Microcomputer design — 5

Visual display and video r.a.m.

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IN ANY computer system of this type the user has to be presented with data from the machine. For programme development this may require the presentation of several hundred characters. At the same time the cost of displaying alphanumeric characters should be minimised. The method chosen for the microcomputer project is a "memory plane peripheral". This is not sited on ports as conventional input/output but consists of logic which shares a section of the memory. This logic is designed to present an r.f. modulated composite video signal to a domestic television receiver in such a way that the contents of this memory section are interpreted as characters.

Any possible conflict of access to the memory between the processor and the logic has been resolved by giving the processor absolute priority. As a concession to appearance the video signal is blanked during access to the c.p.u. It is as though a section of memory is exactly mapped on to a visible plane. The position of a symbol on the screen is a function of the address in the memory and the symbol itself is a function of the least significant 7 bits of the data at that location. Extensive software routines have been written in a monitor programme (held in an e.p.r.o.m.) to pre-

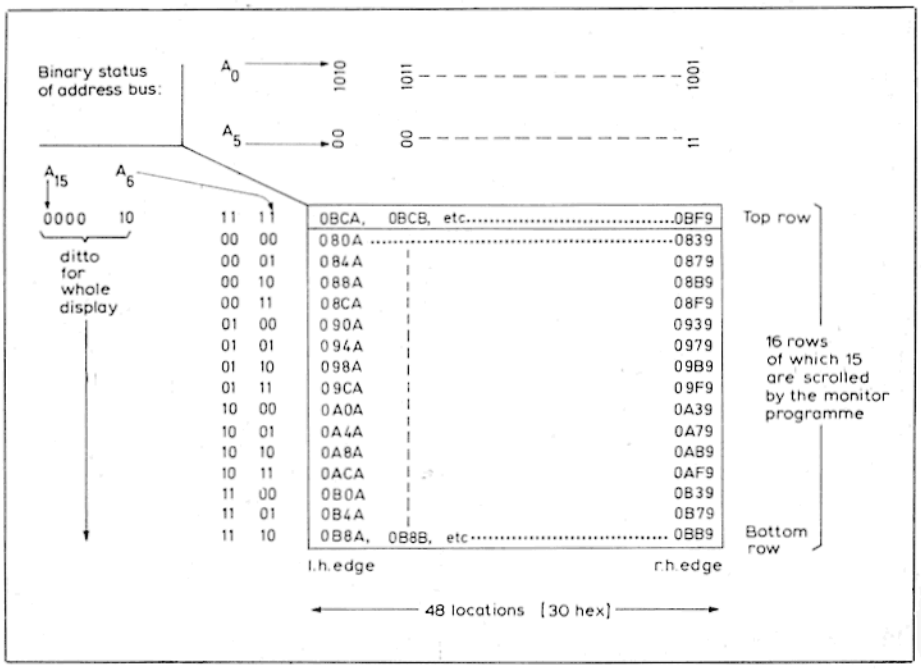
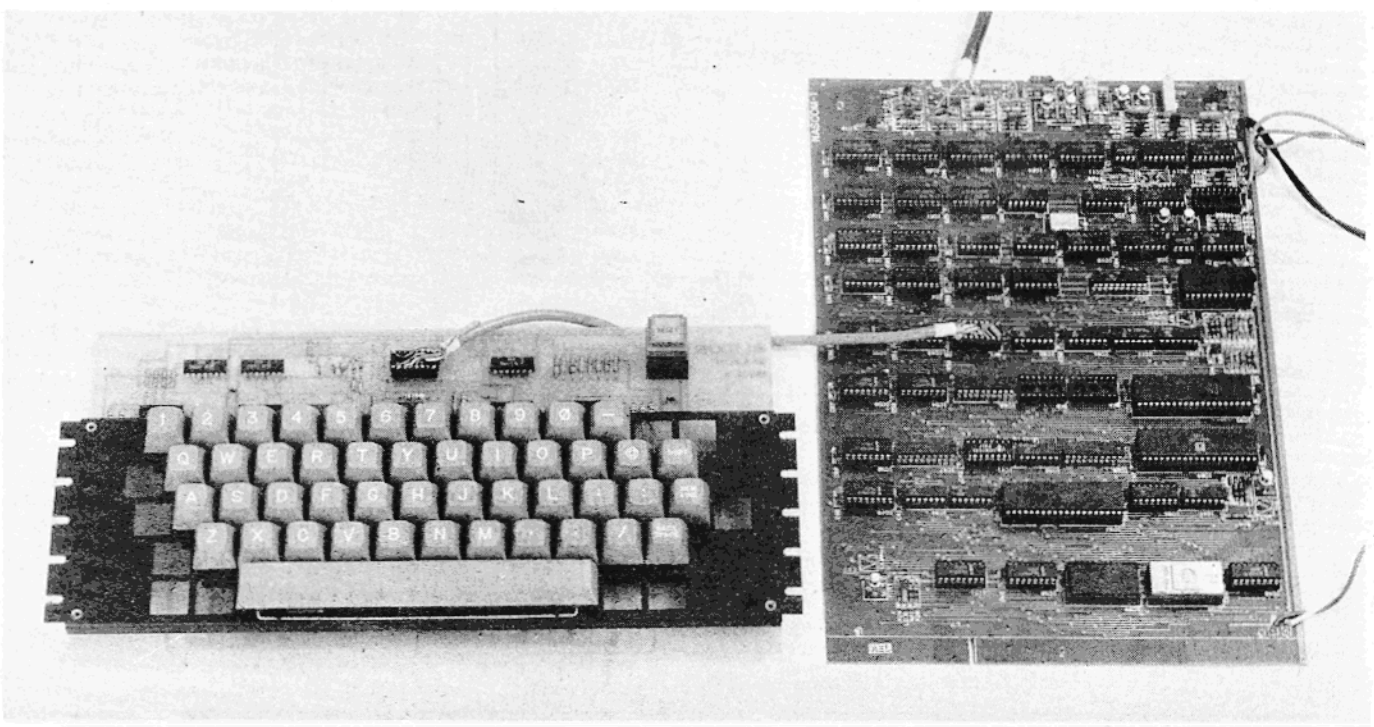


Fig. 1. *Video r.a.m. display adressing. 256 bytes of the 1024 bytes in the video r.a.m. are lost in the margins and are therefore not displayed. These comprise the initial ten memory locations (0800-0809), the last six (OBFA-OBFF) and 15 groups of 16 bytes between the lines.*

The complete microcomputer on which this series of articles is based, as supplied by Lynx Electronics (London) Ltd.



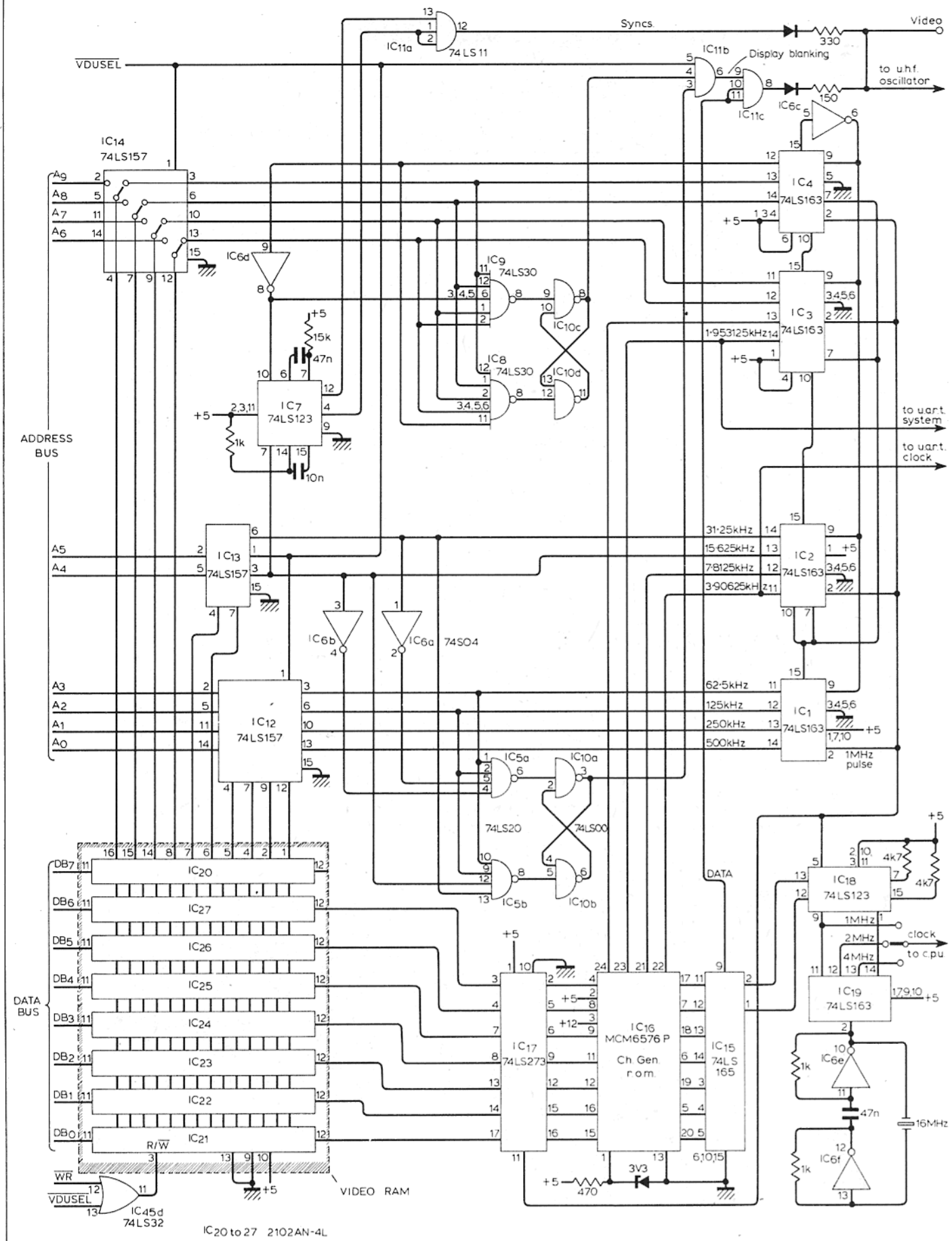


Fig. 2. *The video r.a.m. section of the computer and associated logic.*

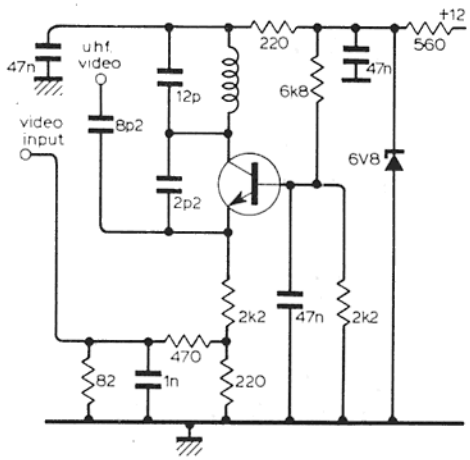


Fig. 3. *Circuit of the u.h.f. oscillator providing a signal for the tv set.*

sent data of the right type in the right locations so that the tv set acts as a v.d.u. This assumes that the memory section is not required for any other purpose, but if it is it behaves to the c.p.u. like normal memory and the user would not be any the wiser if he turned off his tv set. This section of the computer is called a video r.a.m. (see right-hand side of block diagram Fig. 1 in the January 1978 issue, p. 75). Details of the video r.a.m. display addressing are shown in Fig. 1.

The video r.a.m. itself, shown in Fig. 2, is operated by switching the memory i.c. address lines between the c.p.u. address bus and a counter/divider chain so that hardware continuously cycles the address lines to the memory. The memory packages themselves, IC_{20} to IC_{27}, are continuously selected so that their output is always available. This is prevented from jamming the c.p.u. data bus by placing a transmission gate, 81LS97 (not shown), between the data bus and the output pins. For each address the output is latched in IC_{17} and used as the address of a large r.o.m. called a character generator (IC_{16}). The output of this r.o.m. has been programmed to be the video dot pattern of part of a character, according to the raster row number and the character. The 8-bit output is loaded into IC_{15} (a parallel-in, serial-out shift register). The output of this is the black and white information for the tv set. The i.cs IC_{1-4}, IC_{18} and IC_{19} divide the 16MHz crystal oscillator frequency to provide the correct cycling of the memory address lines, and the shifting of video from IC_{15}, and by means of other gates they generate video blanking, frame sync and line sync at the appropriate intervals.

Compatibility with a tv set is further assured by the u.h.f. oscillator shown in Fig. 3. Composite video is also available for driving a television monitor to give a sharper image. The character organisation and size have been designed to optimise legibility on a domestic tv set. The i.cs IC_{12}, IC_{13} and IC_{14} are normally held in the state which connects the memory address lines to the counter/dividers. If the c.p.u. requires to read from or write to the memory these i.cs switch the memory address lines to the c.p.u. address bus.

To be continued. The next article will deal with the Z80 microprocessor used as the c.p.u.

Microprocessor application creates more jobs

A BRITISH fruit machine company is buying £350,000 worth of microprocessors from the British subsidiary of Motorola Inc. The orders, for the 6800, is the biggest to have been placed outside the United States, say Motorola.

At a press conference John Marshall, managing director of Barcrest Ltd, said "Microprocessors are the logical answer to making fruit machines." The industry was highly competitive, and new machines had to be produced all the time. He told *Wireless World* that machines were replaced, on average, once every seven to ten weeks. In addition, saturation had been reached in that there were likely to be few new locations for the machines. In that situation a company had to keep ahead by continually producing new models.

Exporting to Europe was made difficult by different legal requirements in the various countries – "UK machines are not exportable" – and because of the high complexity that market required, especially in West Germany. "Each country generates its own fashions, needing perhaps 20 different machines in a year." Models needed to be produced at very short notice. Engineers needed to be trained quickly to service them, and the buyers of the machines wanted rapid service when the machines went wrong, sometimes within the hour. This created a large spares requirement.

The machines are working in a hostile environment. If they are installed in pubs there is usually electrical interference from electric beer pumps, and some gamblers carry electrical noise generators to try to make the machine malfunction.

Ten years ago, he said, they began to use logic circuitry on plug-in boards, and engineers would carry a set of boards for a range of machines. Then about three years ago they put the common features of the machines on i.c. chips, and Marshall estimated that about 10,000 of these machines were now in use.

"The microprocessor took us a lot further. It enabled us to use a single control system for all the machines. Internally they are identical, or virtually identical, but outside they are different. The difference is in the plug-in programme." They could increase the rate at which they produced new machines, but the bulk of the product remained standard. Each machine contains a central processor chip, two peripheral interface adaptors, and a r.a.m. chip, besides the plug-in combined r.o.m. and p.r.o.m. "Now as machines become obsolete we can change them instantly and, in many cases, on site".

For the last 12 months almost all of Barcrest's output had been microprocessor-based. Over the last eighteen months they had increased their staff by 35%, and several thousand of the machines were now installed throughout Europe.

Barcrest's chief engineer, John Wain, explained that they had been able to make the change over the past two years. The attraction was that microprocessors offered standardised hardware, simple testing in production and in the field, easy programing, a good range of interface chips, an interrupt facility, and second sourcing. In addition to those advantages, he said, automatic test equipment could do a quarter of a million tests on the machines in 7s, as part of the plug in p.r.o.m. programme.

Motorola UK marketing director Mike Alderson announced at the press conference that their 16K r.a.m. chips were now available in quantity and would cost less than £5 each in bulk by the end of the year. The East Kilbride factory was also producing the 6800 microprocessor on 4in wafers. The Barcrest order is an indication that Motorola is firmly committed to the consumer market as the only likely market large enough to drive chip costs down. Chips had to be made and sold by the million, he said, and that meant they had to be very widely used. The chips were expensive to make because they were extremely complex. By definition, he went on, large use "means consumer products. That means driving the 6800 products down the learning curve." One of the biggest markets would be for automotive products in the USA. □

Discriminative metal detector — points arising

In the circuit diagram on page 45 of the July issue the values of C_1, C_7 and C_{14} were not listed. These components will depend upon the coils used in parallel with them. If the Waddington search coil is constructed, C_1 should be 1000pF and C_{14} should be a 7 to 75pF variable capacitor. If an Ambit i.f. coil, type YXRS 17065, is used for L_2, a 470pF capacitor for C_7 will give an oscillator frequency of 89kHz.

The logic gates used for both oscillators can be either NOR types such as the 4001 or NAND types such as the 4011. The gates used for driving the l.e.ds should be 4001 NOR types.