Główny Urząd Miar

Distribution of official time on long waves, using. the 225 kHz carrier wave of the First Polish Radio Program

frame structure, transmitted data, and its purpose

v. 1.0

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1. Diagram of the system:

The system's transmission is organized in time slots of 3 seconds. Messages are sent at a bit rate of 50 bps. In each time slot, the transmission starts at the beginning of the second. After transmitting each command, the system turns off the carrier phase modulation for the next full second. The traffic generated by the Radio Broadcasting Center (RCN) takes place in 20 time slots (from 0 to 19). They constitute a frame transported for 1 minute (minute frame).

Slot number	Elapsed time since the beginning of the broadcast [s]	Destiny
0	0	Time Message 0
1	3	Message 1
2	6	Message 2
3	9	Message 3
⋮	⋮	⋮
18	54	Message 18
19	57	Message 19

Fig. 1 Minute frame of the system.

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2. Structure of the official time frame:

A time frame consists of 12 bytes, i.e., 96 bits sent at a bit rate of 50 bits/s. This means that it takes 1.92 seconds to send a full-time frame.

1.92 sec

BYTE NO.		
1	16 b →	SYNCHRONIZATION STRING
2		
3	8 b →	TIMEFRAME START MARKER
4	3 b →	TIME OF ENTRY TO RECEIVER
5	30 b →	OFFICIAL TIME
6		
7		
8	2 b →	LOCAL TIME
	1 b →	LEAP SECOND PREVIEW
	1 b →	LEAP SECOND SIGN
	1 b →	CHANGING LOCAL TIME
	2 b →	LONG-WAVE TRANSMITTER STATUS
9	24 b →	REED-SOLOMON CORRECTION CODES
10		
11		
12	8 b →	CRC-8 CHECKSUM

Fig. 2 Block structure of a time message.

In addition, **2 B** (0x680C – 0b0110 0b1000 0b0000 0b1100) are transmitted before each frame, which is the start sequence. They are not part of the time message.

The following is the bitwise frame format:

0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
0	1	1	0	0	0	0	0	1	0	1	S0	S1	S2	S3	S4
S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20
S21	S22	S23	S24	S25	S26	S27	S28	S29	TZ0	TZ1	LS	LSS	TZC	SK0	SK1
Reed-Solomon ECC byte 0								Reed-Solomon ECC byte 1							
Reed-Solomon ECC byte 2								CRC-8							

Fig. 3 Bit structure of a time message.

Purpose of individual bits:

- 0x55H - constant synchronization pattern;
- 0x60H - a permanent template signaling the beginning of the official time frame distributed as part of "e-CzasPL";
- 0x5H (0b101) - bits specifying the moment of entering the sent time into the receiver registers – delayed by 0.5 s (25b × 0.02 s = 0.50 s) about the moment of starting to transmit the frame;
- S0 ÷ S29 - bits indicating the number of three-second periods counted from 1 January 2000 (3 × (S0 ÷ S29) = number of seconds counted from 1 January 2000;
- TZ0 ÷ TZ1 - bits specifying the local time; to calculate the local time, add to the time received from the time frame the appropriate offset determined by bits TZ0 and TZ1 (according to the table below);

TZ0	TZ1	Local Time
0	0	0
1	0	+1 hour
0	1	+2 hours
1	1	+3 hours

- LS - bit indicating that a leap second announcement/no announcement is being broadcast:
  0 – no leap second announcement,
  1 – announcement of the introduction of a leap second;
  A leap second can be introduced at the beginning of the quarter:
  Variant I – 1 January or 1 July,
  Variant II – 1 April or 1 October

at 0:00 UTC; the leap second announcement should be broadcast in the period from a few days to a maximum of 1 week before the planned moment of introduction of the leap second;

- LSS - the bit specifying the leap second sign:
  0 – adding a second,
  1 – subtract a second;
- TZC - a bit informing that following Sunday at 1:00 UTC, there will be a change of local time to summer or winter/ordinary time. By default, daylight saving time changes occur on the last Sunday in March (Daylight Saving Time) and the last Sunday in October (Daylight Saving Time/Daylight Saving Time); the announcement of the upcoming time change should be broadcast up to a few days in advance (up to a maximum of 6 days) before the planned local time change;
- SK0 ÷ SK1 - bits determining the state of the transmitter in Solec Kujawski according to the table below:

SK0	SK1	Condition of the transmitter PCSK-225 in Solec Kujawski
0	0	Normal Operation
1	0	Planned shutdown for one day
0	1	Planned shutdown for a week
1	1	Planned shutdown for more than a week

At the end of the time frame, **3** Reed-Solomon correction bytes are sent to allow correction of up to **24** bits of the frame. Bits to be corrected

3. Reed-Solomon Correction Coding:

The implemented Reed-Solomon algorithm can cover **36** bits. The correction covers bits S0 ÷ SK0 (marked in green in Fig. 1).

NOTE

The last bit of the SK1 usage data is not corrected (see Fig. 1).

NOTE

*The correction block consists of **24** redundant bits (bytes 9 ÷ 11).*

4. Checksum and scrambling:

The last free byte is assigned to the CRC-8 checksum.

NOTE

In the previous version of the time frame, 4 bytes of the R-S correction algorithm were predicted. (change after 04.09).

NOTE

The checksum is calculated from whole bytes 4 ÷ 8 (bits 25 ÷ 64) ***After scrambling****, in the scramble process, the data is XOR with the string 0x0A47554D2B, which in the ASCII code corresponds to \NGUM+. Descrambling is accomplished by repeating this operation.*