity check of the whole codeword.

2 Message formats

Although in principle, any message format can be inserted into message codewords, the following formats are regarded as standard. Adherence to these standards will enable a greater measure of interworking to be possible. The formats are not mixed within any one message.

2.1 “Numeric-only” message format

The “numeric-only” format is provided for the transmission of messages which may be represented solely in decimal numerals together with spaces, hyphens, opening and closing brackets, an urgency symbol “U” and one other symbol. There are 4 bits per character in this format and its use will save air-time compared to the other format.

The address which introduces a message (or segment of a message) using this format has its function bits set to 00. The character-set used for the message is as shown in Table 3 which is based on Binary Coded Decimal (BCD). The bits of each character are transmitted in numerical order starting with bit No. 1. Characters are transmitted in the same order as they are to be read and are packed 5 per message codeword. Any unwanted part of the last codeword of the message is filled with space characters.

TABLE 3

“Numeric-only” character set

4-bit Combination	Displayed character
Bit No.: 4 3 2 1	
0 0 0 0	0
0 0 0 1	1
0 0 1 0	2
0 0 1 1	3
0 1 0 0	4
0 1 0 1	5
0 1 1 0	6
0 1 1 1	7
1 0 0 0	8
1 0 0 1	9
1 0 1 0	Spare
1 0 1 1	U (urgency indicator)
1 1 0 0	Space
1 1 0 1	Hyphen
1 1 1 0	☐
1 1 1 1	☐

2.2 Alpha-numeric or general data format

This format can be used for the transmission of messages requiring a greater range of characters than that provided within the “numeric-only” format but it may also be used to replace the latter when circumstances make this essential or desirable. There are 7 bits per character in this format.

The pager address which introduces a message (or segment of a message) using this format has its function bits set to 11.

The International Alphabet No. 5 (7 bits per character) is used in this format. As in the case of the “numeric-only” format, bit order starting with bit No. 1 of each character, and character reading order are preserved in transmission. The complete message is partitioned into contiguous 20 bit blocks for the purpose of filling consecutive message codewords. Thus a character may be split between one message codeword and the next. Any unwanted part of the last codeword of the message is filled with appropriate non-printing characters such as “End of Message”, “end of Text”, Null, etc. All characters, except Null, are complete.

2.3 Loss of synchronization

If a receiver loses synchronization, or if it commences receiving after the preamble has been completed, it is desirable that it can achieve synchronization on receipt of a number of valid batches.

2.4 Decimal representation of pager identities

A decimal representation of pager identity might also be useful. If so, it is suggested that it should be the decimal equivalent of the 21 bit identity.

2.5 Message reception, display and alerting

2.5.1 End of message

It is desirable that the pager ceases decoding a message when either an idle or address codeword is received or when two successive information codewords are indecipherable, even if they immediately follow a message indication pager address.

2.5.2 Minimum message storage capacity

Some form of storage will be necessary for pagers which do not provide a printed output. It is suggested that the minimum storage capacity in pagers designed for the "numerical-only" format should be 20 characters and for the "alphanumeric" format, 40 characters.

ANNEX 2

FLEX-TD

Annex 2 describes the code and format FLEX-TD. In Japan, the air-interface technical standard for radio paging was established by ARIB (Association of Radio Industries and Businesses, formerly RCR) in 1995. FLEX-TD is a paging code that uses the FLEX protocol as a foundation for the air interface. It is capable of applying Time Diversity (TD) to pages. FLEX-TD and the FLEX protocols are described and incorporated in RCR STD 43 (Reference 1).

1 Code and Format

1.1 Basic structure

The Frame structures are indicated in Figure 3. An hour is divided into 15 Cycles numbered sequentially from 0 to 14. Each Cycle consists of 128 Frames (4 minutes), each numbered sequentially from 0 to 127. Each Frame is 1.875 sec long, and consists of a sync signal (115 ms.) and 11 interleaved blocks (160 ms each).

The Sync 1 portion and Frame Information Word (FI) of each Frame is transmitted at 1 600 bit/s. The Sync 1 portion provides a means for obtaining Frame timing and an indication of speed and modulation for the remainder of the Frame. The FI portion consists of Cycle number, Frame number, multiple transmission indicator, and roaming channel indicator.

The Sync 2 portion of each Frame is designated to provide synchronization at the block transmission speed.

In the case of multiple transmission Time Diversity, blocks 0 to 10 are divided into two sub-Frames for two transmissions, three sub-Frames for three transmissions, four sub-Frames for four transmissions. Each sub-Frame consists of Block Information Field (BI), Address Field (AF), Vector Field (VF), Message Field (MF), and Idle Blocks (IB). The repeat transmission interval for a page is specified using a value called the System Collapse Cycle ($1 < 2^m < 128$ Frames). A page is repeated in the appropriate sub-Frame of a future Frame as determined by the System Collapse Cycle. A pager can perform TD (Time Diversity) processing of the repeated transmission signals.

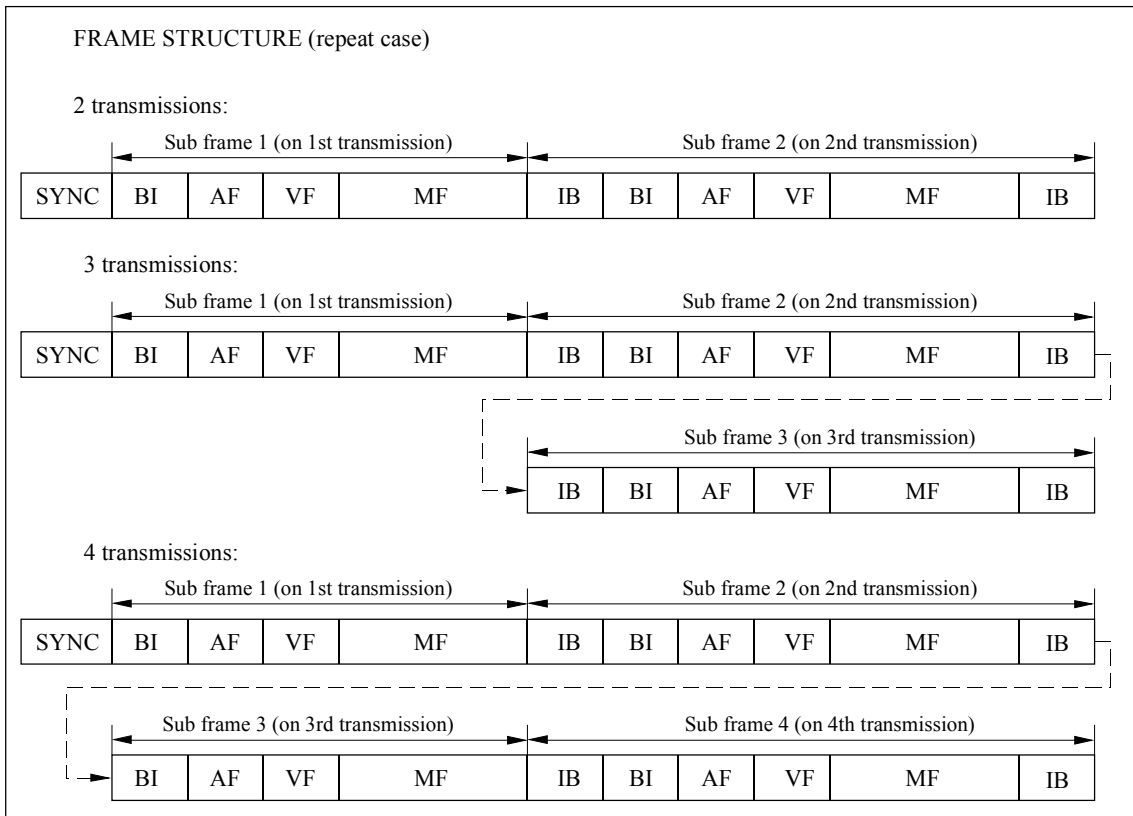
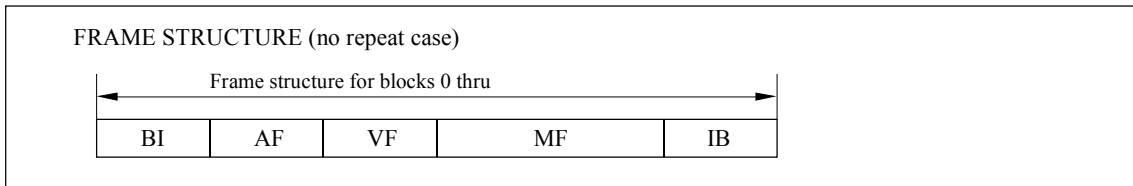
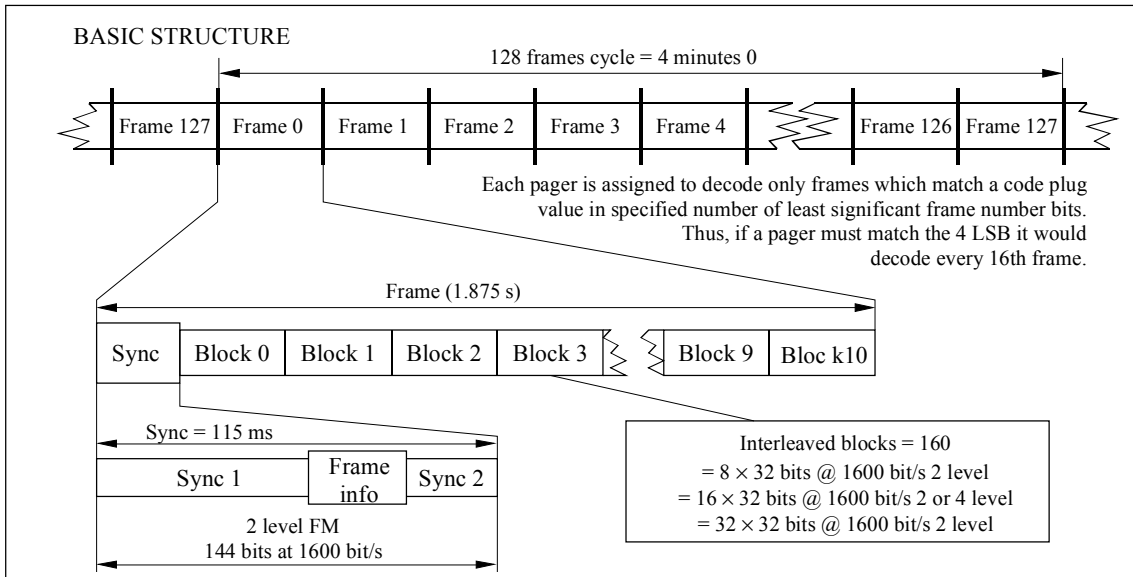
Block Information Field (BI) is usually one code word (a code word consists of BCH (31,21) plus even parity), but may be up to four code words.

Address Field (AF), Vector Field (VF) and Message Field (MF) contain individual addresses, paging types, and messages. An Idle Block (IB) does not contain information, just a 1 600 bit/s alternating pattern of symbols modulated at +4.8 kHz and -4.8 kHz.

1.2 Sync Structure

The sync consists of a Sync 1, a Frame Information, and a Sync 2 part. During the Sync 1 part, information regarding bit synchronization and how to determine the transmission speed of the associated Frame is provided. During the Frame Information Word the Frame number, the Cycle number, and system information is provided. Both the Sync 1 and the Frame Information Word are sent at 1 600 bit/s. Sync 2 defines a method to re-synchronize the following blocks to the transmission speed identified in Sync 1.

FIGURE 3



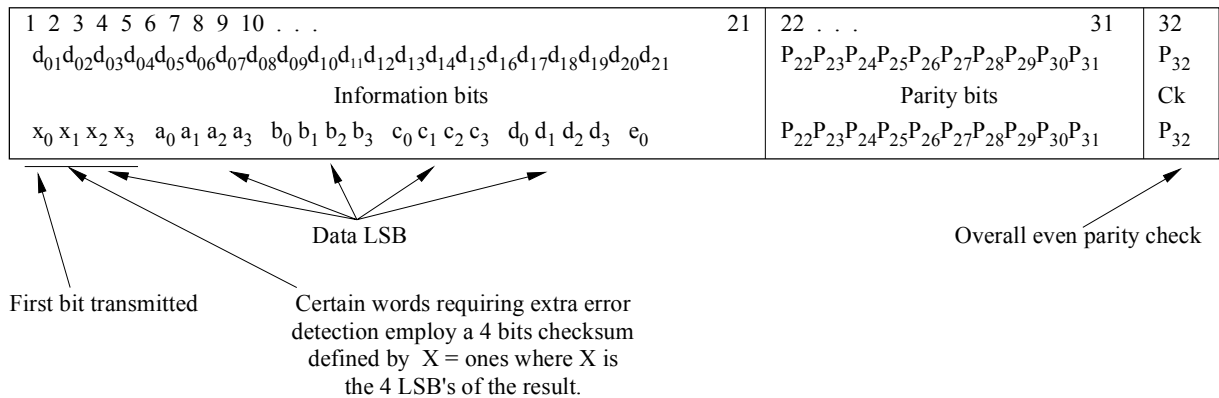
1.3 Block Structure

Each block occupies 160 ms of transmission time independent of the designated Frame speed. A block contains either eight (8), sixteen (16), or thirty two (32) bit code words depending on the transmission speed (1 600, 3 200, or 6 400 bit/s). Code words are interleaved to provide a 5 ms separation between successive bits.

1.4 Code Word Definitions

1.4.1 Code Word Structure

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 code in Annex 1.



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All (31,21) BCH + even parity bit code words received in the 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 3 200 bit/s and 64 consecutive bit errors at 6 400 bit/s 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 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 of the result are transmitted as the Checksum.

1.4.2 Types of Code Words

1.4.2.1 Frame Information Code Word

Identifies the Frame Number, the Cycle Number, multiple transmission indicator, roaming channel indicator, and a Checksum to ensure quality of the received information.

1.4.2.2 Block Information Code Words

The first 1, 2, 3, or 4 words of the first interleaved Block contain Frame and system structure information.

1.4.2.3 Address Code Words

Addresses are sent LSB 1st. This assumes that addresses are assigned in consecutive order resulting in the first address bit on the channel being closer to a random distribution. Addresses are defined to be either a short, a long, a temporary, or a network type. Long addresses are two code words in length.

1.4.2.4 Vector Code Words

Vector code words provide information regarding message location, message type, and message length. Vector types are: numeric, short message/tone only, HEX/Binary, alphanumeric, secure, and short instruction. Vectors associated with "long" addresses are two code words in length.

1.4.2.5 Message Code Words

Twenty one (21) bits are used for messaging information. Message types are either numeric, HEX/Binary, alphanumeric, or secure in format.

1.5 Numeric Character Set

This is the same as defined in the code in Annex 1 where 4 bits define a numeric digit.

1.6 Alphanumeric / Symbolic Character Sets

Characters used in alphanumeric messages are defined in ISO 646-1983E. Products are expected to provide options to re-map certain characters 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.

Symbolic character sets can be defined in standards which combine 2 or 3 ASCII characters to represent one symbolic character. Or, a character set using the HEX/Binary message mode where, for example, a character can be defined to be 16 bits in length can be used.

1.7 Pager synchronization acquisition rule

Minimum channel activity required to support the protocol 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 encoder and pager for the protocol 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.

1.8 Time Diversity (TD)

The same paging messages are transmitted repeatedly separated in time. Pagers can combine the paging signals bit by bit, or combine code word by code word. Pagers which do not process repeats are capable of operating in a system that uses the protocol but do not benefit from the advantages of Time Diversity.

1.9 Traffic management/Transmission of long messages

Long messages, such as alphanumeric messages and transparent data, can be fragmented when they do not fit within a single Frame or when other traffic is scheduled for the same Frame. Message fragmentation makes it possible to mix other short messages and long messages in the same Frame and to redistribute the long message fragments into unfilled Frames.

Carry On is a tool which allows traffic in an overloaded Frame to be moved into the succeeding 1, 2 or 3 Frames.

1.10 Multi-area/Roaming

The protocol roaming uses two methods. The first method is called SSID (Simulcast System Identifier) roaming and is based on the pager identifying a specific simulcast area that is included in the desired roaming coverage. SSIDs are transmitted in the Block Information field of specific Frames. The second method is called NID (Network Identifier) roaming and is based on the pager examining RF channels for the presence of the proper NID. NIDs are transmitted in the Address field and Vector field of specific Frames.

REFERENCE

- [1] Japan RCR Standard STD-43 Rev. A /1996. 6.25 "FLEX-TD RADIO PAGING SYSTEM".
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