22 Computers in the Shack

Computers have been part of a well-equipped radio shack for some years, mostly for data communications and logging/contesting.

More recently, cheap online connections have brought Internet resources into many amateur stations. This chapter aims to show that there are many other uses for the shack computer, making it an essential tool for the constructor.

INSIDE A COMPUTER

Before discussing what a computer can do for you as a radio amateur, it is useful to take a brief look at how it works.

For the purposes of this book, it will be assumed that the computer is a 'PC' operating under Windows. Other computers such as the Apple Mac and older 'hobby' machines (eg Sinclair Spectrum, BBC 'B') could be pressed into service with the appropriate software. Other operating systems such as DOS or Unix can also be used.

The essential components of a computer (shown in **Fig 22.1**) are a processor to do the work, memory to store information, inputs and outputs for communication betweeen the computer and the operator (eg keyboard and screen), software to give it instructions and a power supply.

Central Processing Unit

The CPU is the engine of a computer and is measured by the number of cycles of work it can carry out in one second. Thus a '800MHz' computer carries out 800 million instructions per second. Modern CPU chips get very hot and have heat sinks or even their own cooling fans.

Memory

Just like the human brain, a computer cannot work without being able to store information. There are several types of memory, divided into their function, the storage medium and the amount of time that information can be stored.

Bootstrap

This is a tiny, permanent, memory on a chip. It is known as Read Only Memory (ROM) as it cannot be over-written with new data. Its function is to give the CPU the very basic information it needs to start up and function as a computer.

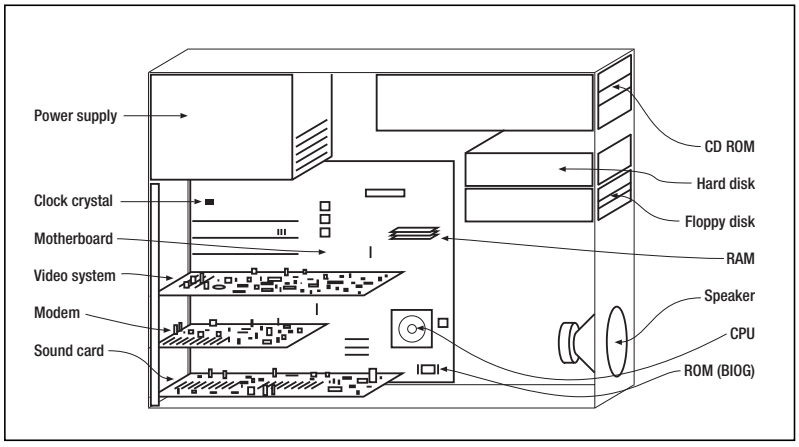

Fig 21.1: Hardware in a typical desk-top computer

RAM

In contrast to ROM, Random Access Memory (RAM) is designed to be continuously re-used. It is the temporary storage used to hold all of the data required during processing. RAM is located on chips so it can be 'written to' and 'read' very rapidly. It is commonly described in 'Megs', though this is Megabytes, not MHz.

Hard disk

Most of a computer's storage is done on a magnetic disk. Although reading and writing is nowhere near as fast as RAM, it has the advantage that it keeps its information indefinitely, even when the computer is not powered up.

Removable memory

This refers to the disks that can be taken out of a computer for future reading by the same of another computer at a later date. Older machines have 3.5in so called 'floppy disks', or 'diskettes' which can store about 1 megabyte of data, whereas all modern computers use CDs capable of storing up to 800Mb or DVDs which can store several gigabytes - that's thousands of megabytes. Additionally it is now possible to plug in an external memory chip capable of storing up to 1 gigabyte in a small space and with rapid read and write.

Input / Output

Abbreviated to I/O, these devices are what is needed for human beings to interact with the computer. They include the keyboard, screen, mouse and sound card.

Operating System

Usually stored on the hard disk, this is the permanently installed software, that makes the CPU into a usable computer. The most commonly used operating system is Microsoft's Windows, although there are amateur radio programs that run under DOS or Unix. The operating system defines how the various parts of the computer work together and how it connects to real people.

Software

Although the operating system is an essential piece of software, it cannot do anything other than make a computer. To perform any useful task, such as word processing or sending e-mail, additional software known as programs must be installed.

A new computer will usually come with some programs, usually an Internet browser and some office functions, but there is an almost infinite number of additional programs that can be added to perform specialist functions. Although some programs, especially those for commercial applications such as producing this book, are very expensive, many are quite cheap or even free. Fortunately, many amateur radio programs are in the latter category.

Power Supply Unit

Like any piece of electronic equipment, the computer has a PSU, to run from the mains. Additionally lap-top computers have hefty batteries capable of running the unit for an hour or two.

OPERATING AIDS

Computers are used to enhance the shacks of many keen DXers. Facilities available to the operator include:

- Logging
- Contest aids
- Rig control
- Maps
- Data communications
- DXCluster
- Propagation information
- Maps and locators

Most of these are outside the scope of this *Handbook*, but detailed descriptions of all of the above can be found in [1].

CIRCUIT DESIGN

Drawing

If you are not good at drawing circuits, good quality illustrations, such as many of those in this book, may be drawn using 'computer aided design' (CAD) software. There are many generic drawing packages, from professional quality software such as CorelDraw to inexpensive or even free programs available for download on the Internet These save the work of producing neat straight lines, boxes and circles but components must be individually drawn. An alternative is to use a CAD program tailored for electronic circuit design. These have the facilities of a generic program, but also have a library of component symbols. Most of the simulator progams described below include schematic drawing facilities.

Circuit Simulators

These allow circuits to be drawn and then analysed, and most are based on the industry standard SPICE. Several are available to try out as free demo versions, usually with restrictions. A useful list can be found at [2].

Some simulators incorporate printed circuit board (PCB) design, whilst others can export data to a dedicated design program. The result can be printed and used in producing the PCB itself.

It is possible to simulate both analogue and digital circuits, or even a mixture of the two. Several of the projects in this book have been initially designed by this type of program, most notably PUFF.

The user starts by drawing the circuit diagram, made from graphical elements provided with the software. The result can be analysed by the program's 'virtual' test equipment, to check how well (or whether) it works. The information displayed can include amplitude vs frequency response, phase vs frequency, group delay vs frequency, gain or loss, and the impedance at input and output. A typical display is shown in **Fig 22.2**.

Changes can be made and the results tested, all before any real construction takes place. As with all software simulations, it is no substitute for knowledge and errors can be reduced by having a basic understanding of how real electronic circuits work.

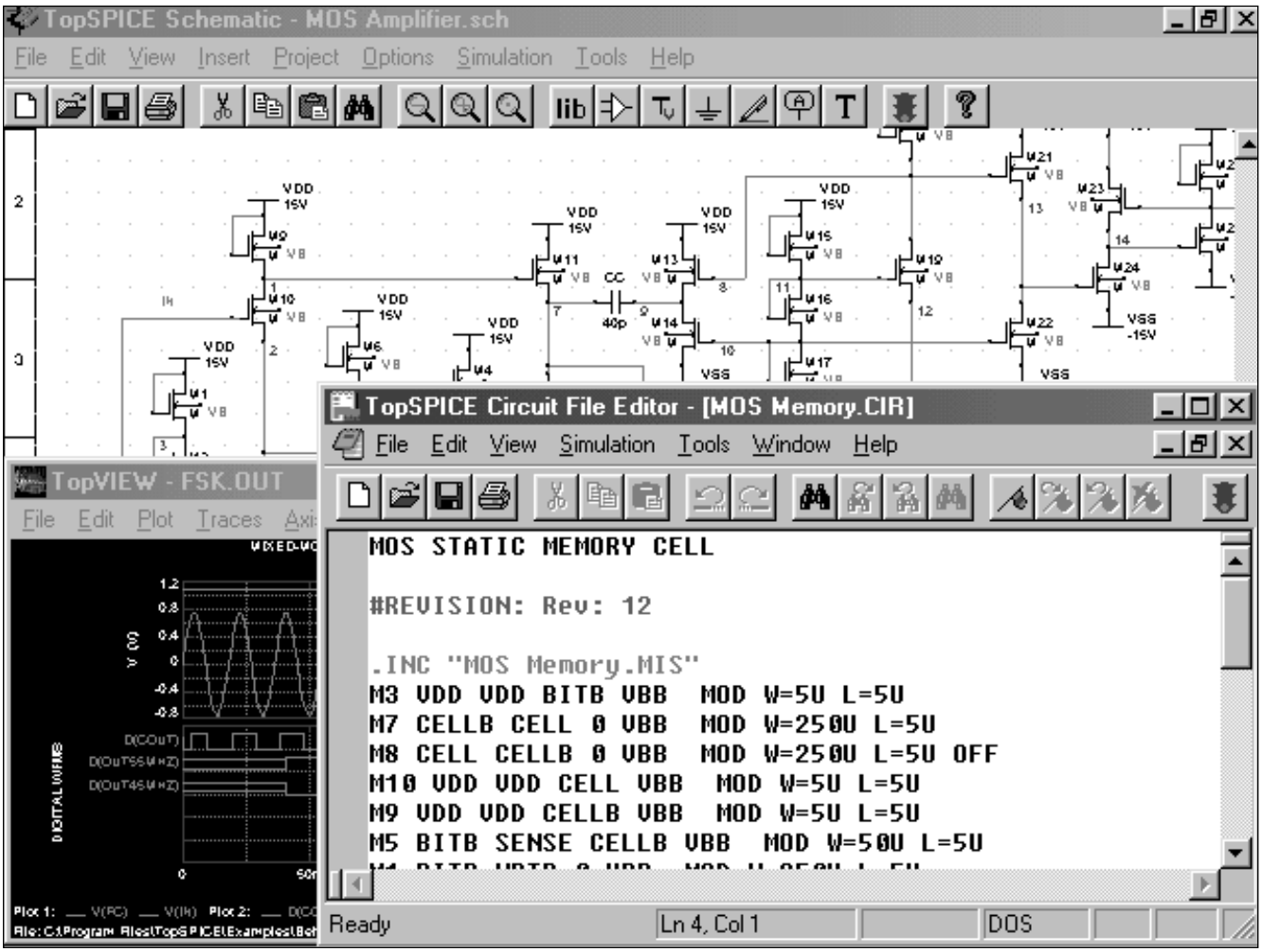

Fig 22.2: A typical circuit simulator / analysis screen. [Source http://penzar.com/topspice/topspice.htm]

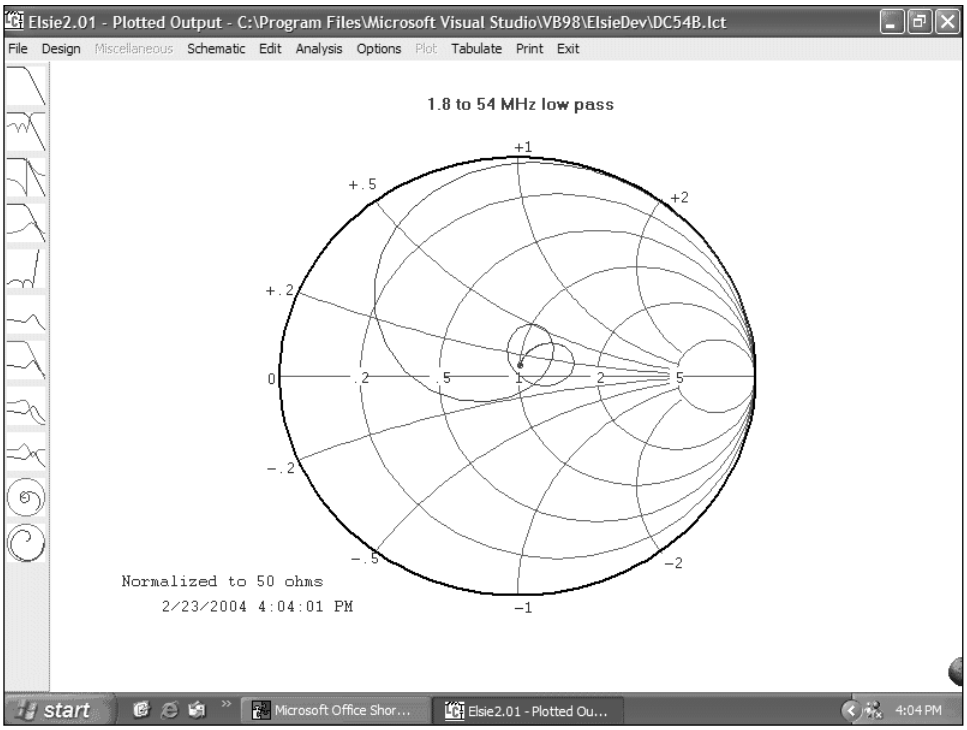

Fig 22.3: A Smith Chart produced by ELSIE, the filter design program from Tonne Software.

Simulators can usually predict performance quite accurately (mostly for analogue circuits), although they do require substantial effort to learn to use effectively.

A circuit simulator won't do the designing for you, but it does help a lot in finding out what is wrong with a design, and predicting what will happen before you actually build the circuit. Note that the cheaper programs will not operate with time-varying inputs, eg intermodulation analysis.

Spreadsheets

Many aspects of circuit design can be calculated, so a spreadsheet program is useful for making the most complex and interactive calculations. Examples are the optimisation of inductors and filters, Yagi dimensions and linear amplifiers.

Alan Melia, G3NYK, has published Loopcalc [3], an Excel spreadsheet which calculates the radiation resistance and efficiency of a 'square' loop and compares it with the radiation resistance and efficiency of a inverted L aerial of a similar size.

Word Processors

In the past, constructors would use rub-down lettering or adhesive characters to produce professional-looking legends on a front-panel. Nowadays a word-processor can generate text in many fonts, and with a little practice it can also be used to produce arrows, meter scales, etc.

Other Software

A useful tool is AADE Filter Design which can be downloaded free from [4]. It will calculate gains, impedances, group delay, phase, return loss and more. Filter types handled include Butterworth, Chebyshev, elliptic (Caur), Bessel, Legendre and linear phase low-pass, high-pass, band-pass, and band-reject filters, as well as coupled resonator band-pass and crystal Ladder band-pass filters using identical crystals. A tutorial is included for those wishing to know more about filters.

A large range of programs can also be downloaded from the website of Reg Edwards, G4FGQ [5]. These include calculators for the design of antennas, transmission lines, inductors, filters and amplifiers. Also included are propagation path-loss calculators.

Resonance of an inductor and a capacitor can be calculated using Resonate from G3NYK's website [3] which has several pieces of software.

Another useful source is Tonne Software [6] which has programs for filter design, meter scales, customised maps, antennas and matching. Most are totally free, or available free in a cut-down version. The filter design program, ELSIE (**Fig 22.3**), was used in the PIC-A-STAR project described in an earlier chapter.

TEST AND MEASUREMENT

A computer can be used to make all sorts of measurements with the appropriate software, and either a sound card or additional hardware (eg an analogue to digital converter).

Audio analysis software such as Spectrum Lab [7] uses the computer's sound card and can be used for such things as measuring distortion, intermodulation, noise, oscillator drift and modulation. It has a built-in tone generator.

Also using the sound card are programs that can measure and display audio signals (in fact up to several tens of kHz), including those at the output of a radio, and may also be used as a data logger for monitoring beacons. One of these is shown in **Fig 22.4**.

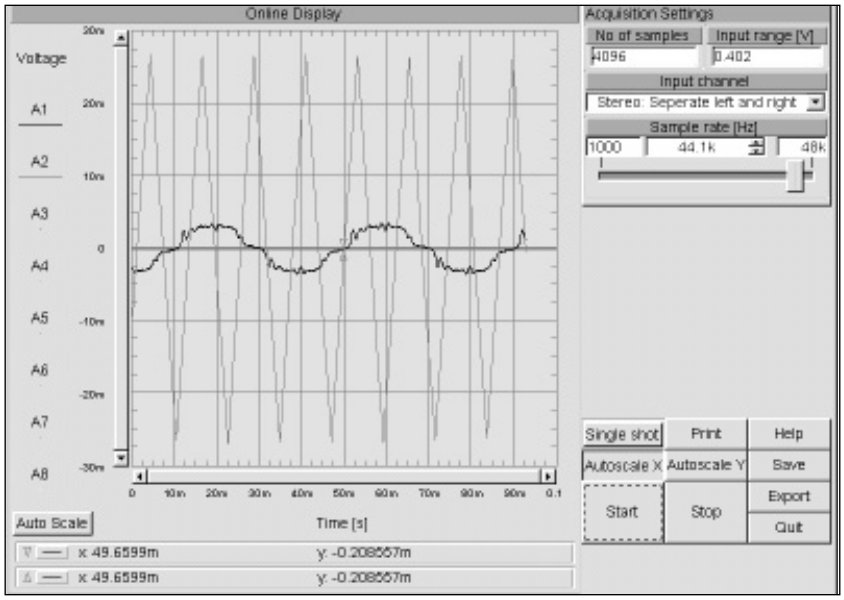

Fig 22.4: A sound-card-based signal analyser with data logging facilities [From http://www.hacker-technology.com/4361/30004.html]

ANTENNA SIMULATION

It is no longer essential to dismantle your antenna in order to experiment with ideas for a new one. Thanks to software originally developed for the US military, and made available in a usable form by amateurs, it is possible to make a 'virtual' antenna on the computer. You can then measure its performance, alter it and measure it again until something practical is found - or the project is abandoned as a failure. Work on a practical antenna need only take place when the 'virtual' one has been optimised.

As with all computer programs, it is possible to get the wrong answer, but this is usually a case of 'garbage in, garbage out'. A good knowledge of antenna theory and practice will help you avoid the major pitfalls. Information on how to obtain antenna simulation software can be found at [8].

Much more about the use of antenna simulation programs can be found in the chapter on Antenna Basics.

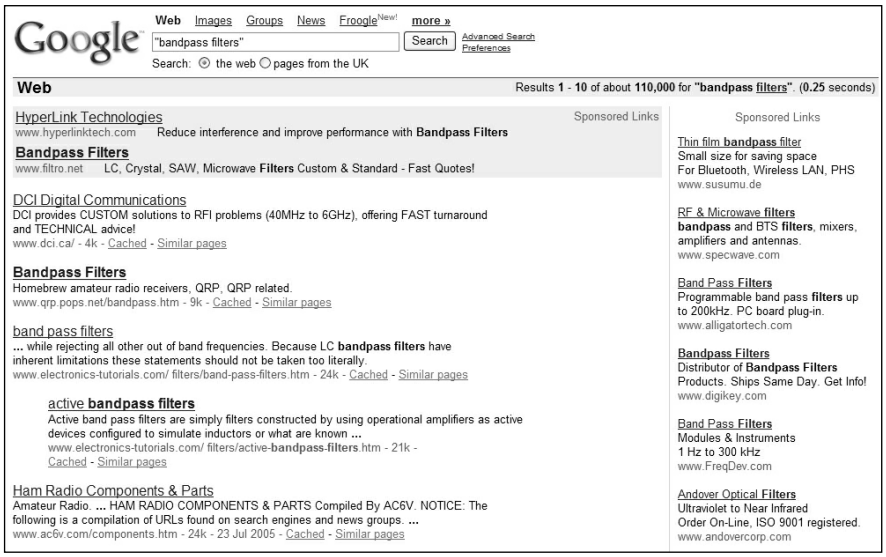

Fig 22.5: An Internet search for "bandpass filters" produces over 100,000 results, including advertisements for commercial filters, technical papers, descriptions and advice by radio amateurs, and lists of where to buy components

THE INTERNET

For very little money, you can have facilities at your fingertips that only a few years ago would have been the envy of the best equipped library in the world, together with communications facilities that have almost totally eclipsed the postal service.

Although the Internet is often used to describe the vast array of web sites, it is actually the network on which sits the web, e-mail and many other facilities. The most common are:

World Wide Web

The 'web' is a repository for many millions of documents, including text, pictures, sound and video. Amateur radio is well represented with information on just about every aspect of the hobby.

There are two main ways to find the information you want. You could start with a large site that covers most aspects of amateur radio, such as those run by the Radio Society of Great Britain [9] or the American Radio Relay League [10], and follow the links to sites carrying additional information. Alternatively, use a 'search engine' such as Google [11] or Yahoo [12], type in one or more keywords (eg circuit simulation) to get a large list of sites that may be useful (see **Fig 22.5**).

The sort of information that can be found on the web includes:

- News and events diaries
- Calculators for component values
- Equipment modifications
- Component catalogues
- Advice from experienced amateurs
- DXpedition information and logs
- Circuits and construction projects
- Propagation and solar data

Fig 22.6: Part of the RSGB's e-commerce site where books, CD-ROMs, maps etc can be bought by credit card. It includes a search facility and detailed descriptions for those who like to browse before they buy

E-commerce

Most shops have a presence on the world wide web, and some are available only via the 'web'. This includes major component suppliers as well as much smaller specialist outlets. All display their wares, and most encourage electronic sales by credit card. This has two advantages, you can browse without leaving your home and you can buy from overseas shops - note, though that VAT, import duty and other charges may be payable on entry to the UK.

The on-line catalogues of Farnell [13], Maplin Electronics [14}, and RS Components [15] and many others are not only places where components can be purchased, but also a really good source of information such as data sheets.

Auction sites such as eBay [16] are where second-hand (and new) bargains may be found. Simply enter a search term (eg "ATU") and choose from an array of items. As with all 'blind' pur-

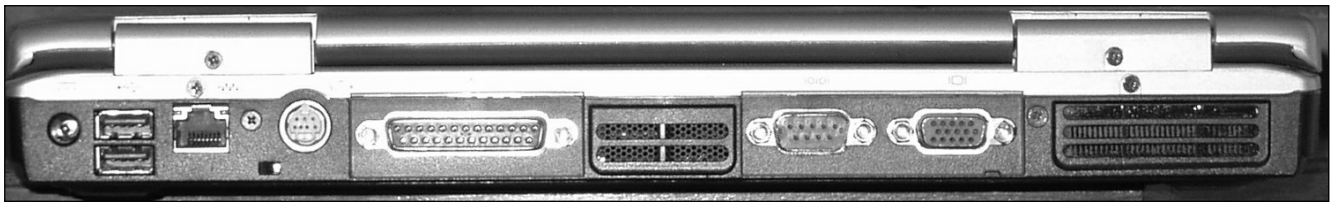

Fig 22.7: Input and output connectors on a laptop computer. From left: Two USB ports, network cable, video out, parallel port (25-way), serial port (9-way) and external monitor.

chases, such as a newspaper advertisement, the buyer should take precautions to prevent fraud. If possible visit the seller and check before you buy.

One of the first examples of e-commerce was book selling, and the Internet makes it possible to search for what you want from millions of books, including many specialist publications that you will never see in a high street shop. Amateur radio books can be bought direct from the ARRL [10] and the RSGB [9] (Fig 22.6).

All sorts of radio and electronics books - even technical papers -can be searched for (by keyword, author or title) on big sites such as Amazon [17] which often has second-hand books listed alongside the new ones. Again, auction sites are a good source of second-hand and antique books.

E-mail

Although your main contact with other amateurs may well be on the air, or at the local radio club, e-mail can still be useful. It can be used to maintain a dialogue with like-minded amateurs all over the world, and allows the exchange not only of text but also pictures (including circuit diagrams), sound files and programs.

Groups

Similar to e-mail are newsgroups and reflectors. These allow groups of amateurs who have something in common, for instance an interest in VHF contesting or the city they live in, to share news and information with all of the other members. if you are new to a particular aspect of amateur radio, this is often the place to get advice from those with much more experience than you.

Some groups, such as those hosted by Yahoo or Google require you to enter a password (available free) before gaining access.

A good example of a special interest group is http://uk.groups.yahoo.com/group/picastar/ which is used by those building the PIC-A-STAR project (see the earlier chapter on this transceiver) to compare notes and get help.

CDs and DVDs

An alternative to the Internet is the compact disk. Many computer programs are available, both free and paid-for, on disk. Advantages over downloading include no phone costs and the ability to re-install the software on a replacement computer with ease.

Publications such as the ARRL's *QST*, RSGB;s *RadCom* (including archives going back to the first ever edition) and books such as this one are also available in full on disk. In addition to saving shelf space, digital books and magazines are usually fully-searchable (ie any word or phrase can be searched for - much more useful than a conventional Index). Visually impaired people can considerably magnify each page on screen if required, or even use a program that reads the publication out loud.

9-pin connector:		25-pin connector:	
1	Carrier Detect	2	Transmit Data
2	Receive Data	3	Receive Data
3	Transmit Data	4	Request To Send
4	Data Terminal Ready	5	Clear To Send
5	Signal Ground	6	Data Set Ready
6	Data Set Ready	7	Signal Ground
7	Request To Send	8	Received Line Signal Detector
8	Clear To Send	20	Data Terminal Ready
9	Ring Indicator	22	Ring Indicator
		Pins 1, 9-19, 21, 23-25 are not used	

Table 22.1: Serial port connections for two types of socket

CONNECTING TO THE REAL WORLD

Much can be done with your computer with just an Internet connection. However, it can be connected to other items such as your radio or equipment under test.

It can also be used to develop software that will eventually be copied to a chip to drive stand-alone equipment. This is the technique used in the PIC-A-STAR transceiver project described in detail in an earlier chapter.

As described earlier, the computer's sound card is an input/output (I/O) device that can be used in amateur radio for digital communications, audio filters, making measurements and so on.

Serial and Parallel

Other I/O sockets on a standard computer include serial and parallel ports. Often just a couple of pins from these multi-way connectors is used for our purposes. For example, the chapter on digital communications shows how transmit/receive switching can be controlled through a serial port.

Serial means that the eight bits in a byte of data are sent one at a time down a single wire, whereas a Parallel port sends the bits simultaneously but needs eight wires. Voltage on the pins switches between minus 3-25 volts and plus 3-25 volts.

Serial ports, sometimes called 'comm' or RS-232, are used for external modems (including packet radio TNCs). Parallel connectors are often called printer ports as they were commonly used for connecting printers before USB ports became universal.

Table 22.1 gives the pin connections for 9-pin and 25-pin serial connectors.

Nowadays, the USB port reigns supreme on modern computers. It has solved many of the compatibility problems experienced with the older I/O systems, but is not easy to use in amateur radio projects.

Fig 22.7 shows the range of input and output ports available on a typical laptop computer.

Controlling your Radio

Many modern base-station transceivers incorporate sockets so that they can be controlled by a computer using special software.

Station control programs, such as those used by DXpeditions and contesters, have facilities to control at least transmit and receive frequency. This can be extended to being able to control your station remotely over a modem (with the appropriate approval, if necessary), as described in [18].

COMMUNICATIONS

Amateurs have been using home computers for making contacts ever since they became available - RTTY programs were available for the 'BBC-B' computer, for example. The chapter on Digital Communications gives much more information.

Towards the end of the 20th century, ways were developed to link amateur radio and the Internet, so that radio amateurs can communicate even though one of them has no radio, or to interlink repeaters via the Internet. Three systems are in use at the time of writing: Echolink [19], eQSO and IRLP [20, 21].

EMC

Sometimes the introduction of a computer into a radio shack causes unforeseen EMC problems. Either the computer (and/or its peripherals) radiates noise on one or more amateur bands, or the operation of the station transmitter causes the computer system to fail or operate erratically.

It is quite possible to make these two equipments compatible by following the measures recommended in the chapter on Electromagnetic Compatibility.

THERE'S MORE . . .

This chapter has barely scratched the surface of how computers can be of benefit radio amateurs and , for that matter, anyone interested in building electronic equipment. No doubt each reader will have his or her own favourite program or Internet site that could have been added.

It is hoped that this brief overview will have sparked some ideas and will set readers searching the Internet, or asking their friends, for new ideas. Computers and amateur radio are a marriage that has only just begun.

REFERENCES

[1] The Amateur Radio Operating Manual, 6th ed, Don Field, G3XTT, RSGB 2004
[2] http://www.terrypin.dial.pipex.com/ECADList.html
[3] http://www.alan.melia.btinternet.co.uk/programs.htm
[4] http://www.aade.com/filter.htm
[5] http://www.btinternet.com/~g4fgq.regp/
[6] http://www.tonnesoftware.com/
[7] http://www.qsl.net/dl4yhf/spectra1.html
[8] http://www.cebik.com/model/nec.html
[9] RSGB web site, http://www.rsgb.org
[10] ARRL web site, http://www.arrl.org
[11] Google search engine, http://www.google.co.uk, or http://www.google.com
[12] Yahoo search engine, http://www.yahoo.co.uk, or http://www.yahoo.com
[13] http://uk.farnell.com
[14] http://www.maplin.co.uk/
[15] http://rswww.com/
[16] http://www.ebay.co.uk/
[17] http://www.amazon.co.uk
[18] 'There's a remote possibility . . .', David Gould, G3UEG, *RadCom*, Aug/Sep 2005
[19] http://www.echolink.org/
[20] http://www.irlp.net/
[21] http://www.ukirlp.co.uk/