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Using a microprocessor. The start of a series of articles on the design of a typical processor-based control system, starting with no assumptions of prior knowledge on the reader's part.

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Viewdata

4 — The Viewdata terminal in more detail

by S. Fedida, B.Sc.(Eng.), M.Sc., F.I.E.E., A.C.G.I, *Post Office Research Centre*

A Viewdata decoder may be considered as being made up of six parts, as shown from left to right in Fig 1(a): a line isolation unit; a modem; a keypad; an input processor; a store (possibly r.a.m.); and an output processor. Indeed the breakdown of facilities is very similar to that of teletext, shown in Fig. 1(b). This diagram also indicates that, apart from additional minor interconnections, parts common to Viewdata and teletext are the store and output processor. These are substantial components and therefore combined Viewdata/teletext receivers show important savings over two separate decoders for the two services. This is a slightly over-simplified picture but the situation will be clarified later.

Note however, an important difference. The input circuits in Viewdata, up to and including the store are bi-directional, thus highlighting the interactive nature of the system. On teletext the input circuits are one way only.

Line transmission

The transmission code used over the telephone line between the Viewdata terminal and the computer is at present 8-bit, 10-unit asynchronous (or start stop), as shown in Fig. 2. Each character consists of an 8-bit code, the first 7 bits containing the information while the 8th bit is a parity bit. Preceding each character is a start bit, with a stop bit terminating the character. The character illustrated in Fig. 2 is M, with odd parity. A 10-unit asynchronous system was chosen for simplicity. It is clearly not as efficient as a synchronous transmission mode, in which characters follow each other without the intervention of start and stop bits, but it is simpler to implement and is currently used by many time-sharing computer systems.

In order to transmit this code over a telephone line, a modem (modulator-demodulator) is required. Essentially this device modulates the code on to a voice frequency carrier, within the speech band, thus obviating the problems encountered with very low frequency transmission over the telephone network. The modem also enables the go and return transmission to take place

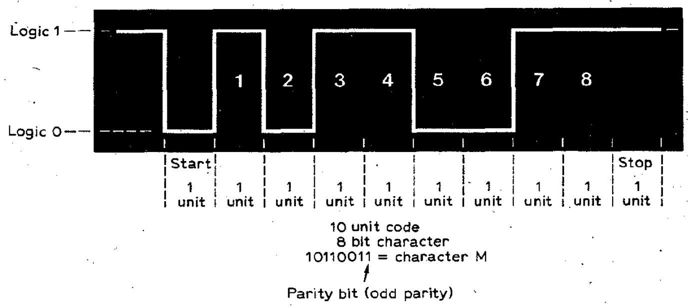

Fig. 2. Transmission code used between a Viewdata terminal and the computer is an 8-bit, 10-unit asynchronous code.

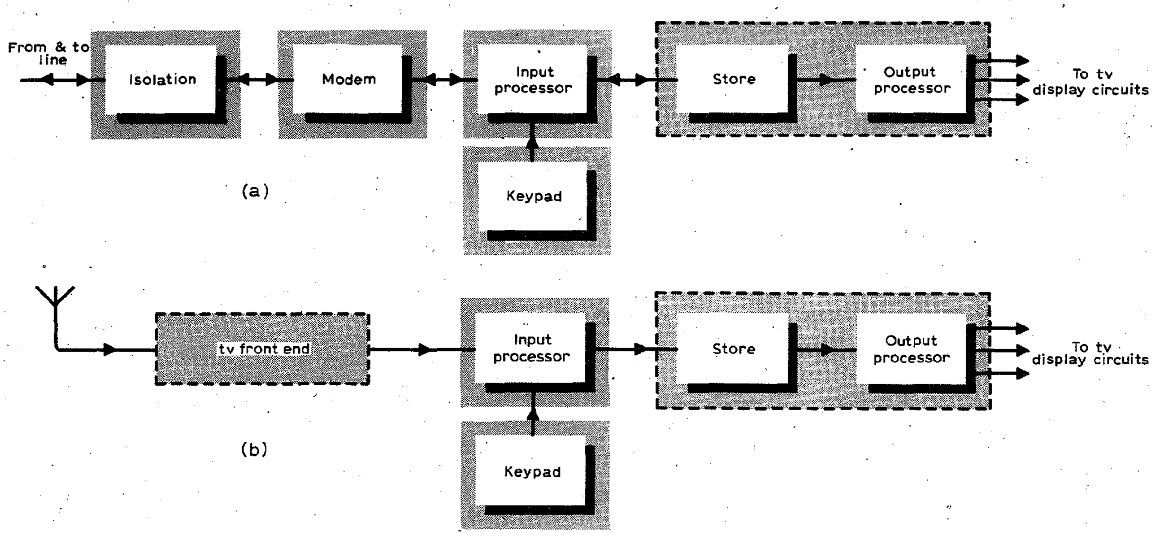

Fig. 1. Comparing the main sections of (a) a Viewdata decoder with (b) those of a teletext decoder

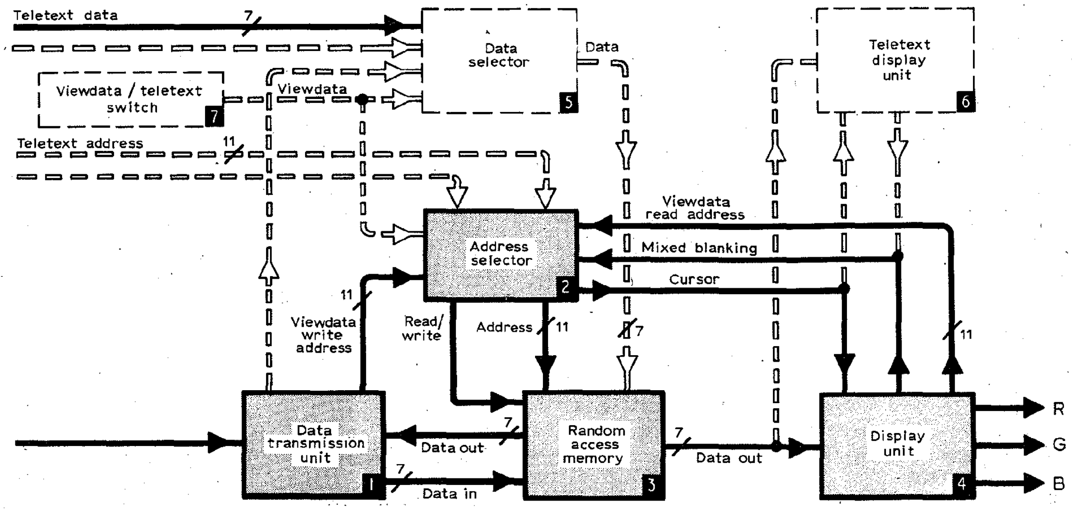

Fig. 3. Simplified block diagram of a Viewdata terminal, with adaptation to teletext shown in broken lines. The number and bar on certain connecting lines indicate that the line is carrying parallel information on that number of wires.

simultaneously over the two-wire telephone line.

Transmission rates selected for Viewdata during the present experimental phase are 1200 bits per second from computer to terminal and 75 bits per second in the reverse direction.

In the computer-to-terminal direction as high a transmission rate as possible is desirable in order to achieve a fast picture build-up. 1200 bits per second was chosen to fit in with a well tried and readily available modem. For the majority of Viewdata displays, consisting for example of mainly alphanumeric characters, the picture build-up is much faster than can be read by the user, and hence quite adequate from this point of view. Where, however, large uniform areas of graphics are displayed, the build-up may appear rather slow (the display shows repetitive information), and improvements to the build-up in this case may be obtained by using special means. But in general the additional complexity is not really worthwhile.

In the direction from terminal to computer the bit rate of 75 bits per second (7.5 characters per second) is quite adequate for hand keying.

The frequencies used in line transmission are as follows:

Forward channel: (from terminal to computer)	binary 1 = 390 Hz binary 0 = 450 Hz
Return channel: (from computer to terminal)	binary 1 = 1300 Hz binary 0 = 2100 Hz

When no data transmission is taking place on the line the terminal is transmitting continuously at 390Hz and the computer at 1300Hz. These tones are used in the modems at either end of the line to provide an indication of continuity, which as we shall see below is of some importance in the operation of the whole system.

When data is being transmitted the carrier is frequency modulated (frequency shift keying), between the binary 1 and binary 0 frequencies, the change being smoothed out to give a gradual transition between the frequencies.

The transmission arrangement used at present is duplex, with "echoing" facilities provided from the computer to the terminal. In a duplex system transmission may take place in both directions at once over the telephone with no mutual interference (hence, of course, the choice of frequencies). Characters keyed at the terminal are first transmitted by the modem to the computer and displayed only when they are "echoed" back. This arrangement gives some important advantages. First, it provides a measure of error detection, the user being aware of any corruption in transmission, errors in the computer or mis-keying errors. Secondly, duplex working also increases the user's confidence in the working of the system, as "echoed" characters provide a continuous indication that the whole system is in satisfactory order.

"Echoing" from the terminal to the computer is not necessary. A parity check is sufficient to provide for the detection of the majority of errors, the computer usually responding in these cases by requesting a repetition of the instruction. The computer also monitors continuously the terminal carrier, thus ensuring that a line break is noted as soon as it occurs. This avoids the possibility of the user being incorrectly charged for using the system after the occurrence of a line interruption.

Experimental Viewdata terminal

The experimental Viewdata terminal at present in use is best introduced in two parts: (a) the data transmission unit, which deals with the Viewdata signal between the telephone line and the internal store, and (2) the display unit, which deals with the Viewdata signal between the store and display device (the c.r.t. of a television set). As explained earlier, much of the display part is common with teletext.

A typical arrangement of a Viewdata terminal is shown in Fig. 3. There are four major units as follows: the data transmission unit (1); the address selector (2); the random access memory (3); and the display unit (4).

The address selector (2) is the only unit which interconnects the input and output processors, essentially for the purpose of preventing mutual interference. Unlike the situation in teletext data is received at random times from the telephone line, completely unsynchronized with the operation of the display. It is therefore necessary to organise the access to the memory for reading out and display on the one hand, and writing-in incoming characters on the other hand, without cross-interference. This function is carried out by the address selector. The write address generated in the data transmission unit (1) and the read address generated in the display unit (4) are both available at the address selector.

A mixed blanking waveform, also generated in the display unit, indicates the times at which characters are required to be extracted from the memory for display purposes essentially during 40 microseconds of every line period, excluding blank lines at the top and bottom margins of the display. During these times incoming characters are made to dwell a little longer in an input character buffer in the data transmission unit and the address supplied to the memory is the read address. At other times the write address is switched to the memory. The address selector also notes the coincidence between the read address and the write address when it delivers a pulse to the display unit to initiate the generation of the cursor display (see Part 3).

Shown also in Fig. 3 in broken lines, are the units required for interfacing Viewdata with teletext. In a receiver already fitted with a teletext decoder, one additional unit is required: the data selector (5), while the Viewdata display unit may be dispensed with and the teletext display unit (6) used instead. The connections required are shown also as broken lines. A Viewdata/teletext switch unit (7) is also shown. This sets data and address selectors to Viewdata or teletext as required.

In the teletext mode the address and data selectors switch the memory to the teletext input circuits, while in the Viewdata mode the memory is available to Viewdata. The read address, however, is now provided by the teletext address, which scans the memory during the mixed blanking period.

Data transmission unit

The data transmission unit is shown in more detail in Fig. 4. This consists of a line isolator (1) and a modem (2, 3, 4), the last-mentioned including a modulator (4) which transforms the outgoing data stream to a voice frequency signal, a demodulator (3) which accepts a voice frequency signal from line and extracts the data stream from it, and a control circuit (2) which switches the connection of the telephone line to the telephone receiver or to the modem.

The transmission control unit (6), which is synchronized by the clock unit (5), accepts the demodulated data in serial form, checks character parity and offers assembled characters to the control codes decoder (9). It also triggers the operation of the timing unit (10) which generates the necessary waveforms used throughout the data transmission unit. The control codes decoder recognises the special control characters used in Viewdata, initiates the corresponding control functions and enables the memory (8) to store the appropriate characters. It also controls the memory address unit (11), which maintains a record of the addresses at which incoming characters are to be stored and instructs the terminal identifier (12), to generate the automatic identification code in reply to an enquiry signal received from the Viewdata computer.

The transmission control unit, the timing unit and the page transmission unit (7) together control the transmission of a complete page from the terminal to the computer. The keypad unit (13) generates and encodes the terminal responses and outputs these direct to the modem, for transmission to the computer.

The data transmission unit operates in two different modes: reception mode and transmission mode.

Reception of Viewdata signals

Isolator and modem. The Viewdata signal enters the terminal from the telephone line, after passing through the isolator. This may consist simply of two pairs of opposite polarity gas discharge tubes, each pair connecting one of the telephone wires to earth. It ensures that voltages originating from the terminal are limited to safe values before entering the telephone network. It also contains fuses, in series with each telephone wire and on either side of the gas discharge tubes, to limit the current flowing. The gas discharge tubes have a striking voltage of about 150V, to avoid breakdown in the presence of ringing tones originating in the telephone line.

Following the isolator is the modem control unit, which contains a relay operated by the "data" button on the telephone. When this button is depressed it switches the telephone line from the telephone receiver to a hybrid transformer within the control unit. This separates the go and return channels connected to the modulator and demodulator respectively.

The incoming Viewdata signal is superimposed on an f.s.k. (frequency shift keying) carrier, binary 1 corresponding to a frequency of 1300Hz and binary 0 to a frequency of 2100Hz. The incoming carrier first goes through two stages of bandpass filtering to eliminate unwanted signals. After this it is frequency shifted by 10kHz, thus becoming a frequency modulated carrier centred on 11.7kHz with a deviation of ±400Hz, the modulation rate being 1200 per second. Frequency shifting the carrier by 10kHz makes the demodulation process much easier by virtue of increasing the number of carrier cycles per modulation cycle.

The incoming carrier is now applied to an unbalanced discriminator and a detector which extracts the data modulation. After filtering, amplification, squaring and level changing the data

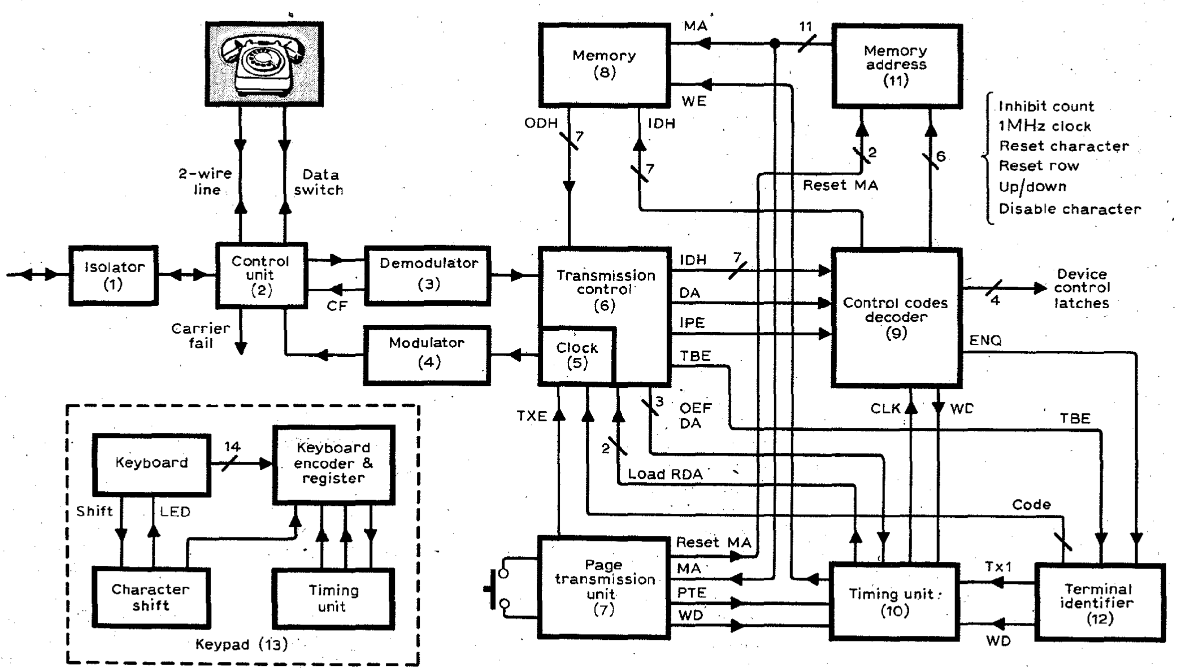

Fig. 4. Data transmission unit at Viewdata terminal. The number and bar on certain connecting lines indicate that the line is carrying parallel information on that number of wires.

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