Recommendation T/CS 20-15 (Innsbruck 1981)

TONES AND ANNOUNCEMENTS

Recommendation proposed by Working Group T/WG 11 "Switching and Signalling" (CS)

Text of the Recommendation adopted by the "Telecommunications" Commission:

"The European Conference of Postal and Telecommunications Administrations,

considering

— that in accordance with the principles outlined in Recommendation T/CS 20-01 [1], the exchange and network features which are required for the implementation of services and facilities should be identified and specified;

— that tones and verbal announcements are generally used to inform the customer of the progress of calls and are also suitable for the use and control of several new services and facilities,

recommends

to the members of the CEPT to recognise and introduce the feature *tones* and the feature *announcements* as described and specified below."

1. GENERAL

Tones and announcements each belong to a special group of sound waves. Each tone and announcement transmitted from the network to the user is an *audible indication* of the network to the user.

An audible indication is understood to be a sound wave within the frequency range of 300-3,400 Hz, which is transmitted to inform the user, e.g. about the state of a telephone call or a supplementary service.

The basic characteristics of an audible indication are the cadence, the frequency and the level. A mathematical presentation of tones and announcements is given in Annex 1 to this Recommendation.

This Recommendation is compatible with the recommended multifrequency push-button signalling systems [2].

2. TONES FEATURE

2.1. Definition

The *tones* feature is defined as the ability of the network to send audible indications in the form of tones to the user.

A tone is an audible indication comprising one or more discrete frequencies but excluding speech.

2.2. Description

2.2.1. *In relation to cadence*

A *continuous tone* is a tone without cadence.

An *interrupted tone* is a tone with cadence (*Note 1*).

A *tone burst* is a relatively short tone which occurs only once.

2.2.2. *In relation to frequency*

A *pure tone* is a tone having only one nominal frequency.

A *composed tone* is a tone made up of more than one nominal frequency present at the same time.

A *multiple tone* is a tone made up of more than one nominal frequency so that no more than one nominal frequency occurs at the same time.

Note: Frequencies above 2,700 Hz should be avoided for tones.

2.2.3. *In relation to level*

A *multi-volume tone* is a tone having a changing level of volume.

A discrimination of tones based on a change of level of volume should be avoided.

Note: The studies on this series (T/CS 20) of Recommendations for the features in an analogue environment has now been terminated. A continuation of the studies has started with the aim to amend these existing features, where necessary, and to specify new features for the ISDN. These Recommendations will be gathered in a new series of Recommendations.

Note 1: In CCITT, the term *intermittent tone* is used.

2.2.4. *Tone diagrams*

Diagrammatically tones may be shown as in Figure 1 (T/CS 20-15).

2.2.5. *Tone source*

A *tone source* is a device producing one tone.

A generator producing a number of tones simultaneously is considered to be composed of the same number of independent tone sources.

2.3. Technical characteristics

The technical characteristics of tones are related to the electric phenomenon sent by the exchange to the user, and which, after transduction, becomes a tone.

All measurements are made on the main distribution frame at the outgoing end of the exchange balanced by the required impedance standard.

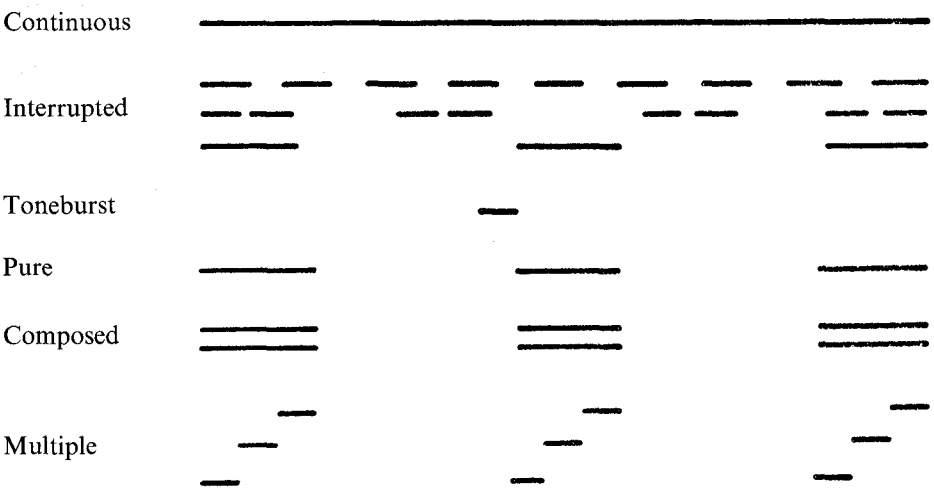


Figure 1 (T/CS 20-15). Tone diagrams.

2.3.1. *Cadence*

Cadence is defined as a particular combination of tone pulse and pause times repeated in a cyclic manner. The pulse and pause times of a number of tones are harmonised at a single value as shown in the list of parameters below. The actual values should be kept within the tolerance limits of $\pm 10\%$ of the nominal values.

2.3.2. *Frequency*

The frequency of tones is expressed in Hertz (Hz). The frequency of a number of tones is harmonized at a single nominal value as shown in the list of parameters below. The actual value of the frequency should in all circumstances be kept within the tolerance limits as mentioned in the list of parameters.

2.3.3. *Level*

The nominal level of the tone is expressed in dBm. The nominal level of a tone sent towards users should be adjustable to suit the subscriber's line loss and the telephone characteristics of individual Administrations. The range of adjustment should be as shown in the list of parameters below.

The level of a tone sent towards the trunk network should comply with current CCITT Recommendations [3].

Differences in the level of successive tones or tone components (and announcements) applied by the same exchange must not exceed 3dB after psophometric correction, not including silence or multi-volume tones. For exceptional reasons, it may be possible to introduce psophometric corrections that exceed this value.

The application and removal of tones must not produce disturbing clicks.

2.3.4. *Purity*

All tones are defined as the sum of sinusoidal signals. Other sound waves may accompany the tone. The signal to noise ratio shall not be less than 30dB, and the collective power of the other sound waves must not exceed 46 dBm (except for dial tone when MFPB is applied where the signal to noise ratio should not be less than 40dB).

2.3.5. *Distortion*

The permitted level of harmonic distortion is included in the requirement concerning the collective power of other sound waves as given in § 2.3.4.

2.3.6. *Crosstalk*

The crosstalk attenuation between two circuits using common parts of the tone source shall be $\geqslant$ 50dB, in all circumstances, for frequencies in the 300-3,400 Hz band.

2.3.7. *List of parameters*

The following values are to be considered as nominal values in the long term. However, in the interim period, other values and characteristics may apply, but the long-term objective should be based on the values stated in Table 1 (T/CS 20-15). For levels, a nominal value should be chosen in the range shown below. The tolerance on the nominal level is $\pm$ 3dB.

2.4. **Utilisation**

Possible uses of tones are listed below.

2.4.1. *Call-related use of tones*

2.4.1.1. Connection set-up

To advise the user:
— to start dialling;
— of the expiry of the maximum period for sending the next digit if the exchange recognises that insufficient digits have been received;
— to wait for called party answer;
— that the called party cannot be reached;
— that the called party is engaged.

Tone	Frequency (Hz)	Level (range) (dBm)	Pulse (ms)	Pause (ms)	Remarks
Dial tone	425 $\pm$ 15	-12 -8			Continuous pure tone
Ringing tone	425 $\pm$ 15	-12 -8	1,000	4,000	
Busy tone	425 $\pm$ 15	-12 -8	500	500	$0.9 < p/p < 1.1$
Congestion tone	425 $\pm$ 15	-12 -8	200	200	$0.9 < p/p < 1.1$
Special information tone	950 $\pm$ 50 1,400 $\pm$ 50 1,800 $\pm$ 50	-20 -16 -20 -16 -20 -16	330 330 330	1,000 1,000 1,000	3 successive tone pulses, one frequency after the other, in each period of 2 seconds
Call waiting tone					
Intrusion tone					
Warning tone	1,400 $\pm$ 50	-20 -16	400	15,000	

Table 1 (T/CS 20-15).

Legend: p/p = pulse to pause duration ratio.

Note: The level values have been determined for analogue environments. Their suitability for digital exchanges needs further study.

2.4.1.2. During the conversation

To advise the user that:
— the privacy of the conversation is not guaranteed;
— the connection has been disconnected.

2.4.2. *Supplementary service-related use of the tones*

2.4.2.1. Control of the service

To advise the user:
— to continue dialling;
— that his command has been accepted;
— that his command has been rejected.

2.4.2.2. During the use of a service

— to provide the appropriate tone, e.g. call waiting tone.

Note: Names and meanings of tones are detailed in Recommendation T/CS 28-02 [4]. Operational aspects of the utilisation of tones are dealt with in CCITT Recommendations E.181/Q.36 and E.182 [5] and in Recommendation T/SF 14 [6].

3. ANNOUNCEMENTS FEATURE

3.1. Definition

Announcements are defined as the ability fo the network to send the user an audible indication in the form of a recorded announcement.

A recorded announcement is an audible indication in the form of speech.

3.2. Description

An announcer is a device which delivers one recorded announcement at a time. An announcing device delivering a number of recorded announcements simultaneously is considered to be composed of the same number of independent announcers.

3.3. Technical characteristics

The quality of recorded announcements is defined by a number of parameters which can be divided into two groups. The first group can be measured with instruments; examples of these items are: the level, the frequency content, the signal/noise ratio. The second group can be qualified by means of subjective listening tests, panel scores, etc. Examples of these items are: intelligibility, recognisability, naturalness and intonation.

Note: Care should be taken when connecting an MFPB receiver to a subscriber's line to which an announcement is being sent.

3.3.1. *Technical measurements*

All measurements are made on the main distribution frame at the outgoing end of the exchange, balanced by the required impedance standards.

3.3.1.1. Level

The nominal level of the recorded announcement is expressed in dBm. The nominal level of a recorded announcement should be adjustable to suit the subscriber's line loss and telephone characteristics of individual Administrations.

The level of the recorded announcement is measured by a speech peak level meter having an upward integration time (= 0.7 full scale) of 2 ms and a downward integration time of 6 dB/s with $R_i \geqslant 20$ kOhm.

Variations in the nominal level of the recorded announcements as a result of fluctuations in temperature, variations in power supply, drift, load fluctuations or production tolerances, must not exceed ± 2 dB.

Differences in level of successive recorded announcements must not exceed 3 dB. The application and removal of recorded announcements must not produce disturbing clicks.

3.3.1.2. Frequency

The frequency characteristic of recorded announcements has the following correction:

1,000 Hz	no correction
1,000-3,000 Hz	+6 dB/octave
3,000 Hz	no correction

3.3.1.3. Signal/noise ratio

The signal/noise ratio in recorded announcements delivered by an analogue announcer should be $\geqslant 35$ dB.

The noise in recorded announcements delivered by an announcer storing digitally encoded announcements in its memory, is quantisation noise whose frequency spectrum is related to the coding/decoding technique applied.

The signal/noise ratio should be $\geqslant 24$ dB (provisional).

3.3.2. *Subjective measurements*

3.3.2.1. Intelligibility

This should be measured by means of a subjective listening test, whereby the value of the articulation index (AI) is $\geqslant 0.7$ (see CCIR report 526 [7]). AI = 0.7 corresponds more or less to a 90% score in tests using monosyllabic phonetically balanced words.

3.3.2.2. Subjective quality

Subjects are asked to listen to five recorded announcements after which they have to express their opinion on the basis of a five-point scale:

1. excellent;
2. good;
3. fair;
4. poor;
5. bad.

The results should be fair, good or excellent in 90% of the cases.

3.4. **Utilisation**

Using announcements, a large amount of different information can be offered to the telephone service users. The provision of announcements may involve more complexity and cost than tones.

Note: See Annex 2 to this Recommendation for an example of a control interface between exchange and announcing device.

Possible uses of the announcement feature are listed in the following.

3.4.1. *Call-related use*

3.4.1.1. Connection set-up

To advise the user:
— of a special condition on calling line;
— of a special condition on called line;
— that invalid information has been received;
— that the system is faulty;
— that there is a queue.

3.4.1.2. During the conversation

To advise the user:
— of an intrusion;
— that the conversation is being recorded.

3.4.2. *Supplementary service related use*

3.4.2.1. Control of a service

To advise the user:
— to continue dialling;
— that confirmation or rejection is required;
— that more specific information is required;
— of a fault condition or lack of capacity.

3.4.2.2. During the use of a service

— to provide the selected recorded announcement to the calling party;
— to provide the selected recorded announcement to the called party.

General designations of verbal announcements are detailed in Recommendation T/CS 28-02 [4].

Operational aspects of the utilisation of verbal announcements are dealt with in CCITT Recommendations E.181/Q.36 and E.182 [5] and in Recommendation T/SF 14 [6].

References

[1] Recommendation T/CS 20-01. *Exchange and network features.*

[2] Recommendation T/CS 46-02. *Multifrequency signalling for push-button telephones.*
Recommendation T/CS 46-03. *Signalling system for push-button telephones combining multifrequency signals with direct current signalling.*

[3] CCITT Recommendation E.180/Q.35. *Characteristics of the dial tone, ringing tone, busy tone, special information tone and warning tone.*

[4] Recommendation T/CS 28-02. *Names and meanings of tones and general designations of verbal announcements.*

[5] CCITT Recommendation E.181/Q.36. *Customer recognition of foreign tones.*
CCITT Recommendation E.182. *Application of tones and recorded announcements in telephone services.*

[6] Recommendation T/SF 14. *Application of tones and speaking announcements in telephone services.*

[7] CCIR Report 526.

ANNEX 1

Mathematical presentation of tones and announcements

1. **GENERAL**

An audible indication may be considered to consist of m sinusoidal sound waves with frequencies f_0, $f_1, \cdots\cdots f_{m-1}$ and respective amplitudes A_0, $A_1, \cdots\cdots A_{m-1}$. The sinusoidal sound wave with frequency f_k is called *frequency component k*.

For tones, m will be a small number (e.g. 1, 2 or 3) and the amplitudes A_k ($k = 0, 1, \cdots\cdots m-1$) are considered to be constant in time.

In order to be able to describe the rhythmical pattern of a tone, a *cadence function* $C_k(t)$ is attributed to each frequency component k, which describes at which intervals of time (tone pulses) the corresponding sound wave is present and where these intervals are located in time.

For interrupted and multiple tones, the cadence function is periodical with a period τ_c which is defined so that it is equal for all frequency components.

Per period, the frequency components may be present in different numbers of tone pulses with different time positions (this is particularly the case for multiple tones). The tone pulses in which frequency component k is present are numbered $0, 1, \cdots\cdots p_k-1$ from the beginning of each period.

The tone pulse i of frequency component k starts after a time t_{ki} has elapsed from the beginning of each period and has a duration time of τ_{ki} (see examples of key diagrams in Section 4).

Where the first period is considered to start at $t = 0$, the presence of tone pulse i of frequency component k in all periods may be described as a *pulse presence function* $E_{ki}(t)$ by using forms of the step function $\varepsilon(t)$ as follows:

$$E_{ki}(t) = \sum_{n=0}^{l-1} \{\varepsilon(t-(t_{ki}+n\tau_c)) - \varepsilon(t_{ki}+\tau_{ki}+n\tau_c)\}$$

Note: The number l of periods depends on the application time of the tone. For a tone source, l may be considered to be infinite.

Now the cadence function of frequency component k will be the sum of the pulse presence functions for all tone pulses in which this frequency component is present:

$$C_k(t) = \sum_{i=0}^{p_k-1} E_{ki}(t)$$

For a composed tone, all frequency components will have the same cadence function.

A multi-volume tone may be described so that, in the tone pulses with different level, different frequency components are present with the same frequency value but with different amplitudes.

A review of formulae for different tones is given in Section 2.

It is theoretically possible to describe the sound wave of an announcement in the same way. However, the number of frequency components and the number of pulses per period will then be very large. It is, therefore, thought to be inappropriate to give a mathematical presentation of announcements.

2. **LIST OF FORMULAE**

2.1. Audible indication:
$$S(t) = \sum_{k=0}^{m-1} C_k(t) \cdot A_k \cdot \sin(2\pi f_k t)$$

2.2. Continuous tone:
$$C_k(t) = 1$$

2.3. Interrupted tone:
$$C_k(t) = \sum_{i=0}^{p_k-1} E_{ki}(t)$$

$$E_{ki}(t) = \sum_{n=0}^{l-1} \{\varepsilon(t-(t-(t_{ki}+n\tau_c)) - \varepsilon(t_{ki} + \tau_{ki} + n\tau_c))\}$$

$E_{ki}(t)$ describes the presence of frequency component k in each cadence period

2.4. Tone burst:
$$C_k(t) = \sum_{i=0}^{p_k-1} E_{ki}(t)$$

$$E_{ki}(t) = \varepsilon(t-t_{ki}) - \varepsilon(t-(t_{ki} + \tau_{ki}))$$

2.5. Pure tone:
$$S(t) = C_0(t) \cdot A_0 \cdot \sin(2\pi f_0 t)$$

2.6. Composed tone: $C_k(t) = C_{k+1}(t)$ for $k = 0, 1, - - - - - - - - - -, m-2$

2.7. Multiple tone: if $C_k(t) = 1$ then $C_{k'}(t) = 0$ for $k \neq k'$; $k = 0, 1, - - -, m-1$
$k' = 0, 1, - - -, m-1$

2.8. Silence: $A_k = 0$ for $k = 0, - - - - - - - - -, m-1$

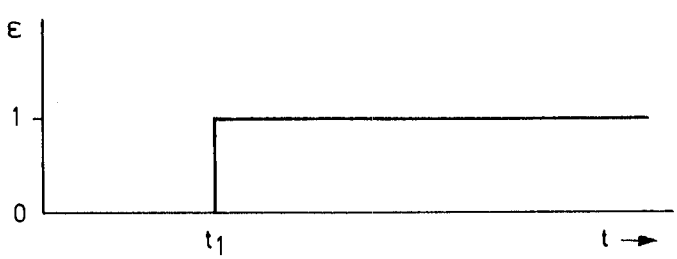
2.9. Announcement: $C_k(t)$ is difficult to describe and m is relatively large.

A review of the elements used is given in Section 3.

3. LIST OF ELEMENTS

A_k: the level of the frequency component k;
$C_k(t)$: the cadence function of the frequency component k;
$E_{ki}(t)$: the periodical block function describing the presence of the i-th pulse of frequency component k in each period;
S(t): the sound wave;
$\varepsilon(t)$: the step function;
f_k: the frequency of component k;
k: a current parameter indicating the frequency component;
l: the number of periods applied;
m: the number of frequency components;
n: a current parameter;
p_k: the number of pulses of frequency component k in one period;
t: the time;
t_{oo}: the starting moment of the first pulse of the first frequency component of a period;
t_{ki}: the starting moment of the pulse i of the frequency component k of a period;
τ_c: the duration time of a period;
τ_{ki}: the duration time of the pulse i of the frequency component k of a period.

Step function: $\varepsilon(t - t_1) = 0$ for $t < t_1$
$= 1$ for $t > t_1$



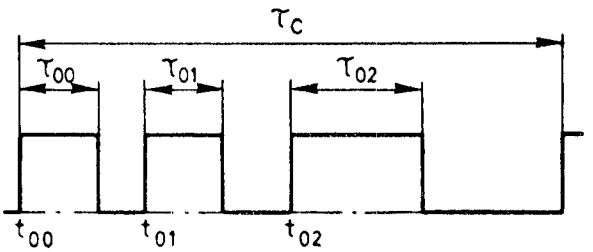
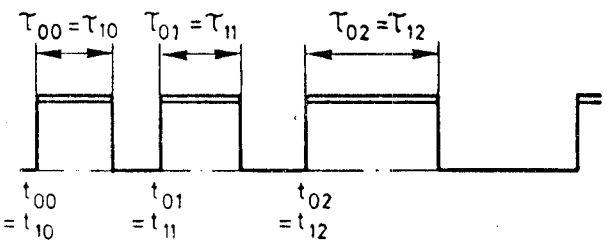
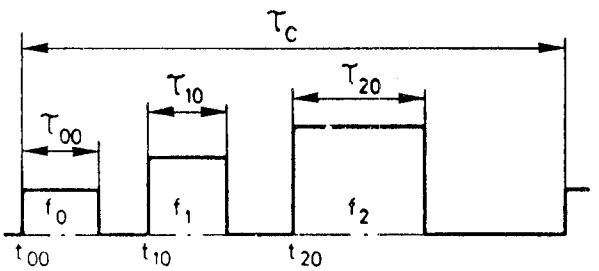
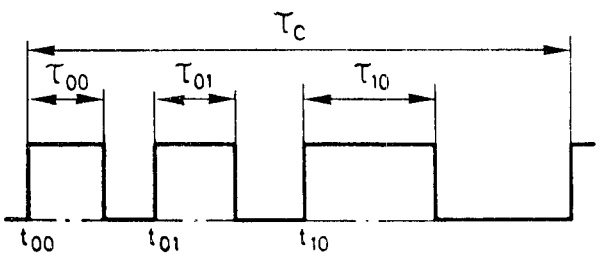
4. KEY DIAGRAM

By means of a *key diagram*, the cadence pattern of a tone may be visualised. A continuous pure tone is shown by means of a straight horizontal line, a continuous composed tone by means of as many closely-spaced parallel horizontal lines as there are frequency components in the tone.

Interrupted and multiple tones are shown by means of a block diagram which is *high* when there is any frequency component present and *low* when there is no frequency component present. For these tones, one period is sufficient for the key diagram. For a composed tone, the high parts of the diagram are marked by as many closely-spaced parallel lines as there are frequency components in those parts. For a multiple tone, the blocks containing different frequency components may be drawn with different heights, and it should be indicated which frequency component is found in which block.

A multi-volume tone may be shown by means of a block diagram in which the high parts of the blocks with different volume are drawn by means of lines with different thickness.

Examples

Tone type:	*Key diagram:*
Continuous pure	
Continuous composed with two frequency components	
Interrupted pure	
Interrupted composed with two frequency components	
Multiple with three frequency components	
Multi-volume with two amplitudes	

Note: The time parameters shown in these examples have only been added for clarification of the mathematical presentation (see Section 1). They may normally be omitted in key diagrams.

ANNEX 2

Control interface between exchange and announcing device (Example)

1. **GENERAL**

The following description concerns an announcing device delivering more than one specific recorded announcement at the same time. All other types of announcing devices can be derived from this interface definition. The communication between exchange and announcing device is achieved by means of *messages* in both directions. Each message is sent as a continuous data stream at maximum speed. Between two successive messages there may be an absence of data.

2. **MESSAGES FROM EXCHANGE TO ANNOUNCING DEVICE**

2.1. **Message syntax**

```
<message>        ::= <head> <block> <tail>
<head>           ::= <DLE> <STX>
<block>          ::= <Type 1> <piece of info>/
                     /<Type 2> <loading>/
                     /<Type 3> <rest>
<piece of info>  ::= <identity> <parameter> <mask> <variables>
<identity>       ::= <word>
<parameters>     ::= <repetition> <line>
<repetition>     ::= <byte>
<mask>           ::= <word>
<variables>      ::= <  >/<variable>/<variable> <variables>
<variable>       ::= <single>/<length> <byte> <words>
<words>          ::= <word>/<word> <words>
<loading>        ::= <kind> <words>
<kind>           ::= <word>
<test>           ::= <code> <mask> <variables>
<code>           ::= <word>
<tail>           ::= <DLE> <ETB> <sum>
<sum>            ::= <byte> <byte>
```

2.2. **Definition of the primitives** (hexadecimal numbers)

```
<DLE>      ::= 10
<STX>      ::= 02
<Type 1>   ::= 01
<Type 2>   ::= 02
<Type 3>   ::= 03
<ETB>      ::= 97
<single>   ::= 1010/ 11/- - - - - -/11F
<word>     ::= 00  /- - - -/OF/1010/11/- - -/FE
<byte>     ::= 0   /- - - - - -/F
<line>     ::= 1   /- - - - - -/F
<length>   ::= 2   /- - - - - -/F
```

2.3. **Semantics**

The <head> defined as <DLE> <STX> is a particular combination of ASCII control characters for communication control indicating *start of text*. For the <tail>, defined as <DLE> <ETS> <sum>, the particular combination <DLE> <ETS>, also ASCII control characters for communication control, indicates *end of block*.

A message of <Type 1> is a command to emit the recorded announcement, defined by the <identity> and <variables> on a certain exit of the announcer <line> as often as defined by <repetition>.

The <mask> indicates which variables are present in the message. The <length> of a <variable> is equal to the number of <words> + 1 of this variable.

A message of <Type 2> is a command to load data in the memory of the announcer. The method of loading and the structure of the <words> of this message are defined by <kind>.
A message of <Type 3> is a command to initiate the announcer or has the purpose of testing the announcer itself.
The <code> indicates which program has to run.

3. MESSAGES FROM THE ANNOUNCING DEVICE TO THE EXCHANGE

3.1. Message syntax

<message> :: = <head> <block> <tail>
<head> :: = <DLE> <STX>
<block> :: = <Type 1> <line status> /
/ <Type 2> <load status> /
/ <Type 3> <test status>
<line status> :: = <word>
<load status> :: = <word>
<test status> :: = <mask> <variables>
<mask> :: = <word>
<variables> :: = < > / <variable> / <variable> <variables>
<variable> :: = <single> / <length> <byte> <words>
<words> :: = <word> / <word> <words>
<tail> :: = <DLE> <ETB> <sum>
<sum> :: = <byte> <byte>

3.2. Definition of primitives (hexadecimal numbers)

<DLE> ::= 10
<STX> ::= 02
<Type 1> ::= 01
<Type 2> ::= 02
<Type 3> ::= 03
<ETS> ::= 97
<single> ::= 1010/11/- - - - - -/1F
<word> ::= 00 /- - - -/OF 1010/11/- - -/EF
<byte> ::= 0 /- - - -/F
<length> ::= 2 /- - - -/F

3.3. Semantics

A message of <Type 1> is a reaction to a command of <Type 1> from the exchange to the announcer.
A message of <Type 2> is a reaction to a command of <Type 2> from the exchange.
A message of <Type 3> is a reaction to a command of <Type 3> from the exchange.
The <variables> contain the possible response to the exchange.

3.4. Variables

A variable of message of Type 1 from the exchange to the announcer can have different meanings:
1. a normally (as used in the common parlance) pronounced number;
2. a queue of separate digits;
3. a normally pronounced announcement containing the date (the month and the day of the month);
4. a normally pronounced announcement containing the time (the hour and minute);
5. a binary number (for instance, Boolean condition).