THE PRINTING DETECTIVE

BY BRIAN FROST

A SERIAL 'TEC ON THE HI-TECH TRAIL

An RS232/Certronics interface is a useful upgrade for the popular Amstrad 8256/8512 wordprocessor. All the software needed is already in the Amstrad. Brian Frost describes how he traced it to its lair...

WELL over 35,000 of the Amstrad 8256/8512 word processor 'typewriters' have now been sold and it is universally agreed that Alan Sugar of Amstrad 'got it right' when he bundled a computer, printer and word processing software into a package at low cost. It has everything that is necessary to create, edit and print high-quality documents all in the one package and many people are very satisfied with the results.

The supplied printer provides good quality but is slow, especially when printing longer documents in nlq mode, making a popular upgrade for word processor users to fit a higher quality printer to the machine. Other users have wished to be able to communicate their documents between one system and another, and the natural upgrading process that will cause many users to eventually opt for another machine will require that they can transfer material out of the 8256/8512 and into the new machine.

No data can be sent out of the machine without the addition of an interface which Amstrad provide as an optional extra. It offers RS232 and Centronics connections, and everything is provided to allow such facilities as split baud-rates for Prestel operation. On examination it turns out that the software is already inside the machine, and this project describes hardware that can be used in place of the Amstrad interface, yet appears identical to the machine but is around one third of the price.

FEATURES

The software for the interface is already resident in the 8256/8512 and provides the capabilities for its control from the supplied cp/m utilities. These will be described later. The interface allows the use of an external printer connected as RS232 or to the Centronics port and the supplied printer may be disabled and the new printer operated as the default.

A modem can be connected and operated with split baud rates on transmit and receive, necessary for such systems as Prestel. The split may be reversed for sending data or files.

DESIGNING THE INTERFACE

It may be of interest to describe the way the interface was designed since it involves a certain amount of detective work rather than original creative electronics. (*Eat your heart out Miss Marple! Ed.*) My motivation was the need to possess a simple RS232 connection to the compu-ter for file transfer to other machines, and realising that the driver software was already resident in my machine I decided to use it to find out what key hardware was required.

Amstrad's laudable commercial success is based on marketing the right product at the right price and I quickly found, as others have remarked, that getting technical information from them is .... well, difficult. One can hardly blame them I suppose, but this difficulty seemed to make it all the more of a challenge to come up with an equivalent to their interface.

Of course it turned out to be more difficult than I first anticipated. I tackled the software in my 8256 using a good monitor/tracer package and discovered that the first hurdle to getting at the software was the initialisation check that the 8256 performs on the serial interface. This is made on boot-up by detecting the presence of register(s) in the serial interface using dummy writes and setting a flag to indicate to other parts of the software the condition 'interface is present/is not present'.

LUCKY SIGNS

I was lucky at this point because before trying to discover what dummy operations were being performed to verify the interface, I had found the ascii string that contains the sign-on message. On inspection, this was found to be complete with the part that informs you that the serial interface is fitted. It transpired that the flag was simply the placement of the string terminator (OOh) over the 's' of the word 'serial' with the result that no interface information was displayed on-screen. Changing this 'OOh' back to ascii 's' resulted in the utilities Device and Setsio that support the serial interface accepting information. (When in Basic, the command:

POKE &HFE52,&H53

does the same job.)

With the ability now to trace the software through to the serial interface routines, I discovered that all the low-level control routines were even better hidden than I had anticipated. These routines are machine dependent, and so it was no real surprise to find that although the cp/m routines sit in memory and can be traced and disassembled, machine dependent routines and such things as screen memory are hidden away in 'bank-switched' memory. This is a neat way of incorporating many extra features or lengthy software without taking up memory space from cp/m. This 'hidden' memory is accessed by bank-switching instructions which overlay the hidden memory over the 'normal' memory. This makes tracing very difficult due to problems of location of the tracer (in one bank) and the code one is tracing (in another bank).

CODED SOLUTION

The solution was to write a very simple piece of code using one of the Z80 block move operations which, when located in the common area of memory from cOOOh to ffffh, would swop to the bank of interest where the serial interface routines are located. It then became practical to copy as much as possible from these routines up and into the common area before switching the bank back again prior to copying this 'copy' back to the same numbered locations, but now in 'accessible' memory. This had the advantage that not only could all the routines of interest be copied (once the general position was known) but that the tracer could directly operate on them in 'real' memory because the code was now resident at the correct addresses.

This proved to be the solution and it was possible to trace and disassemble the machine dependent routines that implemented the cp/m calls to the serial interface. The routines of interest are modular and generally have no interaction, so inspection of each routine revealed a different aspect of the hardware, such as baud rate, or uart type. For example the first question was

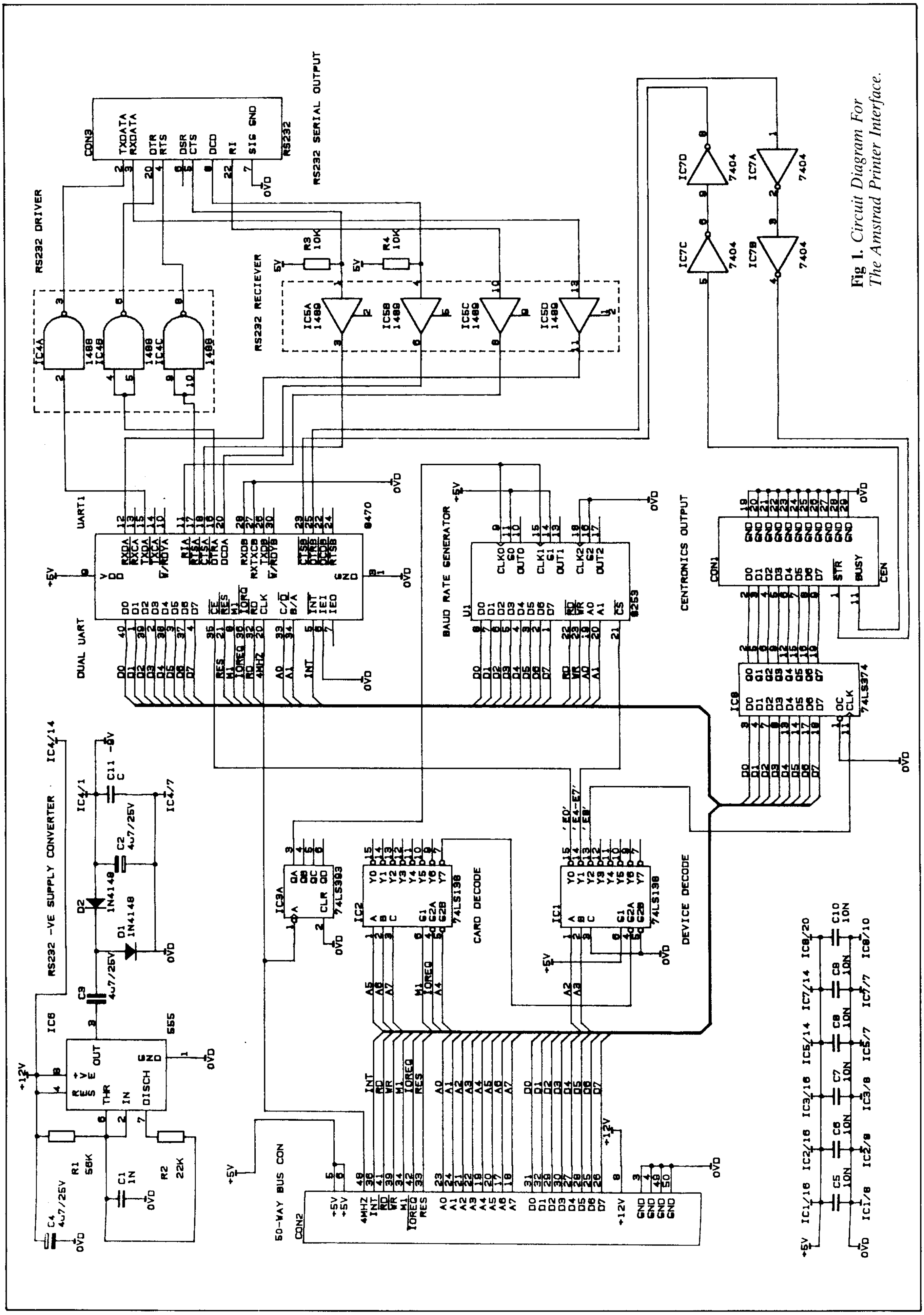

Fig 1. *Circuit Diagram For The Amstrad Printer Interface.*

to establish which uart device was being used. Inspection of the flags used by the routines that send out an ascii character and those that read in an ascii character showed that the device was the Z80 'dart' (or dual uart, now termed the 8470). Subsequent investigation of the Centronics output routine showed a crafty dodge to reduce hardware by using the unused half of it to implement the Centronics handshake strobe and busy lines. It became clear at this point that it was going to be just as easy to implement both the RS232 and the Centronics connection together and to construct the entire interface, and not just the RS232 part.

By a similar technique of software tracing, it transpired that the software-programmable baud-rates were being generated by an Intel 8253 programmable timer rather than by use of uarts that are now available with integrated baud-rate generators 'on-chip'. The Alan Sugar technique is very evident here when it has to be acknowledged that, although on-chip baud rate generation results in the saving of one chip, the actual cost would be, increased by several pounds which would be a very backward step for Amstrad.

Having established the identity of the devices in use, the physical port addresses came easily from inspection of the software, the only remaining discovery being the mechanism and addressing of the Centronics output port. Knowing already that the Centronics strobe and ready/busy had been implemented on the unused half of the dual-uart, I wrote a looping program in basic to send the character 'A' to the printer after assigning the Centronics port to be the listing device. With this character being repeated every 10 milliseconds or so, it was possible to trigger the oscilloscope from the general addressing on the interface and look to see which addresses in the interface were being repeated. Those that referred to the uart could be ignored since they comprised the strobe operations, but when an unexpected address access was compared with the data on the data lines it was found that it coincided with the data bits '41h' (the character 'A'), and so this must be the address at which the data was being written. From the simplicity of this write operation, it was obvious that all that was needed was a simple 8-bit latch at this address to implement the Centronics output port.

With the hardware addresses and devices defined, it was only necessary to interconnect the devices and fill in the details of the circuit as shown in Fig.1.

CIRCUIT DESCRIPTION

The operation of the circuit is quite straightforward, CPU address lines and the i/o operation control lines IOREQ and M1 are combined in the main address decoder IC2 which provides an active low output when any of the card addresses is selected. This output enables a second address decoder, IC1, which decodes lower-order address lines to provide individual chip-select lines for the circuit blocks. In this way the uart, the 8253 timer and the Centronics octal latch are mapped at the addresses required by the internal software.

The 8253 timer supplies the baud rate clock to the uart and requires a supplied clock of 2MHz. Since this is not available directly from the Amstrad connector, it is obtained from the Z80 4MHz by simple division using IC3, a 74LS393.

To provide the serial RS232 capability, lines from the uart pass out through an RS232 driver IC4 which translates the 5V uart logic levels into the specified RS232 bipolar swings of greater than −5 to +5 volts. No negative rail is available from the computer, so a 555 timer IC6 is used in a charge-pump circuit to provide approximately −9V. Every time the 555 timer output goes high, C3 is charged to almost +12V via D1. When the 555 output goes low, this charge is transferred to C2 via D2 to provide a −ve rail of around −9V. Although not stabilised, this method of generating a negative rail from a positive one is low in cost and effective for currents of less than round 20mA. *(It's similar to RAP's circuit in his Real World Interfacing article. Ed.)*

Received RS232 signals are presented to an RS232 receiver IC5 which provides level detection but is actually more importantly in protection of the uart against voltage transients.

The Centronics port is provided by the octal latch IC8, outputs of which are taken directly to the Centronics connector, these being defined as standard ttl logic levels. Centronics connections require an accompanying data strobe provided from the uart via IC7, to provide protection against damage. The BUSY line returned from a Centronics printer is also buffered by IC7 before presented to the uart.

TESTING

Having assembled the circuit it is necessary to perform some rudimentary tests to avoid damage to the Amstrad. Any such damage is undesirable since the signal lines on the rear connector come directly from an internal gate-array chip which is soldered directly to the Amstrad pcb and looks expensive to purchase and decidedly unpleasant to replace.

Having checked that all chips are the correct way around, apply +5V to the connector on the 5V and 0V pins. There should be no more than 200mA drawn.

Apply 12V to pin 8 on the edge connector and check that approximately −9V appears at pin 1 of IC4.

As an additional precaution it is well worth applying 5V to the unit and then running along the signal lines on the edge connector with a 1k resistor tied firstly to 0V, and secondly to +5V, while observing the voltage on the pin with an oscilloscope or meter. This verifies that all pins can easily be driven by the Amstrad and that there are no 'stuck' lines. In the case of 0V, the voltage should be no more than around 0.5V, and for the 5V check the voltage should rise to over 3V. 'Pulling' the pin in this way verifies that it looks like an input.

When the hardware has been checked, the unit can be connected to the Amstrad and the system powered-up. If the hardware is ok, during boot-up the message 'SIO/Centronics add-on' will appear between the number of disk drives and the size of the memory disk.

UTILITIES

There are two supplied utilities that are relevant for the serial interface, Device and Setsio. Both of these are described in Book 1 supplied with the machines, but here are brief descriptions.

DEVICE.COM.

Device allows the serial interface to be assigned to various output or input channels to allow data to be routed depending on its source or destination. For example, a popular application is to route printed data away from the supplied printer to a printer connected to either the serial or Centronics connection on the interface. The command:

DEVICE LST:=SIO

sets all further printing on the machine to occur via the serial interface. Also:

DEVICE LST:=CEN

sets all printing to occur via the Centronics interface. There are many other combinations and typing Device allows the existing configuration to be seen. Full details of Device are on page 87 of Book 1.

SETSIO.COM.

The utility Setsio allows the various attributes of the serial interface to be set, such as baud rate, number of stop bits and handshake protocol. This will be needed if the device connected to the interface requires (say) 2400 baud operation. It has no effect on the Centronics port.

Typing Setsio will show the current state of the interface settings, and full details of how to change baud rates will be found under the Setsio command o page 94 of Book 1.

USING THE UTILITIES

Both these utilities are used when a printer other than the Amstrad printer is permanently connected to the machine. A file called, for example, DOIT.SUB can be created which contains the assignment of the printer to be the default printer and sets the baud rate to suit it. For example, the file contains would be:

DEVICE LST:=SIO
SETSIO 4800

to set the printer to be the list device and to set the interface to 4800 baud. Typing DOIT or booting the disk with DOIT.SUB present would automatically install the printer.

FREEBEE FOR MODEM USERS

Amstrad supply a rather useful program for those of you who wish to connect up a modem on the interface. This is a program called 'MAIL232.COM' and it is buried together with the Locoscript word processor command file on side one of disk one. Copy it on to a spare disk and run it by typing 'MAIL232' under cp/m.

This program has been described as a 'glass teletype' in that it allows communication with bulletin boards or with other users of modems, either in 'real-time' by typing on the keyboard, or, more usefully, using file transfer.

KEY	FUNCTION
F1	'Framing'. Allows baud rate, data bits, parity, stop bits and handshaking modes to be set.
F3	Sets data to be sent from a file or received by a file. All received data enters the specified file until you press ALT and STOP. Also allows hexadecimal mode to be selected for program transfer.
F5	The keyboard may be set ONLINE or OFFLINE.
F7	Change terminal emulation mode and exit to cp/m.

TABLE 1.

When accessing bulletin boards it is only necessary to open an empty file, dial the number and log on to the bulletin board and walk through the menus that you require. When you have completed the operation and disconnected, all of the material that was displayed on the screen has been saved in the file and may be examined at leisure. In the same way, you may prepare an ascii file containing a letter or information that you wish to send and after establishing the link the file can be sent with a simple command.

For reasons of space the commands are here in brief but try it and see. After typing 'MAIL232' there will be a sign-on message followed by the main menu. All operations are controlled by the function keys in Table 1.

While in this menu, any characters received via the modem are displayed on the screen, and any keyboard typing is sent out via the modem. So dial-up your local bulletin board and off you go!

CONCLUSION

The interface described provides both serial communication and a Centronics printer port using the existing Amstrad driver software already resident in the 8256/8512. The capabilities of the Amstrad interface are duplicated with this hardware as a low-cost replacement. PE

BOOKMARK

Electronics and Electronic Systems. G. H. Olsen. Butterworths. £19.95. ISBN 0-408-01369-9. Although this 400 page book has been written for first and second year undergraduates reading for degrees in electronics, electronic engineering, physics and allied subjects, those whose interests are less academic will find much to benefit them from its information. Its intention is to provide a thorough grounding in the ever-changing area of electronics. Basic circuit theory, for both analogue and digital electronics, is covered, well interspersed with formulae. Many practical circuits are included, and the subjects are treated in a down-to-earth fashion.

Practical Digital Electronics Handbook. M. Tooley. PC Publishing. £6.95. ISBN 1-870775-00-7. Many readers will know that Mike Tooley is a contributor to PE and to other magazines. Within the 200 pages of this book he aims to provide readers with a practically based introduction to digital circuits and logic families, together with sections on microprocessors and various memory devices for internal and external control. An appendix then covers items like tools and test equipment. Applications for the latter are discussed, and nine practical constructional projects are presented for strip-board assembly.

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Wanted: Circuit diagram of interface to drive 2V peak-peak negative synch. pulse monitor from Spectrum computer. A. Cooper, 81 Woodfort Road, Great Barr, Birmingham B43 5QN. Tel: 021 3572490

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