TELETEXT AND VIEWDATA SYSTEMS AND THEIR POSSIBLE EXTENSION TO EUROPE AND USA

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INTRODUCTION

In this paper it is proposed to explore the extension of the UK Viewdata and Teletext systems primarily into the USA but also to Europe. The paper is complementary to the paper by N.E. Tanton, BBC, entitled 'UK Teletext – Evolution and Potential'. In adapting and extending an existing system it is worth recognising the basic starting points. For the UK Teletext and Viewdata systems these can be summed up as follows:

1) decoder costs,
2) ease of use by the end user.

The cost of the basic decoding system was considered to be one of the prime parameters of the whole system. The price increment of including Teletext into the domestic tv receiver was targetted at significantly less than 10% and 20% for a combined Teletext and Viewdata system. It was considered that unless these targets were achieved, the market size would not be sufficient to achieve the economy in scale essential for the success of the project. For this reason the system specifications were a collaborative effort between the broadcasters, the Post Office, the set makers, and the IC manufacturers. There are already good signs that the initial concepts were correct.

In setting up the systems specifications, to a large extent it is Teletext which imposes most of the constraints, and for this reason will be the major subject of the paper.

THE BASIC TELETEXT/VIEWDATA DECODER

To understand the consequences of changing the systems to NTSC standards, it is necessary to understand the basic decoder requirements. Fig.1 shows the main sections of a combined decoder.

The section marked Teletext demodulator is a linear circuit. It is in this section that the incoming video signal is converted into a digital signal and a synchronous clock generated. Further, if the full opportunities of Teletext are to be realised such as sub-titling and news-flash, then the display timing system of the decoder has to be locked to the incoming picture signal. This function is also performed within the Teletext demodulator.

The acquisition circuit selects the user-requested page from the incoming serial bit stream. It then converts the signal into bytes of information with an appropriate address and writes the data into a definite location in the page memory. In any Teletext system this process, for speed reasons, has to be handled by dedicated logic.

The Viewdata demodulator is a conventional modem in which the specification on signal-to-noise ratio has been slightly relaxed taking account that only short line working will be required.

The Viewdata acquisition again takes the incoming data stream and converts it into bytes of data with an appropriate address for direct insertion into memory. In the Viewdata system the acquisition circuit also converts the user requests to the central data base into an outgoing data stream. Finally all the automatic call set up, shut down, and identification procedures are handled in this section.

The procedures employed in both these Viewdata sections are largely covered by international standards (CCITT) and this section could be transferred in principle directly to the US and European markets without significant change.

The page memory holds a complete page of data in coded form (ASCII) whilst the character generator converts the digitally-coded signal stored in memory into video signal for display on the picture tube.

The timing section provides the timing signals (line flyback and field flyback pulses) and also addresses both the memory and the character generator to ensure the information is displayed on the correct location on screen.

It is essential for economic reasons that the above three sections are common to both Teletext and Viewdata.

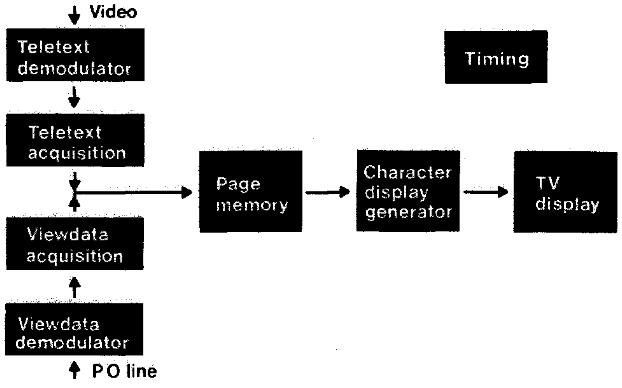

Fig.1 – Basic Teletext and Viewdata system

Significant changes will be required in this area for operation on NTSC as will be discussed later.

The user interface has to interpret user requests and instruct the rest of the decoder. In present systems this is performed by dedicated logic circuits but, in future, it could be handled with advantage by a micro-computer.

There are two main areas to be examined in converting the present UK Teletext and Viewdata systems for NTSC based television sets:

1) transmission format of Teletext,
2) the display format.

The latter point affects both Viewdata and Teletext. However, the implication on Viewdata occurs only in the main data base software and the decoder character generator but not the transmission system. In Teletext it has also a direct implication on the transmission strategy and the acquisition circuits.

TELETEXT SYSTEM CONSTRAINTS

In designing a Teletext system two major factors have to be recognised.

1) Teletext unlike other data communication systems is non-interactive.
2) The data rate is 1 M byte/s.

The non-interactive nature of the Teletext system is perhaps the more important factor. It affects the method of transmission adopted and decoder design; in particular, the techniques adopted for transmission error protection and the need to give apparent user interaction.

There are essentially two ways in which the end user can obtain a piece of desired information from the Teletext system. The first is that he be told in advance of the time of transmission, in much the same way as a tv programme, and therefore be ready to request the page at that time. Alternatively, all the data is transmitted cyclically and the user has to wait for the time in the cycle for the specific data to be transmitted. Both these strategies have been built into the UK system.

The user feedback and error strategies have been based on the cyclical nature of the majority of information. Single transmission of timed information can only be achieved reliably and economically in any Teletext system if the data is transmitted two or three times.

The high data rate, particularly if a whole tv channel is devoted to Teletext, requires special consideration from the decoder designer's point of view. There is no software-based system that could process and sort data at this rate, and consequently the coding system adopted has to minimise the dedicated logic necessary in the decoder to select the data requested and transfer it direct to memory in an ordered manner.

ANALYSIS OF BASIC TRANSMISSION SYSTEM ADOPTED IN UK

The basic format of the data transmission is shown in Fig.2. Essentially, the data stream is located on the tv line in the space normally occupied by video. NRZ coding has been employed for coding a binary bit and transmitted as a raised cosine, see Fig.3. The data stream has been divided up into bytes of 8 bits each and these are further divided as shown into three groups: sync, address, and data. The line flyback pulses are an important part of the Teletext signal and would be required if the whole channel were given over to test transmission.

In essence, the line sync pulses give reliable marking of a packet of data and act as a flag for the synchronisation data (both bit and byte synchronisation). This allows the decoder to readily and reliably keep the data clock in synchronism with the data.

The line flyback pulse is also employed in UK Teletext to flag the address information. Again, to simplify decoder design, the address gives adequate information to the decoder of the nature and precise location in memory of the following data and as a consequence its location on the

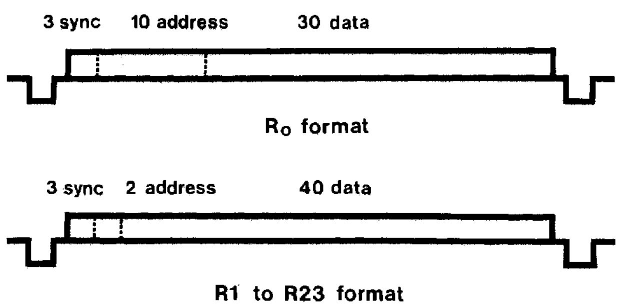

Fig.2 — UK Teletext packet formats

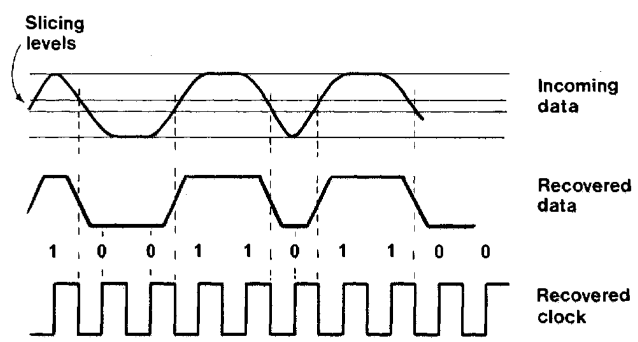

Fig.3 — Data and clock recovery

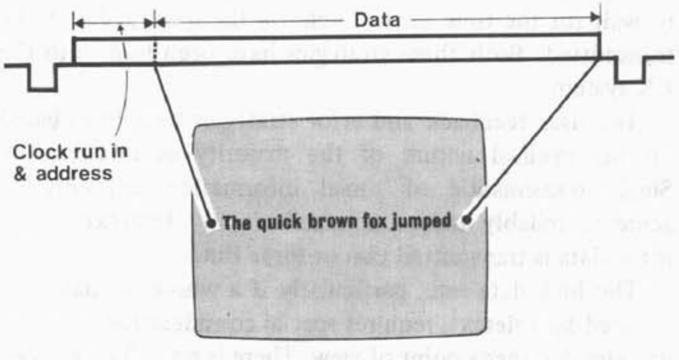

Fig.4 – Direct relationship between data on tv line and display row

final display, see Fig.4. In this way only address data has to be processed at the high incoming data rate.

It is recognised that a page of data will be made up of several packets of data and that certain address information would be common to every packet. To economise in transmission time, two types of packet are defined as shown in Fig.2.

The R_0 packet contains all the common address information for a page of text consisting of several packets of data. The R_0 packet marks the start and finish of a page.

The data to be transmitted may then be divided into a maximum of 32 packets with a unique address location in the decoder memory. In the packets labelled R_1 to R_{31} minimum addressing is incorporated to identify the packet. In this manner the throughput of data is maximised. It should be recognised that one unrequired address bit per packet represents the loss of approximately one packet of message data per page.

The amount of data incorporated in a packet is dependent on the bandwidth of the tv network. In Europe 45 bytes can be reliably transmitted, which permits one row of the final display to be transmitted within one tv line. The bandwidth of the NTSC system will not allow this data rate and an alternative method of packaging will be required. This will be discussed later.

DESIGN ADVANTAGES OF DIRECT ADDRESSING SYSTEM

There are three instances where the fixed relationship between the transmitted data and display data on a tv line is of importance. The first is when the user requests a new page; the second when errors occur in the transmission; and lastly, in the future when full channel Teletext transmissions are implemented.

To cover the first aspect, all present LSI decoders display on screen every page header. Since the page number is always transmitted in the same location, it will appear on screen as a continually changing or rolling display. It has been arranged that the page number rolls from the instant the new page is requested until its acquisition. The user is given immediate feedback; the system is functioning correctly even though the page requested is not being transmitted. Other variants on the facility are clearly possible but they can only be achieved economically if the one-to-one relationship exists.

More important, is to examine the effects of errors in a transmission. If errors occur in any Teletext system, either detected or undetected, the only possible action is to wait for a repeat transmission. Furthermore, since errors are likely to be caused by noise, probably aided by other distortion phenomena (reflections, asymmetric distortions in equipment, and co-channel interference), it is probable that the next reception of the required text will contain errors but in new locations. Advantage can be taken of this fact if the coding system is well chosen. It can be arranged that an integration of correct text automatically takes place by the use of simple parity checks over two or three receptions of the wanted data. For this to be achieved, it is vital that the page selection and the page formatting information are protected against disturbance. Hamming codes for the protection and correction of the address data are employed. The correction is important in that it ensures that the following valid "good" data is not rejected due to a 1 bit error in the address with a consequent extension of the access time of a specific page.

For decoder design, it is essential that the non-standard code (e.g. Hamming protected address) is marked by a flag that can be readily recognised.

In the UK synchronous system the page formatting data always occurs at the start of a tv line and, in essence, the line sync pulses act as the flag. The normal flywheel techniques give complete protection to this method of flagging.

More recent work on multilanguage systems (Ref.1) has led to a technique of achieving greater security on the data than is achieved with the simple parity system by a small addition to the decoder as shown in Fig.5.

The memory has been increased from 1K7 to 1K8 of which 1K7 are employed to store the page of data. The eighth bit is employed as a status bit for the associate byte

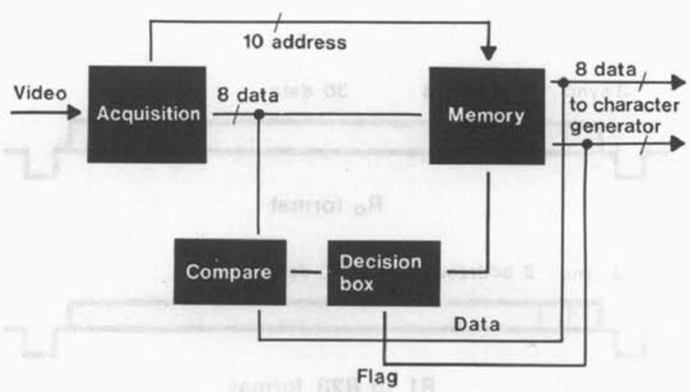

Fig.5 – Strategy for polyglot system

Status of new data	Present flag status	Comparison old & new data	New data into memory	New flag
First reception	–	–	Write	0
Second & subsequent	1	Agrees	Write	1
Second & subsequent	0	Agrees	Write	1
Second & subsequent	1	Disagrees	No	0
Second & subsequent	0	Disagrees	Write	0

Fig.6 – Error strategy

of data. Incoming information is only written into memory after a comparison between it and the data already stored and the status bit. The decision table is given in Fig.6.

In conclusion, it is worth mentioning that conventional methods of protecting serial data such as BCC or CRC are not as effective as the combination of majority decision described above and Hamming protection, although they can be very effective in giving confidence that the data in memory is correct particularly if it contains important numeric data.

Another important advantage of the simple relationship in decoder design arises when the system is extended by inserting data on more lines than the two tv lines currently employed.

A number of organisations are already investigating systems which would dedicate a tv channel to Teletext on 625/525 lines for at least part of the day. In these circumstances data will arrive at approximately 1 M byte/s. This has to be processed and sorted as it comes in unless severe constraints are imposed on the order in which data is transmitted and, in addition, considerable buffer stores incorporated in the decoder with the consequential cost penalty.

With the present simple relationship the data can be readily processed as it arrives and present day decoders can already be adapted with minor change to full 625/525 line operation.

It is of interest to note that 625 line operation would give the possibility of 10 000 full pages with a cycle time of ½ minute, whilst the decoders today already have the capability of selecting 1 out of 2½ million pages.

One of the penalties often attributed to the fixed format concept is the use of serial picture attributes (colour, etc.) as opposed to parallel. Both definitions of picture attributes can be transmitted by the UK direct addressing method. It was, however, a conscious decision at the time of writing the UK specification to adopt serial attributes. Parallel attributes increase the cost of the decoder (at least twice size of memory) and cause an indeterminate increase in the transmission time.

IMPLEMENTATION OF TELETEXT ON NTSC

There are two inter-related aspects to be reviewed: the page format and the transmission data bit rate.

In one solution the one-to-one relationship between data on tv line and the displayed row is retained. In the other the two are optimised independently. In the first solution the existing UK hardware can be employed but an undesirable compromise has to be taken between two conflicting requirements. An alternative system is examined which avoids the conflict between data format and transmission data rate. The second proposal allows field trials to be undertaken over a wide range of data rates.

Page Format

In Europe the page format adopted is 40 characters/row and 24 rows/page. Experience in the UK suggests that editorially it is undesirable to reduce the number of displayed characters below 40. It is also recognised that there is a desire in the USA to implement Teletext via set-top adaptors as well as incorporating them with the tv receiver as is generally practised in Europe.

Thus a bandwidth constraint is imposed on the created Teletext video signal as well as on the incoming data. The factors which determine the outgoing signal bandwidth are shown in Figs.7 and 8. It will be seen that a 40 character display is possible within the NTSC system provided it is not associated with the incoming signal rate.

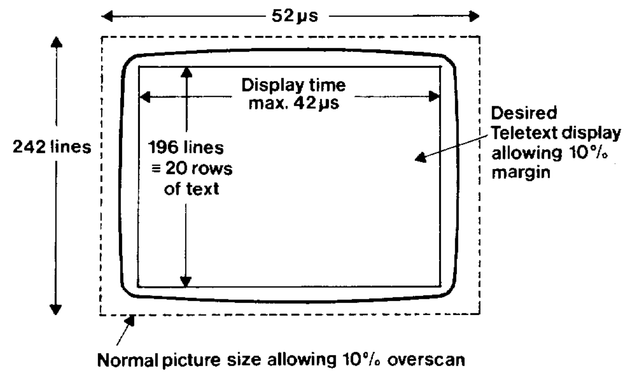

Fig.7 – Factors affecting display of Teletext

No. of characters displayed per row	Display time in µs	Display time per character µs	6 dots/character Display clock rate MHz	Highest fundamental freq. MHz
40	40	1·0	6·0	3·0
	45	1·125	5·3	2·6
32	34	1·0	5·6	2·8
	40	1·25	4·8	2·4

Fig.8 – Display bandwidth for two format strategies

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The number of rows to be displayed is limited by the number of tv lines visible on the screen. A minimum of 10 lines is required to form a row of characters (upper and lower case) which leads to an optimum page format of 40 characters per row and 20 rows.

Transmission Strategy for NTSC

At this stage in the Teletext field trials in the USA, there is no information as to the maximum data rate that can be handled by the NTSC system. For this reason, a number of alternative solutions are given in Fig.9 whilst the basic principles are shown in Fig.10 by a single example.

Display 40 characters/row and 20 rows/page

Data bytes on received data line	Incoming data clock rate (MHz)	Pages per second at 2 data/frame	Pages as % of PAL systems
20	3·8	3	-27
24	4·4	3·6	-12
27	4·9	4	0
30	5·4	4·5	+10
32	5·7	4·8	+17

Fig.9 – Selection of strategies for Teletext on NTSC

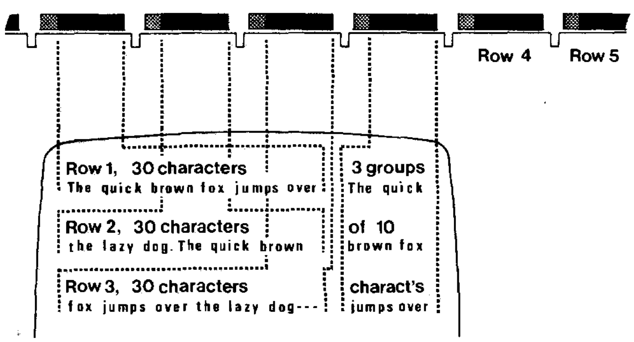

Fig.10 – Strategy for reduced bandwidth defined Teletext transmission with 40 character display

In the example of Fig.10, 32 message bytes are transmitted on a tv line representing a data clock rate of ≃ 5.6 MHz.

In the proposal, the first 20 packets (labelled 0 to 19) are employed to convey the data on the left-hand side of the screen. This permits an identical simple decoder design as currently employed to load the information into memory.

The small sections on the right-hand side of the screen consisting of 8 characters are packaged together into sequential groups of 4 and transmitted on 5 further packets labelled, for instance, 27 to 31 inclusive.

Code transmitted	Location of data on display
R_0	First 32 chara. Row 1
R_1	" " " " 2
R_2	" " " " 3
R_3	" " " " 4
R_{31}	Last 8 chara. Row 1 to 4
R_4	First 32 chara. Row 5
R_5	" " " " 6
R_6	" " " " 7
R_7	" " " " 8
R_{30}	Last 8 chara. Row 5 to 8
R_{16}	First 32 chara. Row 17
R_{17}	" " " " 18
R_{18}	" " " " 19
R_{19}	" " " " 20
R_{27}	Last 8 chara. Row 17 to 20

Fig.11 – Typical transmission sequence for packets using 32 characters as example

To improve the presentation of the data on first reception of the page, it is proposed to interleave these sub-groups within the main sequence. That is, the transmission sequence could be R_0 R_1 R_3 R_{31} R_4 R_5 R_6 R_7 R_{30} R_8 . . . etc., see Fig.11. Experiments have shown that visually no difference can be detected between the above strategy and the present European method of transmitting a complete row.

In Fig.9 five strategies are described with data clock rates from 3.8 to 5.6 MHz which, it is felt, should cover the NTSC requirements. A comparison is also made between the number of pages received per second for each strategy as compared with European systems.

If it were so desired, clock rates above and below the above figures could be employed adopting the principles already described.

The cost implications of the above proposals on the decoder are extremely small, and present-day decoders can be readily adapted to the scheme with a small peripheral circuit.

Possible Future Extensions of the Teletext Service

In the design of the Teletext service in the UK it was considered essential to be able to enhance the service as new features were devised and technology permitted. Already a number of enhancements are being considered.

1) Multipage memory for rapid access of related information
2) Full channel tv
3) Multilingual operation to cater for all Latin languages and non-Latin language requirements
4) Remote programming of character generator for specialised pages, for instance: mathematics, chemistry, and minority languages
5) Remote programming of local home terminal.

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