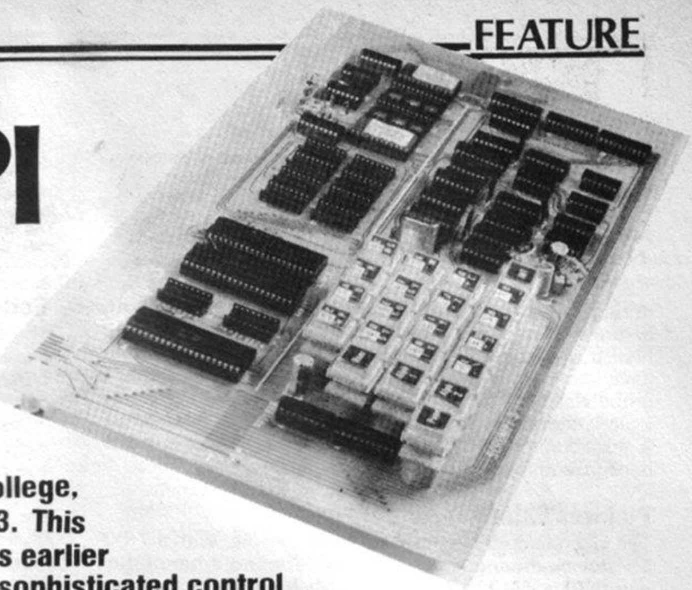
SCRUMPI 3



Justin A. T. Halls, of Queen Mary College, takes a look at Bywood's SCRUMPI 3. This kit is an improvement over Bywood's earlier LED switch kits but is still seen as a sophisticated control device rather than a personal computer. The kit also provides an excellent introduction to the worlds of MPUs.

Srumpi 3 is the cheapest currently available microprocessor kit with full alphanumeric input and a VDU type display. It is the successor to the Scrumpi 1 and 2, switch and LED kits and is based on the same MPU, National Semiconductor's SC/MP. The kit also provides facilities for cassette and teletype interfaces.

Scumpi 3 is built on a 380 X 190mm printed circuit board, with plated through holes and a clearly component overlay. High quality, low profile sockets are provided for all the ICs and two 16 pin DIL sockets are provided for access to the 16 I/O ports and the UART. Access to the TTY interface is via four pins at one side of the board, while power supply lines, reset line and video signal are taken to an eight way, 0.1" edge connector. A UHF modulator is mounted on the underside of the board and provides a signal suitable for most 625 line TV sets via a standard phono socket. Data and address busses are not directly available, but test points are provided at either end of the board. Imput is via a 21 key keyboard, made up of good quality switches with transparent key caps, beneath which are fitted self-adhesive labels identifying the key functions.

Three main chips are the sc/mp ii, which has the advantage over the SC/MP 1 of being faster and requiring only a single +5 V power supply, the INS8154 RAM I/O, which contains 128 bytes of memory and provides 16 individually addressable I/O ports, and the AY-5-1013 UART. Two EPROMS, protected from accidental erasure by opaque labels over the quartz windows, hold the 512 byte monitor program and 512 bytes of user accessible I/O routines, A 7MHz crystal provides a clock from which are derived the VDU control signals as well as a 3.5 MHz clock for the MPU and a 15 kHz clock for the UART. The video interface circuitry occupies nearly half the board and uses the 8675bwf character generator to provide the full 64 upper case ASCII characters in white on black or black on white, either of which may be selected as standard and which may be mixed on the screen.

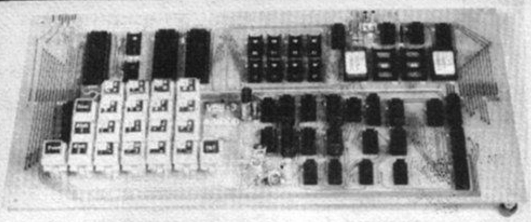
Data sheets are provided for the MPU and RAM I/O chips and two handbooks provide assembly and operating details. An SC/MP pocket instruction guide is also provided. The user has to provide a +5 V, −12 V power supply plus a 7.5V supply for the UHF modulator. It is also necessary to drill holes in the PCB to take mounting pillars if the kit is to be fitted in a case, or take legs if the kit is to be used naked. A reset switch is also needed.

Getting It All Together

Actual construction of the kit was quite straighforward, although the instruction manuals tended to be reminiscent of some car technical manuals, with instructions like 'all sockets, capacitors, resistors, diodes, links and keyswitches can be installed at this point', and the crystal and one of the ICs are never mentioned at all. One component that did cause some problems was the UHF modulator. The position of this is not marked on the board and the connections to it are not indicated. A phone call to Bywood confirmed that this does in fact fit beneath the board, the mounting pins having to be filed down to fit the holes provided. If the kit is not fitted in a case the presence of the modulator beneath the board means that legs must be fitted to enable the board to sit squarely on the table when in use.

When fitting the 21 keyswitches care must be taken as the holes for them are not too accurate and bending the pins too far to make them fit could damage the switch. Since many of the tracks run very close together, care should also be taken with the soldering and it is a good idea to leave the kit overnight after assembly and then re-checking very carefully for the presence of solder splashes or bridges.

To minimise the possibility of damage to delicate and expensive ICs and to ease trouble-shooting, the chips are inserted sequentially, checks being made at each stage to ensure that one part of the circuit works before proceeding to the next. Apart from TV synchronisation problems most of this setting up procedure was very simple, although some statements were a little misleading and a great deal of time was spent won- ▶



The assembled Scrumpi 3 kit. The system's firmware is resident in the two EPROMs seen top left with their protective labels. The three presets we had to fit to get the video levels right can be seen bottom centre.

dering why the address decoding wasn't decoding before we found that the NWDS line had to be earthed first. It is in cases like this that a circuit diagram would have been invaluable. The use of the INV line as a test probe was very clever and useful; if the line is taken to logic 1, the screen remains the same, but if taken to logic 0 the screen inverts (i.e. black characters on a white background instead of white on black).

Pictures Galore

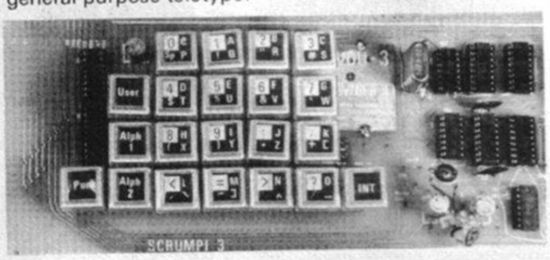
The video circuitry is basically quite simple, with a 7.02 MHz clock driving a series of dividers and a handful of gates. Two MM2112, 256X4 RMs hold the picture in a memory mapped display. The rest of the video circuitry simply consists of the character generator and a number of buffers.

The UHF modulator is pre-tuned to channel 36 and merely needs connecting to the aerial socket of a TV set. It can be run from the on-board +5 V line, but with some sets better resolution, especially when displaying black characters on a white background, is obtained by running the modulator from a separate supply of about 7.5 V. A simple, unregulated battery eliminator, set at 6 V (actual output about 7.5 V) is sifficient.

The Bywood errata sheet points out that some video monitors or converted TVs require a 4 V pk-pk video signal rather than the 1.5 V pk-pk signal provided by the kit, and that this can be obtained by adjusting the values of R3-R5. We had great difficulty in obtaining a stable picture and eventually had to resort to replacing the riesistors with 470R presets; even now picture stability is not as good as it might be and it is continually necessary to adjust the vertical and horizontal hold controls. It is quite possible however that these difficulties are due to the use of a cheap portable TV which may well not be set up correctly. No problems have been found with these modulators in other applications.

Key Features

Bywood have managed to squeeze all 64 upper case ASCII characters onto a 21 key keyboard. This is achieved by the use of three shift keys. One soon gets used to using the shift keys and although it would be more convenient for entering hexadecimal code if the lower case characters were 0-9 and A-F, the current layout has presumably been chosen to ease use as a general purpose teletype.



Close up view of Scrumpi's keyboard. By using the various shift functions this keypad can provide a full alpha-numeric set.

Getting In And Out

The teletype interface, supplies and receives a 20 mA current loop and is therefore compatible with many types of TTY. Control of this interface is purely by software, using the SC/MP 'flag 0' for output and 'sense B' line for input, each bit being set or sensed individually, with a delay instruction being used to set the bit rate to 110 baud or whatever rate is required. Unfortunately, details of sending and receiving routines are not supplied, although these should not prove too onorous to write.

Parallel I/O is provided for by the INS8154 RAM I/O chip which also contains the 128 bytes of RAM supplied with the kit. 16 I/O lines are available and these may be configured as two independant eight bit ports designated A and B, each of which may be specified as an input or an output port. This provides for very versatile interfacing with the outside world.

For these who prefer a serial interface however, an AY-5-1013 UART is provided. The rate at which data is output or received by the UART is determined by an external clock, this being set to sixteen times the desired baud rate. In the Scrumpi 3, the 15.625 kHz line frequency for the VDU is used, providing a baud rate of 960 (not 9600 as stated in the manual). If a more standard baud rate is desired, the internal clock can be disconnected and an external clock provided via one of the I/O sockets; 4 800 Hz will give 300 baud suitable for a cassette interface, while 1 760 Hz will give a rate of 110 baud. No details are given of how to use the UART, but these have been published in ETI (Dec. 1977).

All of these various I/O lines, except the TTY 20 mA loops, are available from two 16 pin DIL sockets. Each socket is provided with +5 V and ground connections, as well as the UART transmit and receive lines and the MPU 'sense A' line, used by SC/MP for software interrupts. In addition socket A has the eight bits of port B, reset, and the UART clock, while socket B looks after the eight bits of port A. Unfortunately the INTR line from the RAM I/O chip, which is used in handshaking routines, is not available, but it could be connected to an unused pin on one of the sockets, as could the serial input and output lines from the SC/MP which are also unavilable.

Where Its All At

The kit comes with 128 bytes of RAM (not counting the 256 bytes used by the VDU) of which 64 bytes are available to the user for writing programs. Of the remainder, 32 bytes are available as a user stack which may also be used by some of the Scrumpi sub-routines, eight bytes are used for storing labels and eight bytes are used as a monitor permanent area, the remainder being used as monitor stacks during various command routines. This RAM occupies the area of memory fron 0F80 to 0FFF (see Fig 1). The minitor PROM takes up 512 bytes from 0000 to 01FF, with 512 bytes of I/O sub-routines in PRO M at 0600-07FF. Keyboard, UART, VDU and parallel I/O takes up all the space from 0C00 to 0F80. Since the SC/MP only provides direct access to the lower twelve bits of the address bus, allowing for 4K of addessability, this leaves 2K to be accounted for. On-board sockets are available for all this, divided into 2×5 12 byte PROMS (5204 or 4214) and1K of RAMas eight 256 X 4 (2112). To expand further than this the top four bits of the address bus have to be latched at NADS time, when they appear on the data bus. However since it is assumed that very few users will want to go beyond the available1Kof RAM and1Kof PROM without the aid of an assembler, access to the control lines and busses is not provided. For testing purposes however, the busses are available at test points at either end of the board and control lines could be taken out be means of wire links fron convenient points.

Controlling Your Scumpi

The monitor contains five basic commands. Typing 'I', followed by a four digit hexadecimal address and 'INT', results in the display of the address called and the data stored there. A number of alternatives now exist. Typing in a two digit hex number followed by 'INT' will cause that number to be stored at that memory location and the address and contents of the next byte of memory are displayed. Instead of entering data you can type =n, where n is an integar from 0-7. The lowest two characters of the address are then stored and can be used later, by typing '?n', which will calculate the offset required for a programme counter relative jump to the address labelled by n. When using '=n' or '?n' the address is not incremented and the offset provided or fresh data may be entered at that location in the normal way. To return from the data input mode to command level, you can either press reset or type '>'. Typing the command 'L' followed by 'INT' will result in the display of the eight bytes of memory holding the labels.

The command 'H', followed by a four digit hex address, produces a hexadecimal dump of the next 48 bytes from the address given, arranged as six rows of eight bytes, each row preceded by the address of the first byte in that row.

Having entered a program using 'I' command and having checked it using a hex dump we now want to run it. This is done simply by typing 'G' and the address at which the program starts, bearing in mind that the first byte of a program is always ignored. Software breakpoints may be inserted in a program by using an XPPC 3 instruction, exchanging the program counter for the contents of pointer register 3, which returns control to the monitor and gives a current status dump. In this the contents of the three internawcpointer registers are shown, (P3 will always point to the address of the breakpoint), as well as the contents of the accumulator, extension register and status register. In addition, the 32 bytes of user stack are also displayed. The program can be continued from where it left off by typing the command 'C'

In addition to the monitor, eight I/O subroutines are provided for use by user programs. With these data may be entered from the keyboard or written to the VDU, or messages can be displayed on the VDU. Alternatively the value in the accumulator can be displayed as a hex number (rather than as an ASCII character) with or without a trailing space, or a hex number can be read from the keyboard. Finally four bytes from the user stack may be used to display a six digit number with its sign. All of these subroutines are accessed simply by exchanging the program counter and pointer 3 and most of them are re-enterable.

If additional PROMs are used to extend the monitor, they will be automatically detected by the existing monitor, which checks for a 00 at address 0200, and used directly. One additional PROM that is available from Bywood is a dissassembler, which will take a machine code program and translate it back into mnemonic form, producing a full assembler style listing.

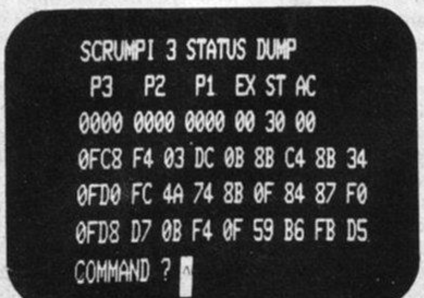
Reading It Up

The two handbooks are well and entertainingly written, starting from absolute basics and working up, so that even someone who had never heard of a microprocessor before would soon be able to use the Scrumpi. Book 1 starts with an explanation of the hexadecimal number system and proceeds to build a micro-(macro-?) processor called PC/MP (Paper and Cardboard Micro Processor) with which it explains all the happenings inside the MPU, by making you do all the internal operations yourself. In this way a deep understanding of what actually occurs within the MPU is imparted.

Having explained the workings of MPUs in general the architecture of SC/MP is considered, along with the necessary associated components such as RAMs and PROMs. Book 1 then goes on to describe the construction and use of Scrumpi 2, most of which is of little interest to the Scrumpi 3 owner, although the final section on interfacing with the outside world via UARTs and ports is of interest even if lacking in detail.

Book 2 is more concerned with Scrumpi 3 and begins by describing the rationale behind the design of this kit. Construction and testing details follow, with a circuit diagram for the VDU and a block diagram for the rest of the system. Bywood consider that 'the PCB is its own circuit diagram' and that further documentation is therefore unnecessary. Having built and tested the kit, you are taken through a series of demonstration pro- ▶

Scrumpi 3's status dump displays the current value of the SC/MP's internal registers plus a hex dump of a section of memory.



grams which display the full character set, write messages on the screen and demonstrate all the internal logical and arithmetic functions that are available. Here again the text is clearly written and we soon got to know how to use the majority of the various facilities that are available. Finally the memory assignments are given as well as a description of the monitor routines, I/O subroutines and the optional disassembler. At the end of the book is a glossary of technical terms, some useful addresses and data on the SC/MP II and the INS8154.

What there is of the handbook is excellent, well written and well illustrated and without too many errors. However, a great deal of information is lacking, such as any details of how to use the UART or how to configure and use the I/O ports. It would also have been nice if a few simple user programs could have been included, say for a cassette interface, handling the teletype link and maybe some mathematical routines.

Terminal Device

In general this kit succeeds in doing what it sets out to do very well indeed. It is nicely produced, fulfills its designers requirements and the distributor, Bywood Electronics, are very helpful in the event of any difficulties or problems.

The quality of the product is let down however, on two counts. The main defect lies in the lack of information supplied with the kit and this is a very serious failing. A TTY. 20 mA loop interface is provided, with no indication of how to send data to it, or how to receive data from it and whith no mention of what format the data should be in. i.e. what should be supplied in the way of start, stop and parity bits. Also, no data or infornation is provided on the UART and even when a data sheet has been obtained, describing how to use the device, it is necessary to trace out the tracks on the PCB in order to identify the TBMT and DAV lines. Admittedly a data sheet is provided for the INS 8154, but this is only of marginal use when attempting to use the device and such a versatile chip as this deserves far more recognition in the manuals.

The other failings of the kit are relatively minor, but seem all the more unnecessary for that very reason. Things like not using the serial input and output lines from the SC/MP. The kit already has impressive I/O facilities, but why not make use of a facility that is sitting there waiting to be used. The unused INTR line from the RAM I/O chip is another case in point, since this negates a large proportion of the power of the I/O device, especially if you want to interface to devices such as A/D converters which require a certain amount of handshaking.

Once you have found out how to use them, the I/O facilities on this kit are very good, largely thanks to the versatility of the RAM I/O chip, which gives such a varied selection of I/O modes. The keyboard is not as convenient as a full QWERTY keyboard, but it is perfectly adequate for a kit that is intended for semi-dedicated applications. The 8 X 32 character TV display may seem limited in size when compared to full VDU systems, but is quite adequate for the vast majority of applications and it has even been found possible to play Conway's Game of Life on it, although this led to some rather interesting edge effects at times.

This kit is certainly a great advance over Bywood's previous, LED and switch kits and with a price tag of around £150 is certainly good value for those who are either hooked on SC/MP or who are prepared to use the full power of the kit to make it pay its way as an intelligent terminal for a larger or more powerful system.

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