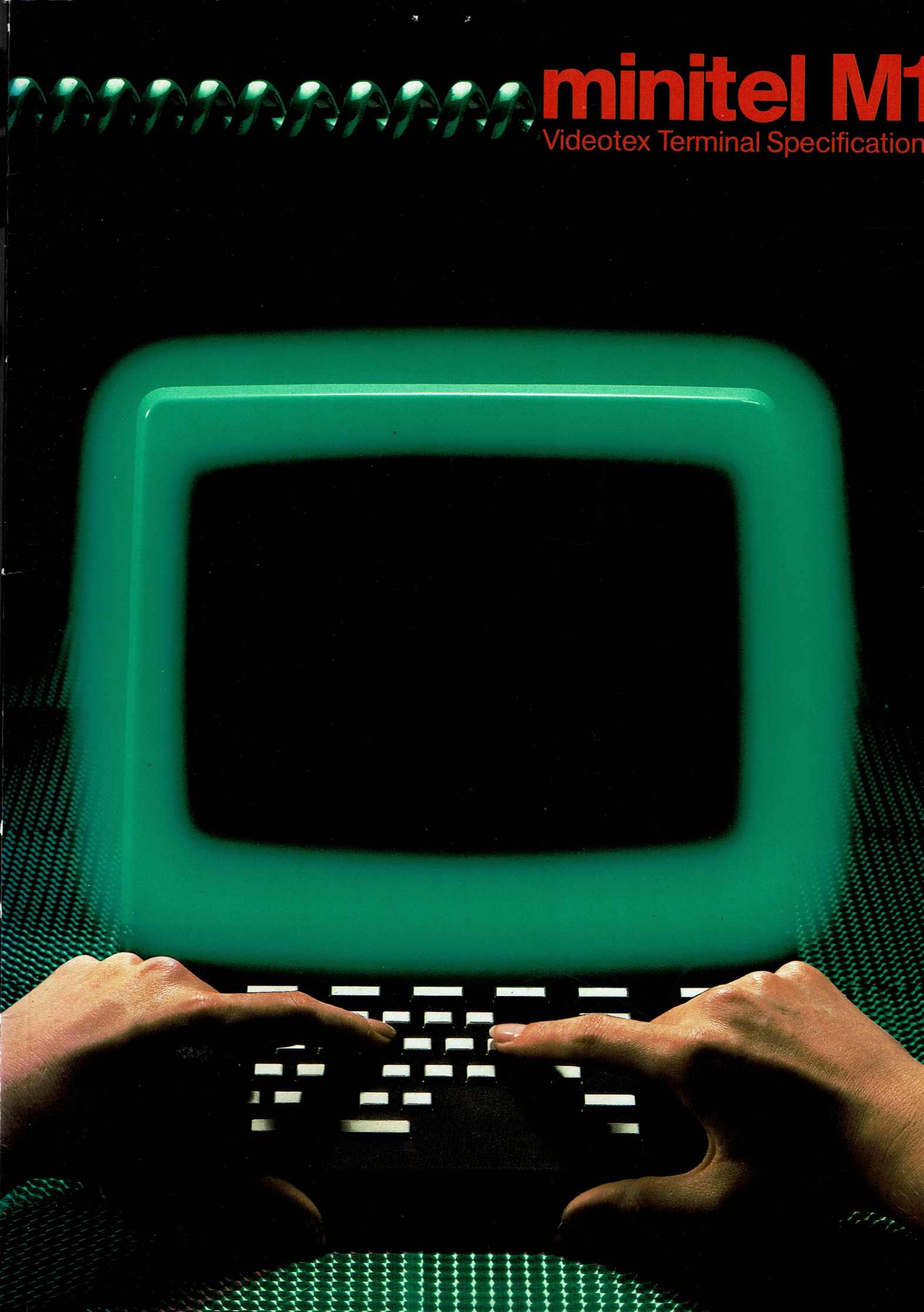
minitel M1

Videotex Terminal Specification



TELECOMMUNICATIONS PTT

Technical specifications of the MINITEL M1 terminal

ALCATEL B.S

M DAIAN J.Bernard

DEPARTEMENT VIDEOTEX

Temporary edition – December 1984

This Edition of the MINITEL M1 specifications is based on the document "STUM" issued by the French Telecommunication Administration (PTT/DGT/DAII) describing the MINITEL M1 ordered by the French PTT for the extension of the Electronic Telephone Directory in France and the development of the French Videotex infrastructure.

Remarks and questions concerning this international version of the document should be forwarded to:

Intelmatique FRANCE
98, rue de Sèvres 75007 PARIS, Tel.: 33 (1) 306.16.36
Telex: 203185 TELEMAT. F. – Fax: 306.13.24 (Groupe 2)

1 General features

Minitel is a compact and stand alone data processing terminal which allows the display of videotex coded information.

Designed for large scale diffusion amongst business and residential users Minitel corresponds to technological and ergonomic requirements which make it a fully userfriendly terminal.

The user's installation consists of a conventional telephone plug and the Minitel (M1) which comprises a black and white CRT, an alphanumerical keyboard, a modem, a power supply, and connectors for various peripheral equipments.

There are two user modes:

- the local mode where Minitel can be used as a "screen console" for computer applications.
- the connected mode allowing remote processing at any telephone equiped site with any data base.

Owing to a small CRT, dimensions are considerably reduced. It is possible to design even portable Minitels and some are already available.

Once installed, simple maintenance can take place in situ. Life expectancy of all the components when used in normal conditions and correctly installed is beyond 10 years.

Optimal terminal functioning conditions are between +5 °C and 40 °C; when operating between – 5 °C and 45 °C, certain malfunctioning may occur but without any damage to the hardware parts.

2 Connection

2.1 Power connection

Minitel is connected in France to the electrical power mains (EDF) using a standard plug without earth connection and a 3 meter cord.

The applied voltage is 220 V ± 10% AC, 50 ± 1 Hz in 5 °C to 40 °C operating conditions. Power consumption does not exceed 35 W and a fuse (inaccessible to the user) protects the terminal.

The user does not perceive power disturbances if they do not exceed 100 ms at a rate of 1 second per cut-off.

The export versions of Minitel comply with existing local electrical standards.

2.2 Telephone line connection

Minitel is directly connected to the telephone line (main line or secondary line) by means of a PTT jack reference 721190N and the appropriate 3 meter cord.

The associated telephone SET is connected to the Minitel by a plug which ensures normal traffic of incoming or outgoing calls with the network, (when the Minitel is off or off-line).

The export versions of the Minitel also comply with every existing telephone standard.

2.3 Minitel peripheral equipments

A 5 pin DIN socket allows connection of Peripheral equipment to Minitel.

3 Environment and security requirements

3.1 Radio-electrical interferences

Minitel conforms to the CNET* specifications relating to terminal interference emissions and terminal susceptibility to external source interference.

*CNET: Centre National d'Etudes des Télécommunications
38-40 avenue du Général Leclerc - 92131 ISSY-LES-MOULINEAUX - Tel.: 33 (1) 638.44.44

3.2 Security requirements

Minitel conforms to the user protection standard NF C 92-130. User intervention (besides typing, luminosity controlling and on/off switching) is unnecessary for normal functioning.

The terminal is entirely protected against accidental introduction of metallic objects such as pins, needles, etc.

Fan-cooling is not provided and if operating at 20 °C ambient temperature the terminal temperature never exceeds 40 °C. Minitel design allows rapid interchanging of damaged cords (mains or telephone).

The electrical and telephone cords can easily be replaced.

The export models of Minitel are designed to meet local safety requirements.

4 The different versions of the Minitel

Minitel is available in several versions.

Minitel M1 is the basic version with a 9" black and white screen and no internal telephone dialer. Minitel 10 comprises a fully integrated electronic telephone capable of memorizing a private phone directory of 20 numbers. Other versions include simple internal telephone dialer or provide a full colour screen. Multi-mode terminals are also available, supporting Prestel, 80 rows ASCII modes, arabic or greek alphabets.

The version of the Minitel is programmed in the identification field of the ROM memory.

The field contains 3 Bytes (see at 8.2.9) corresponding to:

- the Minitel constructor,
- the Minitel version,
- the software version.

The existing versions are as follows:

– French versions:

- **Cb:** Minitel Telic M1 with ABCD keyboard,
- **Cc:** Minitel Telic M1 with AZERTY keyboard,
- **Cr :** Minitel Telic-Matra M1 with invertible modem,
- **Bc:** Minitel Radiotechnique M1,
- **Br :** Minitel Radiotechnique M1 with invertible modem.

– Export versions:

Contact the different Minitel manufacturers

– La Radiotechnique - TRT -
51, rue Carnot
92156 Suresnes - France
Tel.: 33 (1) 772.51.00

– Matra
5-7, Avenue Albert-Einstein
ZI
78190 Trappes - France
Tel.: 33 (3) 062.60.24

– Telic-Alcatel
4, rue de Chevilly
B.P. 31
94267 Fresnes - France
Tel.: 33 (1) 666.21.19

1 Basic operation

Basic operation of the Minitel consists in: powering-up to the local mode; on-line connection to the connected mode; off-line disconnection to the local mode; switching-off.
A knob controls the brightness of the screen.

1.1 Local mode

After having plugged in the Minitel to the mains and to the telephone line, powering is obtained by depressing on/off switch. Simultaneously a pilot lamp lights-up and the letter "F" appears (black on a white background) in the upper right hand corner, which indicates that the terminal is in the local mode.

During this mode the CRT displays the character that corresponds to the alpha-numerical key being depressed.

Ten seconds are necessary in normal temperature conditions for the CRT to warm up.

The terminal can hence be used by a micro computer connected to the peripheral socket.

1.2 On-line mode

Minitel can be connected to a data base in less than 500 ms after powering.

In order to be connected on-line, the user must dial-up the data base number using the associated telephone set. Hearing the specific tone (1300 Hz or 2100 Hz) he must depress "CONNECT/DISCONNECT" key. As the key is depressed the letter "F" is replaced by "C" in the upper right hand corner. Then hang up the telephone. For the Bc and Br versions of the Minitel the user can depress the "CONNECT/DISCONNECT" key immediately after dialing. The search for the carrier frequency is performed by the software. During this phase "C" flashes and when connection occurs "C" becomes steady.

1.3 Off-line mode

The user can disconnect the Minitel by depressing the "CONNECT/DISCONNECT" key twice. Hence, the terminal is disconnected from the data base and returns to local mode. The letter "F" replaces "C" in right hand corner. If the terminal does not receive any clear screen command from the host, the last page remains displayed.

1.4 Switch-off

The Minitel can be switched off unconditionnally at any time by depressing the on/off switch.

2 The keyboard

The user keys can be classified into the following categories: alphabetical keys, punctuation keys, digital keys, function keys.

2.1 Alphabetical keys

These keys comply with the AZERTY (or QUERTY) capital letter arrangement. The corresponding small letters are obtained by simultaneous depressing the shift key. The space bar produces a blank with background colour.
The export versions of the Minitel can be provided with other alphabets (greek, arabic, etc.) (see part 1).
(3 photos of TELIC, TRT, MATRA keyboards).

2.2 Punctuation keys

They correspond to the punctuation indicated on the keys (, . ' ; – : ?).
Used with the shift key they respectively correspond to the following signs: < > @ + = * /.

2.3 Digital and symbol keys

They correspond to the digits inscribed on the keys 1 2 3 4 5 6 7 8 9 0 * #.
Used with the shift key they respectively correspond to the following signs: ! " # $ % & ' ( ) ↑ [ ].

2.4 Function keys

The function keys are easily recognized by their different size. The "SEND" key is green on the Minitel M1.
A particular significance of these keys can be assigned by the videotex service during the session. However, usually they have the following meaning.

2.4.1 Local action keys

UP/DOWN: magnifies by two the top or bottom half of the screen.
Shift key: no inscription depressed simultaneously with another key, allows access to small letters, accents, particular symbols and certain controls.

2.4.2 Transmitted function keys

- CONNECT/DISCONNECT: provides connection or disconnection.
- SEND: validates the data acquisition.
- CANCEL: erases the last data typed (one or several words).
- ERASE: erases the last character typed.
- REPEAT: reproduces partially or entirely the page in case of transmission error.
- PREVIOUS: during data acquisition: previous field;
  during transmission: previous page.
- NEXT: during data aquisition: next field;
  during transmission: next page.
- INDEX: access to the service index or menu.
- GUIDE: help access.

2.4.3 Simultaneous depression of the shift and function keys

- shift key + ERASE: selection of the exchange rate with peripherals (see chapter 7).
- shift key + REPEAT: activation of the error correction procedure (see chapter 6).
- shift key + SEND: transmits the carriage return (CR) character.
- shift key + INDEX: circonflex accent (^)
  + GUIDE: diaresis (°°)
  + PREVIOUS: accute accent (´)
  + NEXT: grave accent (`)
  + CANCEL: inverted slash(\).

The accents must be typed before the letter and are only displayed when the letter has been typed.

3 Control procedures

3.1 Preliminary controls

Check that the letter "F" is visualized in the upper right hand corner after terminal powering.

3.2 Modem testing

A correct functioning check may be obtained by modem testing in the local mode (see chapter 6).

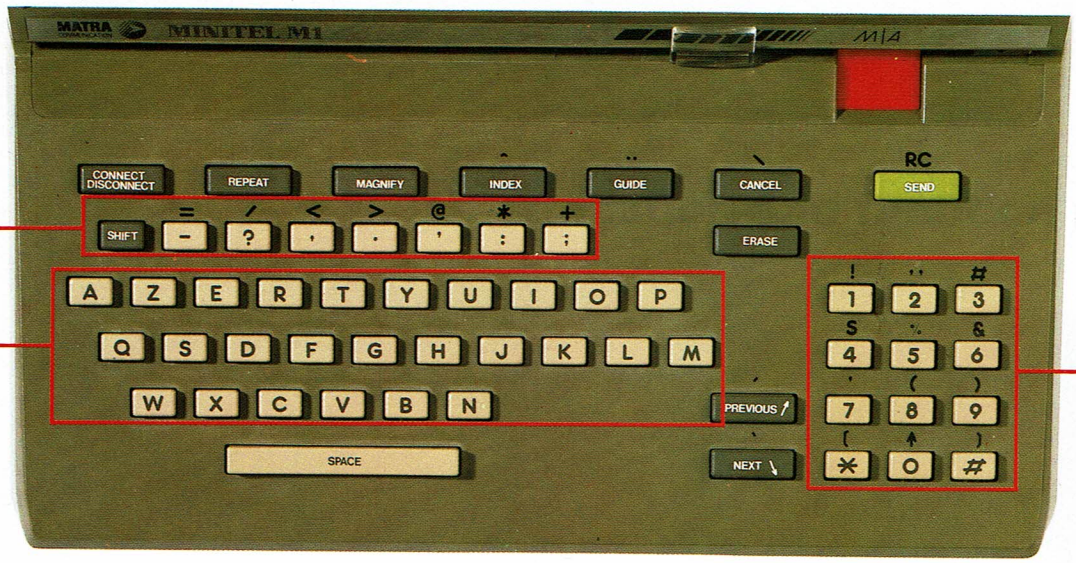
In normal operating conditions and in the local mode:

- depressing a character key must result in the displaying of the character in the current row.
- depressing the "CONNECT/DISCONNECT" key must result in the replacement of "F" by "C" in the upper right hand corner.
- depressing other function keys must not produce a change in the display.

3.3 Connection testing

After having called a host, check that depressing the "CONNECT/DISCONNECT" key upon reception of the tone results in the replacement of the letter "F" by "C" in the upper right hand corner, and the displaying of the service index.

MATRA

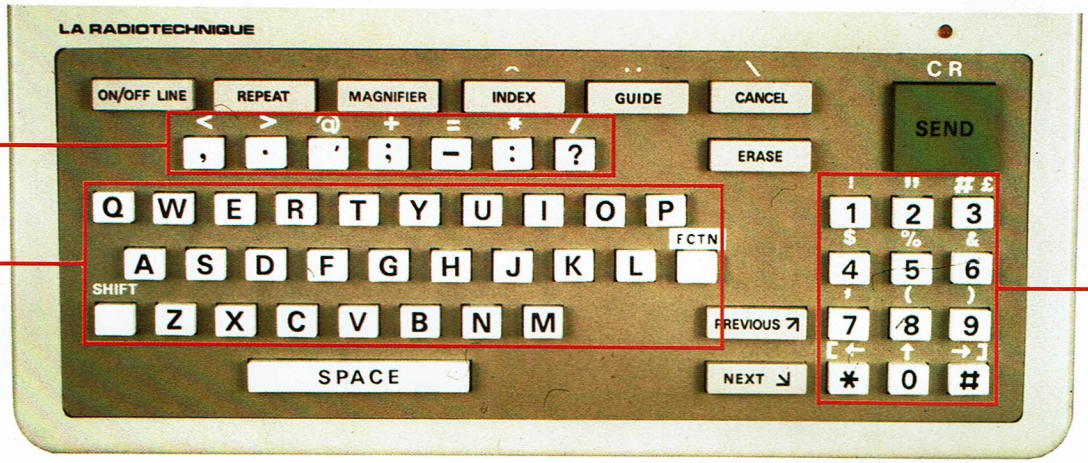


part 2

part 1

part 3

LA RADIOTECHNIQUE



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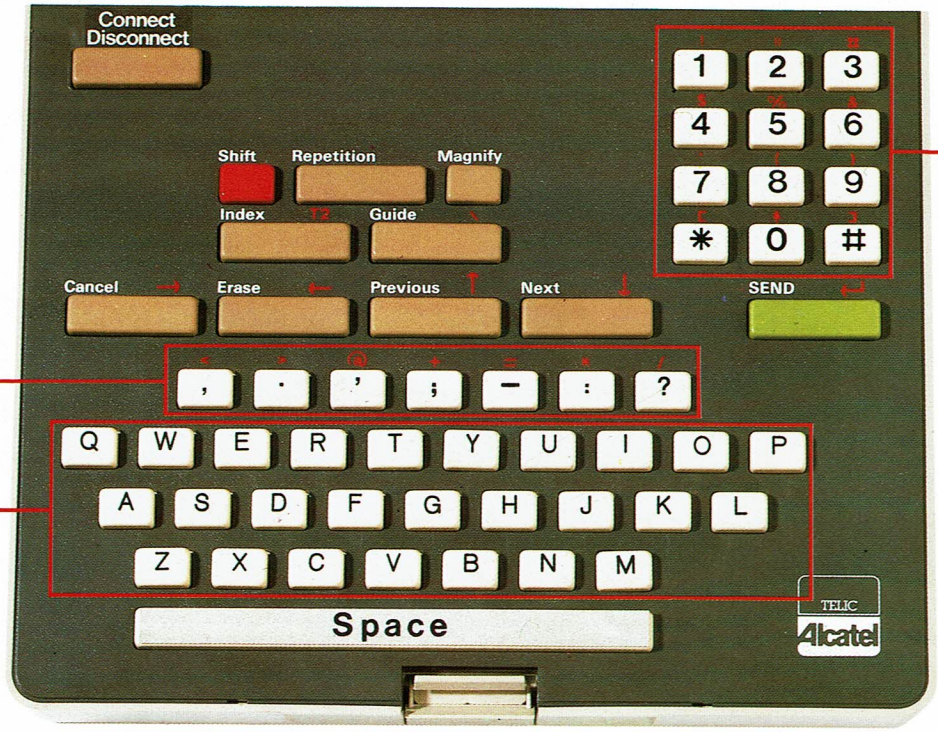
TELIC



part 2

part 1

part 3

1 Functional organization

Minitel is an open terminal designed to be capable of communicating with all compatible data bases and of extending its capabilities thanks to peripheral equipment.

1.1 Architecture

Minitel M1 is composed of 4 modules composed of software and hardware:
- the screen module, which decodes and displays data (see chapter 4).
- the keyboard module, is the user input system (see chapter 5).
- the modem module, ensures data transmission and reception between the Minitel and the data base (see chapter 6).
- the peripheral socket module, ensures data transmission and reception between Minitel and the peripheral equipment (see chapter 7).

The above modules are managed by a resident software layer called **Protocol** (see chapter 8) which basically ensures data switching between the modules. The Protocol also manages particular function modes of the Minitel or of modules. Thus Minitel can be considered as a **star network with centralized management.** (See fig. 3.1).

1.2 Functioning modes

Minitel is a videotex terminal and during the normal functioning mode manages a page mode display. Furthermore it possesses particular functioning modes (unactivated during the normal functioning mode) which are as follows:
- the scroll mode in replacing to the page mode;
- magnifying;
- 1200 baud line reception with error correction;
- the teaching mode.

These modes are activated by protocol controls (see chapter 8).

1.3 Internal switching capabilities

In the absence of particular switching controls received from the data base or from a peripheral equipment, Minitel has a basic internal switching configuration. This configuration is always obtained when powering the Minitel, during on-line or off-line connection or after disconnecting a peripheral equipment.

1.3.1 Internal switch configuration in the local mode

When Minitel is in the local mode the software sets the modem into a loop configuration and positions the following switching between the modules:
- from keyboard to modem;
- from modem to screen;
- from keyboard to peripheral equipment socket;
- from peripheral equipment socket to screen.

(See fig. 3.2.)

Thus, all data entered at the keyboard is sent to the socket module and to the screen because of the modem loop. Likewise all data received by the socket module is sent to the screen module.

1.3.2 Internal switch configuration in the connected mode

When Minitel is in the connected mode, the switching configuration between modules is as follows:

- from keyboard to modem;
- from modem to screen;
- from modem to peripheral equipment socket;
- from peripheral equipment socket to modem.

(See fig. 3.3.)

Thus, the data flow transmitted by the host and received by the modem module is sent to the display and socket modules. Likewise incoming data from the socket module is multiplexed with the keyboard input and transferred by the modem module to the host.

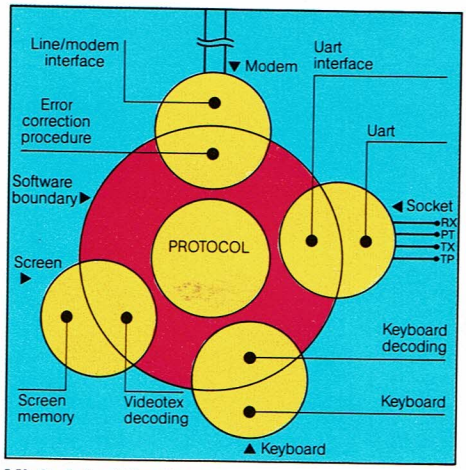
1.3.3 Transmission echoing

In the basic switching mode Minitel performs echo transmission. For example, in the connected mode, every displayable character keyed-in and received by the modem module is transmitted to the data base. The latter sends the character back to the modem module which in turn sends it to the screen module for display. This echo allows the user to check if the data base has correctly interpreted the keyed-in character. In case of error the character displayed will either differ from the one keyed-in or appear as an error symbol (?).

2 Coding principles

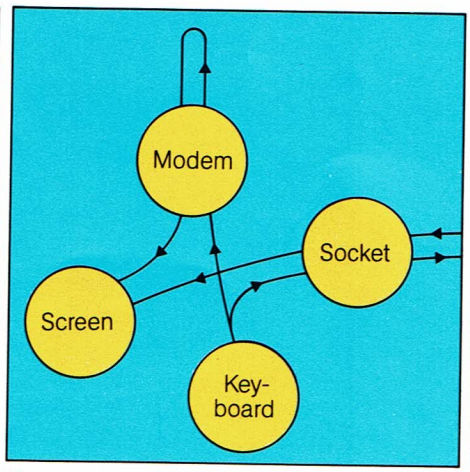
Data transmitted and received by the modem module (to or from the data base) or by the socket module (to or from a peripheral equipment) is sent by means of serialized 8 bit words or bytes comprising 7 bits for data and one even parity bit. The latter allows transmission error detection and is notably used by the error correction procedure.
(See chapter 6, paragraph 5).

Fig. 3.1



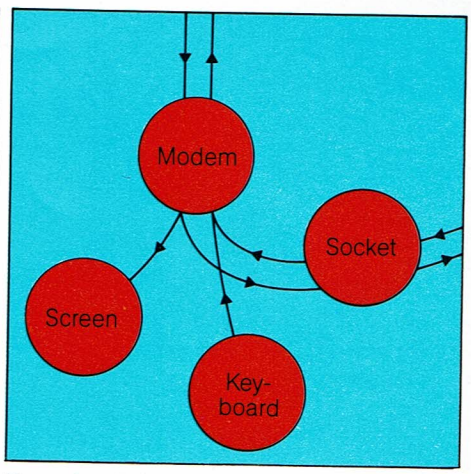
Minitel Architecture

Fig. 3.2



Normal switching in the local mode

Fig. 3.3



Normal switching in the connected mode

1 General features

The screen module ensures data displaying. It forms a physical and logical entity composed of the screen, the display assembly and the videotex decoder.

1.1 The screen

The display consists of a 9" (23 cm) black and white CRT ensuring good legibility whatever the data displayed, for a user facing the screen at less than 1 meter.

The screen assembly is adapted to particular conditions of use: frequent switching-on and limited operation. However, CRT damage may occur if a frame is displayed continually over a long period of time. Consequently, certain terminals switch the screen to a standby mode during the absence of data reception from the modem, keyboard or socket.

A knob allows brightness adjustement of the screen to ambient luminosity. Its range is defined in such a way that it is always possible to see the "F" on a dark background after switching-on the Minitel. All other adjustments are performed during assembly.

1.2 The display assembly

The display assembly forms an entity comprising a one page memory, a character generator and a display processor.

- The **page memory** has the capacity to contain a full screen page, that is 1000 16 bit words or 2 k bytes. To each 16 bit word corresponds one of the 1000 (25 x 40) display locations. The memory is permanently refreshed by the videotex decoder software and is read 50 times per second by the display processor.
- The **character generator** contains the 127 available characters for display, represented on an 8 column by 10 line matrix format.
- The **display processor** combines and synchronizes the data issued from the page memory and from the character generator in order to establish the RGB signals which are in turn combined into a video signal with eight levels of grey. It also controls the non interlaced scanning of the CRT.

1.3 Videotex decoding software

The software is stored in the microprocessor's ROM programme memory. It interprets 7 bit code words issued from the modem, keyboard or socket module and generates 16 bit words to be stored in the page memory.

2 Display characteristics

The display characteristics of the screen module are those adopted for the Teletel service defined by the CEPT and CCITT (recommendation S100) for alphamosaic videotex representation.

2.1 Glossary

- **line**: corresponds to a single horizontal TV line.
- **row** (row of characters): a row of characters is displayed after 10 line scans. When referring to characters it is preferable to use the term row instead of line.
- **page or screen**: group of rows which fills the display screen.
- **character**: is a displayable symbol. It is defined by a number of points in a dot matrix, some dots describe the character's shape while the others belong to the screen background.
- **character location**: it is the smallest screen location capable of containing a character, to which corresponds a 16 bit word in the page memory.

2.2 Formats

2.2.1 Screen format

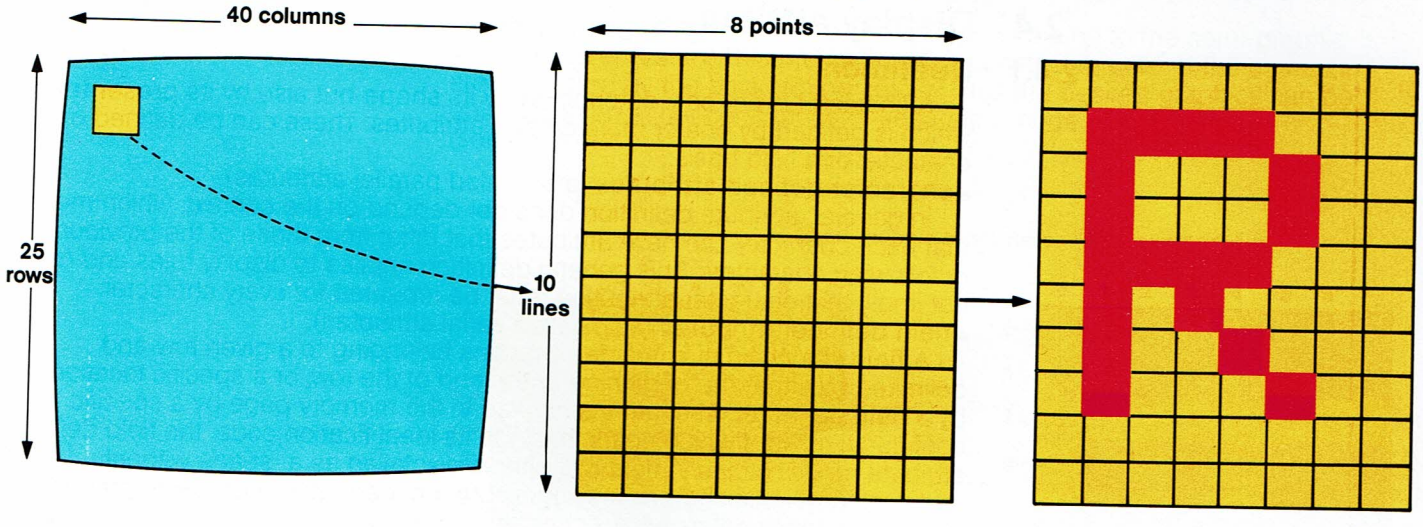
The screen is composed of 25 rows numbered from 00 to 24 each comprising 40 character locations numbered from 1 to 40. Thus a page contains 1000 character locations.

Note: row 00 is a service row normally reserved for system messages. Special controls access this row.

2.2.2 Character format

Each elementary character location resides in a dot matrix containing 8 columns and 10 lines.
(See fig. 4.1)

Screen format (Fig. 4.1)



The points of the matrix which do not belong to the symbol belong to the screen background. Certain characters entirely fill a line or a column of the matrix, such as horizontal and vertical bars, and also arrows but only at the tail end. These characters are said to be jointive characters. Note that the arrows are alined with horizontal and vertical bars in order to form continuous graphics. Contiguous semi-graphic characters also reach the border of the character location. (See paragraph 2.3.2.).

2.3 Character sets

Minitel can display two sets of characters: an alphanumerical set and a semi-graphic set.

2.3.1 The alphanumerical set

The alphanumerical set is composed of 127 different alphabetical, digital and symbols characters which are as follows:

- 26 capital letters (A-Z)
- 26 small letters (a-z)
- 8 accented capital letters Â È É Î Ô Ù Œ Ç
- 13 accented small letters à é u è â ê î ô û ë ï œ ç
- 10 digits (0-9)
- 1 space (SP)
- 2 currency signs (£, $)
- 1 error symbol (¦)
- 3 fractions (1/2, 1/4, 3/4)
- 14 signs (arrows, accolades, strokes, brackets) ↑↓→←◫◫◹◸⊟⊟◫⊟[ ]
- 23 punctuation signs: ! " # & ' ( ) * + − @ % ° , : ; = > < ± ? ÷.

(See fig. 4.2. G0 and G2 table).

2.3.2 Semi-graphic set

The semi-graphic set is obtained by "shading" 64 combinations of 6 elementary cells which make up the dot matrix. Each of these 6 cells is either character or background coloured.

(See fig. 4.3. G1 table).

2.4 Display attributes

2.4.1 Definition

A character is not only determined by its **shape** but also by its **presentation** which is defined by one or more display attributes. These can be defined on a character or a field basis.

- **character defined attributes** (also called parallel attributes).

In general, attribute definition does not depend on the context, which means that each character can have attributes that differ from those of the previous or following characters. This general definition applies to display rules and does not imply that character attribution must be repeated for every character.

- **field defined attributes** (also called serial attributes).

A **field** is a chain of character locations belonging to a given row and delimited by either the beginning or the end of the row, or a specific location set by a **field delimiter**. The latter is marked in the memory page by a specific configuration word which bears, besides its identification code, the field defined attribute modifications. A field delimiter is displayed as a space without underlining nor blinking possessing all other current attributes. Semi-graphic characters act as delimiters for background colours.

2.4.2 List of attributes

- **character colour** describes the colour of the points which constitute the character. It is also called the foreground colour;
- **background colour** describes the colour of the points which do not constitute the character. The eight colours available are: black, white, blue, green, red, yellow, magenta and cyan. However, for the Minitel's black and white CRT display, these colours are represented as different levels of grey.

The colour/grey level correspondence as follows:

Black		B	Green	70%	L4
Blue	40%	L1	Cyan	80%	L5
Red	50%	L2	Yellow	90%	L6
Magenta	60%	L3	White		W

Percentages are expressed as regards to full luminance amplitude.

The perimeter of the display is black:

- **simple or double height;**
- **simple or double width;**
- **simple or double size;**
- **normal/inverted polarity**: the character points and the background points exchange their colours; the flashing mode is also inverted;
- **flashing**: the points of the character are alternatively assigned to their colour or to the background colour. The flashing rate is slow (about 0,5 Hz);
- **concealing**: characters possessing this attribute remain invisible and are replaced by a black background. The mask field begins and ends with a half size delimiter.

The positionning of the following full screen attributes determines whether or not the masked fields should be displayed:

–**conceal**: the fields with the concealing attribute are not displayed and are replaced by the black background; Minitel is implicitly in the mask mode after powering and on-line connection;

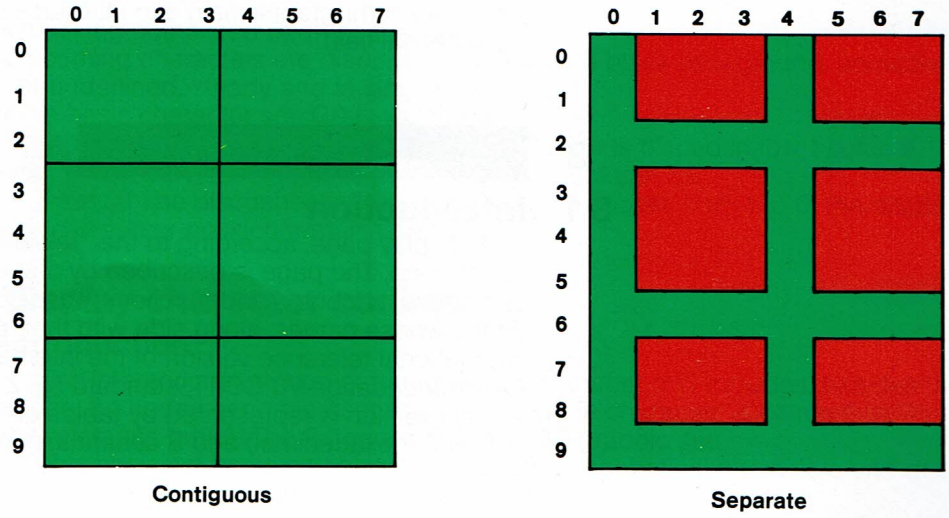
–**reveal**: the above fields appear this time as though there were no masking attribute. This is obtained when the full screen revealing attribute is received. The full screen masking attribute provokes the inverse effect;

- **lining**: this attribute provokes character underlining in an alphanumerical field and separated mosaic in a semi-graphic field;

–**underlining**: it is possible to underline all alphanumerical characters. Underlining consists in filling the last line of the character. This line possesses all the other character attributes: colour and flashing;

–**contiguous/separated**: all the characters belonging to the semi-graphic set can be separated. This means that the constituing cells of the character are separated by the backgroung colour. Thus the desired graphics can be obtained in an either contiguous or separated mode.
(see fig. 4.4).

Semi-graphic characters



2.4.3 How to use attributes

The use of attributes depends upon the type of characters used, namely the alphanumerical characters, the semi-graphic characters and the field delimiters.

The following table describes the attribute possibilities.

	Character set		
Attribute definition	Alphanumerical	Semi-graphic	Field delimiter (2)
	Character colour		
Character level (parallel)	• Flashing • Character height • Character width • positive/negative polarity	• Flashing • Background colour (1) • Separated	• Background colour of the following field • Masking
Field level (serial)	• Background colour (3) • Concealing • Underlining (4)	• Concealing	

Remarks

(1) Every semi-graphic character serves as a background colour delimiter for an eventual following alphabetical field in the same row.

(2) The delimiter is repeated in two locations on two successive rows for double height characters and repeated on two consecutive locations belonging to the same row for double width characters. A combination of the two gives double size characters. Effectively, the delimiter is coded as a space for transmission and is also capable of containing size attributes for alphabetical characters, as well as the polarity attribute.

(3) If "clear screen" is received, the software fills the page memory with full black foreground-coloured semi-graphic characters in order to prevent serial attributes from appearing on the entire current row when displaying a new page.

(4) When a semi-graphic field follows an underlined alphabetical field, the former is not separated; the underlining reappears in the following alphabetical field unless the graphic field contains a masking or unmasking delimiter. However, neither a semi-graphic character nor a masking/unmasking delimiter within the semi-graphic field can introduce underlining in the subsequent alphabetical field.

3 Coding characteristics

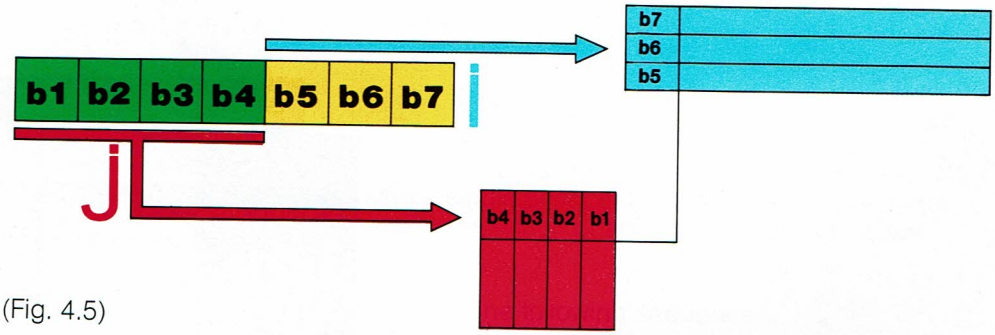
3.1 Introduction

A display page, according to the "Teletel" characteristics is transmitted in a coded form. The page is described by a succession of codes relating to characters, attributes and functions. The vocabulary includes 127 different codes whose names, along side with their definitions, belong to the international reference version of the international alphabet n° 5 (recommendation V3 CCITT, standard NF Z 62010).

This version is represented by tables of 16 rows numbered 0 to 15 (decimal) or 0 to F (hexadecimal) and 8 columns, numbered 0 to 7.

Each of the 127 codes is represented in binary on 7 significant bits (plus an even parity bit). The first 4 L.S.B. indicate the row and the last 3 M.S.B. the column locations in the table. (See figure 4.5).

If necessary, the codes may be combined according to the international standard ISO 2022 (NF Z 62500).



(Fig. 4.5)

Codes are described by 2 numbers (or a number and a letter separated by slash (e.g. A = 4/1). The notation is hexadecimal. The first indicates the column and the second the row in the table.

The decimal/hexadecimal conversion table is as follows.

Decimal notation	0	1	2	3	4	5	..	9	10	11	12	13	14	15
Hexadecimal notation	0	1	2	3	4	5	..	9	A	B	C	D	E	F

Column 0 and column 1 in the table are control codes and form the **C0** set. Minitel disregards all unrecognized control codes.

3.2 Screen initialization

When the Minitel is powered, or if in the local mode, the PT signal on the peripheral socket passes from 0 to 1 (see ch. 7) or if the Minitel is connected on-line, the screen is initialized in the following manner:

- cursor not displayed (except during connection of Bc and Br versions);
- page mode (scrolling not active);
- masking authorized upon connection;
- incoming characters are displayed in white on a black background, unmasked, not underlined, steady and in simple size;
- the basic character set, G0 is validated.

Moreover, after powering the Minitel, the cursor is placed in row 1 column 1 and "F" appears with negative polarity in row 0 column 39.

After off-line disconnection or if the PT signal passes from 1 to 0, the display and the cursor position remain unaltered.

3.3 Display character coding

3.3.1 Introduction

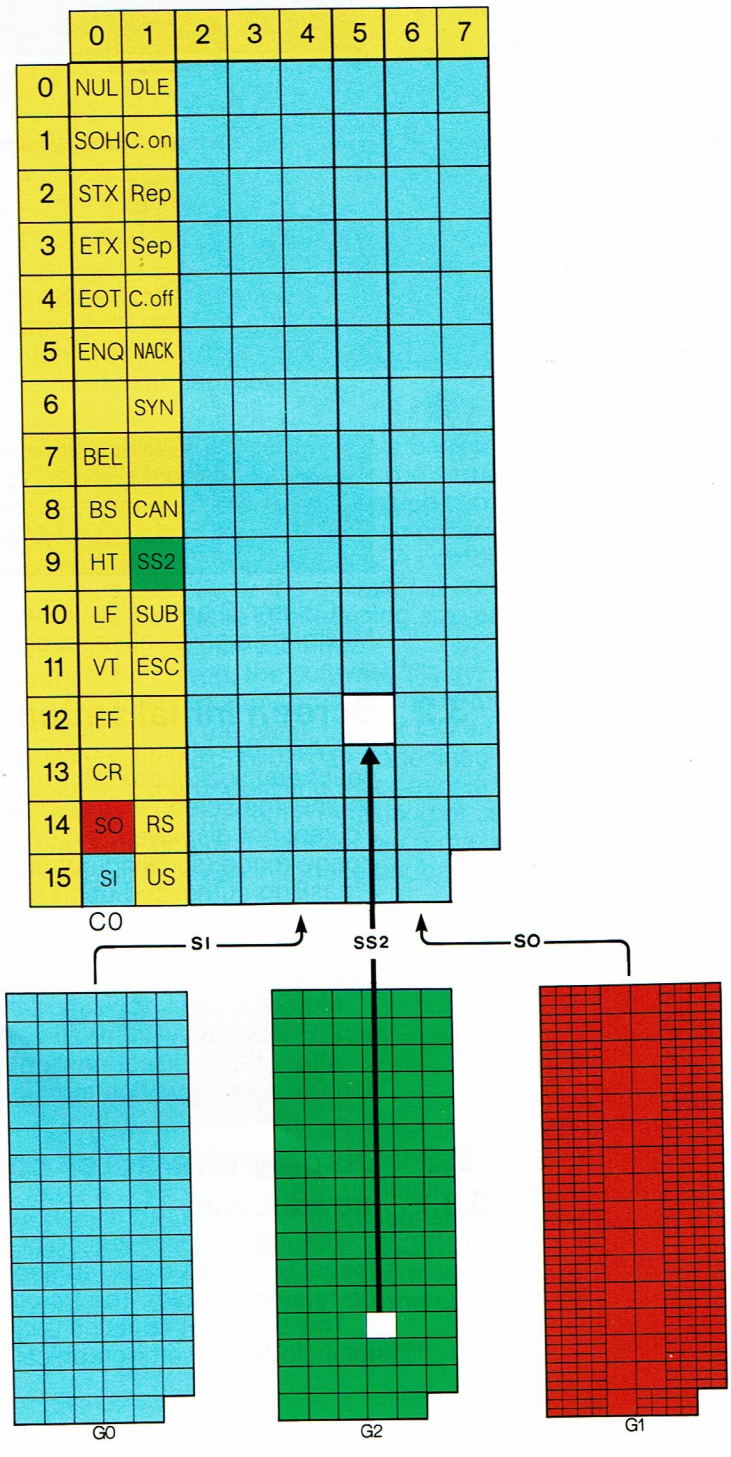
The international version of the reference alphabet n° 5 includes, besides the space, 94 codes each representing a displayable character. (Column 2 to 7 in the reference table). The 94 codes form the **G0** graphic set.

This basic set contains only part of the 127 alphabetical characters and does not include the semi-graphical set necessary for "Teletel" operation.

The remaining characters are accessed via a combination of codes called a code sequence. This allows access to 2 auxiliary characters sets namely: **G2** a complementary character set, **G1** the semi-graphic set.

Their set description and syntax rules are defined in figure 4.6.

(Fig. 4.6)



3.3.2 Alphanumerical character coding

Alphabet n° 5 character coding.

The character set belonging to international alphabet n° 5 is called the basic graphic set G0. It comprises all the non accented capital and small letters of the roman alphabet, the 10 digits and a certain number of special symbols such as punctuation. Accented letters are not included. G0 characters are invoked by a unique binary code which figures in fig. 4.2.

Accented letter coding

Accented letters are invoked by a 3 code sequence; the first two codes call the accent and the third invokes the letter belonging to G0.

This is made possible by defining an auxiliary 94 character set noted G2. G2 characters are accessed by using a single shift control **SS2** (1/9). The accents figure in column 4 of the G2 set. The selection of an accent does not cause cursor progression.

Example: The letter "é" is obtained by the following sequence.

1/9	4/2	6/5
SS2	(´)	(e)

Thus Minitel can display all the accented small vowels à, â, é, è, ê, ë, î, ï, ô, ù, û and certain capital vowels Â, È, É, Î, Ô, Û used in France. Export versions of Minitel take advantage of this feature for generating accented signs, eg, ñ, ĩ, etc.

The cedilla only applies to the small and capital C.

In any case, all letters marked by an accent or a cedilla which do not belong to the lists above are displayed as simple characters.

Special letter coding

Special letters are not reduced to accented vowels. In French there is the ligature œ (small and capital) which also belongs the G2 set.

Example: SS2, (7/10) gives œ (small)
SS2, (6/10) gives Œ (capital) and

Special symbol coding

Certain symbols such as arrows, currencies do not belong to G0. They belong to columns 2 and 3 of G2 and are also prefixed by SS2.

3.3.3 Semi-graphic character coding

The G1 set which has identical structure to the G0 set contains all the semi-graphic symbols defined for display. Prefixed by a SO (shift out) code, **all** the following codes ranging from 2/0 to 7/E are interpreted as semi-graphic characters. The SO (0/E) code modifies the meaning of all characters in columns 2 to 7 which follow. They belong to the G1 set and are semi-graphic.

The SI (0/F) shift in returns to the G0 basic set. Thus, every graphic character sequence **included between SO and SI belongs to the G1 set.**

3.3.4 Particular interpretations

- when the terminal is in the semi-graphic mode the SS2 control is ignored;
- trying to access an undefined character in the G2 set by SS2 produces an horizontal bar which means: unknown character.

3.4 Attribute coding

3.4.1 Introduction

Display attributes belong to the C1 set, columns 4 and 5, of the international alphabet n° 5. Prefixed by ESC (1/B) they form a two code sequence; the attribute code belongs to the following table.

	2	3	4	5	6	7
0			Black character	Black background		
1			Red character	Red background		
2			Green character	Green background		
3			Yellow character	Yellow background		
4			Blue character	Blue background		
5			Magenta character	Magenta background		
6			Cyan character	Cyan background		
7			White character	White background		
8			Flash	Conceal		
9			Steady	Stop lining		
A				Start lining		
B						
C			Normal size	Positive polarity		
D			Double height	Negative polarity		
E			Double width			
F			Double size	Reveal		

28 codes are available and are classified as follows:

- character colour (8 functions);
- blackground colour (8 functions);
- size (4 functions);
- flash or steady (2 functions);
- start and stop concealing (2 functions);
- start or stop lining (2 functions);
- positive or negative polarity.

The ESC sequences using unrecognized codes in C1 are filtered out by the Minitel screen module.

3.4.2 Character attribute definition

The attributes defined on a character basis receive parallel treatment, which means that they are only assigned to the character and that each character is free to have attributes that differ from those of the previous or subsequent characters. However, a character defined attribute generally applies to all the subsequent characters and requires no further repetition.

The attribute becomes ineffective in three cases:
- after subsequent explicit attribute redefinition;
- after delimitation of the display page by a unit or sub-unit separator, (see paragraph 3.5 – format effectors);
- after initialization (see paragraph 3.2).

Remarks:
- the size and polarity attributes are not applicable to the semi-graphic characters (G1 set). If these two attributes have been set before invoking G1, the terminal will automatically come back to normal size and positive polarity. Sequencies trying to activate these attributes whilst G1 is invoked are ineffective;
- in the semi-graphic mode, the lining attribute is defined on a character basis and introduces separate mosaics;
- with double height codes (ESC, 4/D) and double size codes (ESC, 4/F), the characters in the two rows have the same colour. Characters with these attributes are generated from the left of the second row;
- videotex decoding software addresses 2 or 4, 16 bit memory locations according the dimensions of the character, that is, double height, double width or double size;
- when the processor recognizes a double height or double size attribute the two rows i and i + 1 are reserved for the display of respectively top and bottom of characters until the end of the row. If an overlapping character is defined in rows i + 1 and i + 2 the top of the character is displayed in row i + 2 and the bottom part in i + 1. This inversion prevents current Minitels from writing double size or double height characters in quincunx.

Minitel does not take into account double height or double size attributes in rows 00 and 01.

A similar process takes place for double width definition.

When the processor recognizes a double width or double size attribute the two successive locations j and j + 1 are reserved for the display of left and right parts of characters.

If another character with double width or double size is located in columns j + 1 and j + 2 of the same row, the right part of the character is displayed in j + 1 and the left part in j + 2. Thus, overlapping gives an incorrect display.
- The character defined attributes are applicable to all subsequent character chains except when the latter meet a unit or sub-unit separator: US, RS, FF, (see paragraph 3.5.2).

3.4.3 Field attribute coding

The software analyses and takes into account all incoming serial attribute definitions. Thus Minitel continually updates **a latent serial attribute context.** But the attributes only become effective for display:
- upon the reception of a space (2/0) which will be displayed (as a half space during masking) in the current background colour or as required in the newly defined background colour, with size and polarity attributes. The space marks the beginning or the end of a field;
- or upon the reception of a semi-graphic character (G1 set) which provokes background colour attribute validation. Every semi-graphic character acts as a field colour delimiter for the following or immediately precedent alphanumerical field. The other latent field attributes are validated when a space is sent on the Bc and Br versions or the first explicit delimiter on the other versions.

Remarks:
- a single space is sufficient to validate several modified serial attributes;
- the first space received after serial attribute definition is stored in the page memory as a delimiter, even if there is no several attribute context modification.

Example: ESC, 5/3, 2/0, 2/0, the second space is not a delimiter;
ESC, 5/6, 2/0, ESC, 5/6, 2/0, the spaces are both delimiters.

– after a SO command the software temporarily inhibits underlining in the serial attribute context. It is taken into account after the first delimiter found and not only after a space.

– Minitel does not check the page memory. Whilst changing fields (using LF, VT, BS, HT) the serial attributes of the new field are valid as long as no delimiter appears and activates the current context: serial attributes are not attached to the cursor. Writing a character in a delimiter location inhibits the serial attributes activated by that delimiter; the field's new serial attributes become those of the previous field (on the left).

3.4.4 Full-screen mask attribute coding

Full screen masking is obtained by the following sequence ESC, 2/3, 2/0, 5/8 and revealing is obtained by: ESC, 2/3, 2/0, 5/F.

3.5 Format effectors

3.5.1 Introduction

The format effectors position the cursor (current writing location) on one of the 40 character locations belonging to one of the rows in the screen-page. The latter constitutes a "unit". A unit can be sub-divided into sub-units.
A sub-unit is a group of consecutive characters belonging to one or more consecutive rows located between two unit or sub-unit separators.

The cursor origine is in the lower left hand corner of the character (in order to account for large characters). After powering Minitel, the cursor is positionned in column 01, row 01.

3.5.2 Available functions

Available paging functions are coded as follows:
- BS (backspace) (0/8): the cursor moves one step to the left,
- HT (horizontal tabulation) (0/9): the cursor moves one step to the right,
- LF (line feed) (0/A): the cursor moves one step down,
- VT (vertical tabulation) (0/B): the cursor moves one step up,
- CR (carriage return) (0/D): the cursor moves to the beginning of the current row,
- RS (record separator) (1/E): the cursor moves to column 1 row 1. This is an explicit unit separator,
- FF (form feed) (0/C): the cursor moves to column 1 row 1 and the screen is completely erased from rows 1 to 24. This is a unit separator,
- US (unit separator) (1/F): sub-unit separator,
- CAN (cancel) (1/8): the current row is filled with spaces assigned to their current attributes. The cursor position remains unchanged. This is not a delimiter.

3.5.3 How to use the functions

General use

BS, HT, LF, VT, and CR codes neither modify the current attributes nor the invoked set (SO, SI). The cursor thus transmits current attributes with the exception of the field defined attributes. However the field defined attributes are not transported with the cursor. (See paragraph 3.4.3).

The reception of a unit or sub-unit separator (US, FF, RS) restores the default visual functions. The separator invokes the G0 basic set and the incoming characters are displayed in white, on a black background, revealed, not underlined, steady and in simple height. These codes do not modify the overflow mode (page or scrolling mode) defined by the sequences in paragraph 3.6.5.

Remarks:

Restoring serial attributes when US positionning occurs elsewhere than in column 1 is achieved by redefining the attribute sequence followed by a separator (space or semi-graphic character) before displaying characters. However positionning in column 1 requires the displaying of a character and not a cursor move (BS, HT...) in order to take into account the default attributes.

Upon receiving FF, the software fills the screen, except row 0, with semi-graphic black characters, which serve as background colour delimiters.

Using the "sub-unit" separator

The US code (1/F) is followed by two characters which are not displayed.

If the characters both belong to columns 4 to 7, they respectively represent (on 6 significant bits) the row and column address of the first character of the sub-unit. The active position of the cursor is placed at the addressed location.

If the two US parameters are invalid the US sequence is ignored.

Example:

Displaying A in row 5 column 25 is obtained by: US, 4/5, 5/9, 4/1.

Positionning the cursor on row 5 column 1 is obtained by US, 4/5, 4/1.

Overflowing

When overflowing occurs, the 41st character of a given row is displayed at the beginning of the following row. Overflowing on row 00 does not occur and the cursor remains in column 40.

Overflowing also takes place for double height and double size characters by jumping 2 rows. If a character is entered after column 40 in lines 23 or 24 it is displayed at the beginning of row 2. When a double size (or resp. double width) character is entered after column 40 the character is visualised in column 40 in double height (resp. simple size) without overflowing. If double height or double size attributes are entered in row 1, the terminal ignores them and in case of overflow validates them in row 2.

The BS (0/8) character entered when the cursor is in column 1 moves the cursor to column 40 of the previous row. When situated in row 1 column 1 the BS produces a jump to row 24 column 40. In row 0 column 1 BS has no effect.

The HT (0/9) character entered when the cursor is in column 40 moves the cursor to column 1 of the following row. When situated in row 24 column 40 HT moves the cursor to row 1 column 1. In row 0 column 40 HT has no effect.

The LF (0/A) character entered when the cursor is in row 24, moves the cursor to the same column position in row 1 in the page mode and translates the display one row up (except row 0) in the scrolling mode.

The VT (0/B) character entered when the cursor is in row 1, moves the cursor to the same column position in row 24 in the page mode and translates the display one row down (except row 0) in the scrolling mode.

When Minitel is in the scrolling mode, overflowing causes the display to "roll up" or "roll down" one or two rows, depending on the size/height attribute. Row 0 is unaltered.

Access to row 00

Row 0 can only be accessed by US 4/0, X/Y (Y: column number, X: 4 or 5 or 6 or 7). Once positionned, the cursor does not react to VT. Upon receiving LF the cursor is positionned on the last location occupied between rows 1 to 24 before being positionned in row 00 and all the former attributes are restored.

The only way to leave row 0 is by sending a unit or sub-unit separator or a LF.

3.6 Complementary functions

3.6.1 Ancillary functions

- Repeat: REP (1/2). This code precedes a character in columns 4 to 7 (6 significant binary coded bits) and indicates the number of times the last character sent is to be repeated with all current attributes. The character itself is excluded from the count. The function is applicable to all displayable characters (including accented characters, spaces and obliteration).

Example:

SP, REP, 4/A means that space will be repeated 10 times giving: 10 + 1 = 11 spaces.

SS2, 4/1, 6/5, REP, 4/A means that è will be repeated 10 times giving: 10 + 1 = 11 è characters.

SO, ESC, 4/2, 5/F, ESC, 4/1, REP, 4/A, ESC, 4/2, REP, 4/C, will display a green mosaic block followed by 10 red and 12 green blocks.

- NUL (0/0) used as a filter, it is ignored by the screen module and can be placed anywhere, even in escape, single shift or repeat sequences.
- SPACE: SP (2/0). Moves the cursor one step to the right leaving the previous cursor positions with the current background colour. (respecting the polarity attributes).

All current attributes are assigned to the space except blinking.

- DELETE: DEL (7/F). Moves the cursor one step to the right leaving the previous cursor position(s) with current character colour. All other current attributes are active.

If G1 is invoked the 7/F code is interpreted in the same way as 5/F with identical possible attributes including lining. During the SI mode lining, is excluded.

- BELL: BEL (0/7) upon receiving this code Minitel emits a short beep for less than one second. A succession of BEL prolongs the beep time.

3.6.2 Cursor position status

Upon receiving the ESC, 6/1 sequence, the terminal responds by sending on-line the cursor position by means of the US code and 2 data bytes. Cursor position requests belong to the protocol language. (See chapter 8).

3.6.3 Extension function codes

These functions have already been described.
- SO (0/E): shift out to the G1 set
- SI (0/F): shift in to the G0 set
- SS2 (1/9): single shift the G2 set
- ESC (1/B): Escape to C1.

3.6.4 Display of the cursor character

- DC1 (1/1): display of the actual position of the cursor as a block.
- DC4 (1/4): cursor position invisible.

When the cursor is positionned on character (even semi-graphic) the latter is displayed with alternative negative and positive polarity.

The cursor only occupies a single location. It is invisible if character and background colours are identical, or if placed on a delimiter or a masked field.

3.6.5 Particular display functions

The protocol controls the following functions: (see chapter 8).
- scrolling:
  - start scrolling: ESC, 3/A, 6/9, 4/3
  - stop scrolling: ESC, 3/A, 6/A, 4/3.
- magnifier (upper half of the screen)
  - on: ESC, 3/A, 6/9, 4/6
  - off: ESC, 3/A, 6/A, 4/6.
- magnifier (lower part of the screen)
  - on: ESC, 3/A, 6/9, 4/7
  - off: ESC, 3/A, 6/A, 4/7.

After such a sequence the terminal sends an acknowledgment (see chapter 8).

3.6.6 Screen module address

The protocole language can address the screen module by the following codes (see chapter 8).
- during reception 5/0
- during transmission 5/8.

3.7 Special filters

The screen module ignores the following sequences

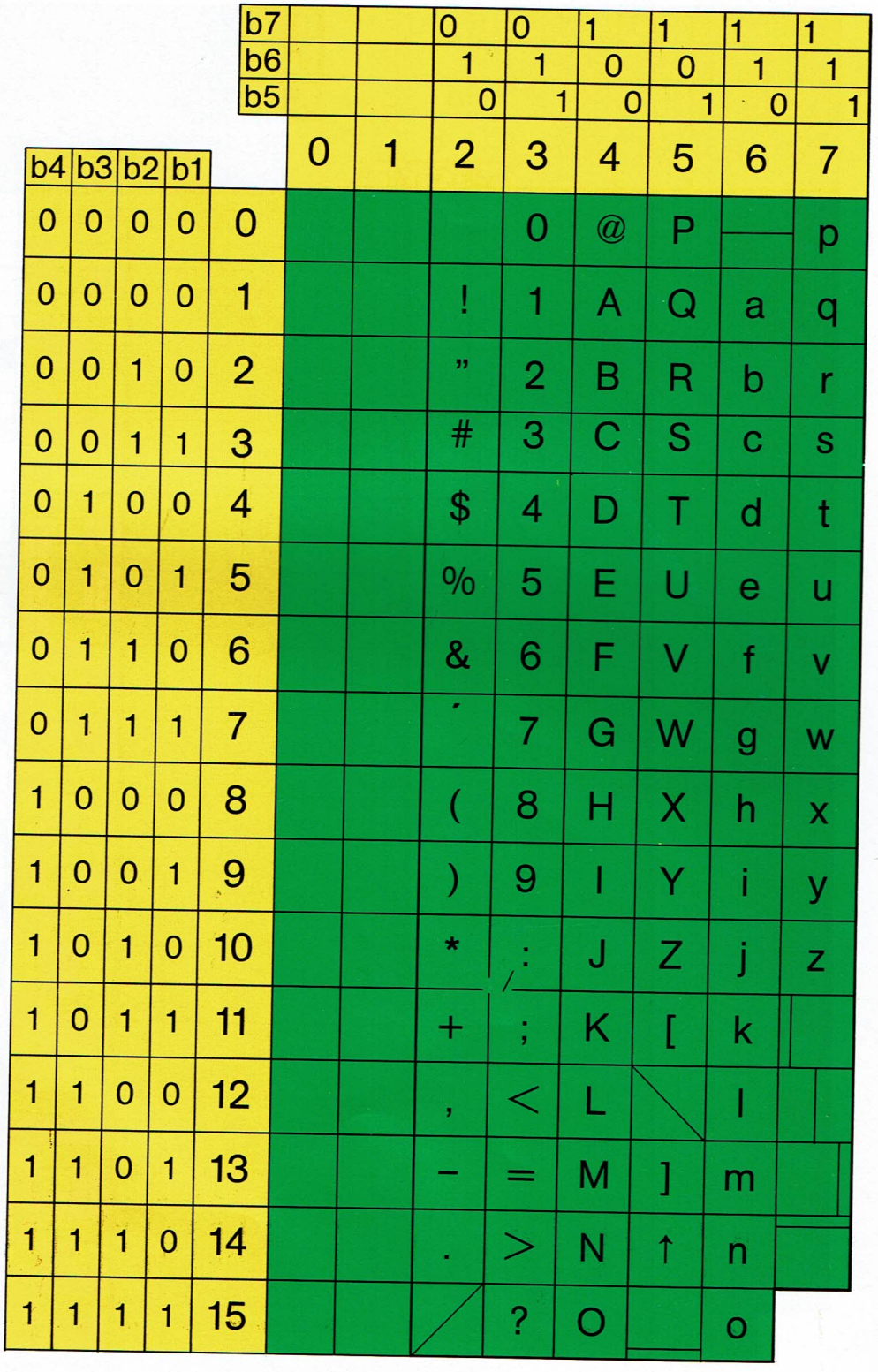
- ESC, 3/5, X)
- ESC, 3/6, X)
- ESC, 3/7, X)
- SEP, X (used to code the keyboard controls).

The screen module ignores all incoming codes or sequences after the reception of ESC, 2/5. It thus passes into the **transparent screen mode**. In order to leave this mode, the screen module must necessarily receive ESC, 2/x, Y where Y lies between 3 and 7 and where X belongs to columns 8 to F. Invalid ESC, X sequences are also ignored as well as any ESC 2/x, 2/y ... 2/z, Y sequence where Y belongs to columns 3 to 7 (ISO 2022).

3.8 Error processing

A character parity check error results in the displaying of the error symbol. The same sign is displayed when SUB (1/A) is received. It retains all the current attributes and is used independently of the G set invoked.

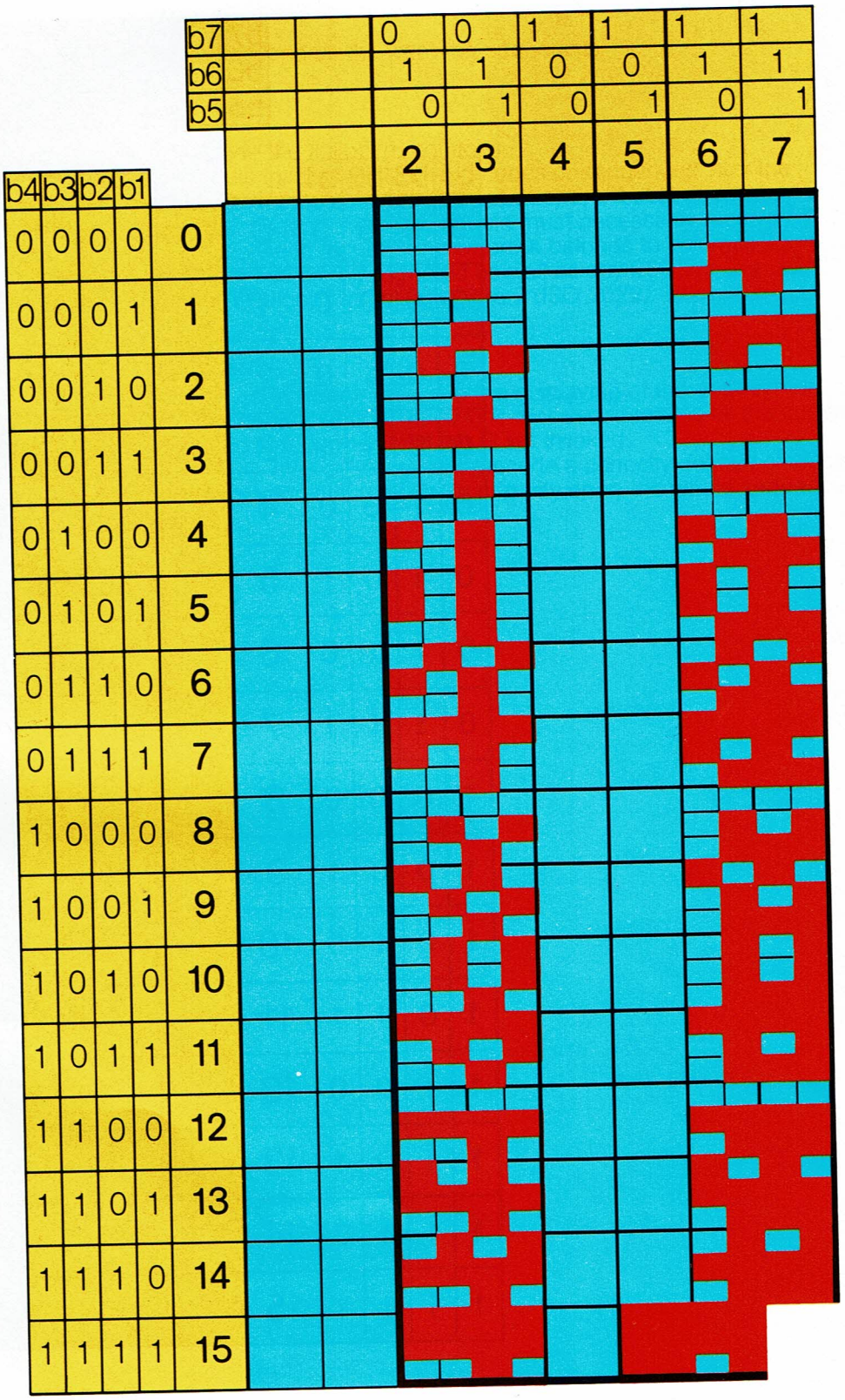
However if US, ESC, REP, or SS2 do not precede a correctly defined character sequence (due to non-conformity or parity or parity error) the whole sequence is ignored.



b7			0	0	1	1	1	1
b6			1	1	0	0	1	1
b5			0	1	0	1	0	1
b4	b3	b2	b1		0	1	2	3	4	5	6	7
0	0	0	0	0				0	@	P	—	p
0	0	0	0	1			!	1	A	Q	a	q
0	0	1	0	2			”	2	B	R	b	r
0	0	1	1	3			#	3	C	S	c	s
0	1	0	0	4			$	4	D	T	d	t
0	1	0	1	5			%	5	E	U	e	u
0	1	1	0	6			&	6	F	V	f	v
0	1	1	1	7			’	7	G	W	g	w
1	0	0	0	8			(	8	H	X	h	x
1	0	0	1	9			)	9	I	Y	i	y
1	0	1	0	10			*	:	J	Z	j	z
1	0	1	1	11			+	;	K	[	k	
1	1	0	0	12			,	<	L	\	l	
1	1	0	1	13			-	=	M	]	m	
1	1	1	0	14			.	>	N	↑	n	
1	1	1	1	15			/	?	O	_	o	

G0 SET

(Fig. 4.2)


b7 b6 b5
0 0 1 1 1 1
1 1 0 0 1 1
0 1 0 1 0 1
2 3 4 5 6 7
b4 b3 b2 b1
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 10
1 0 1 1 11
1 1 0 0 12
1 1 0 1 13
1 1 1 0 14
1 1 1 1 15

G1 SET

(Fig. 4.3)

b7			0	0	1	1	1	1
b6			1	1	0	0	1	1
b5			0	1	0	1	0	1
			2	3	4	5	6	7
b4 b3 b2 b1								
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	10						Œ	œ
1 0 1 1	11				˘			
1 1 0 0	12		←	¼				
1 1 0 1	13		↑	½				
1 1 1 0	14		→	¾				
1 1 1 1	15		↓					

The G2 characters which do not belong to the table are not recognized by the Minitel. Their default display is a lower horizontal bar.

G2 SET

(Fig. 4.3)

1 General features

The keyboard module is a hardware and software entity which enables data acquisition by the Minitel. It is composed of a keyboard and the corresponding software.

1.1 The keyboard

The mechanical characteristics ensure the correct interpretation of 10^6 depressions of each key. Furthermore, the keyboard also respects certain ergonomic and waterproof requirements. It can also easily be interchanged by the user. The keyboard has a 8 x 8 matrix layout which enables a capacity of 64 keys. However only 57 keys are programmed on the Minitel M1.
They are subdivided into 4 categories (see chapter 2 paragraph 2).

1.1.1 26 alphabetical keys and the space bar

These keys represent the capital letters. When depressed with the shift key they produce small letters.

1.1.2 Seven punctuation keys

, . ' ; – : ? when used with the shift key they respectively produce
< > @ + = * /

1.1.3 12 digital and symbol keys

1, 2, 3, 4, 5, 6, 7, 8, 9, 0, *, # when used with the shift key they respectively produce:

1	2	3	4	5	6	7	8	9	0	*	#
!	"	#	$	%	&	'	(	)	↑	[	]

1.1.4 8 function keys and 3 special keys

Functions keys

These keys are used to transmit controls to the data base (REPEAT, INDEX, GUIDE, CANCEL, ERASE, PREVIOUS, NEXT, SEND).

3 special keys

The CONNECT/DISCONNECT key provides line connection and disconnection The MAGNIFY key and the SHIFT key have a local effect. Using the SHIFT key with certain function keys gives the following:

- SHIFT + INDEX: circonflex accent ^
- SHIFT + GUIDE: diaeresis ¨
- SHIFT + PREVIOUS: accute accent ´
- SHIFT + NEXT: grave accent `
- SHIFT + CANCEL: inverted slash \
- SHIFT + SEND: carriage return **CR**

1.2 Software

It provides the following functions:

- keyboard polling;
- coding the depressed keys. The keyboard is not inhibited during transmission thus allowing the user to continue keying.
- recoil filtering if they last less than 5 ms.

Controls, except the ones used with the shift key, do not require dual key depressing. Multiple key pressing is ineffective, however after releasing the keys one of them is taken into account.

2 Keyboard module character transmission

Each key depression generates a character or a character sequence which corresponds to the key inscription. The same applies to those used with the shift.

2.1 Keys relating to character transmission

In general, these keys invoke the transmission of a character or character sequences which, according to internal switching, is displayable by the screen module (see chapter 4).

The accents are transmitted before their assigned letter. The coherence is only checked during reception: if an accent sequence features a letter which cannot be accented, the sequence nonetheless is sent with three characters..

(Table 5.1: characters transmitted by keyboard depression).

Table 5.1

Alphanumerical characters sent by the keyboard

Key inscription	Character code	Character code when using SHIFT
From A to Z	From 4/1 to 5/A	From 6/1 (a) to 7/A (z)
Space	2/0	7/F or 2/0
1	3/1	2/1 !
2	3/2	2/2 "
3	3/3	2/3 #
4	3/4	2/4 $
5	3/5	2/5 %
6	3/6	2/6 &
7	3/7	2/7 '
8	3/8	2/8 (
9	3/9	2/9)
0	3/0	5/E ↑
*	2/A	5/B [
#	2/3	5/D]
, coma	2/C	3/C <
. full stop	2/E	3/E >
' apostrophe	2/7	4/0 @
; semi colon	3/B	2/B +
– hyphen	2/D	3/D =
: colon	3/A	2/A *
? question mark	3/F	2/F /

2.2 Actions of the function keys used with the shift key.

Whether in the local or connected mode, these keys invoke transmission of sequences beginning with SEP (1/3), called the code reply separator, followed by a 4/X ($1 < X < 9$) code to the modem and/or socket module or the screen module. The character following SEP, with the exception of ESC, is always filtered by the screen module and is thus never displayed.

2.2.1 The magnify key and the shift key

The magnify key

This allows the successive displaying of the upper and lower halves of the page in double height finishing with normal height. The key only has a local action and in no way causes transmission of characters to the modem or socket modules.

The shift key

Depressing only the shift key causes no character transmission.

2.2.2 The "CONNECT/DISCONNECT" key and the function keys.

The "CONNECT/DISCONNECT" key

- In the presence of a carrier frequency during the local mode, depressing this key causes on-line connection.
- During the connected mode, a simple depression of this key causes a SEP, 4/9 sequence to be sent to the modem module only, whatever the switching or the status of the module. A double depression of the key causes the off-line disconnection of the modem.

Further details are given in chapter 6.

The function keys

- "SEND"
- "PREVIOUS"
- "REPEAT"
- "GUIDE"
- "CANCEL"
- "INDEX"
- "ERASE"
- "NEXT"

2.2.3 Actions of the shift key used with the "ERASE," "REPEAT," "CONNECT/DISCONNECT" keys

These cause a character to be transmitted (see paragraph 1.1.4).

Depressing a function key with the shift key generates controls which are processed by the protocol:

- Shift + "ERASE" (T1 function): programs, by means of the keyboard or the socket, the exchange rate for external peripheral equipment (see chapter 7). No character is transmitted to the modem or socket modules;
- Shift + "REPEAT" (T2 function): serves as a terminal request to the data base for activation of the error connection procedure (see chapter 6). It is ineffective when the terminal is in the local mode. Each time T2 is depressed, the Minitel sends a SEP, 4/A sequence to the data base;

• Shift + "CONNECT/DISCONNECT" (T3 function): causes a SEP, 4/9 sequence to be sent to the socket module regardlessly of the internal switching or module status. In the case of the Br versions of the Minitel, the T3 function followed by another key causes certain sequences to be sent to the socket. T3 followed by a space sends SEP, 4/9.

Table 5.2. **Function keys**

Key inscription	Character code	Character code when using the SHIFT key
SEND	1/3, 4/1	O/D Carriage return
PREVIOUS	1/3, 4/2	1/9, 4/2 Accute accent (´)
REPEAT	1/3, 4/3	1/3, 4/A T2 function: error procedure activation request
GUIDE	1/3, 4/4	1/9, 4/8 Diaresis (¨)
CANCEL	1/3, 4/5	5/C Inverted slash (\)
INDEX	1/3, 4/6	1/9, 4/3 Circumflex accent (^)
ERASE	1/3, 4/7	T1 function: 2 bytes must set the socket exchange rate
NEXT	1/3, 4/8	1/9, 4/1 Grave accent (`)
MAGNIFY	local action no Tx	
SHIFT	no Tx if unaccompanied	
CONNECT/ DISCONNECT	1/3, 4/9 only Tx to the modem	1/3, 4/9 T3 function: the characters are only sent to the socket

3 The teaching mode

The keyboard module is also capable of assuming the "teaching" mode. When activated, depression of the alphabetical keys causes the small letters to be sent instead of the capitals. In this mode the latter are obtained with simultaneous depression with the shift key.

This mode is invoked by a protocol control (see chapter 8).

1 General characteristics

The modem module comprises all the hardware and software elements necessary for Minitel data base connection via the telephone network. These elements are composed of the modem itself, the coupler plus corresponding software and the error correction software.

1.1 Telephone line interfacing

The telephone line interface acts as an adaptor by ensuring the following functions:

- **telephone line switching:** a relay provides telephone line switching to either the telephone (associated to the Minitel for dialing up) or the terminal's modem after on-line connection.

After disconnection the telephone becomes once again available;

- **over-voltage protection;**
- **line current regulation:** a regulator ensures that the established line current remains between 20 to 60 mA.

The set up time, defined as the time required for the current to reach 60 mA after obtaining on line modem switching, must not exceed 5 seconds. However, the modem is able to receive and transmit immediately after switching;

- **impedance matching:** the nominal impedance is 600 ohms with a dismatching ratio of no more than 20% in the voice band.

1.2 The modem

The modem ensures the modulating and demodulating functions, by converting binary signals (used by the Minitel microprocessor) into modulated analogical signals (for on-line transmission) and vice-versa. The modem is capable of being connected either to the telephone line or directly to another modem (functioning in the absence of line current is possible).

The FSK modulation adheres to the V23 CCITT recommendation. The modulation rate allows simultaneous data transmission; at 1200 bauds from the data base to the terminal and 75 bauds in the opposite direction. This configuration can be inverted by Minitels belonging to the "r" family (see chapter 7, paragraph 9).

1.2.1 Modulation

The modulation is a FSK modulation of the microprocessor serial data output (via the coupler). In the basic mode, the frequency shift is +/– 30 Hz for a 420 Hz carrier frequency.

The frequencies used belong to channel 101 defined in the R35 and R70 recommendations of the CCITT. The frequency spectrum conforms to the CNET technical specification n° ST/RTS/TDP/73.

The modulation rates and characteristic frequencies for data transmission are defined below:

modem configuration	rate	bit 0	bit 1	carrier frequency	frequency shift
normal	75 bauds	450 Hz	390 Hz	420 Hz	30 Hz
inverted	1200 bauds	2100 Hz	1300 Hz	1700 Hz	400 Hz

The transmission level is adjusted during assembly and ranges from –6 dBm to –18 dBm. It is currently set to –10 dBm ± 2 dB.

1.2.2 Demodulation

Demodulation takes place by decoding the frequency shifts of the 10 bit characters received. In the normal configuration the frequency shift is +/–400 Hz for a 1700 Hz carrier frequency.

The modulation rates and characteristic frequencies for data reception are the following:

modem configuration	rate	bit 0	bit 1	carrier frequency	frequency shift
normal	1200 bauds	2100 Hz	1300 Hz	1700 Hz	400 Hz
inverted	75 bauds	450 Hz	390 Hz	420 Hz	30 Hz

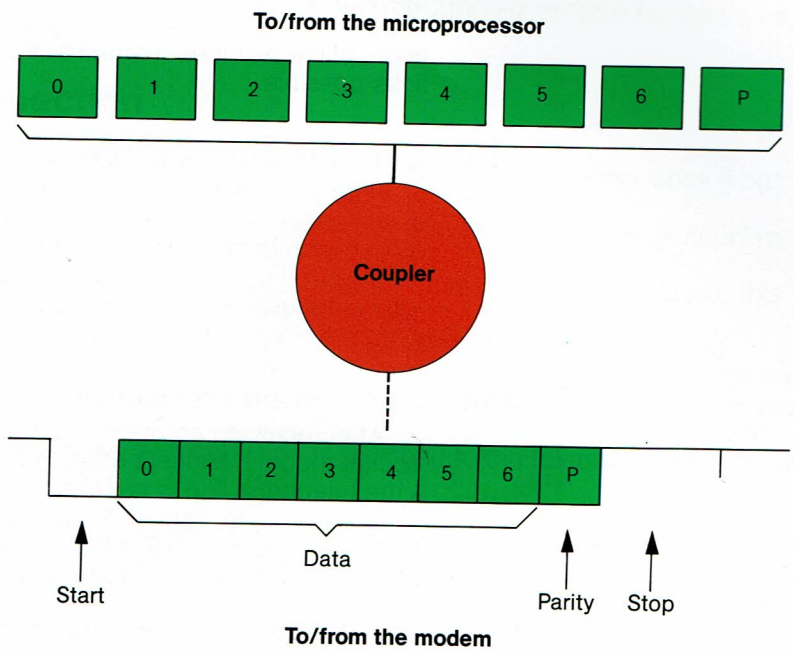
The demodulation uses a detector which declares the carrier frequency present, if the line signal level is greater than –43 dBm or carrier frequency absent, if the level is inferior to –48 dBm. Furthermore, hysterisis is always greater than 2dB. The maximum admissible reception level est –6 dBm.

1.3 The coupler

The modem has an associated asynchronous coupler which serializes and deserializes according to the modem configuration. It also carries out parity checking.

In fact data is transmitted on line in the serial asynchronous mode. Each character begins with a "start" bit and ends with a "stop" bit. There are 7 significant bits (the first received is the LSB) and an even parity bit. See fig. 6.1

Fig. 6.1



This corresponds to a reception rate of 120 characters per second at 1200 bauds and a transmission rate of 7.5 characters per second at 75 bauds. The opposite occurs in the inverted configuration.

When a parity error is detected by the coupler, the protocol (see ch. 8) sends the SUB (1/A) code to the data base and transforms the faulty character into a SUB character displayed as an error character (?).

1.4 Error correction procedure (ECP)

The error correction procedure software lies in the modem module. It corrects errors due to transmission of the 1200 baud data received in order to obtain a correct display of videotex pages.

The detailed functioning figures in paragraph 5.

2 Modem testing

The modem module is always physically available: during the local mode the microprocessor carries out loop testing of the modulator and demodulator following type 3 of recommendation V54.
(See chapter 3 fig. 3.2).

In this case, the modem module systematically retransmits all incoming data. Thus, in the local mode, keyboard inputs (other than function keys) are echoed back to the screen module for display.

This configuration allows the user:

- to get familiarized with the keyboard;
- to test a maximum number of hardware and software components.

3 Line connection-disconnection

The modem module allows Minitel inter-connection to systems also adhering to the V23 recommendations and which operate in the opposite configuration, that is with 1200 baud transmission and 75 baud reception.

Furthermore, the data base modem does not necessarily have to respect the V25 CCITT recommendation procedure (automatic dialing and/or answering of switched telephone calls, including echo suppressor inhibiting when the call takes place between manual switching boards). This procedure makes satellite links possible.

3.1 On-line connection

Minitel modem module connection to a data processing system takes place in two cases:

– After manual action by the user: after calling the host and receiving the data tone (2100 Hz or 1300 Hz) and depressing the "CONNECT/DISCONNECT" key.
– By a control issued by the external peripheral socket module: when the protocol receives the sequences PRO 1, CONNECTION (1/B, 3/9, 6/8).

3.1.1 Connection procedure

After receiving an on-line connection request on behalf of the user or the socket module, Minitel performs the following operations:

- the telephone line is switched to the modem;
- the letter "C" is displayed in the upper right hand corner, row 0 column 39, and the sequence SEP, 5/9 is transmitted;
- the 1300 Hz carrier frequency is continually received from the data base for 1,7 s.;
- the 390 Hz carrier frequency is continually transmitted as soon as 1300 Hz carrier frequency is detected. The transmission takes place only if the software detects the presence of the 1300 Hz tone for a sufficient time, in order to avoid untimely connection due to interferences; otherwise, the software disconnects the modem after a predefined time;
- switch of CD status (Carrier detection) to the active state; then the letter "C" becomes steady and the internal switching is set to connected mode;
- the protocol transmits the new status sequence SEP, 5/3, 80 ms after the 390 Hz transmission of the terminal's modem.

Remarks:
• in order to ensure the connection of all terminals, it is necessary for the data bases **to transmit the 1300 Hz tone for 10 to 20 seconds** in order to allow the carrier detection by the Minitel for at least 1,7 seconds after having depressed "CONNECT/DISCONNECT";
• for V25 data base connection, the software detects a 2100 Hz tone prior to the 1300 Hz tone.
Two cases may occur:
– if the 2100 Hz tone is detected during at least 300 ms by the Minitel's software, connection will occur after having received the 1300 Hz tone for 60 ms;
– if the 2100 Hz tone is not detected, the Minitel awaits the detection of the 1300 Hz tone for 1,7 s. before connecting.
Some terminals are able to connect automatically which means that the terminal does not wait for the carrier frequence to connect the modem on-line. In this case, the terminal searches the carrier frequency for 40 seconds as stated previously.

3.1.2 Minitel reactions

During the connection phase, Minitel behaves in the following manner:
• no erractic displaying during the 2100 Hz connection phase;
• the absence of the 2100 Hz tone during 75 +/–20 ms after its transmission is not interpreted as carrier loss;
• characters keyed in during the time included between the depression of "CONNECT/DISCONNECT" and the effective on-line connection are disregarded. Likewise, if for some reason, characters are sent to the Minitel during this interval, the modem cannot take them into account. As soon as "CONNECT/DISCONNECT" is depressed the 2100 Hz or 1300 Hz data tones are no longer audible.

3.2 Disconnection

Disconnection can be obtained in four cases:
• by the user if he depresses "CONNECT/DISCONNECT" twice (once if on the service index);
• by the data processing system or a peripheral equipment: the protocol must receive PRO 1, DISCONNECTION (1/B, 3/9, 6/7);
• in the absence of the carrier frequency for more than 450 ms. Should this absence be shorter, no erratic display occurs;
• if the user turns off the Minitel and consequently the modem module.

In the 3 former cases, the software orders disconnection and displays the letter "F" in the upper right hand corner (row 0 column 39). The last displayed page remains unaltered on the screen.

In every case, the telephone line is switched to the telephone which again becomes available for normal use.

Note: If a second telephone set is connected in parallel, dialing up is possible and the Minitel will not be disconnected unless the receiving signal level falls below –43 dBm.

3.3 CD signal status

Connection and disconnection modify the CD (carrier detection) status. When the status changes, Minitel returns to the basic modes as regards interna switching, functioning modes, broadcasting, videotex attributes but maintains the socket exchange rate. Moreover, the terminal is in the non transparent mod (see chapter 8 paragraph 2.1) for the modem and socket modules. Full screen masking is positionned only when CD is set to 1 (connected mode) and is not affected otherwise. If the status changes, the data displayed and the cursor position are not altered. The protocol only sends the status change to the input modules, namely the socket and modem modules.

4 Modem inversion

Minitels whose second identification byte in the ROM memory is an "r" can invert their modem exchange rate. Thus the modem can transmit at a rate of 1200 bauds and receive at 75 bauds.

Inversion is used to increase the data flow transmitted by the Minitel when using certain peripheral equipment such as a smart card reader.

4.1 Inversion set-up

The inversion is controlled by the host (concentrator or data base) or requested by a peripheral equipment and is obtained by the following sequences:

- ESC, 3/9, 6/C (PRO1, RET1): modem inversion control for 1200 baud transmission and 75 baud reception;
- ESC, 3/9, 6/D (PRO1, RET2): return to normal mode. The terminals filters the PRO1, RET1 sequence when transmitting at 1200 bauds and PRO1, RET2 whe transmitting at 75 bauds.

4.1.1 Inversion requested by a peripheral equipment

If Minitel is transmitting at 75 bauds (normal Mode)

The peripheral equipment transmits PRO1, RET1: if the modem is already inverted, the protocol reinitializes the inversion procedure; otherwise the termir transmits SEP, 4/C to the videotex network requesting in return an inversion control. The request is filtered out by the videotex network if it considers that inversion is impossible. If inversion is possible, the videotex network seeks the identification of the Minitel, and if compatible ("r" version), sends a PRO1, RET1 sequence.

The PRO1, RET1 sequence is not acknowledged by the protocol. However, after initializing the inversion, the terminal sends SEP, 5/8 to the socket modu When inversion has taken place, the protocol sends SEP, 5/1 to the socket ar modem modules and on the contrary SEP, 5/9 SEP, 5/3 to the socket module in case of inversion failure and hence disconnection.

If Minitel is transmitting at 1200 bauds (inverted mode)

The peripheral equipment sends a PRO1, RET2 sequence. It is transforme by the protocol into the SEP, 4/D sequence and sent to the data base as a "return to normal mode" request. As above, this sequence is not acknowledg by the protocol. The peripheral device awaits a SEP, 5/8, SEP, 5/1 sequence for correct inversion or a SEP, 5/8 followed by a SEP, 5/9, SEP, 5/3 sequence meaning inversion failure and disconnection.

Remarks:

- internal switching permitting, the SEP, 4/C and SEP, 4/D sequences can be directly sent by the peripheral equipment. The SEP, 4/D sequence must alw be filtered out by the videotex network when received at a 75 bauds rate;
- all requests made by the Minitel are resumed in table 8.1.

4.1.2 Inversion requested by the data base

If Minitel is transmitting at 75 bauds (normal mode)

The data base or the videotex network sends a PRO1, RET1 sequence to the Minitel. If terminal inversion is possible, the terminal interrupts the 75 baud carrier frequency, which detected by the network acknowledges the beginning of the inversion. Full acknowledgement is marked by the reception of a SEP, 5/1 sequence transmitted by the Minitel at a 1200 baud rate.

If Minitel is transmitting at 1200 bauds (inverted mode)

After having identified the Minitel's capability of inversion, the videotex network interrupts the 75 baud carrier frequency and awaits a 75 baud carrier frequency transmitted by the Minitel.

To conclude the inversion the network may send the ESC, 3/9, 6/E (PRO1, ACRET) sequence to the Minitel.

Remarks:

- when the error correction procedure is active the inversion controls are the last significant data in the block. The block is completed as required by NUL (0/0) characters;
- passing into the inverted mode automatically inhibits the error correction procedure. However the function status bit remains unaltered;
- if the error correction procedure was active before passing from the normal to the inverted mode, it is automatically reinitialized upon returning to the normal mode. The PRO1, ACRET inversion acknowledgement sent key the data base constitutes the first data bytes in block 00;
- during the inverted mode, all procedure start/stop controls are memorized and immediately acknowledged. In any case, an inversion control or request performed with an already inverted Minitel has no effect.

4.2 Inversion description

4.2.1 The principle

It begins by the suppression of the 75 baud carrier frequency. This is performed by the Master.

A loss of the 1200 baud carrier frequency is considered untimely.

The Master, after having inhibited its carrier wave and conducted its inversion cannot return to the normal mode; if its request is not acknowledged within 450 ms after inversion, the master disconnects itself.

Before ordering the suppression of the 75 baud carrier frequency, the concentrator and Minitel's external peripheral equipment software check that no further repetitions of superior blocks are required.

4.2.2 The slave mode

As soon as the slave no longer detects the 75 baud carrier wave it increments a counter (CP). If a continued silence lasts for more than 70 ms, an inversion control is issued. In the case of the terminal, it sends a SEP, 5/8 sequence to the socket module and transmits a 75 baud carrier wave. The queues are unaltered and the switching between the socket and screen modules is maintained.

The slave seeks to detect a 1200 baud carrier frequency lasting at least 40 ms within a 220 ms time window. During this delay modem data transmission and reception are inhibited. At the end of the 40 ms delay, the software sets the modem rate status bit and enables modem transmission reception. The CP counter is reset and the error correction procedure is inhibited; after a 90 ms delay or after receiving the PRO1, ACRET sequence, it sends SEP, 5/1 to the modem and the socket.

If the 1200 baud carrier frequency is not detected within 220 ms, the slave inverts itself back to normal and transmits the 1200 baud carrier frequency, sends a SEP 5/8 to the socket enables modem transmission and reception and allows normal communication. Such a case results from untimely loss of the 75 baud carrier frequency.

If the software cannot detect an established 75 baud carrier frequency when the counter reaches 450 ms, it is disconnected and the terminal sends SEP, 5/3 to the socket.

Thus 3 possible sequences can be sent to to the socket module when the terminal is the slave:

- successful inversion; the socket receives SEP, 5/8 then SEP, 5/1;
- untimely carrier interruption lasting for less than 450 ms; the socket receives SEP, 5/8 then SEP, 5/8;
- the carrier wave interruption excedes 450 ms, the socket receives SEP, 5/8, SEP, 5/8, SEP, 5/9 and SEP, 5/3.

4.2.3 The Master mode

Upon receiving the control, the Master conducts its inversion and transmits the 1200 baud carrier wave. It sends SEP 5/8 to the socket and seeks to detect an incoming carrier wave for at least 40 ms within a 450 ms time window which corresponds to the delay remaining in the CP counter upon inversion. During this phase, the software inhibits modem data transmission and reception. After 40 ms of carrier wave detection the master sends the acknowdedgement SEP, 5/1 in the case of the Minitel or PRO1, ACRET in the case of the network.

Remark:

In order to avoid rising front detection, the Master begins searching for a continuous 75 baud carrier wave after a certain delay, or after having detected the absence of the 1200 baud carrier wave, which depends on the modem of the Master.

At the end of the delay, if no carrier wave has been detected, the terminal is disconnected and it sends SEP 5/3 to the socket.

When the terminal is the Master, two cases can arise:

- the inversion is successful, the socket receives SEP, 5/8 then SEP, 5/1,
- the inversion fails, the socket receives SEP, 5/8, SEP, 5/9 and SEP, 5/3 sequence.

4.3 Inversion for Minitel interconnection

This mode allows the interconnection of two Minitels. It is obtained by a peripheral equipment request: 1/B, 3/9, 6/F (PRO1, OPPO) and in this case the calling Minitel behaves as a concentrator.

At this point, the above terminal having received the sequence sets the terminal status bit 0 to high and sends the SEP, 5/0 sequence to the socket (see paragraph 8.2.1).

When the user depresses the "CONNECT/DISCONNECT" key, the softwar switches the relay, enables the 1200 baud carrier wave transmission sets up the normal internal switch configuration of the normal mode, positions the CD bit and sends SEP 5/9 to the socket.

In this mode, no 75 baud carrier frequency testing occurs and inversion is impossible.

After disconnection, the Minitel passes into the local mode and status bit is low.

5 Error correction procedure (ECP)

The error correction procedure (ECP) ensures the correct displaying of the videotex pages by countering all the data errors resulting from incoming transmission; these can afflict the data itself, including the parity bit or the synchronization bits "start" and "stop"; the latter generally produce a disrupted display and missing characters.

Observation reveals that more than 50% of videotex pages received in error only comprise one faulty character, which failed to be discovered by the parity check in 10% of the cases.

These results led to adopt for the 1200 baud line, fixed **data block length transmission** accompanied by an error correction procedure based or an extended Hamming code. This offers **a possibility of correcting one erroneous bit per block;** whereas blocks containing more than one error are continually retransmitted until correctly interpreted.

The procedure (ECP) does not apply to the 75 baud line owing to its reduced data rate, reduced interference sensitivity and to the "echo" data transmission.

The invertable Minitels do not have an ECP for 1200 baud transmission.

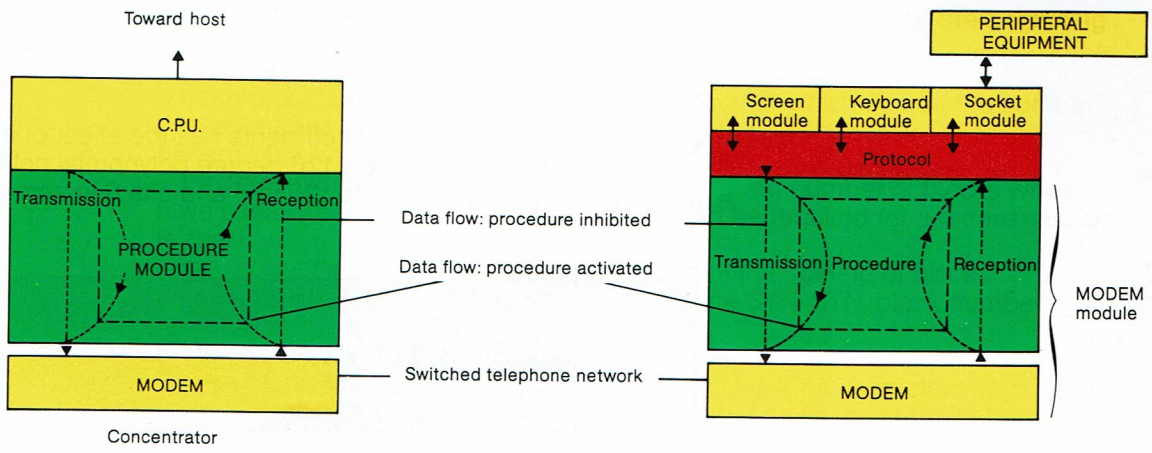
5.1 General description

5.1.1 The function of the procedure in the data link

The ECP contained in the Minitel's modem also resides in the network interface of the data processing system: the concentrator's modem. The constituing functions of the procedure can be programmed in hardware or software.

(In order to simplify explanations, it is supposed that the data base is only accessed through a concentrator.)

Implementation of error correction module

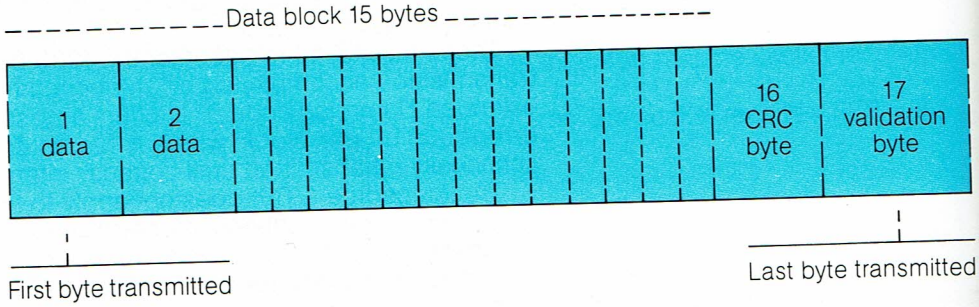


Minitel ECP is programmed by software contained in the microprocessor ROM. It is refered to as the "procedure module".

5.1.2 Data block structure

Minitel interprets bytes made up of 7 data bits plus an even parity bit which begin with a "start" bit and end with a "stop" bit. The LSB is the first received during serial transmission.

The concentrator forms blocks containing 15 data bytes, a cyclic redundancy check (CRC) byte and a validation byte: the latter enables rapid detection of character desynchronization.

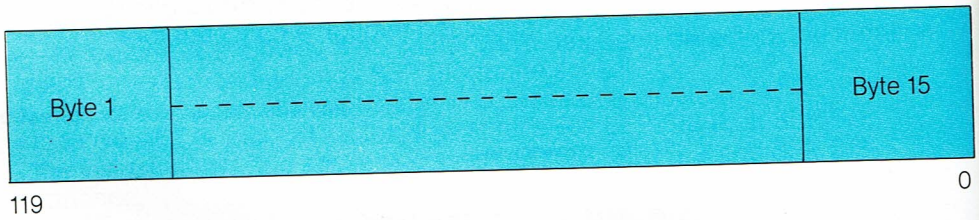


5.1.3 Forming byte 16 (CRC) and byte 17 (validation)

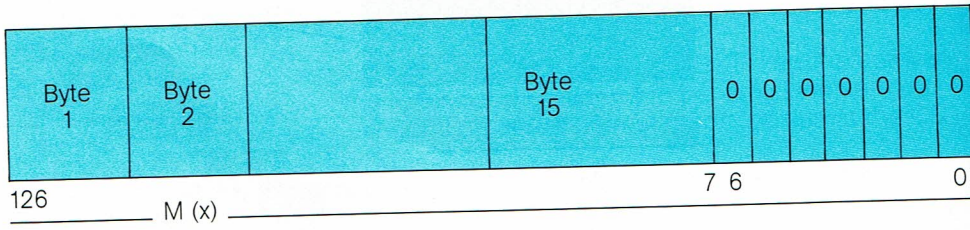
Byte 16 is the remainder resulting from the division of the preceding data bytes by a generating polynomial.

The principle is as follows:

- bytes 1 to 15 are made up of 120 bits which are considered as coefficients of a 119 degree polynomial;



- adjoining byte 16 with null coefficients has the effect of multiplying the polynomial by x^7 giving a new 126 degree polynomial noted M(x). Its coefficients range from bits 126 to 7 and bits 6 to zero are nul;



- the polynomial M (x) is divided by the generating polynomial $G(x) = x^7 + x^3 + 1$. The remainder R (x) is of degree 6;
- the coefficients of R (x) code bits 0 to 6 of byte 16 and bit 7 serves as their parity bit;

• the newly obtained 126 degree polynomial T (x) formed by bytes 1 to 15 and bits 6 to 0 of bytes 16 is perfectly divisible when dividing modulo 2 by the generating polynomial G (x).
• byte 17 (validation) is set to 0.

5.1.4 Operating with ECP

From the concentrator to the Minitel

The concentrator's procedure module receives 7 bit characters from the CPU, calculates the parity bit, forms the data blocks and transmits them to the coupler for serialization.

The Minitel's procedure module receives deserialized characters from its coupler; it counts the number of bytes received in the block and checks the validity and controls their contents by means of the CRC byte:

If correct, the data is sent to a higher level namely the protocol software after elimination of the parity bit (forced to 0).

If incorrect, two cases may occur:
• if a block contains only one erroneous bit the Minitel procedure module proceeds to correct the error before sending the block to the protocol;
• if there are several errors, the Minitel requests the concentrator to reiterate block transmission as from the erroneous block.

It is therefore necessary:
– to be able to identify the block;
– that the transmitter's procedure module be capable of locating a given block for retransmission;
– that the receiver's procedure module be capable of identifying the beginning of a retransmission sequence.

Hence:
– each procedure module has a modulo 16 counter which counts the number of blocks transmitted or received and enables to tally the block transmission/reception for eventual block location;
– the transmitter's procedure module stores a given number of blocks which have already been transmitted but which could be required for a retransmission request;
– the receiver's procedure module is advised of the starting of block retransmission by a resynchronization sequence SYN, SYN, block number.

From the Minitel to the concentrator

The transmission module of the Minitel receives 7 bit characters from the protocol software, calculates the parity bit and transmits the bytes to the serializer. If the Minitel's procedure module requires retransmission of a block from the concentrator it transmits a retransmission request sequence, (NACK, block number) which has priority over all the current data being transmitted by the protocol.

The concentrator's reception module receives deserialized character bytes (7 bits + 1 parity). Its procedure module is continually in search of retransmission requests. The remainder of the incoming characters are transferred to the CPU after having had their parity bits filtered out by the procedure module.

5.1.5 Code transparency

Control characters used during this procedure are also coded on 7 bits plus a parity bit.

The modules must remain transparent to all data exchanged between the terminal and the data base.

In order to ensure this transparency during the procedure, a transparency character (DLE) precedes each control character received by the procedure mode from the CPU or the protocol software.

This character, inserted in the data flow by one of the procedure modules, is filtered out by the other procedure modules upon reception, before transferred the data to a higher level (CPU or protocol).

5.1.6 Starting and stopping the ECP

It is possible to inhibit or activate, the ECP.

These controls belong to the protocol language (see chapter 8) and are not directly interpreted by the **procedure modules**, but by internal concentrator or Minitel software.

Reminder:

- only the concentrator is allowed to inhibit/activate the procedure. Minitel and its peripheral equipment can only obtain inhibition/activation by means of request addressed to the concentrator;
- Minitel's reply to a procedure control issued by the concentrator is a sequence indicating its function mode status.

5.2 Concentrator procedure module functioning

5.2.1 Procedure operation

The procedure is controlled by the CPU and can be activited after the following events:

- Minitel user request (T2);
- Minitel peripheral equipment request;
- Minitel identification request obliging procedure activation;
- insufficient quality of line transmission determined by the fact that the Minitel is sending too many "SUB" characters.

Normal operation

With the concentrator's procedure module inhibited, the CPU begins by sending the enable control to the Minitel (1/3, 4/A) and waits for the reply. Character transmission to the Minitel is at this point inhibited.

The CPU searches amongst the incoming characters from the Minitel for the acknowledgement. The remaining characters are processed normally.

When the sequence is recognized, and the procedure module status bit is active, the concentrator procedure module is activated and character transmission to the Minitel in once again possible.

Failure

Two types of failure may occur because of line disturbance:

- the control sequence is ignored by the Minitel;
- the concentrator fails to recognize acknowledgement.

If after a 1400 ms delay, set by the activation control, the concentrator fails to detect Minitel acknowledgement, the control is reiterated thus rearming a new 1400 ms delay. Eight reiterations are possible and if all unsuccessfull the concentrator disconnects the line.

If the concentrator misinterprets the Minitel's acknowledgement, the latter having activated its procedure module, expects to receive blocks issued by the concentrator. The incoming controls are interpreted as characters belonging to the first block. Since the block is assessed invalid, a repeat control is sent to the concentrator.

After having received more than 5 repeat controls of block 0 (NACK, 4/0) the concentrator may consider the acknowledgement as positive.

In this case, the concentrator's procedure module is activated by two separate internal controls:

- one issued upon receiving explicit Minitel acknowledgement (correct Minitel reply);
- the other after implicit acknowledgement (repeat controls: NACK, 4/0) informing the procedure module that the first block (0) must be preceded by a synchronization sequence (SYN, SYN, 4/0).

5.2.2 Block formation

Forming bytes 1 to 15

The blocks are formed from incoming CPU characters, by the activated procedure module, and comply to the following rules:

- the DLE (transparency) character always precedes a DLE, SYN and NACK issued by the CPU;
- the first character contained in the block cannot be a NUL character. If it should occur, the procedure places the NUL character at the end of the preceding block during its transmission or retransmission (for a repeat request). Thus, all NUL characters appearing after formation of byte 15 of block n will be memorized, thereby allowing byte 1 of block n+1 to contain the first non NUL character found;
- during block formation, a 16 ms time out is set each time a character is received from the CPU. When the delay expires, the block is completed by the stored NUL characters. This allows correct treatment of data flow interruptions and character echoing from the Minitel;
- the procedure module calculates the bit 7 parity bit of each incoming character.

Forming the CRC (bytes 16) and validation (bytes 17)

Byte 16, the CRC, is the remainder of the division of the M (x) 126 degree polynomial by the generating polynomial $G(x) = x^7 + x^3 + 1$.

Byte 17 is forced to zero.

5.2.3 Block transmission

Character block formation begins after procedure module activation.

The blocks are transmitted immediately after formation in a byte 1 to byte 17 order.

The mod 16 block counter is reset to zero upon transmission of the first block (block 0).

The block transmission takes place at the rate of block formation and the counter is incremented after sending a complete block.

The "NUL" characters, having been stored because of exclusion from byte 1 block formation, are transmitted between the blocks. Their transmission has a certain importance. Indeed, certain Minitel processing needs time for execution (eg. CAN in double height) which may lead to input buffer saturation. NUL characters "give time" for processing because they are not stored in the buffer.

A 134 ms time out is set after every block has been transmitted. It reveals block transmission silences. When the delay expires one or several NUL characters are sent to the Minitel to compensate eventual loss of NUL characters during block formation.

5.2.4 Repeat request processing

General treatment

As soon as the concentrator procedure module is activated it searches for repeat request (NACK, X) sequences.

The first character, NACK, signals a repeat request and the second code belonging to column 4 of the G0 set indicates the number of the block on the 4 LSB where repetition must begin.

In order to be able to repeat any required block, the concentrator's procedure module must be capable of storing 16 blocks (because of mod 16 counting).

Reception of a NACK immediately interrupts current block transmission and the X character received causes the transmission of a resynchronization sequence (SYN, SYN, Y).

The block to be retransmitted is located by the Y character which is coded on the 4 LSB in column 4 of the G0 set.

The procedure then resumes transmission as from the required block.

Excluded "NUL" characters are not sent during this phase.

The high transmission rate justifies immediate interruption as soon as the NACK character is received. Indeed, if the entire sequence were necessary before interruption, the time lapse between second character misinterpretation and effective repetition could lead to loss of the required block.

Special treatment

Repeat requests issued by Minitel generally concern blocks sent by the concentrator procedure module.

However, certain disturbances can provoke repeat requests for blocks not yet transmitted. For example, if a repeat request is disrupted or if line noise causes Minitel to receive a sufficient number of erroneous characters to consider them as being a block.

Henceforth, the term "repeatable field" definies the set of blocks stored in the buffer which have already been transmitted; their number does not exceed 15.

With the exception of general treatment where the repeat request is not perturbed and concerns a block in the repeatable field, repeat requests containing an erroneous second character (incorrect parity, configuration or format) or a block number outside the repeatable field are processed as follows:

- if a block is being transmitted the NACK control interrupts the process and the procedure module sends the resynchronization sequence giving the block number of the interrupted block and resumes transmission, from the beginning of the given block;
- in the absence of block transmission, the waiting blocks must be preceded by a resynchronization sequence giving the block number before being transmitted;
- if there is no waiting block, the procedure module stores the request which will be treated as above after block formation.

Detecting a NACK with a parity error has no effect on block repetition and neither does the DLE, NACK sequence. In the latter case, the "DLE" is filtered out by the procedure module and "NACK" is transferred to the CPU.

5.2.5 Procedure inhibition

Just like for procedure activation, procedure inhibition is controlled by the CPU.

Normal operation

The CPU sends a disactivation sequence (1/3, 4/B) to the Minitel and awaits confirmation: meanwhile character transmission to the Minitel is interrupted.

This character sequence is processed by the procedure module and inserted in a block. It occupies the last significant position in the block, the eventual remaining positions being completed by "NUL" characters.

The CPU then seeks the Minitel acknowledgement amongst the incoming characters which continue to be processed normally.

The procedure module which is still active continues to seek out and attend to repeat requests as previously described.

When the CPU recognizes the acknowledgement sequence by the Minitel's procedure module status bit being disactivated, the CPU disactivates the concentrator's procedure module.

Transmission to the Minitel is henceforth performed in the character mode.

Failure processing

Two types of failure may occur because of line disturbance:

- the control sequence is ignored by the Minitel; this rare case may be due to an unrecognizable error configuration;
- the concentrator fails to recognize acknowledgement.

If the after a time out of 1550 ms, set by the inhibition control, the concentrator does not receive acknowledgement, the control is reiterated thus rearming a new time out delay.

Eight reiterations are allowed, and if all are insuccessfull, the concentrator disconnects the line.

5.3 Minitel procedure module operation

5.3.1 Activation

The protocol upon receiving the activation sequence orders the modem module to activate the procedure module and sends its mode status in acknowledgement to the concentrator.

If the activation sequence is received whilst the procedure is already active, the acknowledgement is returned but the procedure is not reinitialized (as opposed to the Cb5 and Cc5 Minitels where initialization does take place).

Procedure module activation causes a reset of the block counter.

5.3.2 Block reception

Minitel's procedure module contains an input buffer where incoming blocks are stored as they are acquired.

The first character received other than a "NUL" after activation is byte 1 of block 0.

A parity check is carried out on bytes 1 to 16; in the case of a parity error, the procedure module positions a flag and stores the byte number in error.

A second flag is positionned if there are several parity errors.

The series of bits constituting bytes 1 to 15 and bits 6 to 0 of byte 16 are considered as coefficients of a 126 degree polynomial noted T' (x).

This polynomial is divided by the generating polynomial G (x) giving a remainder noted R' (x).

In the absence of transmission errors T' (x) must equal T (x) sent by the concentrator and perfectly divisible by G (x). This implies that R' (x) = 0.

A block received is declared valid if byte 17 is NUL with correct parity.

A block is declared correct, if it is valid, if the parity is correct and if R' (x) is NUL.

A block is "correctable", if it is valid, if R' (x) is not NUL and if there is only one parity error.

In all other cases, the block is in error and must be retransmitted.

If a block is correct, or has been corrected, it is transferred to the protocol software; the mod 16 block counter is incremented and the procedure module waits for the next incoming block starting with a non NUL character.

Remark: Framing errors are taken into account. This error is usually due to character desynchronisation and the elimination of erroneous characters would lead to important character loss.

5.3.3 Correct block transferring to the protocol

The procedure module only transfers relevant data to the protocol and filters the following:

- bytes 16 and 17
- "NUL" characters
- "DLE" transparency characters
- All parity bits (bit 7 forced to 0).

In order to avoid discontinuous displaying, relevant data is transferred to the protocol software at the same rate as data reception.

5.3.4 Correction

Error correction is possible if only one bit per bloc is in error.

Correction is undertaken if R' (x) is not NUL and if there is only one parity error.

In this case, it is possible to write $T'(x) = T(x) + x^P$

Where T (x) is the polynomial transmitted

$T'(x)$ is the polynomial received
x^P is the error introduced by transmission
Moreover $T'(x) = G(x)\,Q'(x) + R'(x)$
$T(x) = G(x)\,Q(x)$ since $T(x)$ is perfectly divisible by $G(x)$
Thus $G(x)\,Q'(x) + R'(x) = G(x)\,Q(x) + x^P$
Therefore $R'(x) = x^P \bmod G(x)$

Resolving this equation determines the location of the bit in error.

However, the correction only takes place if the P bit belongs to the byte parity error; Otherwise repetition of the block is requested.

Once corrected, the block is processed normally.

5.3.5 Block repeat requesting

When the procedure module requests the concentrator to repeat a block, it sends the NACK, X sequence.

The transmission has top level priority. However if the procedure module has transmitted a "DLE" character, the "NACK, X" sequence is only sent after the second character of the DLE sequence, which may be a SYN, DLE or NACK character.

The repeat request is sent as soon as a block is found incorrect or invalid, that is with a parity and/or framing error.

5.3.6 Resynchronization after a repeat request

After sending the repeat request, the procedure module waits for a resynchronization sequence "SYN, SYN, X". The X corresponds to the block number requested, coded on bits 0 to 3: after which block reception resumes normally.

The resynchronization sequence begins with a SYN character. When it is detected with correct parity the second character expected is also a "SYN" with correct parity. If not so, the request is renewed. Upon receiving the X character (bit 6 = 1 bit, 5 = bit 4 = 0) it is compared to the number requested and must coincide. If in error, the request is renewed.
Moreover, after sending a repeat request NACK, X a time out is set to a programmed delay between 133.33 ms and 1120 ms. If the resynchronization fails to arrive before delay expiration, the request is renewed and the timer is rearmed.

5.3.7 Stopping the procedure

The controls for procedure inhibition sent by the concentrator are used by the protocol to disactivate the procedure module. The latter returns the functioning mode status to the concentrator in acknowledgement.

When the inhibition control is received by a Minitel whose procedure is already inhibited, the control is ineffective. However functioning mode status is transmitted (Cb5 and Cc5 Minitels do however reinitialize their input buffer).

1 General characteristics

The socket module interfaces the connection of the Minitel to peripheral devices such as a printer, a microcomputer, a smart card reader, an auxiliary keyboard, etc.

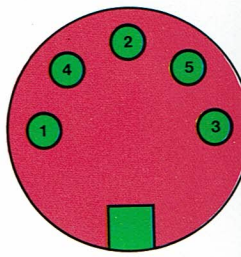
The socket module includes the socket for external connection and a software and/or hardware coupler other than the one used by the modem module.

1.1 The socket

The peripheral equipment socket is a DIN 5 pin female type and has the following characteristics:

- serial transmission;
- serial reception;
- peripheral equipment transmitting;
- Minitel powered;
- ground reference.

The pin layout is as follows:

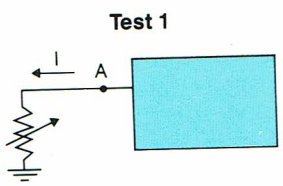


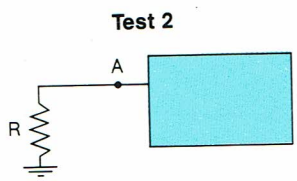
- 1. Minitel data input (RX signal);
- 2. ground reference;
- 3. Minitel data output (TX signal);
- 4. peripheral equipment transmitting (PT signal);
- 5. terminal powered (TP signal).

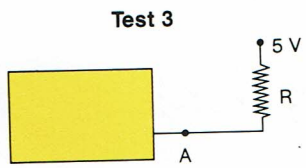
1.2 Electrical levels

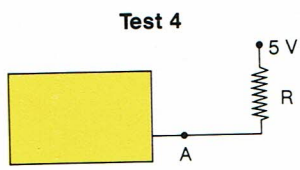
Minitel and the peripheral equipment must meet the requirements defined by the following tests:

• Input	: test 1: if $I < 250\ \mu A$	then $3\ V < V_A < 1$
	: test 2: $R = 120\ \Omega$	then $V_A < 0.4\ V$
• Output High level	: test 3: if $R = 200\ K\Omega$	then $V_A > 2.5\ V$
• Output Low level	: test 4: if $R = 6.8\ K\Omega$	then $V_A < 0.4\ V$









The protective resistor and the interface design enable a maximum voltag of 18 V to be continually applied to the inputs and outputs except for the Cb and Cr terminals (9 V protection).

Short-circuiting pins is not destructive. The 0 logic is obtained by a low le on the pins.

1.3 Link characteristics

The socket module enables full duplex asynchronous transmission at 1200 bauds.

1.3.1 Signal formats

Tx and Rx signals

The reception (RX) and the transmission (TX) of Minitel data signals are carried out in a serial asynchronous mode. The constant format is 7 data bits plus an even parity bit.
(see fig 6.1 – Chapter 6)

PT signal

This signal indicates that the network of peripheral devices connected to Minitel is occupied. It is used as an "active sequence" indicator for the Multiprotocol (see paragraph 7.2). This signal must not be activated when connecting a peripheral device.

TP signal

Powering the Minitel causes the TP (Terminal Powered) to pass from the high to the low state.

Remark: A future version of the Minitel will enable this output to power (5V) low consumption peripheral equipment. However for the time being, powering by TP is not possible.

1.3.2 Exchange rates

The RX and TX exchange rates are programmable.
– 300 or 1200 bauds for the "r" versions (invertable) of the Minitel.
The only authorized rates are:

1200 - 1200
300 - 300

The programming is performed at the keyboard by the user.
The original TELIC versions with non invertible modems also include a 75 baud rate, which gives the following possible exchange rate combinations:

1200 - 1200
300 - 300
75 - 1200
1200 - 75
75 - 75

Furthermore, programming can be obtained either automatically by the peripheral equipment or manually from the keyboard.
In every case, the basic exchange rate is:
1200 - 1200 (see paragraph 3.3).

2 The Multiprotocol

Several peripheral devices can be simultaneously connected to the socket forming a chain network thus allowing data transmission from a transmitter to one or more receivers. Peripheral addressing and access conflicts are not controlled directly by the protocol but at a "superior" level by external software called "Multiprotocol" which acts as a data link manager. Every peripheral equipment connected to Minitel contains Multiprotocol software.
The PT signal allows the chain network status to be known. If free, a peripheral equipment may take the line by forcing the PT signal to a low status.

3 Socket module operation

3.1 Normal internal switching configuration

During the connected mode of the Minitel the incoming data flow from the central system is transferred to the screen and socket modules. Likewise, in the absence of specific switching, the characters received by the socket module are multiplexed before being sent to the data base, with the characters keyed in at the keyboard. Thus the normal switching configuration allows peripheral equipment to be connected without protocol intervention.

During the local mode of the Minitel, the input data to the socket is transferred to the screen, while data keyed-in, is sent to the socket module and the screen module because of modem looping. Minitel, thus behaves as a display monitor operating in a local echo mode.

3.2 PT signal status changes

If the PT signal passes to a low status, Minitel maintains the current switching, socket exchange rates, functioning modes, broadcasting status and current videotex attributes. The socket module is in the non-transparent mode. However the modem remains transparent.

When the PT signal passes to a high status, Minitel restores normal internal switching and socket exchange rates. Moreover, the terminal is in a non transparent mode for socket and modem modules (see chapter 8).

Finally, if the Minitel is in the local mode, it restores the default functioning mode and attributes and ceases broadcasting. However, if in the connected mode it maintains the functioning mode, broadcasting status and current videotex attributes (see table 7.1).

TABLE 7.1

MINITEL REACTION TO CONNECTION OR DISCONNECTION OR TO THE OPENING OR CLOSING OF A MULTIPROTOCOL SESSION

	Socket exch. rate	Cursor	Concealing	Modem Transparency	Socket Transparency	Broadcasting status	Switching	Functioning mode	Attribute
Connection		•*	•	•	•	•	•	•	•
Disconnection		•		•	•	•	•	•	•
Closing a session during local mode	•			•	•	•	•	•	•
Closing a session during connected mode	•			•	•		•		
Opening a session					•				

• = default mode restored.
* = except versions Bc and Br

Each time PT changes status the protocol sends a SEP, 5/4 sequence to the socket and modem modules if the terminal is in the connected mode. In the local mode, status change causes a SEP 5/4 sequence to be sent to the socket and modem modules (in the "b" and "c" versions) and only to the socket module in the "r" version.

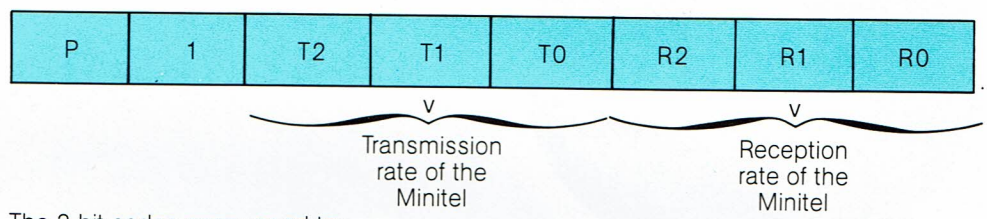
3.3 Programming the exchange rate

After powering the Minitel or after a low/high transition of the PT signal (end of session) the exchange rate between the Minitel and the peripheral equipment is reset to 1200 bauds (basic rate).

At any time, these rates, may be altered either manually by the user at the keyboard or automatically by the peripheral equipment (on versions "b" and "c"). These controls only apply to the exchange rate between the socket and the terminal.

3.3.1 Programming the rate by a peripheral device

This type of programming can only be obtained with "b" and "c" versions of the Minitel. The peripheral equipment modifies its exchange rates by the following sequence: ESC, 3/A, 6/B, exchange rate byte. The format of the exchange rate byte is:



The 3 bit codes correspond to:
001 = 75 bauds / 010 = 300 bauds / 100 = 1200 bauds.

The redefined exchange rates become effective only after the socket module receives a protocol acknowledgment sequence:

ESC, 3/A, 7/5, exchange rate status, which confirms the newly defined exchange rates to the peripheral equipment.

3.3.2 Programming the rate by the user

By means of the keyboard T1 function (shift + "ERASE") the user can modify at any time the exchange rate whatever the terminal status. The programming depends on the Minitel versions.

"b" and "c" versions

Depressing the T1 function followed by two digits, sets the transmission and reception rates respectively to:

T1-1-1 = 75/75 bauds
T1-2-2 = 300/300 bauds
T1-4-4 = 1200/1200 bauds
T1-1-4 = 75/1200 bauds
T1-4-1 = 1200/75 bauds

"r" versions

Depressing the T1 function followed by two digits offers

T1-2-2 = 300/300 bauds
T1-4-4 = 1200/1200 bauds

If incorrect rates are keyed in, the socket rate remains unchanged.

Each high transition of PT resets the programming. Thus the terminal updates its rate status but does send the rate acknowledgment.

1 Introduction

All the modules (screen, keyboard, modem, socket) are controlled by a central system called the **protocol**.

This system, by means of the **protocol language**, performs data switching between the modules and sets particular terminal functioning modes.

The protocol language is not composed of transmittable data and hence does not obey internal switching rules.

The terminal functioning modes comprise the scrolling mode which replaces the page mode, magnifying, the error correction procedure and the teaching mode. Implicitly the page mode is active with all other functioning modes inhibited.

The modules are referred to by a combination of transmission and reception codes belonging the protocol language.

module	transmission code	reception code
screen	5/0	5/8
keyboard	5/1	5/9
modem	5/2	5/A
socket	5/3	5/B

2 The protocol language

Protocol controls and messages established by the protocol are all introduced by different sequences which depend on the number of consecutive bytes.

- ESC, 3/9, X = PRO1, X
- ESC, 3/A, X, Y = PRO2, X, Y
- ESC, 3/B, X, Y, Z = PRO3, X, Y, Z

It should be noted that the 0/5 code (ENQ = identification request) and the ESC, 6/1 (cursor position request) are also protocol controls. Furthermore certain SEP, X sequences are also issued by the protocol.

The above controls are only interpreted by the protocol and are not transmitted to other modules. The protocol generally acknowledges every control received.

2.1 Terminal status

2.1.1 Initial status

After powering, the Minitel is in the following configuration:

- normal internal switching;
- basic functioning mode;
- switching control achnowledgements are not broadcasted;
- the modem and socket modules are in the non transparent mode;
- default videotex attributes;
- the cursor is in the 01-01 location.

Moreover, the terminal sends the SEP, 5/3 sequence to all the receiving modules.

2.1.2 Change of status

During a change of status (see table 8.2) the following sequences are sent.

- SEP, 5/0: change of status due to connection CS (connection status);
- SEP, 5/1: change of MR (modem exchange rate) status;
- SEP, 5/3: change of CD (carrier frequency detection) status;
- SEP, 5/4: change of PT (peripheral equipment transmission) status.

These sequences are sent to all **receiving modules** whatever their availability.

2.1.3 Terminal status

This status reflects the current terminal status. The control format is:

- Request: PRO1, TERMINAL STATUS (7/0)
- Reply : PRO2, REP TERMINAL STATUS (7/1), status byte.

The terminal status byte is formed by:

P	1	0	PT	CD	0	MR	CS

- P : parity bit
- PT : PT pin status (1 = session activated)
- CD : carrier frequency detected (1 = connected)
- MR : Modem exchange rate (1 = 1200 baud terminal reception)
- CS : Terminal status upon connection (1 = Minitel interconnection) see paragraph 4.3.

2.2 Connection – Disconnection

These controls are only addressed to the modem. The disconnect control acts in the same way as a double depression of the "CONNECT/DISCONNECT" (or a 450 ms interruption of the carrier frequency). Minitel then passes into the local mode.

If the protocol receives a connect control, it must ensure modem line connection, in the same way as a simple depression of the "CONNECT/DISCONNECT" key.

The connect/disconnect control can be issued by a peripheral equipment and the disconnect control by the data base. If redundant they become ineffective.

The control format is:
- connection: PRO1, CONNECT (6/8)
- disconnect: PRO1, DISCONNECT (6/7)

2.3 Internal switching controls

2.3.1 Definition

After either powering, connecting or disconnecting the modem or ending a socket session, the Minitel is configured into the normal internal switching mode (see chapter 3) with all the modules activated.

However, the data base or a peripheral device can issue switching controls in order to connect or interrupt transmission between a module and one or more receiving modules.

The given possibilities are:

Receiving module	Transmitting module			
	Socket	Modem	Keyboard	Screen
Socket	•	x	x	
Modem	x	•	x	
Keyboard			•	
Screen	x	x	x	•

x : possible switching
• : general inhibition/activation of the module itself.

The switching controls are effective whatever the module status.

The delays required for transmission and for control processing are not handled by the protocol.

2.3.2 Control format

The switching controls have the following format:

- PRO3, control code, receiver module code, transmitter module code.

The control codes are:

- OFF (6/0) to interrupt the switch
- ON (6/1) to connect the switch.

The protocol recognizes all controls issued by the modules and processes them as they arrive.

2.3.3 Module inhibition/activation

If the transmitter and receiver designation are identical for a switching control, the protocol conducts an inhibit/activate control.

The control format is:

- PRO3, control code, module code, module code.

Inhibition (OFF)

Inhibition of a module interrupts all data exchanges between the given module and those connected to it:

- keyboard: The keyboard is inhibited, with the exception of the magnify key, "CONNECT/DISCONNECT" and the shift T1, T2, T3 function keys.
- screen: Rows 00 to 24 remain unmodifiable except for the row 00 column 39 location which displays local data.
- modem: with the exception of controls received or transmitted by the protocol as well as the SEP, 4/9 (depressing "CONNECT/DISCONNECT" in the connected mode), SEP, 4/A (ECP activation), SEP, 4/B (ECP inhibition) sequences issued by the protocol, no data is able to transit between the modem and connecting modules.
- socket: like the modem module, appart from protocol controls and the SEP, 4/9 (sent after T3) sequence, data transfers are impossible. However the socket exchange rate remains inaltered.

Activating (ON)

The implied module once again becomes available for data exchanges.

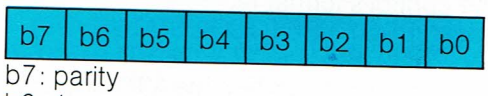
2.3.4 Internal switching status request

In order to avoid conflictual switching (which may occur when a peripheral device wishes a particular configuration already positionned by the data base), each module has the possibility of requesting at any moment an internal switching status. The peripheral device is thus informed of the switching context and of the module transmission/reception status.

The controls include a request and a reply:

- module transmission/reception status request: PRO2, TO (6/2) transmission/reception code;
- status reply (acknowledgement) PRO3, FROM (6/3), transmission/reception code, followed by the module status byte. The reply is only sent by the protocol to the requesting module, regardless of the current internal switching concerning the module;
- module status byte.

The protocol sends a status byte for each module concerned. Depending on the request, this byte contains all the switching information to or from the specified module. The byte format is as follows.



b7: parity
b6: 1
b5: 0
b4: 0
b3: socket
b2: modem
b1: keyboard
b0: screen

1 = connected
0 = disconnected

The status byte also contains the module status itself. The bits belonging to the diagonal in the above table are represented by:
0: module inhibited
1: module active.

2.3.5 Status control acknowledgement

The protocol processes all incoming switching controls and replies after having altered the switching by giving the new status of the receiving module.

The control format is PRO3, FROM (6/3), transmission/reception code, followed by the module status byte.

The acknowledgement is **systematically** sent to the requesting module.

The protocol filters out all the echoed requests received from the data base or a peripheral equipment.

2.3.6 Broadcasting controls

Broadcasting controls allow acknowledgement sequences to be sent to other modules which request updated information on the switching configuration.

Broadcasting control format

The format is the following.
PRO2, control code, reception code.

The control codes are:
BROADCAST (6/5): all internal switching acknowledgements will be sent to the assigned receiver.
CEASE BROADCAST (6/4): the assigned receiving module will only receive acknowledgements for its specific requests.

The Minitel is implicitly in the NON BROADCASTING mode after the following events:
– Minitel powering
– modem line connecting or disconnecting
– leaving a socket session.

The protocol sends a protocol status acknowledgement to the receiver which requests broadcasting.

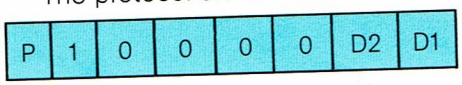
Protocol status

The protocol status indicates the status of the broadcasting of switching acknowledgements.

The control's format is:

- request: PRO1, PROTOCOL STATUS (7/6)
- reply: PRO2, REP PROTOCOL STATUS (7/7), protocol status byte.

The protocol status has the following configuration



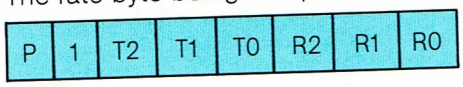
P: parity
D1: 0 if the acknowledgements are broadcasted to the modem.
D2: 0 if the acknowledgements are broadcasted to the socket.

2.4 Socket exchange rate controls

These controls only apply to the "b" and "c" versions of the Minitel. They allow the socket exchange rate to be modified at any time by a peripheral device.

2.4.1 Control format

The control is:
PRO2, PROG (6/B), rate byte.
The rate byte being composed of:



P: parity
T: transmission rate
R: reception rate

001 = 75 bauds
010 = 300 bauds
100 = 1200 bauds

2.4.2 Acknowledgement

The control is acknowledged by the protocol which sends the following sequence to the peripheral device:

PRO2, REP RATE STATUS (7/5), rate status byte (identical to the rate byte).
It is sent at the newly defined exchange rate.

2.4.3 Rate status

This status represents the current exchange rate. The control format is:

- request: PRO1, RATE STATUS (7/4);
- reply: PRO2, REP RATE STATUS (7/5), rate status byte.

Remark:
When the user modifies the rate by means of the keyboard (T1) the status is updated but is not transmitted to any of the modules.

2.5 Ancillary function controls

2.5.1 Control formats

- activation: PRO2, START (6/9), function mode
- inhibition : PRO2, STOP (6/A), function mode.

The existing function modes are:

- 4/3: scrolling mode;
- 4/4: error correction procedure (ECP);
- 4/5: teaching mode (small letters at the keyboard);
- 4/6: upper-half magnifying;
- 4/7: lower-half magnifying.

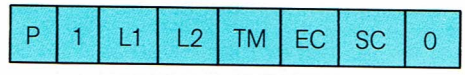
These controls can be sent either by the data base or a peripheral device.

Remarks:
– the ECP only applies to the data base/terminal link
– when the modem module orders a change of mode, the protocol sends the SEP 5/6 sequence to the socket.
– However when a change of mode is ordered by the socket module, the above sequence is not sent to the modem.

2.5.2 Acknowledgement

These controls are acknowledged by the following protocol sequence: PRO2, REP FUNCTION STATUS (7/3), function status byte.

The latter is composed of:



P: parity

L1, L2: magnifying
00: absence
01: upper
10: lower

TM: teaching mode (1 = active)
EC: error correction procedure (1 = active)
SC: scrolling (1 = active)

The ECP inhibit/enable controls acquired by the socket are not acknowledged by the protocol because they are processed by Minitel and transferred to the data base.

2.5.3 Function mode status

This status represents the current functioning modes:
- request: PRO1, FUNCTION STATUS (7/2);
- reply: PRO2, REP FUNCTION STATUS (7/3), status function byte.

Remarks:
– depressing the keyboard magnify function updates the status mode, but does not send an acknowledgement.
– the magnifying function is lost when passing to the scrolling mode. Here again, no acknowledgement is sent.
– the terminal filters out all the sequences, such as the status requests, which are received in echo from the data base or a peripheral device.

2.6 Error correction procedure controls

2.6.1 Activating the procedure

The ECP is initialized by the data base/videotex network, by the user (T2 function) or by a peripheral device. However, it should be noted that it is always the videotex network which carries out activation and inhibition controls.

After depressing the T2 function or a PRO2, START PROCEDURE control sequence issued by a peripheral device, the protocol sends a SEP, 4/A sequence to the concentrator whatever the switching or status of the modem module. In return, the concentrator sends a PRO2, START PROCEDURE sequence to the Minitel which constitutes the real activation sequence. The protocol replies to the concentrator by sending its function mode status. (see paragraph 2.5).

2.6.2 Inhibition

The Minitel inhibits the ECP after receiving a PRO2, STOP, PROCEDURE sequence from the data base.

The T2 function can also be used as an inhibition request.

When the socket module receives the PRO2, STOP PROCEDURE sequence from a peripheral device, the protocol sends a SEP, 4/B to the data base, whatever the switching or status of the modem module, which acts as an inhibition request.

Remarks:

- a peripheral device may, if the internal switching is adequate, send the SEP, 4/A and SEP, 4/B sequences directly to the data base.
- the peripheral device requests are not acknowledged by the protocol.

2.7 Modem inversion controls

The modem inversion requests issued by the data base or a peripheral equipment are:

- PRO1, RET1 (6/C): modem inversion so that the Minitel can transmit at 1200 bauds and receive at 75 bauds;
- PRO1, RET2 (6/D): return to normal control;
- PRO1, ACRET (6/E): return to normal acknowledgement.

The interconnection of Minitel is always set by a peripheral which sends:

- PRO1, OPPO, 6/F and is acknowledged by a SEP, 5/0 sequence to the socket.

The "Br" versions of the Minitels, pass from the interconnected to the slave mode by the control: PRO2, OPPORE (6/F, 3/1);

- this allows 1200 bauds half duplex transmission between the Minitels. The control is acknowledged by the PRO2, REP TERMINAL STATUS, status byte, sequence which is sent to the requesting module.

An inversion request or control is ineffective if the modem is already inverted. The inversion automatically interrupts the ECP. Following inversion, the acknowledgement is sent to the modem and socket modules (see paragraph 2.1). After returning to the normal state, the ECP resumes with block counting beginning at zero.

2.8 Transparent mode

The transparent mode sequence is:

- PRO2, TRANSPARENCY (6/6), number of bytes.

Issued by the socket or the modem module it warns the protocol not process the bytes that follow.

This allows masking of one to 127 bytes. NUL bytes (0/0) are not taken into account if issued by the modem module.

The protocol acknowledges the sequence by SEP, 5/7 which is sent to the requesting module.

After receiving the given number of bytes, the return to the non-transparent mode is not declared.

A party error detected on the number of bytes causes the control to be ignored and the acknowledgement not to be sent.

When the ECP is active, the number of bytes corresponds to the bytes transferred from the modem to the protocol.

2.9 Identification request and remote loading

The data base on the videotex network is able to:
- write identification data into non volatile Minitel memory blocks, RAM1 (16 bytes) and RAM2 (16 bytes) by means of the remote loading procedure;
- to read identification data stored in these blocks or in the microprocessor ROM.

The ROM block contains three bytes included between SOH and EOT characters. These bytes respectively represent:
– the Minitel constructor
– the Minitel version
– the software version.
The reference table figures in table 8.3.

Remote loading and identification requests are controlled by the protocol. The reply is never sent to the socket module. Moreover, the latter is unable to conduct remote loading and all its identification requests are ignored by the protocol.

2.9.1 Remote loading

The loading sequences are:
- PRO1, IDEN1 (7/8) for RAM1;
- PRO1, IDEN2 (7/9) for RAM2.

The protocol stores, for each block, all the characters (except NUL) which follow the sequence until it meets a EOT (0/4) or the 16th byte. A parity error in the sequence causes a SUB (1/A) character to be sent to the data base to replace the erroneous character in the RAM.

2.9.2 Identification request

The sequences are as follows:
- ENQ (0/5) for RAM1 block;
- PRO1, ENQRAM (7/A) for RAM2 block;
- PRO1, ENQROM (7/B) for the ROM data.

If the SOH (0/1) characters precedes either one of the remote loaded blocks (RAM1 or RAM2), the protocol responds to the identification request by sending the stored data until it meets an EOT character (or the 16th byte). In the absence of the SOH character heading the field, the protocol does not acknowledge the request.

2.10 Cursor position request

A peripheral device or the data base may at any time request the cursor position on the screen. The reply is sent to the requesting whatever the switching status.

The formats are as follows:
- request: ESC 6/1;
- reply: US, Row, Column.

2.11 Protocol filters

2.11.1 The general case

The protocol must not take into account certain controls which are issued by the modem and socket modules.

Hence, the protocol filters:

- sequences received from the data base or a peripheral device:
  - PRO3, FROM, transmission/reception code, byte
  - PRO2, REP TERMINAL STATUS
  - PRO2, REP FUNCTIONING STATUS
  - PRO2, REP EXCHANGE RATE STATUS
  - PRO2, REP PROTOCOL STATUS
  - PRO1, X
  - PRO2, X, Y — X, Y, Z being undefined protocol characters
  - PRO3, X, Y, Z,
- sequences received from a peripheral device:
  - ENQ
  - PRO1, ENQRAM
  - PRO1, ENQROM
- exchange rate programming by the data base:
  - PRO2, PROG, X.

2.11.2 Special filters

- the NUL (0/0) character is always filtered out by the modem module, even when belonging to a sequence preceded by ESC (1/B) SEP (1/3), US (1/F), REP (1/2), SS2 (1/9);
- the remote loading sequences PRO1, IDEN1 and PRO1, IDEN2 issued by the data base initialize RAM storing but are not forwarded to other modules;
- the same applies to the ENQ character and the PRO1, ENQRAM and PRO1, ENQROM sequences issued by the data base;
- the ESC, 6/1 sequence which calls for the cursor position is not transferred to other modules;
- the PRO2, START, PROCEDURE and PRO2, STOP, PROCEDURE sequences, issued by a peripheral device are processed by the protocol and transformed into a SEP, 4/A respectively SEP, 4/B sequence which is sent by the modem;
- during the ECP, DLE, NACK and SYN characters issued by the socket module are sent to the concentrator preceded by a DLE character. Furthermore, the latter when preceding sequences issued by the data base are filtered out before sending the data to the socket module;
- the ESC character is never sent to a module without subsequent characters.

2.11.3 Sequence processing priorities

• the protocol during the transparent mode, processes with priority ENQ characters and all protocol sequences SEP, US, REP, SS2, sequences preceded by ESC. However the ENQ character in a sequence preceded by ESC has no priority. Likewise, two consecutive ESC characters or ESC, ENQ are not taken into account by the protocol or screen, but are transferred according to the current switching;
• the screen module cancels all interrupted SEP, US, REP, SS2 sequences preceded by ESC other than protocol sequences. But the protocol transfers all incoming characters (included SEP, US, REP and SS2) according to the current switching with the exception of the protocol sequences and the ENQ character when not included in a sequence beginning with ESC;
• during the transparent mode, protocol sequences and ENQ characters are not processed after the reception of an ESC, 2/5 sequence until the reception of an "end of transparency" sequence;
• during transmission, the repeat requests (NACK, X) have maximum priority; then come the identification replies and the contents of the transmission buffer.

2.12 Error processing

2.12.1 Parity errors

A parity error detected by the protocol is transformed into a SUB (1/A) character, which is transferred according to internal switching. It is also sent to the issuing module.

2.12.2 Control syntax errors

A syntax error in a control (or a parity error) causes the protocol to ignore and to refrain from acknowledging the control. The issuing module having received no reply nor a SUB character sets a time-out delay.

Protocol controls

	Mnemonic	Code	Syntax	Action
1	OFF	6/0	1/B, 3/B, 6/0, RX module code, TX module code	• Inhibit switching
2	ON	6/1	1/B, 3/B, 6/1, RX module code, TX module code	• Enable switching
3	TO	6/2	1/B, 3/A, 6/2, RX or TX module code	• Module status request
4	FROM	6/3	1/B, 3/B, 6/3, RX or TX module code, status byte	• Status request acknowledgement
5	NO BROADCAST	6/4	1/B, 3/A, 6/4, RX module code	• Acknowledgement is only sent to the requesting module
6	BROADCAST	6/5	1/B, 3/A, 6/5, RX module code	• All acknowledgements are sent to the receiver
7	TRANSPARENCY	6/6	1/B, 3/A, 6/6, number of bytes	• Transparency to the protocol of following data
8	DISCONNECT	6/7	1/B, 3/9, 6/7,	• Off-line disconnection of the modem
9	CONNECT	6/8	1/B, 3/9, 6/8	• On-line connection of the modem
10	START	6/9	1/B, 3/A, 6/9, functioning mode	• Start particular functioning of peripheral equipment
11	STOP	6/A	1/B, 3/A, 6/A, functioning mode	• Stop particular functioning of peripheral equipment
12	PROG	6/B	1/B, 3/A, 6/B, exchange rate byte	• Programming of the socket exchange rate
13	RET1	6/C	1/B, 3/9, 6/C	• Modem inversion
14	RET2	6/D	1/B, 3/9, 6/D	• Revert to normal mode
15	ACRET	6/E	1/B, 3/9, 6/E	• Inversion acknowledgement
16	OPPO	6/F	1/B, 3/9, 6/F	• Inversion for interconnection
17	OPPORE	6/F, 3/1	1/B, 3/A, 6/F, 3/1	• Pass from interconnected made to slave mode
18	TERMINAL STATUS	7/0	1/B, 3/9, 7/0	• Terminal status request
19	REP TERMINAL STATUS	7/1	1/B, 3/A, 7/1, terminal status byte	• Status reply
20	FUNCTIONING STATUS	7/2	1/B, 3/9, 7/2	• Functioning status request
21	REP FUNCTIONING STATUS	7/3	1/B, 3/A, 7/3, functioning status byte	• Functioning reply
22	EXCHANGE RATE STATUS	7/4	1/B, 3/9, 7/4	• Exchange rate status
23	REP EXCHANGE RATE STATUS	7/5	1/B, 3/9, 7/5, rate byte	• Exchange rate reply
24	PROTOCOL STATUS	7/6	1/B, 3/9, 7/6	• Protocol status request
25	REP PROTOCOLE STATUS	7/7	1/B, 3/A, 7/7, protocol byte	• Protocol status reply
26	IDENT1	7/8	1/B, 3/9, 7/8	• Block 1 remote loading prefix
27	IDENT2	7/9	1/B, 3/9, 7/9	• Block 2 remote loading prefix
28	ENQ RAM	7/A	1/B, 3/9, 7/A	• Block 2 identification
29	ENQ ROM	7/B	1/B, 3/9, 7/B	• Terminal identification

Table 8.1

Protocol sequences

Sequence	Action
1/3, 4/1	SEND key
1/3, 4/2	PREVIOUS key
1/3, 4/3	REPEAT key
1/3, 4/4	GUIDE key
1/3, 4/5	CANCEL key
1/3, 4/6	INDEX key
1/3, 4/7	ERASE key
1/3, 4/8	NEXT key
1/3, 4/9	CONNECT/DISCONNECT key
1/3, 4/A	Error correction procedure activation
1/3, 4/B	Inhibit ECP
1/3, 4/C	Modem inversion request (TX = 1200 bauds)
1/3, 4/D	Modem return to normal request (TX = 75 bauds)
1/3, 5/0	Status change upon connection
1/3, 5/1	Change of modem exchange rate
1/3, 5/2	Line connected/disconnected
1/3, 5/3	Modem connected/disconnected
1/3, 5/4	PT status change
1/3, 5/5	Auxiliary software modules connected/disconnected
1/3, 5/6	Functioning mode status change
1/3, 5/7	Transparency acknowledgement
1/3, 5/8	Start of inversion procedure
1/3, 5/9	Connect/disconnect phase

ROM identity bytes

Byte 1: Minitel constructor	
A : MATRA - TEMAT	Minitel commercialised by the French PTT/DGT
B : LA RADIOTECHNIQUE - TRT	
C : TELIC-ALCATEL	
D : THOMSON	
E : CCS	
F : FIET	
G : FIME	
H : UNITEL	
I : OPTION	
J : BULL	
K : TELEMATIQUE	
Byte 2: Minitel version	
b : Minitel M1 with ABCD keyboard	
c : Minitel M1 with AZERTY keyboard	
d : Minitel M10 with AZERTY keyboard	
e : Minitel colour CRT with video input and overlaying	
h : calculator emulating a Minitel	
j : printer	
r : Minitel M1 with invertable modem	
s : Minitel M1 with non invertable modem	
Byte 3: software version	

Table 8.2

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