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Contents

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Foreword

This European Telecommunication Standard (ETS) has been produced by the Radio Equipment and Systems (RES) Technical Committee of the European Telecommunications Standards Institute (ETSI).

This ETS consists of two parts as follows:

Part 1: "Technical characteristics for private wide-area paging systems";

Part 2: "Functional characteristics and access protocol for private wide-area paging systems on shared channels".

Provisions for ElectroMagnetic Compatibility (EMC) are defined in ETS 300 719-1 [1] and ETS 300 741.

Transposition dates	
Date of adoption:	20 June 1997
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Date of withdrawal of any conflicting National Standard (dow):	30 April 1998

Introduction

Private Wide-Area Paging (PWAP) systems are basically On-Site Paging (OSP) systems with an extended range achieved by using a higher transmitter power (for guidance 25W could be a suitable value) and antenna location, as well as a specified receiver sensitivity. Private Wide-Area Paging systems can operate as a set of two or more paging systems working independently from each other and having overlapping coverage areas and sharing the same channel. Potential applications include emergency services, hospitals and manufacturing industry that may be located at various sites within the covered area.

These systems may use time sharing in order to increase the number of virtual available channels. The time sharing specified in this ETS is based on a free-running system with dynamic channel access, that requires minimum overhead and provides for maximum available net-air time.

This access protocol applies to single frequency simplex operation where the carrier sense mechanism is available for use according to this protocol. It features dynamic channel access by applying CSMA/CA techniques. This access protocol is applicable for:

- multiple users who do not share a common central control facility but do share a common single radio channel, for the independent transmission of paging-messages;

- multiple users who do not share a common central control facility but do share a common single radio channel, for the independent transmission of analogue speech and / or paging messages, and where speech-transmissions do not have any priority over the transmission of (non-speech) paging-messages.

This ETS does not include performance characteristics that may be required by the user or requirements for interfacing equipment.

The conditions for licensing as well as conditions for interfacing to Public Switched Telephone Network (PSTN) are determined by the appropriate authorities.

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1 Scope

This European Telecommunication Standard (ETS) specifies the access protocol and functional characteristics for Private Wide-Area Paging (PWAP) systems. Such systems are characterized by one-way data and speech transmissions on radio channels shared by different users. This ETS gives freedom for the use of any bit rate, any type of modulation or any type of protocol which fulfils the requirements of this ETS in order to access a shared radio channel.

In this ETS the operational aspects of the private wide-area paging service have been included.

2 Normative references

This ETS incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this ETS only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

[1] ETS 300 719-1 (1996): "Radio Equipment and Systems (RES); Private wide-area paging system; Part 1: Air interface specification".

[2] ITU-R Recommendation 584: "Standard codes and formats for international radio paging".

3 Definitions, abbreviations and symbols

3.1 Definitions

For the purpose of this ETS, the following definitions apply:

3.1.1 General definitions

base station receiver: A receiver fitted with an antenna socket and intended for use in a fixed location. This can be a stand-alone device or part of a transceiver.

bit: Binary digit.

block: The smallest quantity of information that is sent over the radio channel. A constant number of useful bits are always sent together with the corresponding redundancy bits.

packet: One block or a contiguous stream of blocks sent by one transmitter to one particular receiver or one particular group of receivers.

3.1.2 Functional definitions

access: To gain occupancy of the Radio Frequency (RF) channel.

cycle time (t_c): The length of time between subsequent transmissions of the same system at full load.

transmission time slot interval (t_t): The duration of channel occupancy of a paging system (subclause 5.3.4).

ordinal number: An integer assigned to each system to establish a sequence.

system: A service provider of private wide area paging.

3.2 Abbreviations

For the purpose of this ETS, the following abbreviations apply:

CSMA/CA	Carrier Sense Multiple Access/Collision Avoidance
EMC	ElectroMagnetic Compatibility
emf	electromotive force
PSTN	Public Switched Telephone Network
PWAP	Private Wide-Area Paging
RF	Radio Frequency
RPC1	Radio Paging Code 1
RSSI	Received Signal Strength Indication
SIC	System Identification Code

3.3 Symbols

n	number of systems
t_c	cycle time
t_i	observation interval
t_o	observation time
$t_{o\ max}$	maximum observation time
t_t	transmission time slot interval

4 Functional characteristics

4.1 General

The private wide-area paging system is a privately owned and operated paging system to serve an area within and beyond the boundary of the site. The intended free field range of a system is approximately 10 km (to comprise a city and its near surroundings). The radio channel may be either shared by several systems or dedicated to a single system.

The radio part of a private wide-area paging system as defined in this ETS is made up exclusively from equipment that conforms with ETS 300 719-1 [1]. Other equipment that may be connected to it shall fulfil the standards applicable to that equipment (if any).

Any coding or modulation scheme may be applied in any part of the protocol except the System Identification Code (SIC), subclause 5.4.

4.2 Correlation of system parameters

Since the system parameters: number of systems (n), transmission time slot interval (t_t) and cycle time (t_c) are interdependent, different choices should be available on different RF channels. For alerting purposes, short transmission time slot intervals (t_t) and short cycle times (t_c) are useful whereas for the transmission of messages long transmission time slot intervals (t_t) and therefore longer cycle times (t_c) may be allocated.

5 Access protocol

5.1 General

The access protocol defined in this ETS shall be used for each occupation of the RF channel with automatic channel access.

The access protocol provides for equal sharing of the channel by all systems. The actual channel occupancy depends on the system's traffic demand and a fixed sequence.

5.2 Principles

The protocol is controlled by the transmission of System Identification Codes (SIC). The protocol is self-synchronizing and does not use an external time reference.

The equipment shall determine its right to initiate a transmission from the observation of the channel and the evaluation of a previously transmitted SIC. If the channel is idle, the system shall introduce its transmission by sending out its own SIC. The equipment shall not access the channel as long as the latter is occupied.

5.3 Procedure

Each paging system shall determine the sequence of transmissions from the evaluation of previous transmissions on the same channel. In order to evaluate correctly the authorization to transmit, the succession shall be indicated by an ordinal number, which is part of the SIC. Every transmission shall be terminated by the SIC. In order to access the channel, an observation time (t_o) is introduced, the duration of which is determined by the channel loading.

Time slots shall be numbered in sequence. This may be done by formal administration or automatically.

The duration (t_t) of the transmission shall not be greater than the transmission time slot. Each paging system shall determine its turn to access the channel by analysing the ordinal number of the system which is about to finish. If its own ordinal number follows directly in series, it may then start a transmission. If the paging system's own ordinal number does not follow directly, it shall wait for as many observation intervals (t_i), as indicated by one less than the difference between its own ordinal number and the number of the terminating system. In either case, the channel may then be seized for the duration of one transmission time slot.

At low traffic, the channel can have transmission gaps which are longer than the maximum observation time (t_o). In this case a new transmission shall be started by transmitting the SIC with the ordinal number of the system included. To cope with the accidental simultaneous access of another system (collision), the transmitter shall then be powered down to start the actual transmission of data only in the time interval (t_i) indicated by the system's ordinal number and provided the channel is detected as free up to that time. Whenever the observation time (t_o) is triggered by transmitting a SIC, any system with a lower ordinal number shall have priority to access the channel. See also figure A.1.

5.3.1 Carrier sense delay

5.3.1.1 Definition

The carrier sense delay is the time which elapses between the application of a carrier to a base station receiver input and the detection of the presence of that carrier by that receiver.

5.3.1.2 Method of measurement

The receiver input terminal shall be connected to a signal generator and shall be adjusted to the operating frequency as specified by the manufacturer. The signal generator shall be set to an output level of 1 µV emf and the RF signal shall be unmodulated.

One burst of 200 ms ± 20 ms shall be applied to the input of the receiver under test. The time difference between the carrier presence detector output and the rising slope of the input signal shall be recorded.

The signal generator output shall achieve the wanted level of 1µV emf within 1 ms after it has been switched on.

5.3.1.3 Limit

The carrier sense delay shall not exceed 25 ms.

5.3.2 Observation time

The observation time (t_o) shall start at the end of the previous transmission. It will also start at power on. The observation time (t_o) is subdivided into as many observation intervals (t_i) as there are systems (n) sharing the channel. The duration of one observation interval (t_i) shall be 70 ms.

NOTE: This is double the transmitter attack time according to ETS 300 719-1 [1].

Therefore the maximum observation time $t_{o\ max}$ is given by:

$$t_{o\ max} = n \times t_i$$

The end of transmission is when the received signal level has dropped below 6 µV emf.

5.3.3 Initiation of the transmitter

The initiation of the transmitter shall follow the procedure in subclause 5.3.

The time which elapses from the middle of the respective observation interval to the point where the transmitter carrier power has reached a level of 1 dB below the steady state power shall be less than or equal to the transmitter attack time ETS 300 719-1 [1], subclause 7.6.

5.3.4 Duration of the RF channel occupancy

The time interval during which packets of data can be sent by a system is t_t. Equipment shall provide for the following ranges and step sizes:

t_t = 6 s,..., 30 s; step size 1 s

The transmission time available to each system on any given channel is determined by the licensing authority.

5.4 System Identification Code (SIC)

Since the SIC is read by all systems, the code and modulation scheme of the SIC is specified. For paging purposes the Radio Paging Code 1 (RPC1) has been specified by ITU-R Recommendation 584 [2]. Therefore this code has been chosen for the SIC. The SIC terminates each transmission.

5.4.1 Format of the identification signal

The System Identification Code (SIC) shall be transmitted in one block consisting of three RPC1 codewords (1 address and 2 message codewords) as shown in figure 1.

If the bit rate and modulation of the paging data and of the SIC are not the same, the block shall be preceded by "bit sync". In this case, bit synchronization is required because the auto-correlation properties of the "sync word" are calculated with respect to their corresponding "bit sync".

If bit rate and modulation of the paging data and of the SIC attached to the end of the data are the same, "bit sync" shall not be transmitted.

bit sync.	sync. word	idle word	addr. word	msg. word	msg. word

Bit sync.	Bit sequence: 1010.1010.1010.1010.1010.1010.1010.1010.
Sync. word	Sync. Word (32 bit) (0111.1011.1111.1111.1110.0011.1011.1010)
Address word	32 bit RPC1 Address Code word (2 082 448)
Message word 1, 2	2 × 32 bit RPC1 Message Codewords

Figure 1: Format of the System Identification Code (SIC)

The address code word is the same for all the systems sharing the channel. It allows for the evaluation of the following two message words with 2 × 20 information bits. The address code word identifies the type of service as Private Wide Area Paging (PWAP).

5.4.2 Contents of the SIC message words

The message words are available for transmitting information corresponding to system or licensing authority needs according to the categories in table 1.

Table 1

Category	Identifier	No. of bits
Licensee number	Lnb	12 in msg. word 1
Maximum number of systems sharing the channel	MN	4 in msg. word 1
Regional licensing office	LOF	4 in msg. word 1
Area code	AC	8 in msg. word 2
Individual system identification	SID	8 in msg. word 2
Ordinal number	ON	4 in msg. word 2

The bits according to these categories are to be assembled in the above given sequence as in RPC1 coding conventions. The maximum total number of useful bits is 40. All categories should be coded in binary as numeric characters (and will be presented in 4 bit nibbles).

5.4.3 Modulation scheme for the SIC

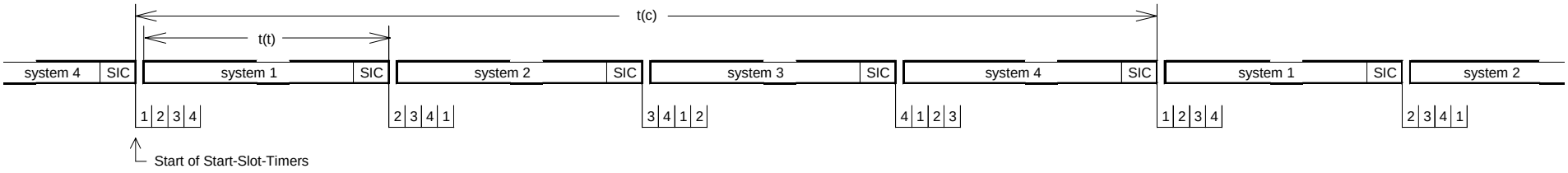
The parameters of the system identification code are given in table 2.

Table 2

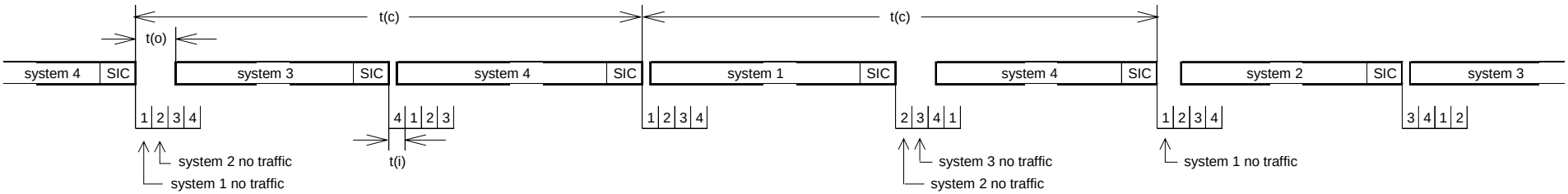
Parameter	Value
Type of modulation	Direct 2 level FSK
Transmission rate	1 200 bit/s
Deviation (channel spacing)	± 2,0 kHz (10,0 kHz)
Deviation (channel spacing)	± 2,5 kHz (12,5 kHz)
Deviation (channel spacing)	± 4,0 kHz (20,0 kHz)
Deviation (channel spacing)	± 4,5 kHz (25,0 kHz)

Annex A (informative): Examples of sharing situations

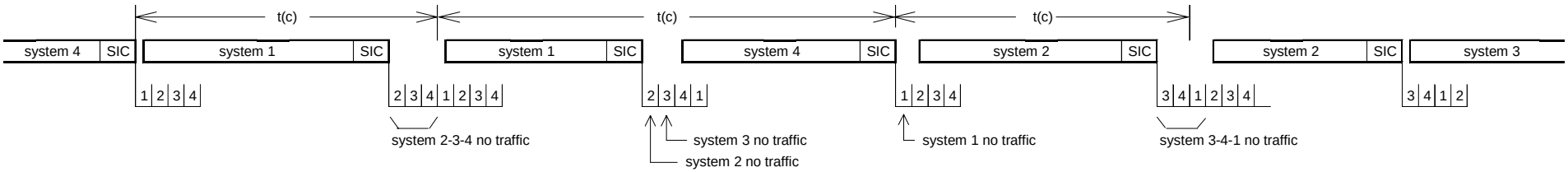
traffic load on all systems (n=4)



traffic load on some of the systems (n=4)



traffic load on some of the systems (n=4)



SIC System Identification Code
t(c) cycle time (dependent upon traffic demand, variable time)
t(i) observation interval
t(o) observation time
t(t) Duration of the RF channel occupancy

Figure A.1: Channel access with differently loaded systems

Annex B (informative): System implementation information

B.1 Correlation of system parameters

The number of systems (n), the transmission time slot intervals (t_t) and cycle time (t_c) should be traded off against transmission slot efficiency and delay time. Channels with different combinations of these parameters should be offered, e.g. channels with short transmission time slot intervals (t_t) for small delays and channels with long transmission time slot intervals (t_t) for long messages. A useful choice of systems (n), transmission slot intervals (t_t) and cycle time (t_c) is given in tables B.1 and B.2. Different combinations of the above mentioned parameters should be allocated to different RF frequencies.

Table B.1

t_t [s]	n	t_c[s]
30	2	60
20	3	60
15	4	60
12	5	60
10	6	60
8	8	64
6	10	60
15	2	30
10	3	30
7,5	4	30
6	5	30
5	6	30

Table B.2

t_t = 6s		t_t = 8s		t_t = 10s		t_t = 12s		t_t = 14s		t_t = 16s		t_t = 18s		t_t = 20s	
t_c[s]	n	t_c[s]	n	t_c[s]	n	t_c[s]	n	t_c[s]	n	t_c[s]	n	t_c[s]	n	t_c[s]	n
12	2	16	2	20	2	24	2	28	2	32	2	36	2	40	2
18	3	24	3	30	3	36	3	42	3	48	3	54	3	60	3
24	4	32	4	40	4	48	4	56	4		4		4		4
30	5	40	5	50	5	60	5		5		5		5		5
36	6	48	6	60	6		6		6		6		6		6
48	8		8		8		8		8		8		8		8
60	10		10		10		10		10		10		10		10

B.2 System roll-out

In order to establish new systems adaptively on a channel the following features are provided for:

- the maximum number n of systems to be allocated on the channel is included in the SIC;
- an area code is included in the SIC;
- every system transmits its SIC at least once within a given period of time (e.g. 5 minutes);
- the base station receiver is equipped with a Received Signal Strength Indication (RSSI) facility to measure the field strength of adjacent and far away systems.

If these features are implemented, systems are only linked to the channel when:

- the programmed area code matches that of the systems operating on the channel;
- "channel occupancy not completed" is detected;
- a minimum field strength of far away systems is not exceeded; and
- the ordinal number of already transmitting systems is smaller than the maximum number n.

The maximum number n of systems to be allocated on the channel is programmed in the base station according to the provisions given for a specific channel. Before using the channel for the first time the new system searches for far away systems by detecting the SICs transmitted within a specific period of time (e.g. five minutes). If the field strength of a far-away system, which is characterized by a different area code, supersedes a certain threshold, the channel is not accessed. In this case two areas are overlapping at this site and therefore a different frequency has to be chosen.

B.3 Timing diagram

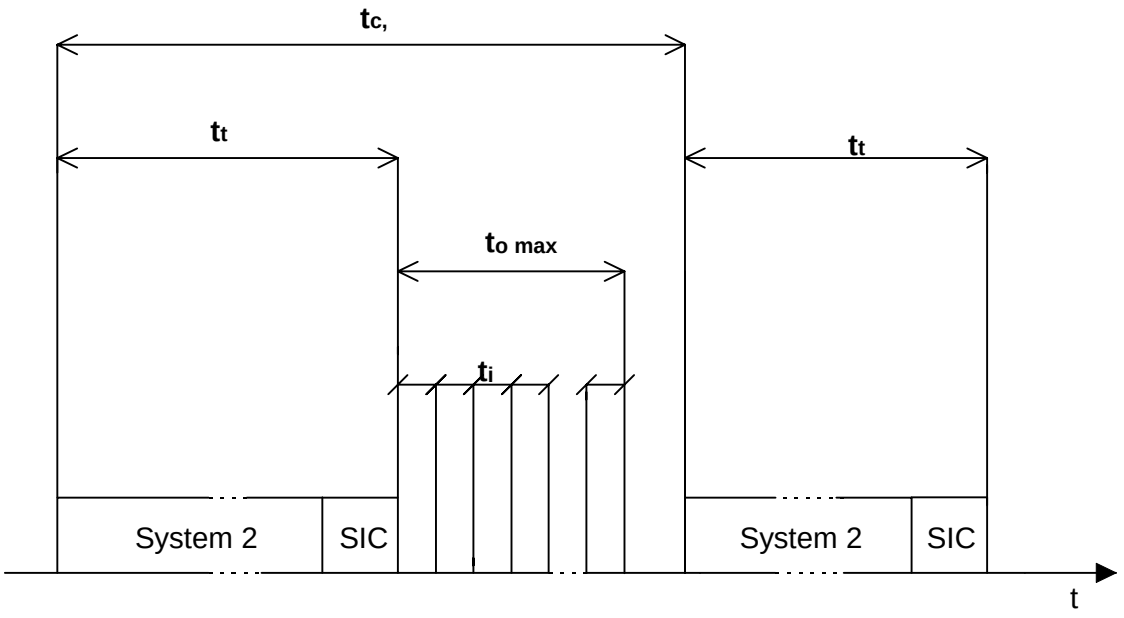


Figure B.1

Annex C (informative): Bibliography

- CEPT Recommendation T/R 20-05: "Low power personal paging systems".
- ESPA publication 4.2.7: "Proposal for a standard for Private Extended Range paging".

History

Document history			
August 1996	Public Enquiry	PE 112:	1996-08-19 to 1996-12-13
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