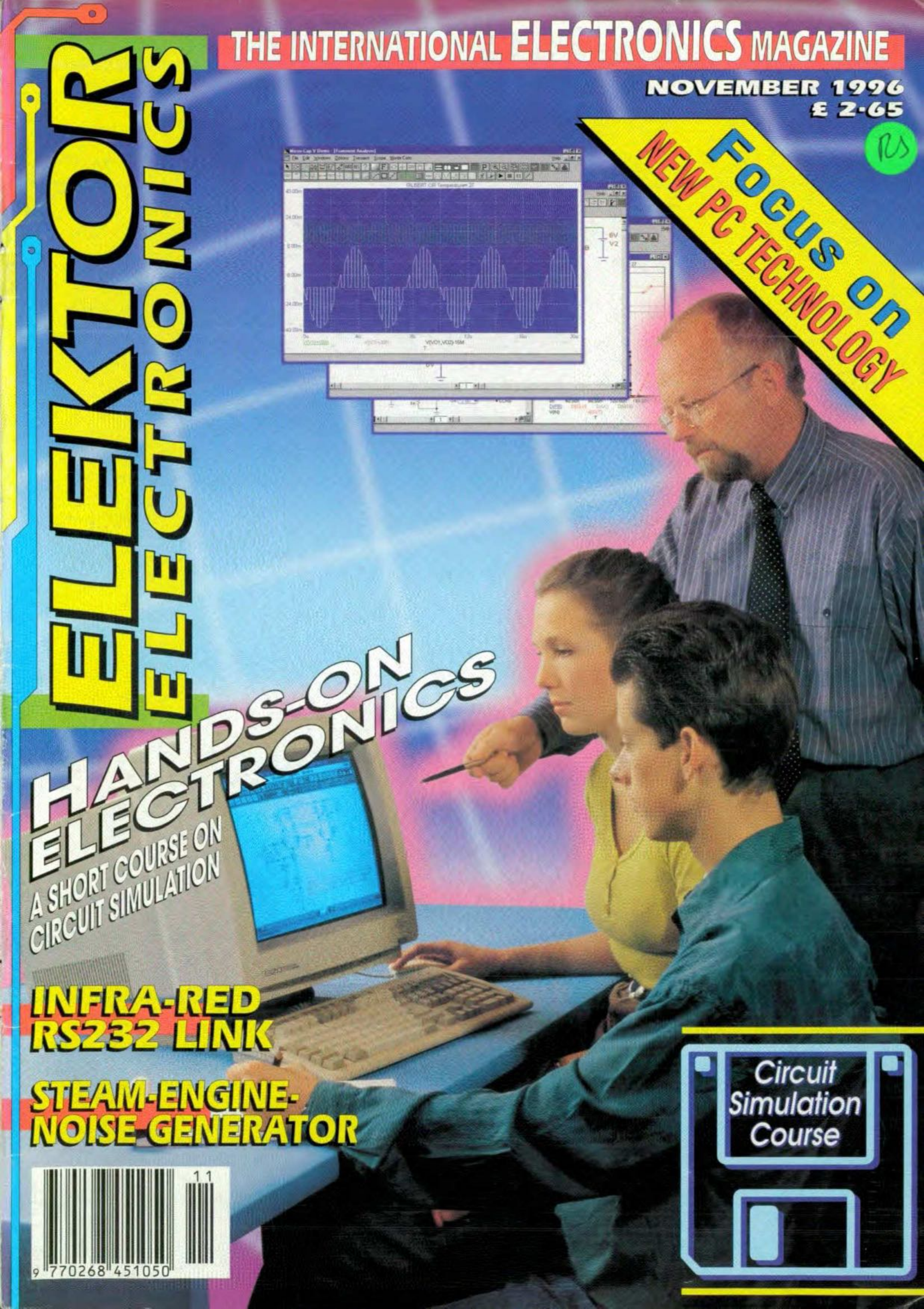

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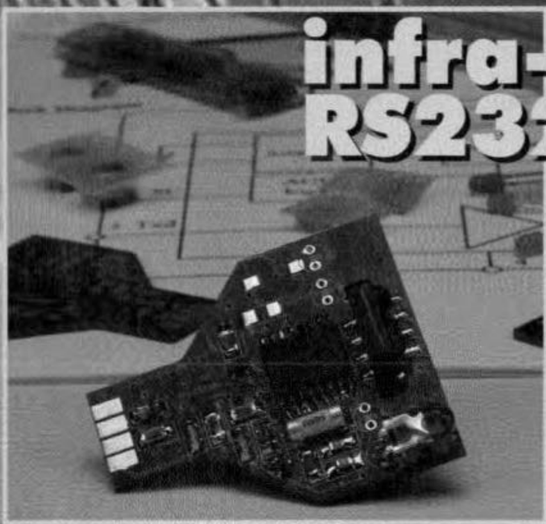

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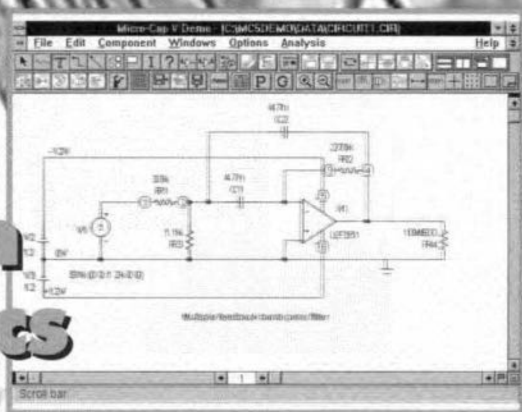

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November 1996 Volume 22
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straightforward complex

YEAR OF ENGINEERING SUCCESS

In early September, the Year of Engineering Success in 1997 (YES) was launched in London. During next year, thousands of events are planned to take place in schools, shopping centres, industrial plants and laboratories around the country to raise the profile of engineers. The cost of around £20m is likely to be met by large industrial organizations, but support will also be given by the engineering and scientific institutions.

MET OFFICE TRIALS ON THE INTERNET

Britain's Meteorological Office, which supplies weather data to most West European countries, has begun trials of a service that sells five-day weather forecasts over the Internet. Each forecast costs £1·00 ($1.60). Users must first receive a PIN by giving credit card details. The trial is limited to the first 500 users who access the site at *http://www.meto.gov.uk*

ELECTRONIC SHOPPING SET TO GROW

A report by Gemini Consulting, part of the Cap Gemini Sogeti information technology consultancy, predicts that up to a third of shopping in Britain will be done from work or home, using electronic terminals and television. It says that growth in retailing through the Internet and interactive television will soon start to affect traditional retailers, with homeshopping taking at least 8% and possibly 30% of the market by 2005. At that time, electronic shopping in the UK will be worth up to £21bn.

CALLING THE TUNE

The Association of British Orchestras has a new web site for its 58 member orchestras, which include most of the country's major internationally-recognized orchestras. The site contains soundclips, pictures, concert listings and news.*http//www.orchestra.co.uk*

TV SCREENS FOR HANGING ON THE WALL

During the recent CeBIT Show in Hanover, Germany, Fujitsu announced that, after many a false start, the flat-screen TV is about to enter the market.

Consumer giant Philips, together with subsidiary Grundig, will use Fujitsu's 107 cm (42 in) flat panel plasma displays in a new range of colour TV receivers.

Consumers have been asking for years for a television set that can be hung on the wall like a picture. The introduction of wideband television has intensified this demand, since 16:9 ratio cathode ray tubes (CRTs) are very deep.

Most TV manufacturers have been searching for years for an alternative to the CRT. Systems like liquid-crystal displays (LCDs), projection TV, digital-mirror screens, lasers and multi-cathode-ray tubes have been considered and deserted owing to lack of success. At last, Fujitsu has shown that it is now possible to produce perfect images on a wideband television receiver. The display unit shown at the CeBIT is only 10 cm deep.

The plasma screen in the display unit has a reading angle of about 160°. Until recently, these screens were available in monochrome versions only. However, combined efforts of the Japanese manufacturers and the Japanese government (with the aim of having an HDTV receiver with plasma screen available for the Winter Olympics in 1998) has put the development of a colour plasma display into top gear.

The front of the plasma display is a sheet of special glass whose rear is coated with a dielectric film, on top of which is a thin layer of magnesium oxide (MgO). The electrodes that produce the picture display are contained in the dielectric film.

The glass at the front is separated from that at the back by a grid that provides a certain space between the two sheets of glass. Red, green and blue dye material, as well as an addressable electrode, have been inserted into the free space so created.

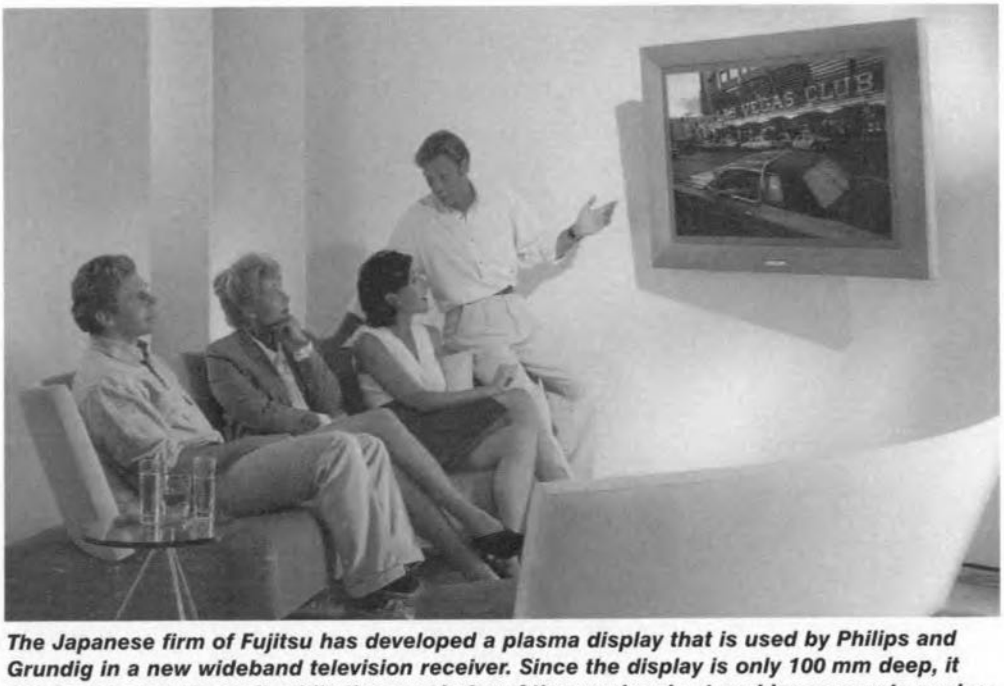
Where the carrier and the addressable electrode meet, a local discharge in xenon gas is brought about by a high-voltage pulse. The ultraviolet radiation released by the discharge actuates the dye and ensures a clear and relevantly coloured pixel (=picture element, i.e., spot of light). Each pixel, measuring 1.08 mm by 1.08 mm consists of a green, a red, and a blue dot. The display has a resolution of 562×480 pixels and measures 920×518 mm. The plasma panel has a peak brightness of 300 cd cm^{-2} and a contrast ratio of 70:1.

The plasma display technology has one significant flaw: the brightness of a pixel cannot be modulated. In the Fujitsu display, this difficulty has been solved by driving each pixel eight times per cycle. The drive to the screen occurs at a frequency of 400 Hz.

The breakthrough in the development of plasma displays came about once the drive and the conversion of ultraviolet light into visible light had been enhanced considerably.

There is, of course, a substantial amount of electronic circuitry, such as the receiver, the audio section, and the drive circuits, to go with the display to form a complete television receiver, but this is contained in a separate enclosure that can be stored away from the display. The display, which weighs a few kilograms (about five pounds), can be hung on the wall as shown in the photograph.

Philips expects to have receivers in the shop by the end of



The Japanese firm of Fujitsu has developed a plasma display that is used by Philips and Grundig in a new wideband television receiver. Since the display is only 100 mm deep, it can be hung on the wall, while the remainder of the receiver is stored in a separate enclosure elsewhere in the viewing room.

this year, but don't rush to your dealer just yet: the initial price is likely to be close to £9,000. This price is expected to be halved towards the end of the century, when the manufacturers hope to sell one million units worldwide.

The first sets will be aimed at the high end of the market and will include Dolby Surround Sound, PALplus signal processing and Megatext. Moreover, interfaces for connection to PCs, such as VGA and TTL, will be provided as standard.

BRITISH SCHOOLS LEAD THE WORLD IN IT

Pupils at schools in Britain have more access to information technology than in any other G7 nation, according to an independent study published by Research Machines, a leading supplier of educational technology. The report revealed that UK secondary schools provide twice as many computers per hundred pupils as in Germany, and that the UK is further ahead than Japan, France and Italy. Only Canada and the USA approach the UK ratio of one computer to 8.5 pupils, and Britain is the only country of the seven to have at least one computer in every primary school.

BRITAIN LEADS EUROPE IN LIBERALIZING TELECOMS SERVICES

Proposals by the Department of Trade and Industry to license new international telecoms services have resulted in 46 companies applying for licences to provide international services over their own facilities. According to Britain's Science and Technology minister, Ian Taylor, this shows that the UK has gained a lead in Europe by early liberalization of its telecommunications market. The government remains committed to developing a strong, competitive UK telecommunications industry. Increasing competition in every sector of the telecoms market means cheap, high-quality telecoms services becoming available to companies across the UK industry, which boosts the nation's competitiveness and its attractiveness to inward investors.

CANINE AGENTS SEARCH THE INTERNET

A British company has developed what it claims to be the world's first software which uses intelligent agents to retrieve information from the Internet. AutoNomy, from AutoNomy Systems in Cambridge, allows a user to train the agents, represented as dog icons, to search and surf the World Wide Web in pursuit of information. Using artificial intelligence technology, the agents trawl the Net for any relevant information required by the user and return it to a user's PC without them having to surf the Web at all. Dr Michael Lynch, managing director at AutoNomy, says there has been an explosion in the number of sites and services available on the Internet and this has led to difficulties in obtaining information on a particular subject or from a specific organization. Among the other benefits of the system are that the agents can be posted to

Events

October

15. ***Behind the Internet****. Lecture at Strathclyde Regional Council, Strathclyde House 1, Glasgow*
15. ***Real-time computer show****, Glasgow*.*
17. ***Real-time computer show****, London**
** Details on these shows from Alan Timmins, 01252 629937*
17. ***Making sense in the virtual world****. Lecture at Salford University.*
18–27: The ***Connect 96*** *consumer electronics show at the NEC, Birmingham.*
21. NATIONAL LECTURE: ***Spellbinding movie magic with digital imaging technology****. Lecture at the IEE Faraday Room, London*
23. ***Auto electronics****. Lecturer at Bromley Court Hotel, Bromley.*
29 – 2 Nov: The ***Networld+Interop 96*** *Conference and Exhibition at Earls Court 2, London. For details phone 01203 426 468*

November

1–3 The ***Acorn World Exhibition*** *at the National Hall, Olympia, London. For details phone 01264 710428*
6–9. The ***Apple Expo 96*** *at the Grand Hall, Olympia, London. For details phone 0181 984 7711.*
12–15: The ***Electronics 96*** *exhibition in Munich, Germany.*
26–28: The ***Manufacturing Week*** *Exhibition at the NEC, Birmingham.*

IEEIE continuing professional development events in November:
5: Time Management
5: Contract law appreciations for electrical contracting
13: Writing good technical reports
14: Earthing and bonding
15: Fast approach to language learning (French)
21: Negotiating skills
27: Project safety planning
29: Specification and instruction writing
Details from: IEEIE, Savoy Hill House, Savoy Hill, London WC2R 0BS. Telephone 0171 836 3357 Fax 0171 497 9006

Internet provider like an e-mail message and perform their searches 'off-line', saving the user the telephone costs; documents retrieved by the agents are automatically linked together using highlighted words or hypertext links on a user's PC for easy analysis. Moreover, agents can be trained to alert parents to pornographic and other undesirable information on the Net.

AMATEUR MATHEMATICIANS: UNITE!

Mathematicians working at the Cray Research Unit claim to have discovered the largest prime number so far: $2^{1,257,787}-1$. Finding such a number is a colossal task, which proves the extraordinary power of the Cray T94 super computer. Even on this giant machine, it took more than six hours to prove that the number could not be factorized.

Their finding, which can be found on the Internet at *http://reality.sgi.com/csp/ioccc/noll/prime/prime.html*, has prompted a group of computer programmers to try to find the next largest (or even larger?) prime number using an array of PCs. This array is linked by the Internet and already consists of several hundreds of PCs. Any budding mathematician wishing to join up with them should contact *http://our world.compuserve.com/homepages/justforfun/prime.html*

LONDON'S NEWEST UNDERGROUND LINE SETS NEW IT STANDARDS

When the extension to London's Jubilee underground railway line opens in March 1998, £60m will have been spent on passenger safety and information systems. Among the innovations will be visual 'next station' indicators aboard the trains; high-legibility information displays at stations; public-address systems that adjust volume automatically to changes in background noise; and surveillance television giving 100% cover of all public places. Staff will have an information management systems through which data will be given priority to display only essential information and act as a decision support system. If a problem occurs with any equipment or an emergency arises, the information system will raise the alarm, log the incident and prompt staff with suggested courses of action and the follow-up operations to be undertaken.

£50,000 AWARD SCHEME TO BOOST MULTIMEDIAPRODUCT DESIGN

British companies with fewer than 250 employees and a turnover of no more than £16m can apply for awards of up to £50,000 to help them design the next generation of multimedia under a scheme announced by the Department of Trade and Industry. The Information Society Creativity Awards (ISCAs) form part of the government's Information Society Iniative, a £35m project to give British business a better understanding of communication technologies. The ISCAs are aimed at promoting the creation of digital content that can be used in online and interactive media such as CD-ROMs, the Internet, digital TV, advertising and music.

NEW METHOD OF NETWORKING COMPUTERS

A new method of networking computers has been launched by UK computer manufacturer, AST Computer. Called Centralan, the product enables up to 12 sets of keyboards, screens and mice to be connected to a single desktop PC, allowing maximum use to be made of a single processor and hard-drive unit. It is particularly suited to less-processor-active applications such as word processing and can cut costs considerably. Announcing the product last month, the company's general manager said: "Centralan is designed to complement existing PC technology, not to replace it. It bridges the gulf which currently separates the traditional PC and the networked computer." Up to 12 users, two of whom can be connected remotely to Centralan via modems, can share files and printers and run multi-user applications.

MULTIMEDIA POLICE KIOSK FOR LONDON

The first multimedia police kiosk which enables the public to record crimes and incidents and make witness statements, face to face with a police officer, over an in-built videophone, will soon arrive in the London Borough of Newham. The kiosk will be open 24 hours a day and can display text in different languages, photographs and maps as well as full-motion video. Touch-screen technology produces local information on screen, such as maps, plus access to counselling and third-party information services. Eventually, it will be possible for drivers asked to present documents to police stations to do so remotely from the kiosk by using scanning facilities which will then forward the digital image of the document to a police terminal. Newham will be the first to install kiosks as part of an EU initiative to encourage the use of technology to improve community communications.

INTERNET USERS URGED TO CLUB TOGETHER FOR THE BEST DEAL

Consumers in Britain will soon be able to club together on the Internet to negotiate discounts on products from holidays and cars to household goods. The Consumers Association is to set up an Internet site called Which? Online before the end of the year offering a range of products. It will enable people wanting, for example, a particular make of car, to get together with other potential buyers to discover the cheapest dealer and then make an approach to him to get the best price. Of its 750,000 members, the associations expects 500,000 to be able to go on-line. The association also plans to put on-line a large library of reports on consumer goods and services.

COMBINED CORDLESS AND CELLULAR TELEPHONES ON THE HORIZON

Pocket telephones that act as cordless handsets when in the office and as digital mobile phones outside will be on the market in a few years, according to Britain's Science and Technology minister, Ian Taylor. He announced recently that the Department of Trade and Industry had awarded space on the 1800 MHz band, currently occupied by Orange and One-2-One, to rivals Vodaphone and Cellnet, who are currently limited to the 900 MHz band. This means the latter two companies will be able to develop phones that will operate at the higher frequency in the office wireless phone systems, and on the lower frequency when outside. The two companies have made innovative proposals to provide corporate customers with the facility to use dual-mode handsets. The plans involve the investment of several hundreds of millions of pounds in infrastructure over the next few years, and represent a very significant boost for jobs in the telecom sector.

computing power on the rise

focus on: new processors for PCs

In computer land, extensions for operating systems as well as for user programs are new arrivals every day. Hardware, too, is frequently updated. On average, a processor generation is superseded by a more powerful one in less than a year. In the mean time, the computing power rises in steps as a result of higher clock speeds.

The heart of each computer is called the CPU. Until about 10 years ago, lots of processor families were in use with famous members such as the Zilog's Z80, Recoil's 6502, Motorola's 6809 and Intel's 8086. Looking at today's computers, Intel seems to have gained the largest market share for CPUs, followed at some distance by processor manufacturers supplying look-alike of the Intel architecture: AMD, Cyrix and NexGen. Not everybody wants to jump the Intel bandwagon, however. Apple, IBM and Motorola (the AIM alliance) have joined their forces and developed a competing product called the PowerPC. Each of these three companies have their own reasons for supporting this development. Before long (they claim), a PowerPC-based computer system will appear on the market which will be a true chameleon in computer land. The technological basis for this computer is the PowerPC Reference Platform, a framework of agreements on which the design is based. Built around the PowerPC and the widely accepted PCI bus, this system is said to be suitable for a wide range of operating systems such as WindowsNT, MacOs, Unix, AIX, Solaris and Novell Netware. The structure of the computer based on the concepts proposed by the AIM alliance is illustrated in **Figure 1**.

By our editorial staff

A third processor family exists which is specifically designed for use in PCs: the ARM family of RISC processors. The designers of the ARM are Advanced Risc machines, a joint venture of Apple, Acorn and VLSI.

This article aims at examining the currently available microprocessors used in PCs, and indicating the direction the various technological developments are likely to take.

Apart from the changes and improvements in architecture that result in a higher processing speed, an ever rising clock frequency is common to all processor families as new versions are released. As we write this, a clock speed of 200 MHz is within the range of most processor manufacturers. By mid-1998, the pundits expect, clock rates between 400 MHz and 800 MHz may be expected.

The x-86 architecture

As most of you will know, Intel is the designer of the x86 architecture. Right up to the 80486, all manufacturers have used (virtually) identical names for processors using this architecture. An 80386 manufactured by Intel, for example, was 100% pin compatible with an 80386 from IBM. The introduction of the 80486 processor marked a change in this convention. Cyrix, for example, offered an 80486SLC which was actually a souped-up 80386. The main advantage of the Cyrix chip was that it allowed existing '386 motherboards to match the processing power offered by the then extremely advanced 80486DX processor. With the introduction of the Pentium and, a little later, the Pentium Pro, Intel dropped the use of the 80xxx number

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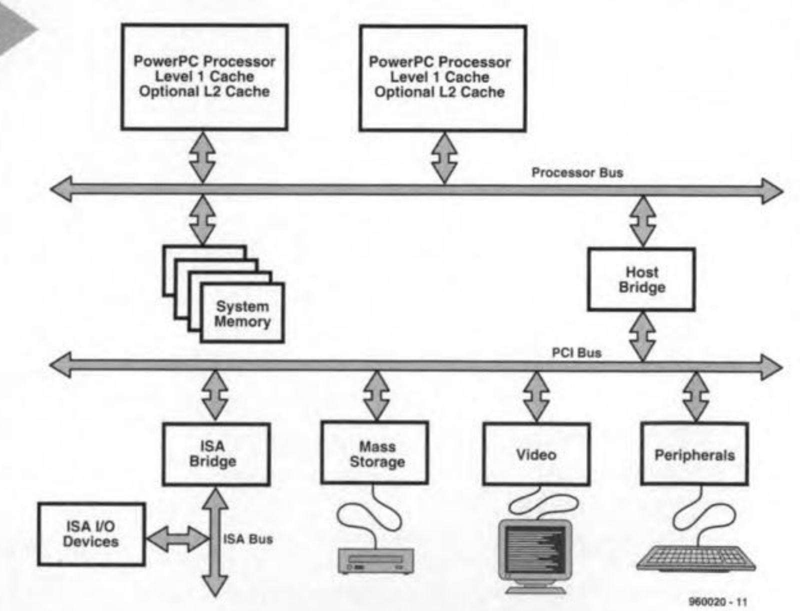

Figure 1. The PowerPC Reference Platform employs the PCI bus, allowing standard extension cards to be used without problems.

series to identify their processors. Instead, Intel switched to names which could be registered as exclusive trademarks. This means that a Pentium or Pentium Pro processor is invariably a processor produced by one of the Intel chip factories.

The manufacturers of Intel look-alike processors are, of course, not to be overlooked when it comes to development activity. Besides Intel, manufacturers like AMD, IBM, Cyrix and NexGen are offering processors which may be applied in PCs running the Windows operating system. An important drawback of this development is, however, that some microprocessors are tied to a certain motherboard type from the same manufacturer. The powerful NexGen processor, for example, will only run on, you guessed it, a motherboard manufactured by NexGen. By contrast, the current series of processors thrown at us by Cyrix and AMD will cheerfully run in almost any Pentium socket.

All processor manufacturers, with the exception of Intel (the reference, after all) conform with the so-called P rating system. This independent speed test (Ziff-Davis Winstone 96) is applied to measure and qualify the computing power of processors. A processor which matches a 150-MHz Pentium as regards computing power is given a P-150 rating. For us plain users this kind of testing and rating system is of little use, and bound to create confusion, particularly if we remain aware of ongoing developments and the fact that the 'distances' between processor families may get larger.

The following sections provide a cursory overview of the known PC processor families.

The x86 line

Intel has two processor families available for desktop systems: the Pentium (a fifth-generation processor) and the Pentium Pro (sixth generation). Arguably, these processors are subject to improvements. Within the next couple of months, Intel will introduce MMX, which, they say, is the first extension of the x86 instruction set since 10 years. MMX refers to 57 MultiMedia eXtensions. Included in the MMX instruction set are special commands for vector and matrix calculations. These allow, for example, a powerful MPEG decoder to be realised. The multiply-accumulator instructions endow this processor with features which are currently only found on DSPs. Thanks to MMX, the software developer also gets a number of instructions at his disposal which will help him increase the speed of games and many other applications in which video has an important function.

As we write this, the finishing touches are made to the P55C, a fifth-generation CPU from the Pentium family member which is the first to feature the MMX instruction set. Not forgetting a clock speed increase to 200 MHz, these are the essential developments on the Pentium front.

Another, equally interesting, development is the design of a Pentium Pro derivate which also features the MMX instruction set. At its introduction, the processor will be produced in 0.35-micron technology, and operate at a clock frequency of 200 MHz. Later versions are expected to run at 300 MHz. An important difference with the Pentium Pro is the absence of the costly on-chip level-2 cache memory. The integrated level-1 cache, on the other hand, is said to become larger. According to informed sources, the successor to the Pentium Pro, called the P7, will not make it to introduction before the summer of 1998. This processor, co-developed by Intel and Hewlett Packard, is aimed at introducing a new 64-bit wide instruction set consisting of VLIWs (Very Long Instruction Words). It is, however, intended to maintain compatibility with the x86 instruction set as well as the set for Hewlett Packard's PA-RISC. Thanks to the VLIW concept, instructions may be coded in a constant, partially parallel, form, which makes the process of decoding the instructions much simpler as well.

Competitors

As noted earlier, alternatives to the Intel processors are offered by, among others, Cyrix, AMD and NexGen. **AMD**, now the owner of NexGen, recently introduced the AMD-K5-PR75, a fifth-generation CPU which is launched as a direct rival of

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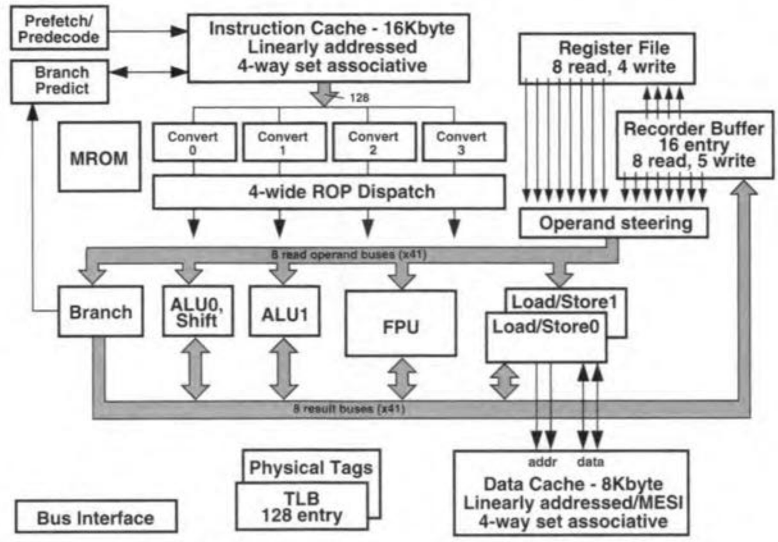

Figure 2. Internal structure of AMD's new K5-series processor. The product is intended as a competitor for a Intel's Pentium CPU.

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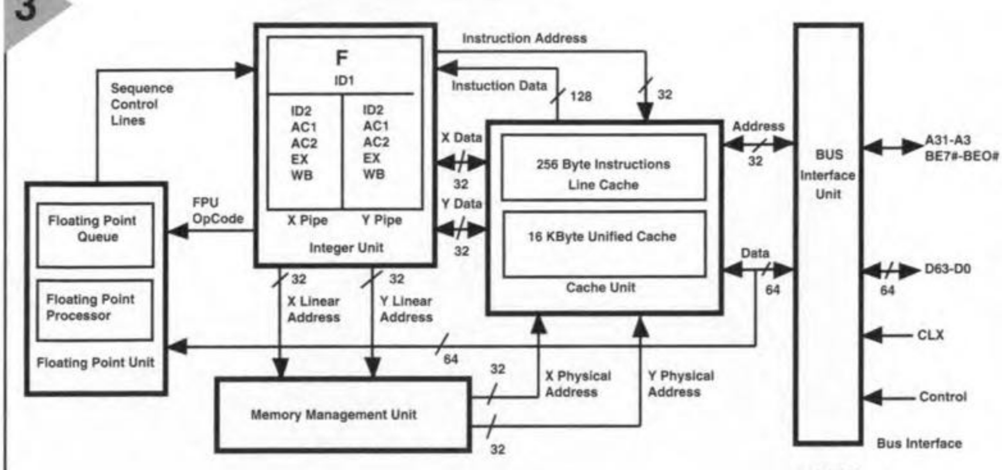


Figure 3. The Cyrix 6x86 is a powerful processor offering Pentium Pro computing power for motherboards with a Pentium socket.

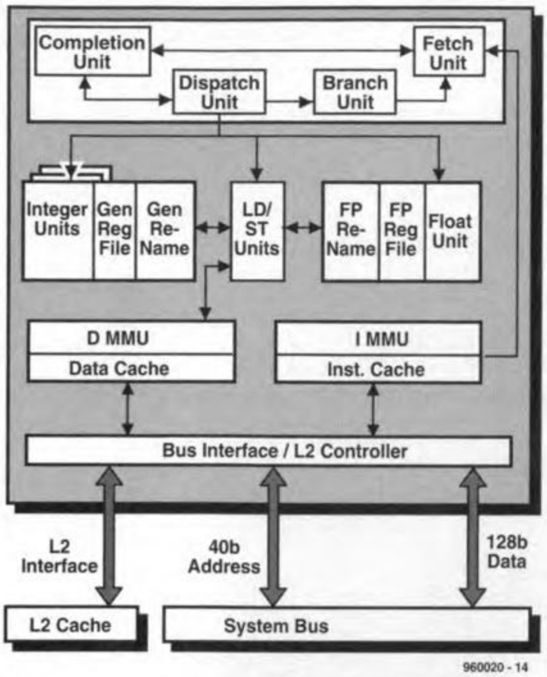


Figure 4. The PowerPC 620 is a RISC processor which utilizes a 64-bit structure. The databus and address bus have respective widths of 128 and 40 bits.

Intel's Pentium processors. The K5 processors, of which the core structure is shown in **Figure 2**, contain a K86 superscalar core, a 16-kBytes instruction cache and a data cache with a size of 8 KByte. On average, this beast has about 30% more processing power than a Pentium processor running at the same speed. The K5-series processors are Pentium-compatible. AMD has announced the AMD-K5-P166 for the first quarter of 1997.

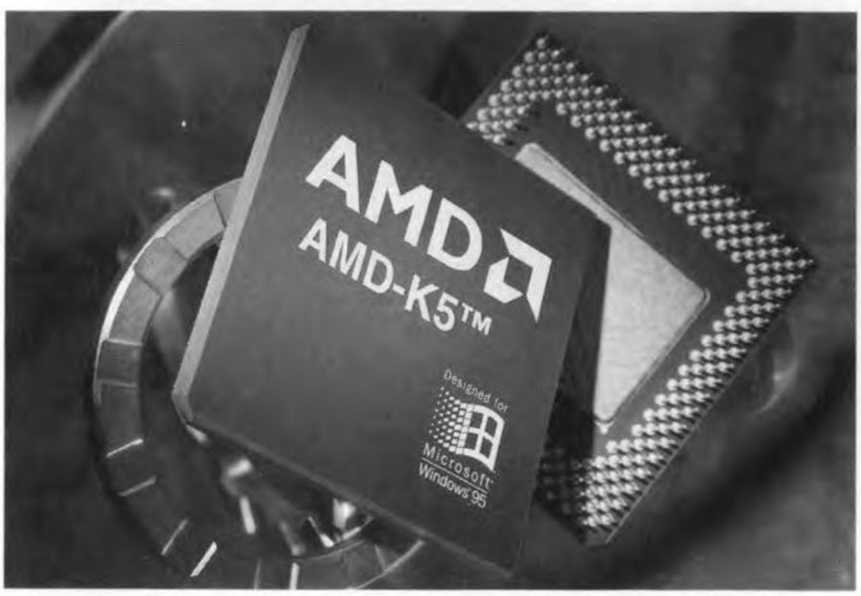
Life does not stop at the K5 processor, of course, and AMD have already revealed their strategy around the K6 (a sixth-generation processor series). As far as computing power is concerned, this CPU is claimed to make the Pentium and Pentium Pro take a back seat. The K6 also sports MMX instructions to speed up multimedia applications. For this purpose, AMD has signed a licence agreement with Intel. Trial production of the K6 will commence during the first six months of 1997. Volume production, AMD hope, will not present problems any more by the end of that year.

Until recently, **NexGen** used to be an independently operating manufacturer of Intel-compatible processors which were sold under the type designation Nx586. These processors make use of the RISC86TM Microarchitecture which guarantees a high degree of compatibility with existing software, and is open to extensions. Thanks to this architecture, x86 instructions may be processed at a speed which is typical of a RISC processor. For the chip designers, the RISC structure is a welcome feature because it takes up far less space. Furthermore, the processor provides 16 kBytes of instruction cache memory and an equal amount for data cache. That's a lot compared to, say, Intel's Pentium which has just 8 Kbytes for data cacheing. Finally, the L2 cache controller is fitted externally to the Pentium, while the Nx586 has it on the chip.

AMD and NexGen, currently one company, are now involved in a redesign of the Nx686. This processor is designed to be pin-compatible with the Pentium, and is due for introduction by mid-1997. With this processor, too, the focus is on multimedia extensions. Further developments of the Nx586 are not planned.

The last CPU manufacturer to be mentioned in this article is Cyrix, a Texas-based company. Today, their top-of-the-range product is the 6x86, a sixth-generation processor whose architecture is shown in **Figure 3**. The most powerful member of the Cyrix family ticks at a clock rate of 150 MHz, and has a P rating of 200. Cyrix, always a good source of sensational developments, are currently working on a considerably enhanced version of the 6x86. The first version equipped with multimedia extensions may be expected by mid-1997. Additionally, the familiar soundcard and modem are reduced to an amount of software and a few simple external components like a D/A converter. Support for video and MPEG decoding is also implemented.

Like Intel, Cyrix do not expect to be able to introduce a seventh-generation processor until the year 1998.



POWER TO THE PEOPLE!

Sometimes you get the impression that the PC market consist of x86-based systems only. Actually, this is true if you look at sales volumes. There are, however, a number of parallel developments which may not be overlooked, including the PowerPC initiative brought to us by Apple, IBM and Motorola.

PowerPC is a family of scaleable RISC processors which are being developed for the market segments. Apart from processors for desktop PCs (the 600 series), there are also embedded controllers (the 500 series) and processors for servers (the 600 series). Within the framework of this article, we will concentrate on the CPUs in the 600 series. Mass acceptance of the PowerPC is fraught with pitfalls, as the manufacturers of the PowerPC have found out the hard way. Ambitious plans launched a few years ago and aimed at preparing the market for acceptance of the PowerPC did not have the desired effect. This was partly caused by the lack of a clear standard. The introduction of the PPCRP (Power PC Reference platform), previously called CHRP (Common Hardware Reference Platform) could well turn the chances in favour of this development. Thanks to PPCRP, the user has a computer available which is capable of supporting all major operating systems. This would mark the end of rivalry such as that between Microsoft and Intel regarding Windows and Motorola an Apple regarding MacOs.

The PowerPC is a genuine RiSC processor. By contrast, most x86 processors are of the CISC type. When the RISC processors were first introduced, their main feature was that these CPUs were able to process any instruction in one clock cycle. Mainly as a result of enhanced instruction processing methods, modern CISC processors can match this processing speed without problems. In many

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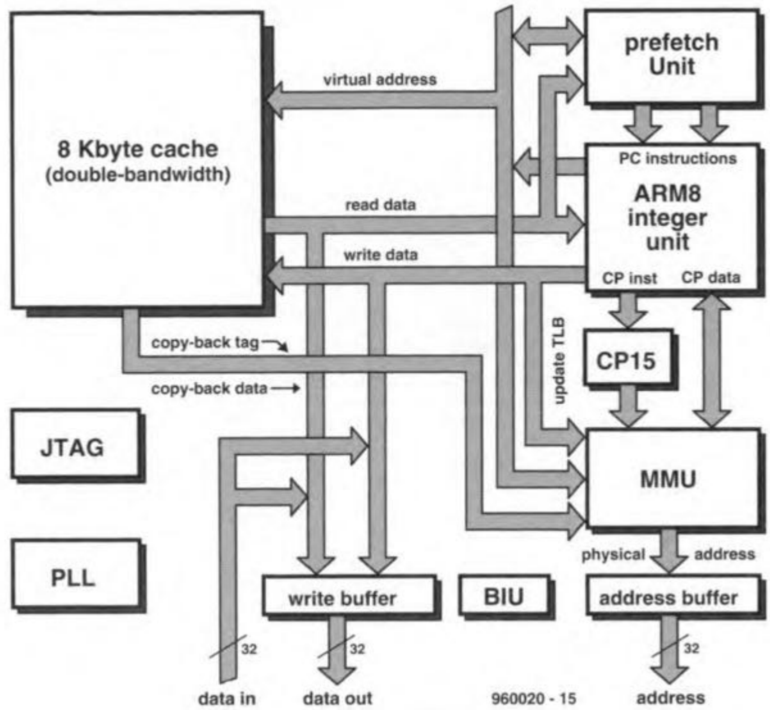


Figure 5. The new ARM810, a powerful RISC processor which holds the number one position for computing power per unit of consumed power. It is mainly found in portable equipment.

cases, the manufacturers achieve this by applying RISC structures internally.

Today, the PowerPC family you may find in desktop systems consists of the PowerPC 602, 603 and 604. A PowerPC 601 or 603e clocked at 100 MHz achieves a P rating of 100. The PowerPC 604 running at 150 MHz, however, achieves a rating of 200.

Extensions like MMX in the Intel processor range are not anticipated with the PowerPC. According to Motorola, the powerful FP unit in the PowerPC makes special multimedia extensions superfluous, the current level of computing power being ample and sufficiently flexible.

The next PowerPC processor to be launched for desktop systems is the PowerPC 620. This 64-bit wide computing giant is promised for introduction by the beginning of next year. We are, however, proud to lift some of the mystery around this computer by presenting the internal structure of the PowerPC 620 in **Figure 4**. The differences between the 604 (currently the top processor in the PowerPC line) and the new 620 are noticeable. The external databus of this 64-bit processor has a width of 128 bits, while a 40-bit wide address bus is used. An interface for the L2 cache is provided on-chip. The processing speed of this CPU is no fewer than four instructions per clock cycle. Because of all these new features, the number of pins on the chip has gone up from 304 to a staggering 625.

ARM, LOW-POWER COMPUTING POWER

The last family of 32-bit RISC processors is the Advanced RISC machine (ARM), which was developed in Europe for a change. The most popular processors used these days were developed on the basis of the ARM6 and ARM7 design macro. Because of its (relative) simplicity (the ARM contains fewer transistors than any other processor), the ARM is easily integrated into other chips. An intelligent ASIC, for example, having an internal RISC processor will not be a problem. As we write this, two new members of the ARM processor family are being introduced. One is the ARM810, a chip which operates at a clock frequency well over 70 MHz, and is based on the new ARM8 design cell (the computing pwer is 80 MIPs). The ARM810 is a totally static RISC processor with an internal 8-kByte cache. Instructions are processed in a five-step pipeline, allowing the execution to be distributed over several periods. **Figure 5** shows the elements which went into the architecture of the ARM810.

The other new product is the new StrongARM SA110 which operates at more than 200 MHz. It uses a modified ARM6 structure, and achieves a computing power of more than 200 MIPs. An interesting detail: the arithmetic unit in this processor (the SA1) contains just 115,000 transistors, which is a remarkably low number of active components compared with any competitive product.

The SA110 marries the computing power of a Pentium (Pro) processor with the ability to power the chip from two penlight batteries. Compare this: a 100-MHz Pentium processor uses about 6 watts of supply power, and a 90-MHz PowerPC 604, about 12 watts. The new StrongARM SA110 uses just 900 milliwatts, so that it is number one for computing power relative to power consumption (MIPs/watt), and an excellent choice for portable equipment.

Although StrongARM continues to build on existing ARM architectures, the design is only modified by USA-based Digital to enable it to operate at a clock sped of 200 MHz and higher.

Again as this article is being written, the first ARM processors are starting to appear which include a special DSP function, called Piccolo. These processors are expected to become fierce competitors of today's fast DSPs. By mid-1998, the first StrongARM processors with an integrated DSP extension will become available.

(960020)

ST62 Programmer

The micro-controllers in the ST62 family manufactured by SGS-Thomson Microelectronics thank most of their popularity to their versatility and efficiency. They do, however, require a special programmer, of which a simple version is contained in the Starter Kit supplied by SGS-Thomson. The project described here, however, allows you to build your own ST62xx programmer with extended features. The circuit is suitable for controllers in the ST621x, ST622x and ST626x series.

Design by L. Lemmens

A versatile programmer for SGS-Thomson microcontrollers

The present programmer is, in principle, also suitable for controllers in the ST624x series, albeit that these devices require an expensive adaptor socket and some very intricate soldering work because of their enclosure forms (QFP80, QFP64 or QFP52). All controllers in the ST62 family feature a common core which consists of an ALU, a Flag Register, a Stack and a Control Unit (**Figure 1**). The difference between the individual devices lies in the size and amount of ROM, RAM and peripherals on the chip. The large number of pins on the ST624x controllers, for example, is caused by the integrated LCD driver with backplane and segment outputs.

Among the standard features available on all ST62xx controllers are a watchdog, an 8-bit timer/counter, an A/D converter and three 8-bit I/O ports (**Figure 2**). The ST626x types have added features such as a serial interface and an auto reload timer which enables, among others, a PWM control to be realized in a simple manner (**Figure 3**).

Table 1 provides an overview which shows that not all I/O lines of the ports (column I/O) are actually bonded out to pins on the IC. Else, there would have been 24 I/O lines. The column marked A/D indicates how many of these lines may be

SPECIFICATIONS

- *Programs all microcontrollers in the ST621x, ST622a and ST626x series*
- *Simple construction, few parts*
- *Software available via BBS/Internet (free), or Readers Services.*

linked to the A/D converter. Similarly, the LED column shows how many of the pinned I/O lines are capable of sinking 20 mA to drive, for example, LEDs, opto-isolators or triacs directly.

The configuration of the I/O pins may be altered during program execution. The available hardware allowing, only software is required to change one and the same pin from an analogue input into a digital input (with or without internal pull-up, possibly with interrupt), or into an open-drain or a push-pull output. Note, however, that this kind of versatility as regards the I/O pins may not be available for all configurations. The datasheets state exactly which options may be selected for each individual pin. The pinouts of the controllers listed in Table 1 are shown in **Figures 4a through 4d**.

Having a maximum clock rate of 8 MHz, the ST62 controllers are not in the fast lane. For many applications, however, speed is less important than the amount of external circuitry you need for peripherals. Especially in that regard, the flexibility and versatility of ST62 controllers offer clear advantages over standard solutions, for example, Intel's 80xx controllers.

A striking difference as compared with other microcontrollers (e.g, the 8051), is the absence of an external address and databus for the connection of external RAM or ROM. Consequently, these memories have to be used sparingly, especially as far as RAM is concerned. Although tricks may be used in this area (e.g., using an external EEPROM to store variables and lookup tables), the actual program should only be stored in the ROM contained in the controller. Obviously, that has implications for ST62-based program development. Programs may only be tested in real time if you have a programmed controller available, and for that you need the programmer described in this article (yes, there are real time emulators, but these are far beyond the reach of many users)

THE PROGRAMMER HARDWARE

The programmer is connected to a parallel printer port on your PC (LPT1 or LPT2). It is controlled via seven lines of the Centronics interface. The programming algorithm is proprietary information which is not given out just like that by SGS-Thomson. You need not bother about that, however, because the present programmer ensures proper programming without the need of extensive documentation on the programming algorithm. Although everything to do with the programming algorithm is arranged almost invisibly by the software and the programmer hardware, it is still worthwhile to give a few hints concerning the operation of the programmer hardware (**Figure 5**).

Pin 2 on the Centronics interface (bit D0) controls the programmer supply voltage. This is done to ensure that the programming socket is voltage-free when a controller is installed or removed. LED D4 acts as the supply on/off indicator on the programmer. Another LED, D2, lights when the programmer is actuated by the PC program. If you wish to use the control software contained in the ST626x Starter Kit, the signal on the D0 line is inverted, and jumper JP1 and zener diode D5 have to be fitted.

Pin 3 (bit D1) switches the programming voltage at the TEST/VPP pin of the controller. As usual, the voltage at this pin is raised during programming, in this case, to 12.5 V. During verifying or reading T3 is switched on. As a result, zener diode D1 is short circuited so that the VPP pin is at 5 V. The presence of the 12.5-V programming voltage is indicated by LED D3. As a matter of course, the presence of the programming voltage also depends on the level at pin 2 (bit D0): no programming voltage without a proper supply voltage!

Pin 4 (bit D2) supplies the programmer with a clock signal which is used for programming, verifying and reading. After being buffered by IC2e, this clock signal is sent to the OSCin (oscillator input) pin of the ST62 device to be programmed.

The available documentation does not provide much information about the signals on pins 5, 6 and 7 of the Centronics interface (bits D3, D4 and D5). It is clear, in any case, that the signal at pin 6 (bit D4) is connected to the reset input of the controller via inverter IC2f, while the inverted signals on interface pins 5 and 7 (D3 and D5) are taken to two port connections (PB6 and PB5). With an ST6215, the only feedback supplied to the PC by a microcontroller to be programmed travels by way of PB7, inverter IC2a and the Busy pin on the Centronics inter-

1

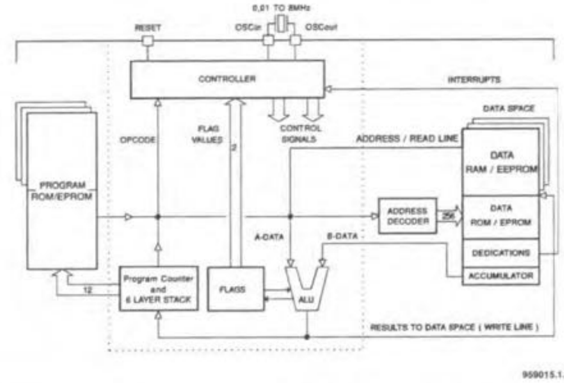
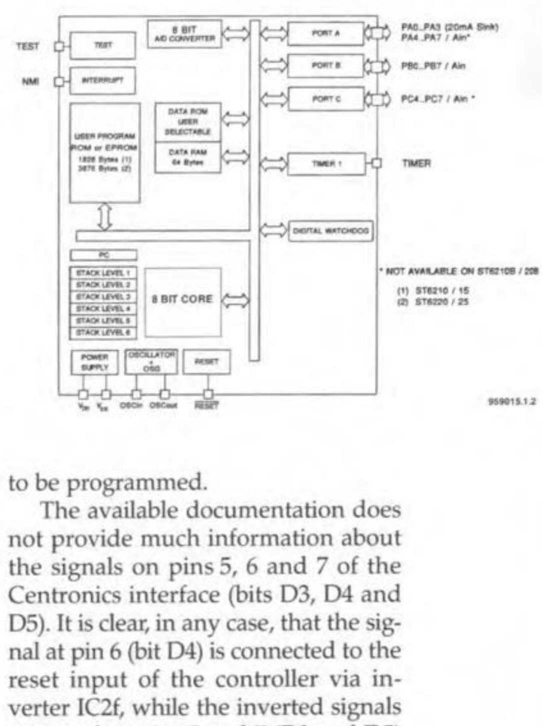


Figure 1. All controllers in the ST62 family have a common core consisting of an ALU, a Flag register, a Stack and a Control unit.

Figure 2. Common to all ST62xx controllers are extended features including a watchdog, an 8-bit timer/counter, an A/D converter, and three 8-bit I/O ports.

2



SGS-Thomson ST62xx - series microcontrollers						
	ROM (kB)	RAM (bytes)	EEPROM	I/O	A/D	LED
ST6210	2	64		12	8	4
ST6215	2	64		20	16	4
ST6220	4	64		12	8	4
ST6225	4	64		20	16	4
ST6260	4	128	128	13	7	6
ST6265	4	128	128	21	13	8

3

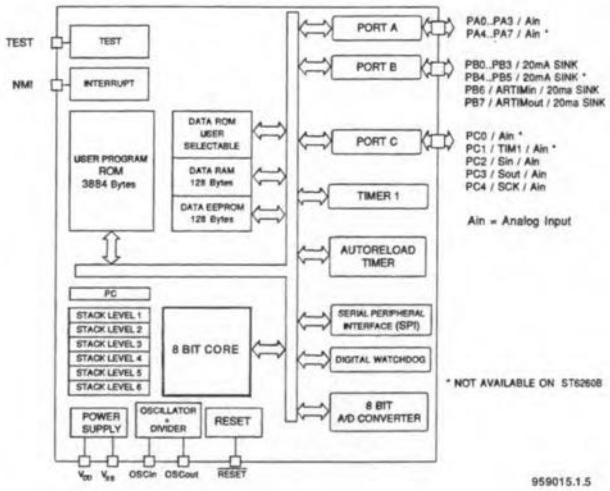


Figure 3. ST626x types in addition contain a serial interface, an auto-reload timer and an EEPROM.

programming sockets) is shown in three versions in **Figure 7**. On the main board, a 28-pin IC socket is soldered, into which another socket is plugged. The reason for doing so is simple: if a contact problem develops, the socket does not have to be desoldered. Instead, you just plug in a new one. This saves unnecessary wear and tear on the socket soldered on to the board. ST6210 and ST6220 controllers are programmed directly in the socket on the main board. Next to the 28-pin socket for the ST6220, a 10-way socket strip is fitted which allows 20-pin DIL-style ST6210 controllers to be fitted using one row of the 28-way socket. Frequent use of the programmer really calls for a ZIF socket to be plugged into the regular DIL socket. Be sure to use a ZIF socket which is suitable for the 20-pin narrow-DIL case of the ST6210 controller. The type mentioned in the parts list meets this requirement. The plug-in adaptor boards are intended for controllers type ST6260 and ST6265. As indicated in the circuit diagram, the adaptor boards also contain SMD decoupling capacitors which have to be soldered straight on to the solder side of the adaptor board.

To enable them to be inserted into the socket on the main board, the adaptor boards are fitted with two 14-pin pinheaders or socket rows with long pins. Longer strips (20-way or 36-way) may be shortened to 14 pins. If pin strips are used, make sure that the ends at the component side of the board are not taller than the other components. If necessary, reduce the length by cutting. The 6265 adaptor board is additionally fitted with two 14-way socket strips which are plugged into a 28-way DIL socket. With frequent use, the ZIF socket may be plugged into this socket again (**Fig-**

4

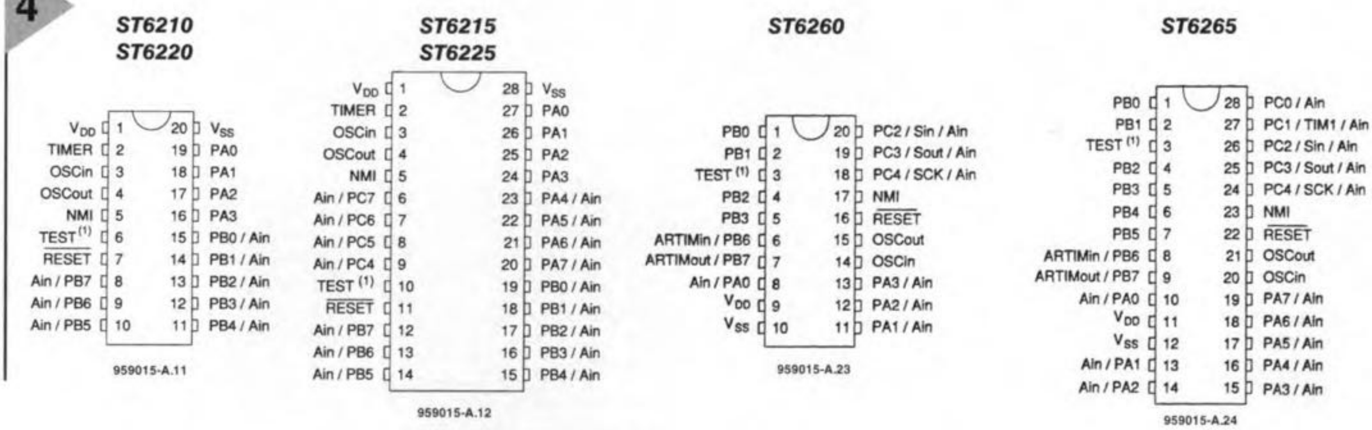


Figure 4. Pinouts of the controllers listed in Table 1.

face. This channel is used to return program memory data to the PC when an ST62 device is being read. Obviously, it is also essential during device verification.

Considering the small number of connections between the PC and the controller, data is conveyed in serial fashion. This is in contrast with many other controllers and EPROMs, where the data traffic is usually parallel (bytewise). Because of the limited size of the program memory contained in the ST62 controllers, a programming job will not take too much time, despite the fact that serial transmission is used.

The power supply, consisting of a 12V/500mA mains adaptor block, may appear to be rather small considering that a 12.5-V programming voltage is needed. Fortunately in this case, most mains adaptors have a relatively high internal resistance, which causes a much higher than nominal output voltage if a small current is supplied like the 25 mA or so required to program an ST62 controller. Also, the programming voltage is not particularly critical: 12 V is also fine for proper programming. Strictly speaking, the supply voltage for the programmer should be 15.5 V because a minimum voltage drop of 3 V should be observed for the voltage regulator.

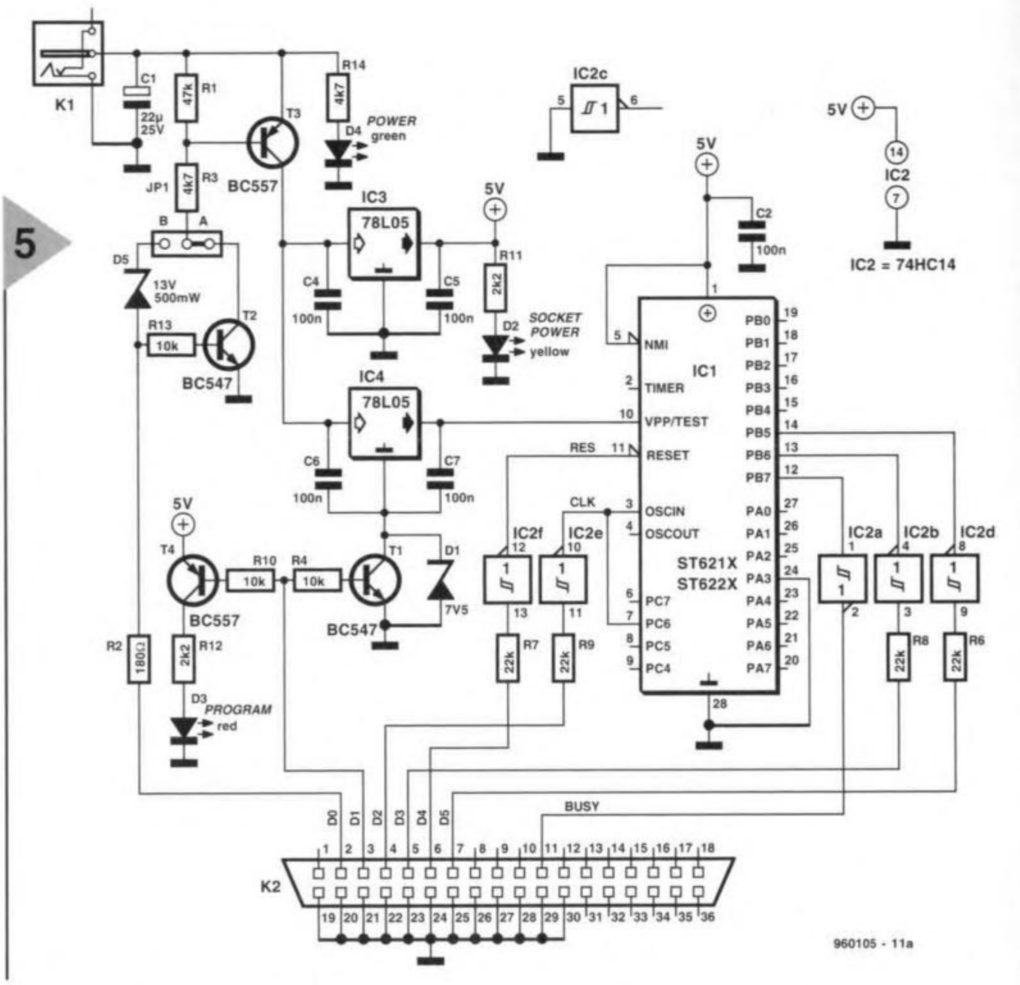
Circuit board, adaptor boards and sockets

Because the hardware for the programmer is relatively simple (compared with, say, a PIC programmer), the printed circuit board is spacious and neatly laid out. The artwork for the main board and the two adaptor boards is given in **Figure 6**.

A standard Centronics socket for PCB mounting is used to establish the link to the computer so that a regular printer cable may be used. The mains adaptor is connected to a PCB-mounted socket. Note that reverse polarity protection is **not** provided, so be sure to check the polarity of the d.c. input voltage before you insert the plug! In case the mains adaptor socket, K1, is not mounted, the two '+' terminals on the board (at either side of the socket symbol printed on the board). This wire link is also shown on the component layout, inside the symbol of the socket, and may be overlooked.

The population of the boards (with

Figure 5. Circuit diagram of the ST62 programmer.



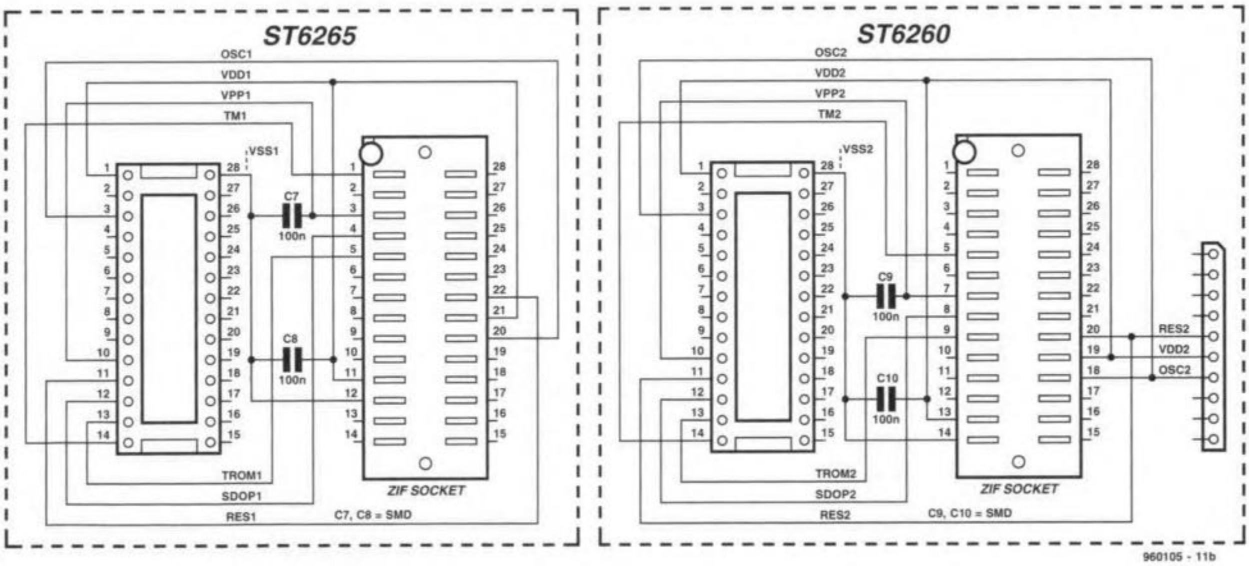
ure 7a), else, the controller goes straight into the 28-pin IC socket.

The situation with the ST6260 adaptor board is slightly different because this controller comes in a 20-way narrow-DIL case. If the indicated ZIF socket is used there is, however, no difference with the population of the 6265 adaptor board, because the ZIF socket is also suitable for the narrow-DIL case. As in Figure 7a, the adaptor board is fitted with two 14-way socket strips, into which goes a regulator 28-pin DIL socket. The ZIF socket is then plugged into the DIL socket again.

If you do not intend to use a ZIF socket, the two 14-way socket strips are not required. Instead, the adaptor board is populated as shown in **Figure 7b** and **Figure 7c** using two regular, stacked, 28-way DIL sockets.

THE PROJECT SOFTWARE

The development as well as the programming software is of the Public Domain category, and may be downloaded from a number of BBSs (bulletin board systems). SGS-Thomson has expressed an intention to make



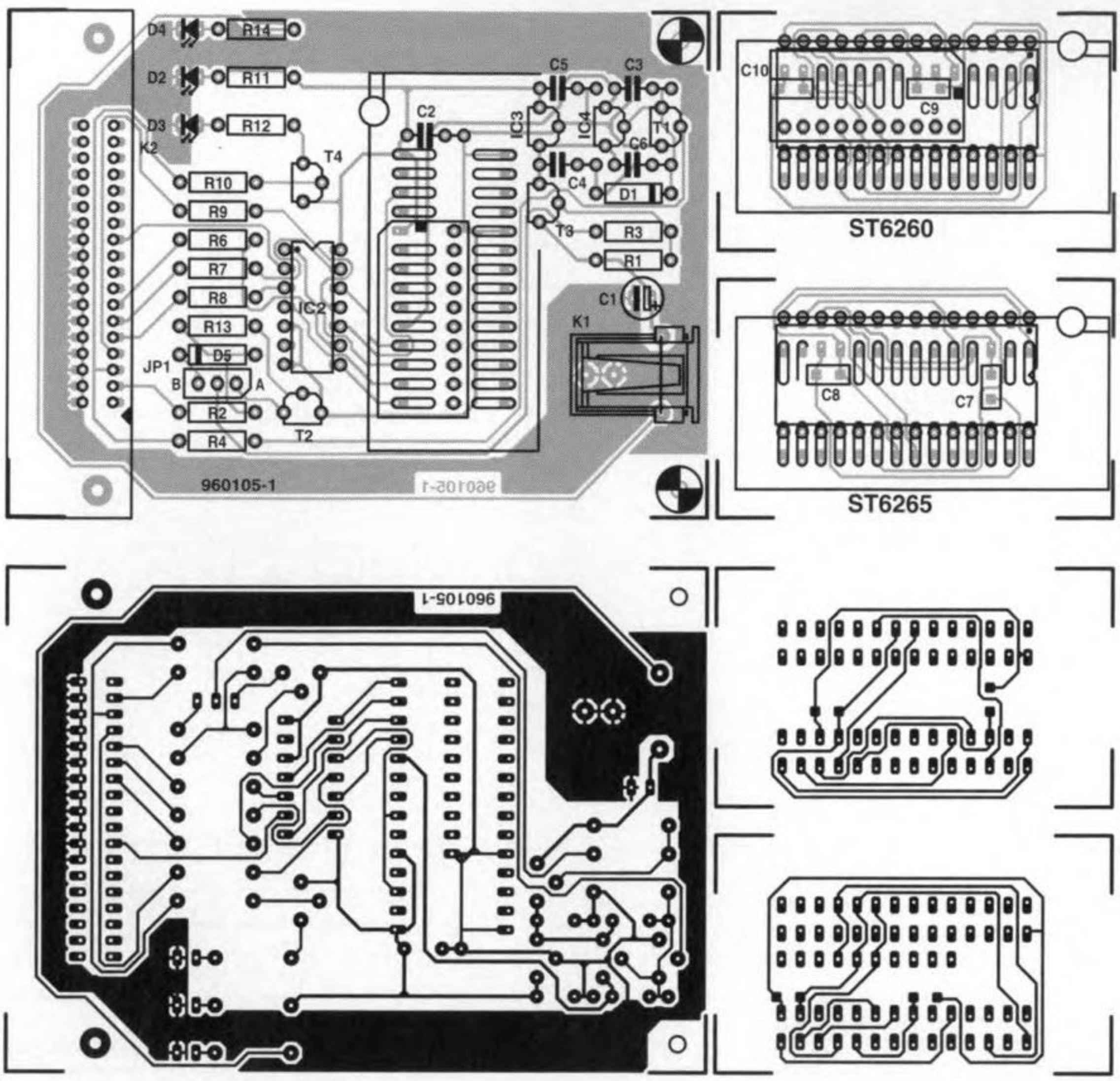
this and other, related, software available via the Internet, too. Their web site is at **www.st.com**.

Apart from the software package for the ST621X-2X (ST6620KIT.ZIP, called package 'A' in the following description), there is a second one for the ST626x (ST626KIT.ZIP, package 'B'). The BBS will also hold files containing examples and FAQs (frequently asked questions). The telephone numbers of the BBSs are given at the end of this article.

To obtain software from a BBS, you first dial the BBS. Once on line, you select the desired software (.ZIP file), then download it using any of the popular file transfer protocols. Next, unpack the ZIP file using the familiar PKUNZIP program.

In addition to the programming software, the packages also contain an assembler (AST6.EXE), a linker (LST6.EXE), a simulator (SIMST6.EXE) and examples. The 'B' package contains the newer version of the programming software which also allows the internal EEPROM to be programmed and read. Both program versions (package 'A' and 'B') are equally suitable for the programmer described here, although the hardware of the programmers in the respective Starter Kits from SGS-Thomson differs considerably. The circuit in the first Starter Kit, for example, has buffering inverters on the Centronics lines. In the other Starter Kit, no buffers are used, instead, each line is protected with the aid of a series resistor. Fortunately, the software may be adapted: both packages contain files with the extension

6



COMPONENTS LIST

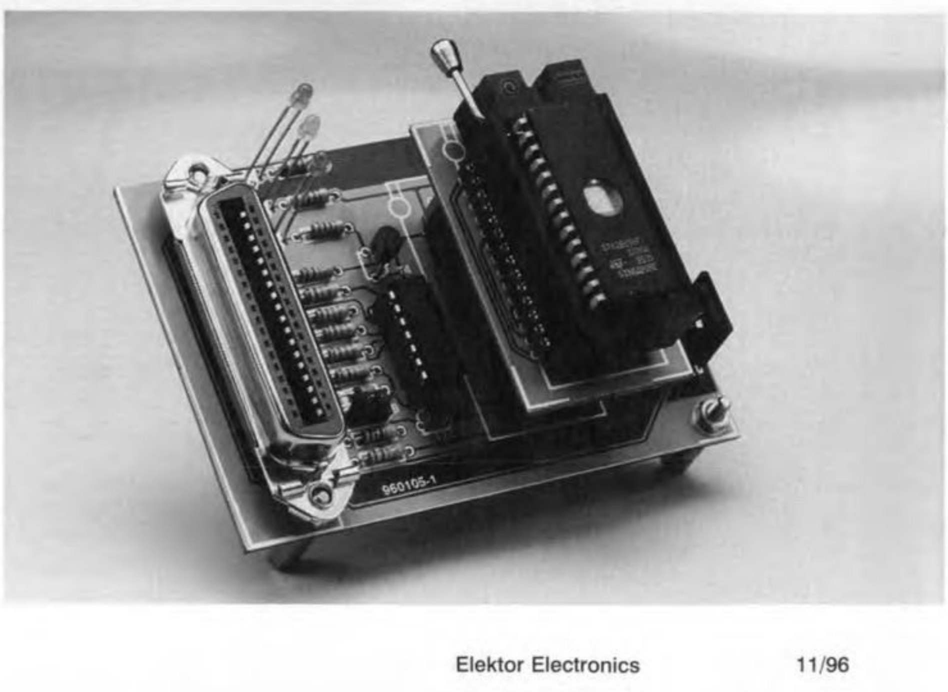
Resistors:
R1 = 47kΩ
R2 = 180Ω
R3,R14 = 4kΩ7
R4,R10,R13 = 10kΩ
R6-R9 = 22kΩ
R11,R12 = 2kΩ2

Capacitors:
C1 = 22μF 25V radial
C2-C6 = 100nF
C7-C10 = 100nF SMD

Semiconductors:
D1 = 7V5 zener 500mW
D2 = LED yellow low current
D3 = LED red low current
D4 = LED green low current
D5 = 13V zener 500mW
T1,T2 = BC547
T3,T4 = BC557
IC3,IC4 = 78L05
IC1 = 28-pin DIL ZIF socket, Aries type 28-6554-10 (Farnell) (see text)
IC2 = 74HC14

Miscellaneous:
JP1 = 3-pin SIL header w. jumper
K1 = mains adapter socket, angled, PCB mount
K2 = 36-way Centronics socket, PCB mount, angled
Printed circuit board and software on disk, order code 960105-C (see Readers Services page).

Figure 6. Artwork of the printed circuit board designed for the programmer (board available ready-made, see Readers Services page).



7

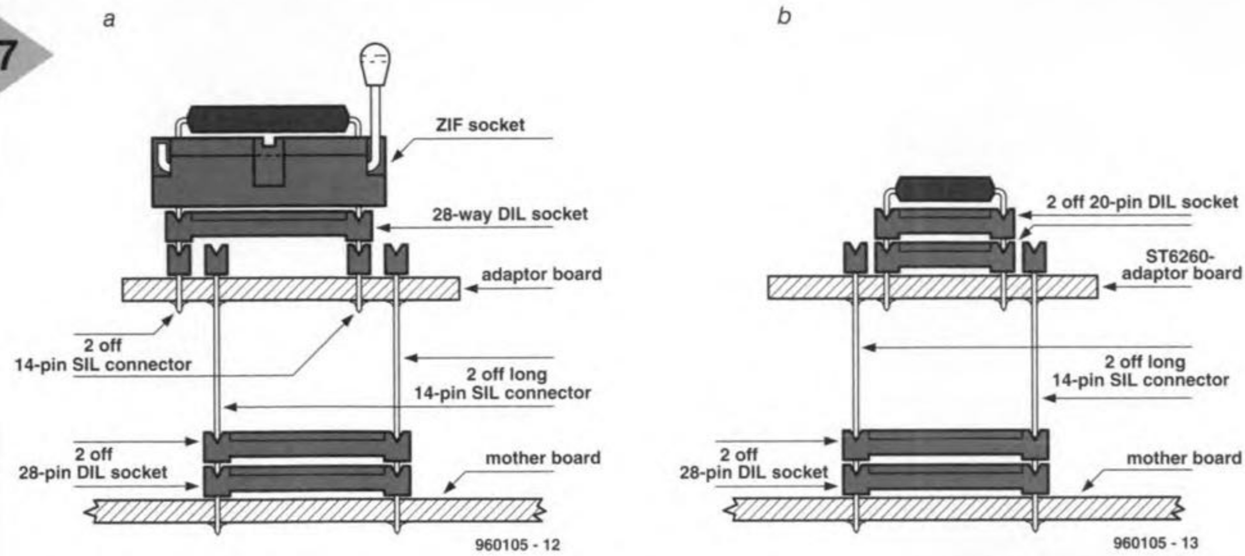


Figure 7. The adaptor boards contain socket strips and/or IC sockets, and are plugged into socket location IC1 on the main board using pin headers. Figure 7a applies to both adaptor boards when a ZIF socket is used. If you want to economise on the ZIF socket, it is simply omitted with the '6265 adaptor. With the ST6260 adaptor board, the two socket strips are also omitted, and the board is populated with two stacked 20-way DIL sockets (Figure 7b).

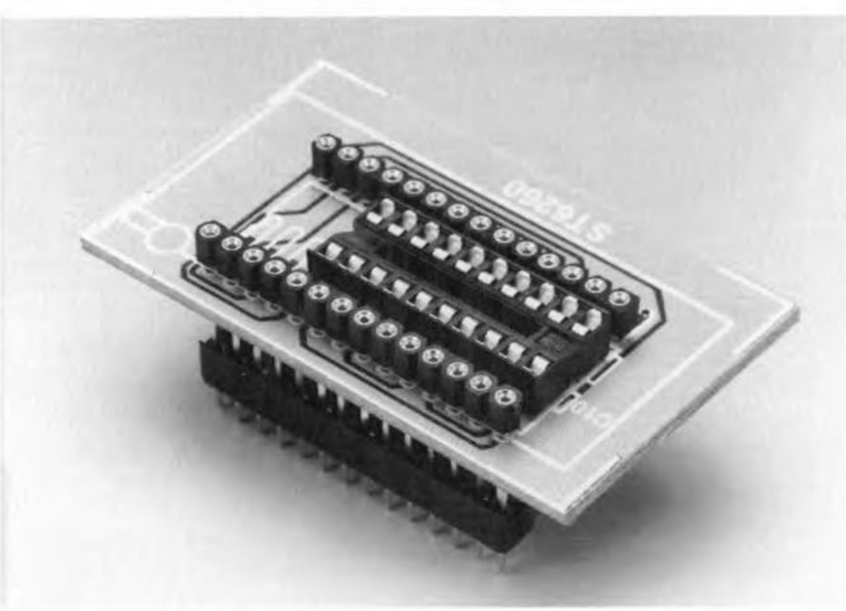
'.DEV'. These files allow the polarity of the programming signals to be changed. This simple solution does not apply to D0, however (supply voltage on/off control), whence the presence of jumper JP1. Set to position 'A' (with T2), package 'A' may be used. When position 'B' is selected (with zener diode), package 'B' may be used. As far as the use of the programmer is concerned, and its features, it makes no difference whether you use (after modification) package 'A' or 'B'.

Concerning the files with the DEV extension, these are SETUP.DEV and KIT626X.DEV. The first line of these files is used to define the printer port used (LPT1 or LPT2). Next come sections for each type of controller in which the polarity of the programming signals and the allocation of the memory is defined. Here, too, a difference exists between the two packages: the software for the ST626 series also supports reading from and writing to the EEPROM inside the controller, an option which is not available with the smaller controllers. In the DEV file you should indicate the number of EEPROM bytes available in the device. A number of parameters must be set to appropriate values in the DEV files to adapt the relevant programs to the controllers to be programmed. Details may be found in the listings shown in **Figures 8 and 9**.

Those of you who do not have a modem, or want to avoid the trouble of downloading and adapting the files, may order the fully modified and ready-to-run version of the software on diskette, through our Readers Services, under order code 966018-1. The disk contains the 'B' package with the necessary modifications to KIT626X.DEV for ST621X and ST622X controllers, plus a couple of programming examples from the 'ST62-Microcontrollers' book by Luc lemmens which appeared recently in the *Elektor Electronics Library*.

Practical use

The programmer is connected to the PC via a commercially available printer cable, preferably to LPT2.



If you use the diskette supplied by us, make sure you first run the virus check as explained on the label. If the disk is okay, you may copy it to a suitably named subdirectory on the hard disk using the INSTALL program on the floppy. Irrespective whether the floppy disk is used, or the files copied from a BBS, Windows 95 users should read the inset tip.

After starting ST6PGM.BAT or ST626XPG.BAT, the desired controller type may be selected from a menu. Finally, the correct printer port is selected via the IOP menu.

If everything is okay so far, only LED D4 lights, indicating that the supply voltage for the programmer is switched on. As soon as the programming software starts to communicate with the controller (programming, reading, verifying), LED D2 lights also. In programming mode, the third LED to light is D3 which indicates the presence of the programming voltage.

The software apparently does not initialise the printer port straight away. Because of this, it may happen that a number of LEDs are already on when the software is started. This means that the supply voltage and/or the pro-

Figure 8. The ST6220KIT software package is actually intended for the ST6210 and ST6220. The modifications shown here add definitions for the ST626x series.

gramming voltage are present at the programming socket before the computer takes over the control over these voltages. As a safety precaution, it is therefore recommended to start the software without a controller fitted in the programming socket, and watch the LEDs. To make absolutely sure that the port is properly initialised, you may also want to run a dummy blank check, a dummy verify, or any other menu function with no device installed in the programming socket, and only then fit the controller to be programmed (using the correct adaptor socket). Experiments in our design lab did not cause damage on any of the controllers used, but it is better to be safe than sorry.

When purchasing controllers, look closely at the type number. If a 'T' is printed after 'ST62', you are looking at an OTP version which may be programmed only once, and can not be erased. Similarly, an 'E' stand for an EPROM version which is normally used for development work. Once the debugged and tested software is known to function properly in a circuit, you may switch from 'E' to the much cheaper 'T' devices. The 'E' device is then erased so that it may be used for another project.

Finally, a tip. When programming a controller, make a note of the name and path of the relevant HEX file. This is necessary because the programming software is unable to display a directory contents. Writing down the name etc. will save you time lost on quitting the program, using DOS to find the file, and starting the program again.

(960105)

Mailbox numbers:

SGS-Thomson BBS in France,
Tel. (+33) 42291416, (9600-n-8-1).

Eurodis (Texim) BBS in the Netherlands,
Tel. (+31) 53 5733373.

Figure 9. The ST626XKIT software package is actually intended for the ST626 series. The modifications shown here add definitions for the ST621x and ST622x series.

8

```
ST62E60B
<Polarities of TM2, TROMIN,
SDOP, OSC1>
1 1 0 1
<Eprom addresses>
0080  0FFF
0080  0F9F
0FF0  0FF7
0FFC  0FFF
*
ST62T60B
<Polarities of TM2, TROMIN,
SDOP, OSC1>
1 1 0 1
<OTP addresses>
0080  0FFF
0080  0F9F
0FF0  0FF7
0FFC  0FFF
*
ST62E65B
<Polarities of TM2, TROMIN,
SDOP, OSC1>
1 1 0 1
<Eprom addresses>
0080  0FFF
0080  0F9F
0FF0  0FF7
0FFC  0FFF
*
ST62T65B
<Polarities of TM2, TROMIN,
SDOP, OSC1>
1 1 0 1
<OTP addresses>
0080  0FFF
0080  0F9F
0FF0  0FF7
*
```

Tip for Windows 95

Users of Windows 95 should note that the ST6220KIT and ST626XKIT software does not work properly unless the following line is added to the CONFIG.SYS file: **switches = /c**.

9

```
ST62E60B
<Polarities of TM2, TROMIN,
SDOP, OSC1>
1 1 0 1
<Eprom addresses>
0080  0FFF
0080  0F9F
0FF0  0FF7
0FFC  0FFF
*
ST62T60B
<Polarities of TM2, TROMIN,
SDOP, OSC1>
1 1 0 1
<OTP addresses>
0080  0FFF
0080  0F9F
0FF0  0FF7
0FFC  0FFF
*
ST62E65B
<Polarities of TM2, TROMIN,
SDOP, OSC1>
1 1 0 1
<Eprom addresses>
0080  0FFF
0080  0F9F
0FF0  0FF7
0FFC  0FFF
*
ST62T65B
<Polarities of TM2, TROMIN,
SDOP, OSC1>
1 1 0 1
<OTP addresses>
0080  0FFF
0080  0F9F
0FF0  0FF7
*ST62E10
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SDOP, OSC1>
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<E2PROM bytes count>
0
<Eprom addresses>
0800  0FFF
0800  0FF7
0FFC  0FFF
*
ST62T10
<Polarities of TM2, TROMIN,
SDOP, OSC1>
0 1 1 0
<E2PROM bytes count>
0
<OTP addresses>
0880  0FFF
0880  0F9F
0FF0  0FF7
0FFC  0FFF
*
ST62E15
<Polarities of TM2, TROMIN,
SDOP, OSC1>
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<E2PROM bytes count>
0
<Eprom addresses>
0800  0FFF
0800  0FF7
0FFC  0FFF
*
ST62T15
<Polarities of TM2, TROMIN,
SDOP, OSC1>
0 1 1 0
<E2PROM bytes count>
0
<OTP addresses>
0880  0FFF
0880  0F9F
0FF0  0FF7
0FFC  0FFF
*
ST62E20
<Polarities of TM2, TROMIN,
SDOP, OSC1>
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<E2PROM bytes count>
0
<Eprom addresses>
0000  0FFF
0000  0FF7
0FFC  0FFF
*
ST62T20
<Polarities of TM2, TROMIN,
SDOP, OSC1>
0 1 1 0
<E2PROM bytes count>
0
<OTP addresses>
0080  0FFF
0080  0F9F
0FF0  0FF7
0FFC  0FFF
*
ST62E25
<Polarities of TM2, TROMIN,
SDOP, OSC1>
0 1 1 0
<E2PROM bytes count>
0
<Eprom addresses>
0000  0FFF
0000  0FF7
0FFC  0FFF
*
ST62T25
<Polarities of TM2, TROMIN,
SDOP, OSC1>
0 1 1 0
<E2PROM bytes count>
0
<OTP addresses>
0080  0FFF
0080  0F9F
0FF0  0FF7
0FFC  0FFF
*
```
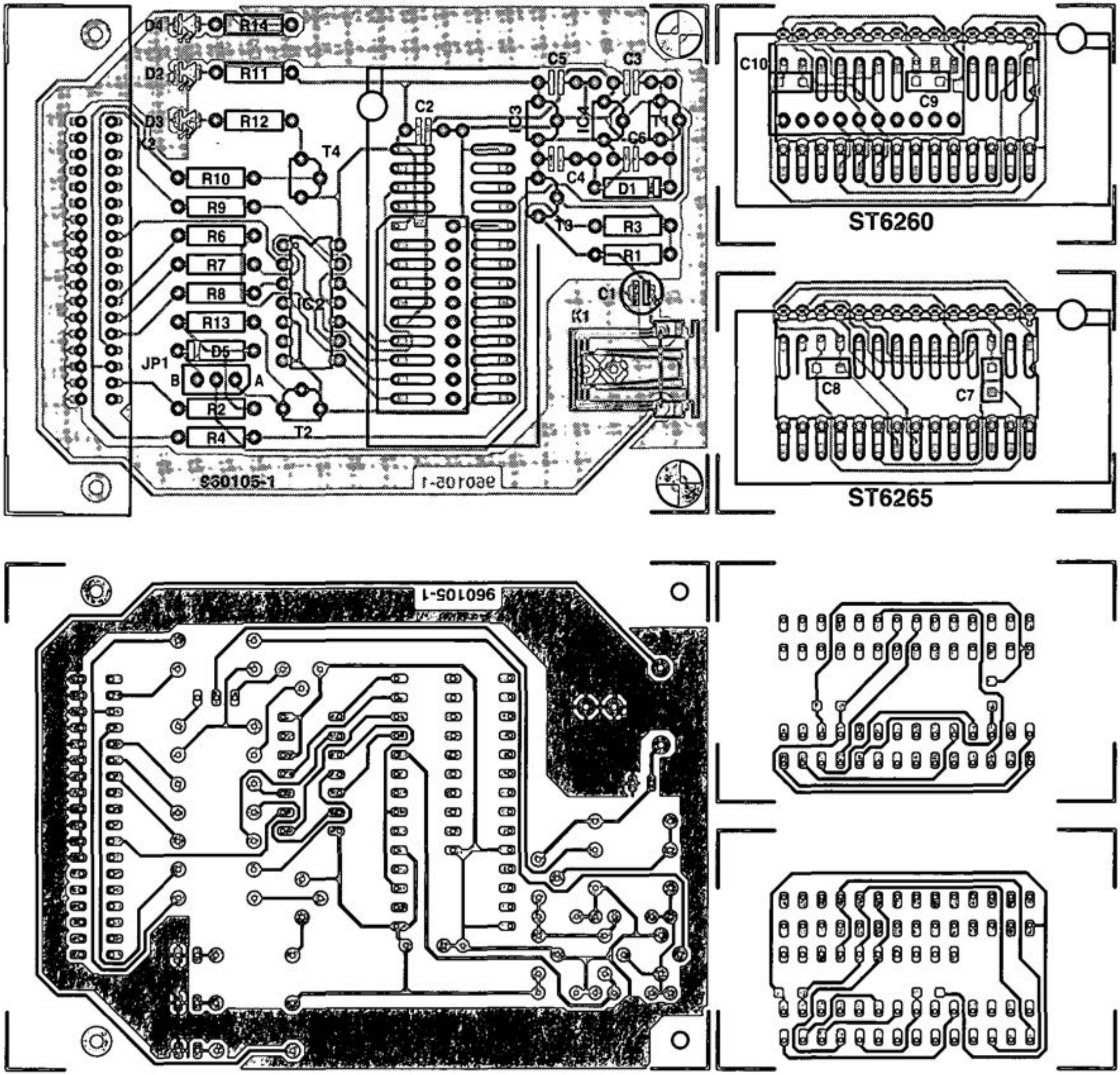



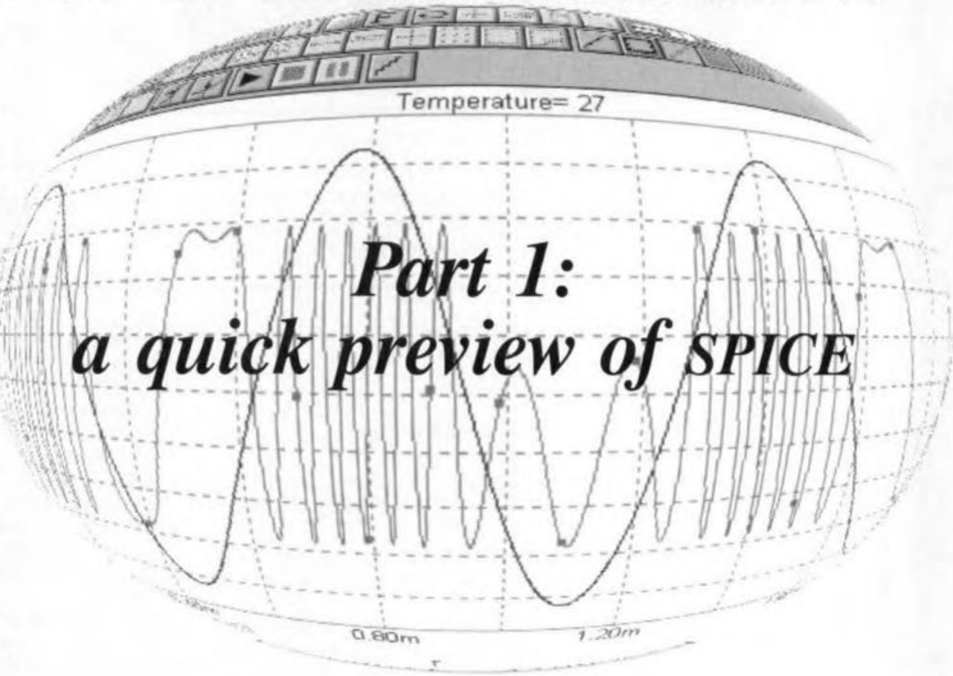
D4
R14
D2
R11
D3
R12
K2
T4
R10
R9
R6
R7
R8
R13
D5
JP1
B
A
R2
R4
T2
IC2
C2
C5
C3
IC3
IC4
T1
C6
C4
D1
T3
R3
R1
C1
K1
960105-1
C10
C9
ST6260
C8
C7
ST6265

Circuit Simulation Course

ELEKTOR Electronics

HANDS-ON ELECTRONICS

a short course in circuit simulation



Part 1: a quick preview of SPICE

Following last month's focus on 'Software for circuit simulation', we now start a short (5-part) course in circuit simulation for beginners to this fascinating subject. The course is based almost entirely on SPICE, here contained in MicroCap V, a software package from Spectrum. A demo version of the program is available free of charge to anyone who asks for it either from Spectrum direct or from one of their distributors. A student version is also available (not free of charge). The demo version may also be downloaded from www page http://www.spectrum-soft.com. Spectrum's e-mail address is 103114.61@compuserve.com What's more, a version of the demo program is available from us at a small charge. See the Readers' Services page.

By Owen Bishop

SPICE was developed as a designer's tool but, now that it has become so widely available, it can also be used in training and education. Instead of getting hands-on experience of electronic circuits on the workbench, the student, the engineer or the hobbyist can get an equal or even wider experience by putting hands on the keyboard. Compared with assembling and testing a circuit on the workbench or breadboard, computer simulation offers the advantages of:

- speed in 'assembly', circuit modifications and testing
- a virtual stock of an enormous range of components in all possible values
- no chance of burning out or damaging the components
- the equivalent of an unlimited range of test instruments, signal generators, oscilloscopes
- precision timing of events
- slowing down the circuit action makes it easier for the user to watch and record what is happening
- the subsequent opportunity to 'browse' through the test results

There are, of course, some pitfalls to be avoided when using a simulator and we shall look at some of these as we proceed.

The various commercial simulation packages nearly all have the same SPICE basis but differ in the details of circuit entry, analysis and display. The simulator used to illustrate this series is *Micro-Cap*. Formerly available as a PC-DOS program as far as version IV, it is now further improved as a Windows™ version, *Micro-Cap* V. The analyses in these articles can be run also on *Micro-Cap IV* or on most of the simulators published by other companies, though the operating routines and the presentation of results will differ. To make the explanations easier, the circuits are uncomplicated and can be run on 'Student' or 'Entry level' versions, and often on 'Demo' versions (such as the Demo version of *Micro-Cap V*), which permit the user to enter and analyse circuits of limited size.

This month, we begin with some elementary circuits to illustrate the major concepts of SPICE-based analysis. In the condensed instructions, actions that follow one after another are linked by an arrow →. This applies particularly to selecting from a series of menus and sub-menus. For example 'Component menu → Analog Primitives → Passive Components → Waveform Sources → Battery' represents a sequence of clickings on the items listed, as they appear.

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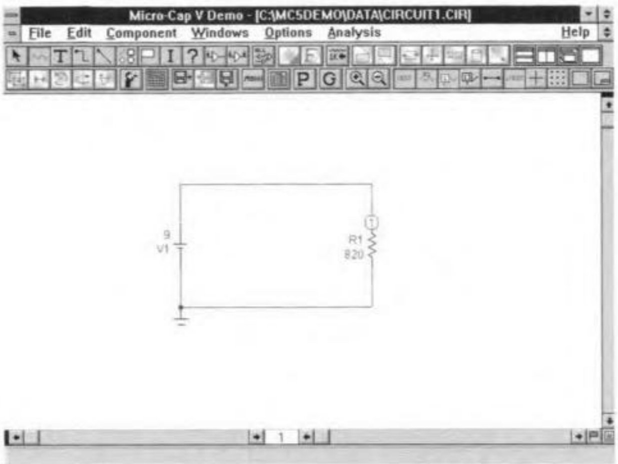

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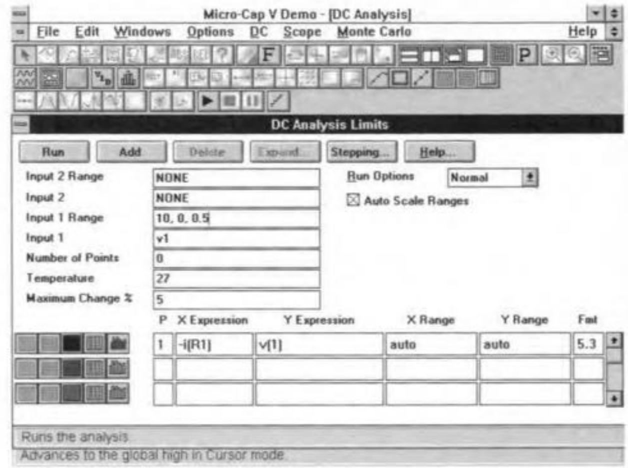

Figure 1. How to wire up the simple diagram of the first run of MC5.

Figure 2. The DC Analysis Limits window.

SCHEMATIC EDITOR

When using SPICE itself, circuits are entered by typing in a *netlist*, which is a list of all the components, their values and the circuits nodes to which they are connected. The netlist includes instructions to the computer detailing the tests to be performed. Like other commercial simulators, *Micro-Cap V* (from now on referred to as MC5) provides for circuits to be entered as a schematic diagram, after which MC5 automatically converts this to its own form of netlist.

When MC5 is first run, the Schematic Editor window appears, blank at this stage except for two rows of control buttons at the top. The component cursor (pointer with zigzag symbol attached) is already enabled to draw resistors. Move it with the mouse, then click on a position to the right of the screen centre. The Component window appears, with the part name, R1, already allocated. You can change this by clicking on the box and typing in a new name. Be aware that names such as 'RC' and 'RE' may cause confusion later, as these may be taken to be parameters for models of semiconductor devices. Select VALUE and enter the resistor value, in ohms; in this example, '820'. Leave the MODELline unaltered, check the Display box to the right of VALUE (so that it shows a cross) to display the value on the schematic, and click on OK. The Component window disappears and a resistor symbol appears, with R1 and 820 beside it. These are green at the moment and at this stage can be deleted (by pressing the Delete key) if you have typed the wrong value. You can confirm this component by clicking somewhere on the screen, and it becomes blue with red name and value. But this also puts a second resistor on the screen. Only one resistor is needed here so, instead of clicking on the schematic area, click on the Component menu → Analog Primitives → Waveform Sources → Battery → back to the screen to place the battery left of centre. Press the left mouse key to obtain the symbol but, before releasing the key it, check that the symbol is the right way up - positive terminal on top. If not, rotate it by holding down the left mouse key and clicking the right mouse key repeatedly, until it is correctly orientated. Then release both keys. The Component window reappears with the component name, V1. Enter VALUE = 9. Check the Display box again.

To wire up the circuit, click on the 4th button in the top row for Orthogonal Wire mode. Draw the two wires shown in **Figure 1**. All SPICE networks need to have the Ground node specified. Click on Component → Analog Primitives → Connectors → Ground → place the ground symbol on the 0 V line, as in the figure. This completes the schematic but, to add node numbers to the diagram, click the 8th button from the right on the 2nd row. The ground line is Node 0; the other node in this circuit is Node 1. Now to find out if MC5 knows about Ohm's law!

DC ANALYSIS

SPICE has three modes of analysis, and the first we try is DC Analysis. In this mode, all capacitors are open-circuited, all inductors are short-circuited, and all waveform sources are set to their initial values. Then one or two of the d.c. voltage (or current) sources are swept over specified voltage (or current) ranges and the node voltages and branch currents

Figure 3. The voltage vs current characteristic is a straight line.

Figure 4. The voltage vs current characteristic may be investigated more extensively in the Cursor Mode.

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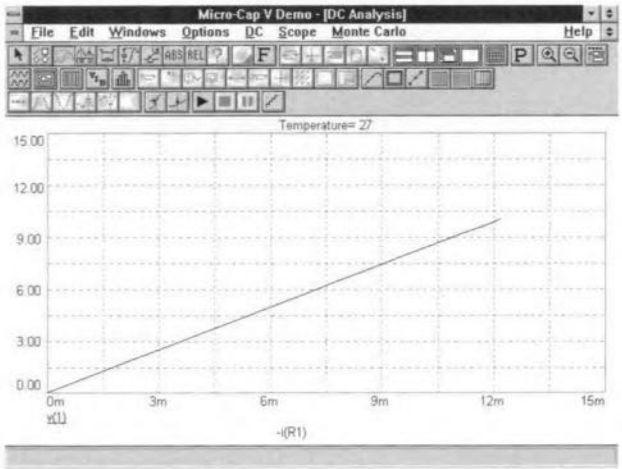

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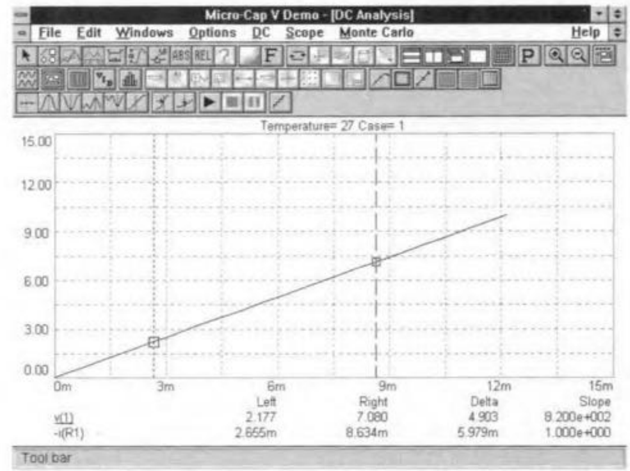

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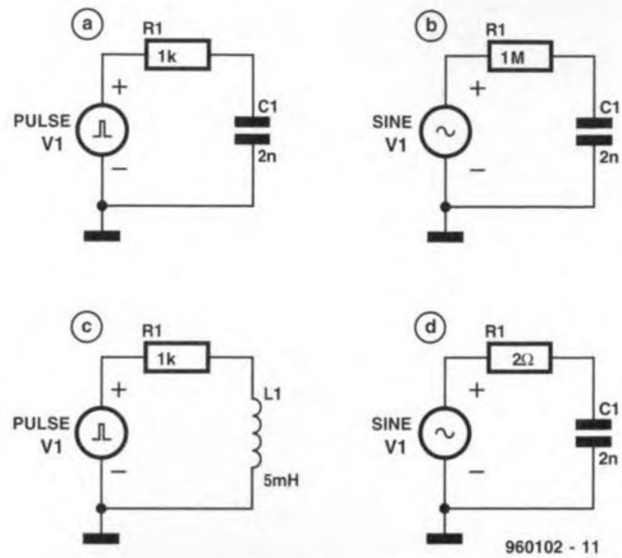

Figure 5. A number of circuits for analysis by the reader – see Investigations.

calculated at each stage of the sweep. To see the effect of this, select the Analysis menu → DC Analysis. The DC Analysis Limits window (**Figure 2**) lets you set the conditions for the analysis, but first run the cursor around the various boxes and buttons on the screen, to observe their functions, which are displayed in turn at the bottom of the screen.

There is only one source in this circuit, so type its name 'V1' as Input 1 (replacing the word 'NONE'). A suitable Input 1 Range is 10, 0, 0.5. These numbers specify the final value, the initial value and the step value of the source, in volts. Note the reversed order of final and initial values. Note also that the value 9V specified for V1 on the schematic is not acted on in d.c. analysis. The maximum change of 5% automatically limits the amount of change at each step, should you have specified a step size larger than this.

Thinking ahead to the graph we wish to plot, resistance is volts/amps so, if the slope of the curve is to represent ohms, we need current on the *x*-axis and voltage on the *y*-axis. The X Expression is -i(R1), which means the negative of the current through R1. We use the negative to plot the graph with conventional polarity, since SPICE takes the direction of current flow to be from positive to negative *within the source*. This means that the current is not conventional current, but flows in the same direction as the electrons. Check the Auto Scale Ranges box so that an appropriate range for the axes is calculated by the software. Click on Run.

The plot of voltage against current is a straight line, showing the voltage is proportional to current (**Figure 3**). The slope of the curve is the resistance, which we can find by reading a pair of values on the graph. But we can investigate the curve more extensively by clicking on the 4th button in the top row to enable Cursor mode (**Figure 4**). There are two cursors, represented by vertical dashed lines, which can be moved sideways by clicking the left or right mouse buttons before moving the mouse. The point at which each cursor crosses the plotted line is picked out with a square, and its coordinates are tabled below the graph. The Delta column shows the difference between coordinates, and under Slope, the value of Delta in each row is divided by the Delta for the *x*-coordinates. This means that the Slope value in the upper row is volts/amps, the resistance value, which is shown as 8.200e+002, which equals 820Ω. This is as expected from the value we gave to R1 originally. These values are for a circuit at 27 °C, the standard temperature for SPICE analyses. This can be altered to any other value or swept over a specified range. Return to the schematic by clicking DC → Exit Analysis.

EXPLORING MC5

(1) Repeat the analysis. With the graph displayed, select Cursor mode as above and use top-row buttons 5 and 6 to measure *x* and *y* distances on the graph.

(2) Use bottom-row buttons 1 to 8 to move the cursors automatically to different locations on the curve; not many of these apply to the present curve but this is good practice for later.

(3) Set up new d.c. analyses by altering the parameters in the DC Analysis Limits window. Alter the range of Source 1. Enter new X and Y Expressions, for example, try v(1) as the X Expression and -v(1)*i(R1) as the Y Expression to plot the power (in watts) dissipated in the resistor.

(4) Edit the schematic by changing the value of R1; click on top row button 8 (I), then on R1 → Component window → edit the resistor value (in SPICE, M is for milli- and MEG is for mega) → click OK →rerun the DC analysis.

(5) Redraw the

Figure. 6. Parameters set in the Transient Analysis Limits window – see Investigations.

Figure 7. Parameters set in the AC Analysis Limits window – see Investigations.

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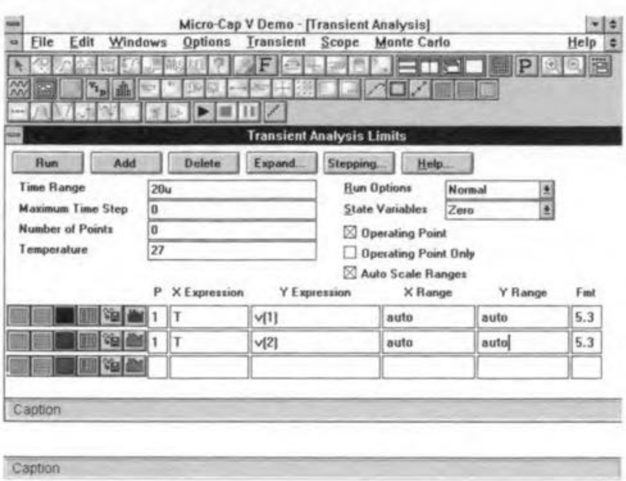

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schematic to put two resistors in series. Then plot the voltages for nodes 1 and 2. Voltages are relative to ground. To plot the voltage on a node relative to a second node, use the format v(*a*,*b*), the voltage at *a* minus the voltage at *b*.

To sum up, the cycle for such explorations, starting from the schematic, is: Analysis menu → DC Analysis → alter the parameters in the DC Analysis Limits window → Run → view graph → use cursors and measure distances → DC menu → Exit analysis → back to schematic → possibly edit it → repeat.

PROBE MODE

From the Analysis menu → DC Probe Analysis. This tiles the schematic with a small graph area. Clicking on one node or a succession of nodes causes the graph to display the voltage there as V1 is swept.

INVESTIGATIONS

Figure 5 shows some more circuits for analysis (answers next month):

(a) Here we use a second SPICE analysis mode, Transient Analysis. This calculates the way in which voltages and currents vary in time. The circuit must contain at least one time-varying source of voltage or current. Here we investigate what happens when the source delivers a single pulse. MC5 has its own pulse source but, to make these instructions applicable to other simulators, use the original SPICE independent voltage source and program it to produce the required pulse. On a new schematic editing screen (File → New → Schematic → OK), click on Component menu → Analog Primitives → Waveform Sources → V. After placing the symbol, its description in the Component window is PART = V1. Key in its VALUE = PULSE (0 1 1e-6 0). These figures define a pulse with low level 0 V, rising to high level 1 V after 1 μs (1e-6) delay, with 0 s rise time. Complete the circuit, then select Analysis → Transient Analysis. In the Transient Analysis Limits window set parameters as in **Figure 6**. Run. The graph displays the pulse and the p.d. across the capacitor. Note the exponential rise. Because we have not specified its length, the pulse lasts until the end of the plot. Transient menu → Exit Analysis → back to schematic. As in Exploration 4 above, edit the V1 pulse parameters to (0 1 1e-6 0 0 14e-6) which produce a pulse starting as before, but ending with a fall time of 0 s after 14 μs. Click OK. To see the effect of this, extend the time range to 30μs in the Transient Analysis Limits then Run. What happens?

(b) Repeat (a) but with a sine source. We use the same SPICE voltage source as above but replace the PULSE parameters with SIN (0 1 1k 0 0). These parameters specify, in order: offset (V), amplitude (V), frequency (Hz), delay (s), damping factor (s^{-1}). The damping factor THETA (Θ) produces an exponential change in amplitude, multiplying the amplitude at any instant by $e^{-\Theta(t-TD)}$, where *t* is the elapsed time and TD is the delay time. The parameter values quoted above produce a sine wave, with zero offset, amplitude 1 V, frequency 1 kHz, and no delay or damping. Change resistor value to 1MEG (1 MΩ). For a Time Range of 5 m (with T as the X Expression), plot the two node voltages, v(1) and v(2). Observe the amplitude and phase relationships between the waveform of the source and that across the capacitor. Try varying the frequency of V1, altering the Time Range to plot, say, 5 cycles. Explore the Cursor mode with these waveforms. By default, MC5 plots the graphs with 51 points. To increase the smoothness of the graphs, put Maximum Time Step = 10u (that is, 10 μs)

(c) Repeat (a) but with a 5 mH inductor in place of the capacitor. Explain the shape of the curve of the voltage across the inductor. Try other timings, or other values for resistor and inductor and observe their effects.

(d) The third SPICE analysis mode is AC Analysis. This calculates the fre-quency response of a circuit as the voltage source is swept over a prescribed range of frequencies. SPICE first finds the d.c. voltages and currents, then applies an a.c. signal, assuming that voltage or current variations are small and linear. Set up the *LCR* circuit. The frequency specified for the sine source is not important in the a.c. analysis, since it is swept automatically. You need to specify its amplitude and phase separately: extend the SIN statement of V1 to SIN (0 1 1k 0 0 AC 1 0). This specifies an a.c. signal of amplitude 1 V and zero phase delay. Click the Analysis menu → AC Analysis → AC Analysis Limits window (**Figure 7**). The Frequency Range is from 100 Hz to 100 MHz (1E8). Note the inverse order of specifying the range. Call for a plot of voltage across the inductor (v(3)) against frequency (F). Run. The graph shows a prominent peak at about 35 kHz, which is the resonant frequency of this circuit. Run the AC analysis with other values of L, C and R (better to change only one at a time, to observe the effects of change more clearly). Then run a Transient Analysis having set the frequency of V1 close to the resonant frequency. What do you notice about the amplitude of the voltage across the inductor?

[960102-I]

In passing ...

Armageddon?

Every sane citizen, whether acquainted with electronics or not, having witnessed the debacles that befell Philips and Sony in the 1980s in respect of their video recorder standards, will, no doubt, assume that we are no longer at risk from idiotic incompatible standards applying to consumer products.

For a while during the past month or so, it seemed, however, that there would be a hiccough in coming to a firm agreement on the digital versatile disc (DVD). It appeared that some of the original protagonists were dragging their feet regarding the paying of licensing fees to the (Japanese) patent holders. Particularly Philips and Sony felt that the development they had done on the new disc entitled them to a lower licence fee. This reluctance put in jeopardy the possibility of having DVD players on the market this coming Christmas.

Fortunately, common sense seems to have prevailed, because the latest news at the time of writing (September 1996) is that at least one company, Matshushita, will enter the Japanese market with two DVD players (Panasonic Type DVD-A100 and DVD-A300) this month. Similar products will become available in the USA towards the end of the year. Moreover, at the CeBIT show in Hanover in September, it was announced that Panasonic DVD players will enter the European market early next year. Price of the sets (in Japan) will be about £500 for the A-100 and just over £600 for the A-300).

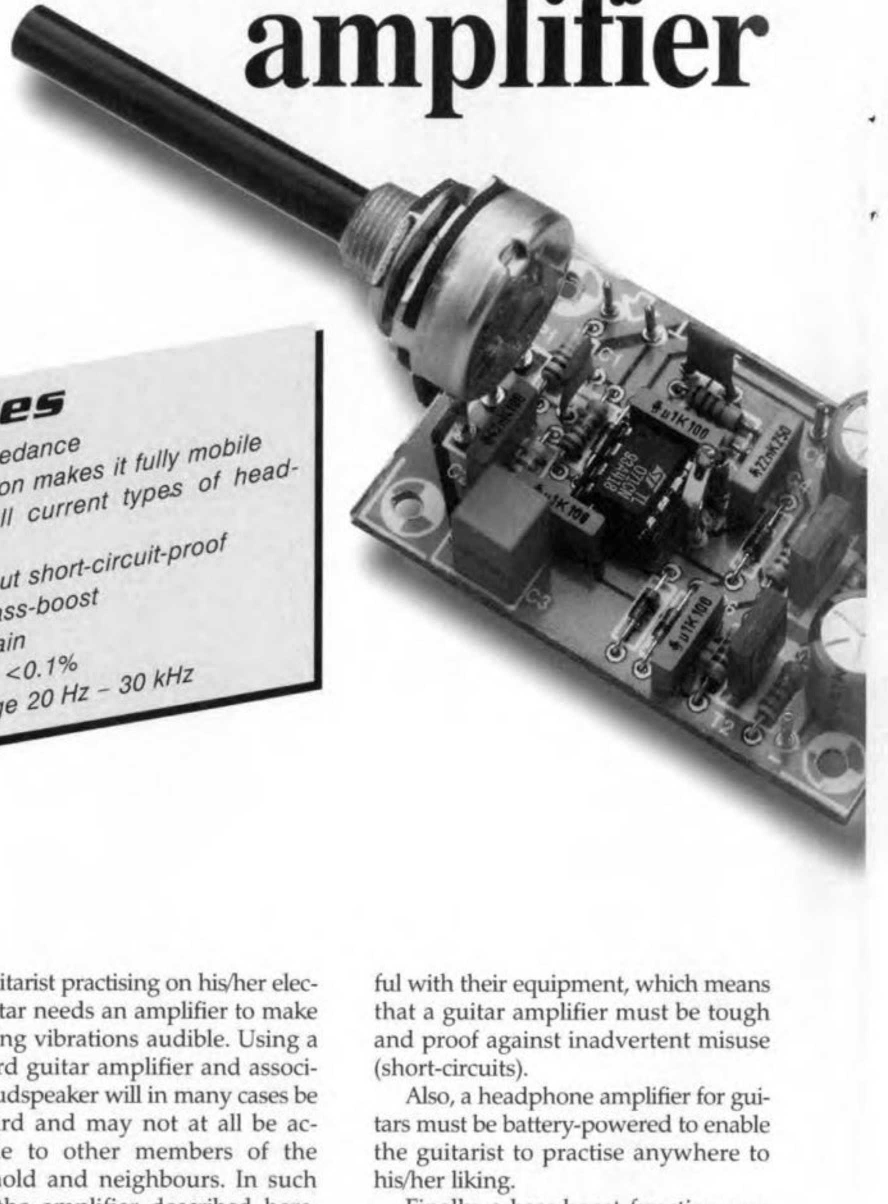
According to statements at the CeBIT show, any fears that early customers may find themselves unable to record at a later stage are unfounded. It was admitted, however, that there are still problems with the development of the LSI chips for MPEG2 decoding, but that specifications that deal with backward compatibility are definite.

It was learned from other sources that the LSI chips may not become available until the end of 1998. Whether this is a political/commercial ruse only time will tell.

[GR965099]

headphones amplifier

for guitarists



Features

- high input impedance
- battery-operation makes it fully mobile
- suitable for all current types of headphones
- input and output short-circuit-proof
- provision of bass-boost
- low current drain
- low distortion: <0.1%
- frequency range 20 Hz – 30 kHz

An amplifier is described whose power is measured not in watts but in milliwatts, since it is intended to drive headphones used by guitarists. Such headphones need only a fraction of the power normally output by a guitar amplifier. The present amplifier is easy to build, battery powered and provided with a bass-boost switch.

Design by T. Giesberts

Any guitarist practising on his/her electric guitar needs an amplifier to make the string vibrations audible. Using a standard guitar amplifier and associated loudspeaker will in many cases be awkward and may not at all be acceptable to other members of the household and neighbours. In such cases, the amplifier described here, which is intended for use with headphones, is an attractive solution. Since the amplifier is powered by a battery, it is independent of the mains supply, so that practising can even take place out of doors without upsetting the neighbours.

Some guitarists may ask why their (electric) guitar cannot be connected to a standard headphone amplifier. There are several reasons for this. One is the input impedance of these amplifiers, which normally is 10–20 kΩ, whereas the output impedance of an electric guitar is ≥ 200 kΩ. If the guitar element were terminated into 20 kΩ, the high frequencies would be attenuated to such an extent that they would be hardly audible.

Another reason is the ruggedness, or rather lack of it, of standard amplifiers. Most musicians are not too careful with their equipment, which means that a guitar amplifier must be tough and proof against inadvertent misuse (short-circuits).

Also, a headphone amplifier for guitars must be battery-powered to enable the guitarist to practise anywhere to his/her liking.

Finally, a bass-boost function was deemed essential in view of the poor bass response of many headphones.

CIRCUIT DESCRIPTION

The design of the amplifier has been kept as simple as feasible—see **Figure 1**. It consists merely of an operational amplifier for voltage amplification and an output stage, operating in Class AB, that provides the requisite power.

The bass boost is obtained from a frequency-correction network in the feedback loop. This network can be disabled with switch S_1.

Low-pass filter R_1-C_1 at the input of the amplifier suppresses any interference or other spurious signals.

Diodes D_1 and D_2 following volume control P_1 protect the amplifier against too high input levels. Resistor

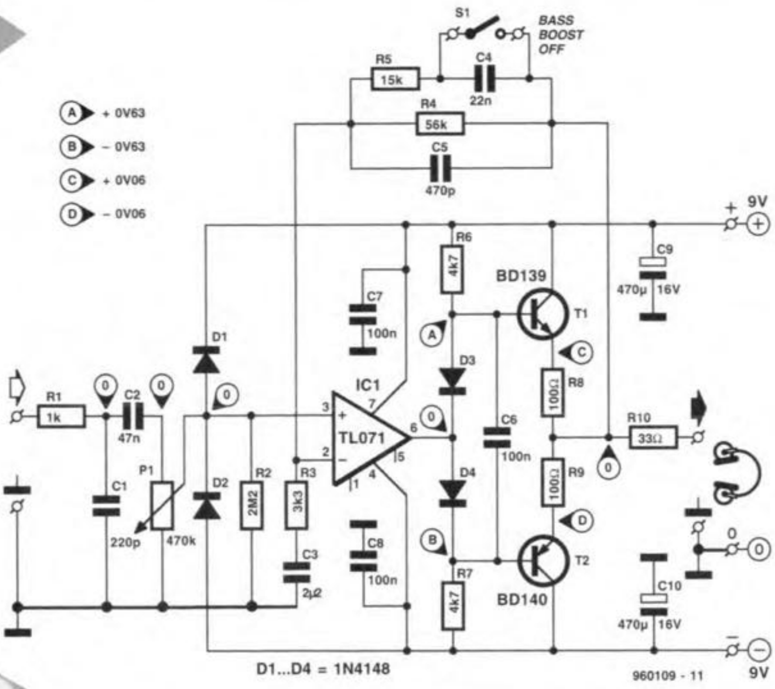


Figure 1. The circuit consists merely of an integrated operational amplifier and a complementary pair of output transistors.

R_2 is necessary to ensure that even in case of a poor volume control there is bias current for the input of IC_1.

As the input impedance of IC_1 is high, the overall input impedance of the amplifier is determined by the values of P_1, R_1, and R_2: about 388 kΩ. If a higher value is needed, a potentiometer of higher value may be used; note, however, that this may increase the level of noise.

The op amp, a good and inexpensive Type TL071, drives the output stage. This stage consists of a complementary pair of transistors, T_1 and T_2, which, in the usual way, are arranged as an emitter follower. Diodes D_3 and D_4 provide the requisite quiescent current for the output transistors.

There is no facility for setting the quiescent current as this proved unnecessary with the low output power. In the prototype, the quiescent current is 0.6 mA, but in other cases this value will depend on the tolerance of the components. The fairly high values of emitter resistors R_8 and R_9 ensure that the level cannot rise too high.

To ensure sufficient base current to T_1 and T_2 during maximum drive, the values of R_6 and R_7 are such that a current of about 2 mA flows through D_3 and D_4. This proved sufficient for the desired performance and kept the current drain of the amplifier low.

The feedback loop is between the junction R_8-R_9 and the inverting input of IC_1. The ratio R_4:R_5 determines the voltage amplification of the op amp.

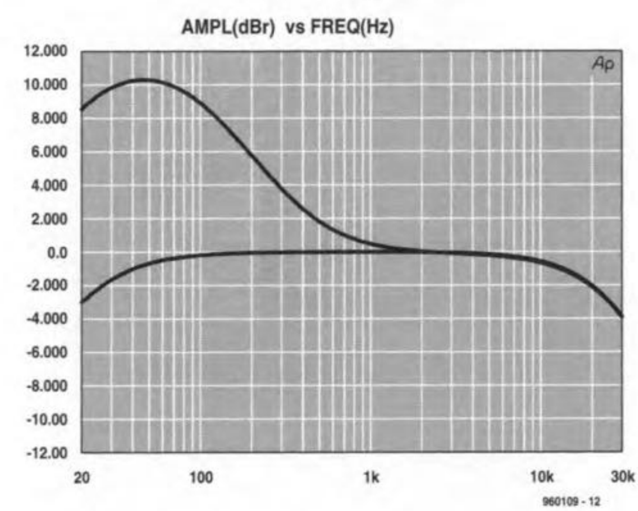
Time constant R_3-C_3 determines the lower cut-off point of the frequency response, which, with values as specified, is 22 Hz. The upper frequency limit is set by C_5, R_4 and R_5, and is, with values as specified, about 30 kHz. With S_1 closed, network R_5-C_4 gives a 10 dB boost in gain at about 50 Hz; the effect of this is seen in **Figure 2**.

POWER OUTPUT

Most headphones need a power input of 5–10 mW for maximum sound. As a compromise between acceptable current drain from the batteries and sound requirements, the present amplifier provides an output of 7.5 mW.

This power output made it possible to give emitter resistors R_8 and R_9 a fairly high value, which ensures a long life of the output transistors, the more so since the types used are intended for much heavier tasks than in the present amplifier.

Figure 2. The switched bass boost gives some 10 dB extra gain at about 50 Hz.



Resistor R_{10} protects the amplifier against short-circuits at the output terminals. Since a headphone impedance of 32 Ω was assumed, R_{10} was given a near-identical value of 33 Ω.

Normally, the connections of the left earpiece and right earpiece are looped in the jack socket, that is, the two earpieces are in parallel. With maximum drive (330 mV input), the amplifier produces an output of 7.7 mW for each 32 Ω earpiece.

If the two earpieces are connected in series (which means altering the wiring to the jack socket), the power output increases. This is because the output stage then works with a load of 64 Ω. In that case, it needs to provide only half the current, which means that it can be driven harder. Maximum drive is then obtained with input signal levels of 500 mV, resulting in an output power to each earpiece of 17.7 mW.

BATTERY PACK

The amplifier needs a power supply of ±9 V, which means that two 9 V batteries are needed. At first sight, this looks odd in view of the space required and also since two batteries cost more than one. The decision to use two batteries was taken because of the following.

In the first place, the unavoidable electrolytic capacitor at the output of an asymmetric supply can be omitted. Although this does not take up as much space as a 9 V battery, there is not much in it.

In the second place, and more importantly, two batteries can be used for far longer than one. This is because with a symmetric supply the amplifier still produces a useful output of 2×1 mW when the potential of each battery has

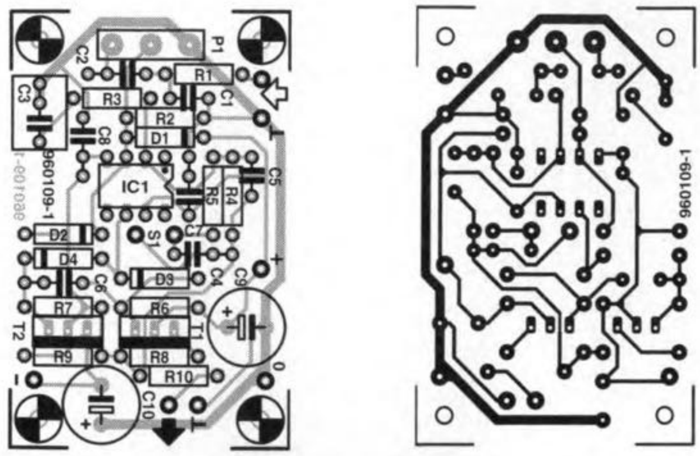


Figure 3. In spite of its small size, the printed-circuit board has remained easy to populate.

dropped to about 3.5 V. With an asymmetric supply, the amplifier output would drop to unusable levels at a battery voltage of about 7 V. It is known from practice that at this potential the battery is not flat by any means. So, contradictory as this may sound, two in this case are cheaper than one.

As far as the current drain is concerned, with maximum drive and a continuous signal, it is ±17.5 mA when the earpieces are in parallel, and ±14 mA when they are in series. In general, music signals, and certainly guitar signals, are nowhere near continuous and the average current drain will, therefore, normally be close to the quiescent current, that is, ±4 mA. This means that the useful life of two 9 V alkaline batteries will be at least 100 hours.

Figure 5. Another chance for checking that all connections to and from the board are correct.

CONSTRUCTION

The amplifier is, of course, best built on the printed-circuit board shown in **Figure 3**. This has purposely not been made very small (although that would have been possible) because this would make the construction rather more tedious.

If the component layout is followed closely, there should be no undue difficulty in building the amplifier. Start with fitting all resistors, the IC socket and other horizontally mounted components. Follow this with the radial components, the output transistors and the IC.

In case of T_1 and T_2, the black stripe on the board indicates the location of the cooling area of the transistor case.

The completed prototype board is shown in the photograph.

Potentiometer P_1 may be mounted to personal requirements: it may be fitted directly on the board or it may be linked to it via three lengths of flexible, insulated circuit wire. To some extent, this all depends on the type of enclosure in which the amplifier is to be housed — and there are many suitable types on the market.

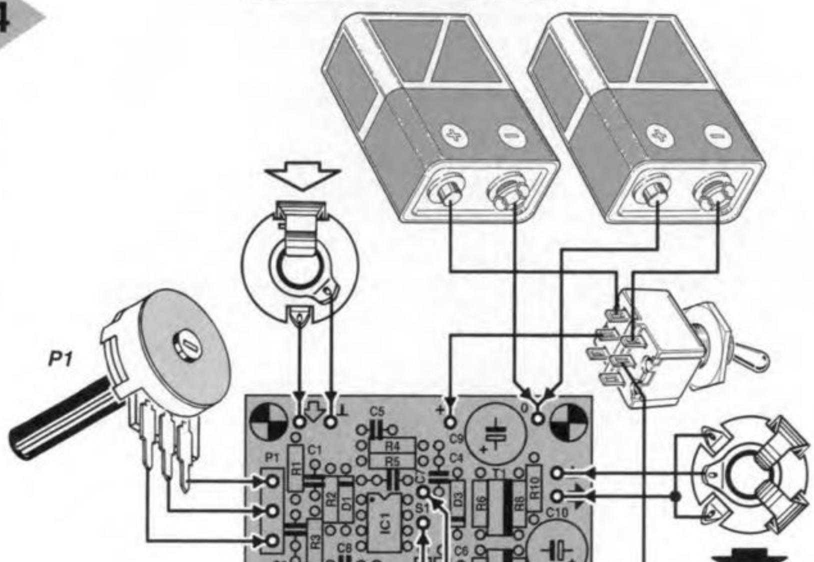
The guitar and headphones should be linked to the amplifier with standard jack sockets and plugs. Do not forget to alter the wiring in the headphone jack if necessary (as discussed earlier in this article).

In view of the symmetric supply lines, the on/of switch must be a double-pole type.

For clarity's sake, all important connections to the board are shown again in **Figure 4**.

TESTING

Testing the amplifier is straightforward: connect a pair of headphones to



Parts list

Resistors:
R_1 = 1 kΩ
R_2 = 2.2 MΩ
R_3 = 3.3 kΩ
R_4 = 56 kΩ
R_5 = 15 kΩ
R_6, R_7 = 4.7 kΩ
R_8, R_9 = 100 Ω
R_{10} = 33 Ω
P_1 = 470 kΩ logarithmic potentiometer

Capacitors:
C_1 = 220 pF
C_2 = 47 nF
C_3 = 2.2 μF, metallized polyester, pitch 5 mm or 7.5 mm
C_4 = 22 nF
C_6, C_7, C_8 = 100 nF
C_9, C_{10} = 470 μF, 16 V, radial

Semiconductors:
D_1–D_4 = 1N4148
T_1 = BD139*
T_2 = BD140*
* complementary pair of the same make

Integrated circuits:
IC_1 = TL071CN

Miscellaneous:
S_1 = single-pole on/off switch
2 off 9 V battery with connecting clip
1 of double-pole on/off switch
PCB Order no. 960109 (see Readers' Services towards the end of this issue)

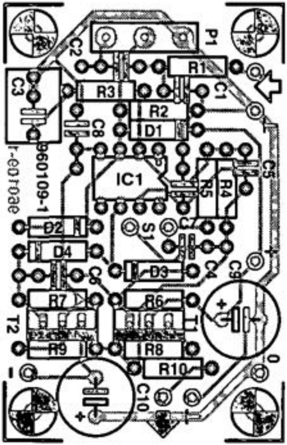
the output and touch the input with a finger. Depending on the position of the volume control, a faint or strong hum will be heard. It is wise not to put the headphones on, but leave them lying in earshot on a table or workbench.

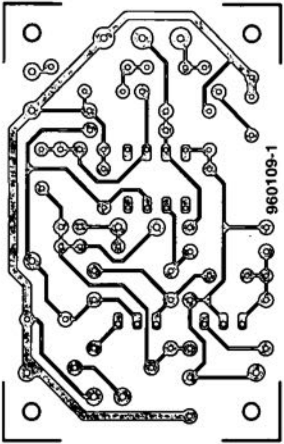
If there is no sound from the headphones, check the voltage at the points shown in the circuit diagram. Possible faults are likely to be in three areas:

- one of the output transistors is not fitted properly – the bold black stripe on the component layout of the board indicates where the metal area should be located;
- one of diodes D_1–D_4 is defect or fitted incorrectly;
- op amp IC_1 is defect – this may be caused by rough handling or overheating during soldering; in either case, there is no alternative but to replace the device.

If all connections are in accordance with those shown in Figure 5, and all components values and, where applicable, polarity, are correct, there is not much else if anything that can go wrong.

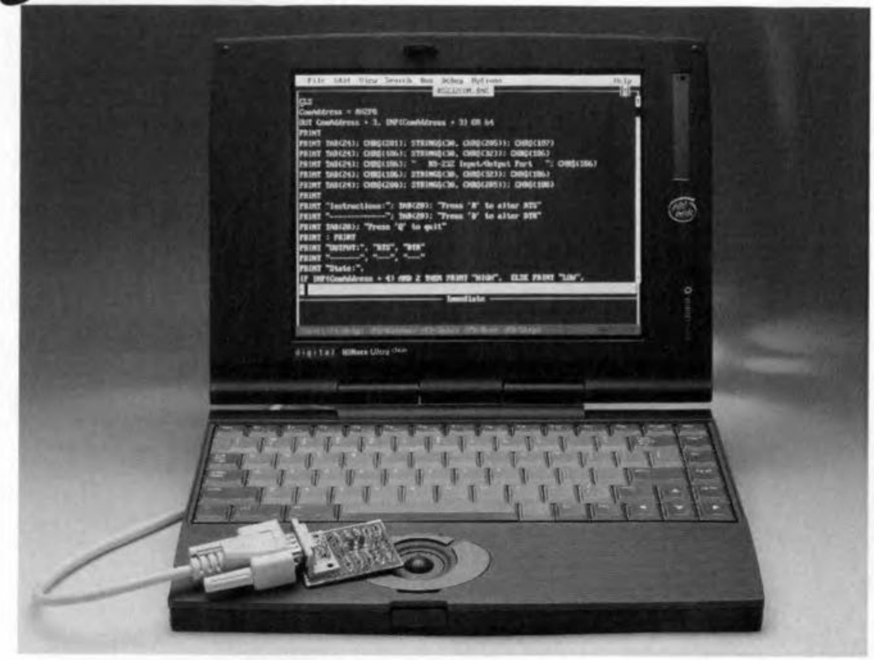
[960109]


P1
C2
R1
C3
R3
C1
R2
C8
D1
960109-1
IC1
R5
R4
C5
D2
S1
C7
D4
D3
C4
C9
C6
R7
R6
T2
T1
R9
R8
R10
C10
0
-
+


960109-1

serial i/o port

RS232 port goes parallel



Although a serial port is usually intended for, well, serial communication, it may be used in a different way. This article describes a simple BASIC program which turns the RS232 port on your PC into an interface with four parallel inputs and two parallel outputs. The investment: a few pence for components, and a little type work.

Design by J. Schuurmans

Computers normally have a parallel port (the Centronics interface to which the printer is attached) and a serial port (identified as 'RS232 interface'). In actual fact, both ports are parallel in essence. On the serial port, the control signals are, in fact, ordinary I/O lines whose logic level is under the control of instructions written to a serial controller IC. The logic levels of the control lines on the RS232 interface is an indication about the progress of the data transfer process. On most serial ports identified as 'RS232', the following digital I/O lines are used: DCD, DSR, RTS, CTS, DTR and RI.

The BASIC program shown here writes commands directly into a number of registers con-

1

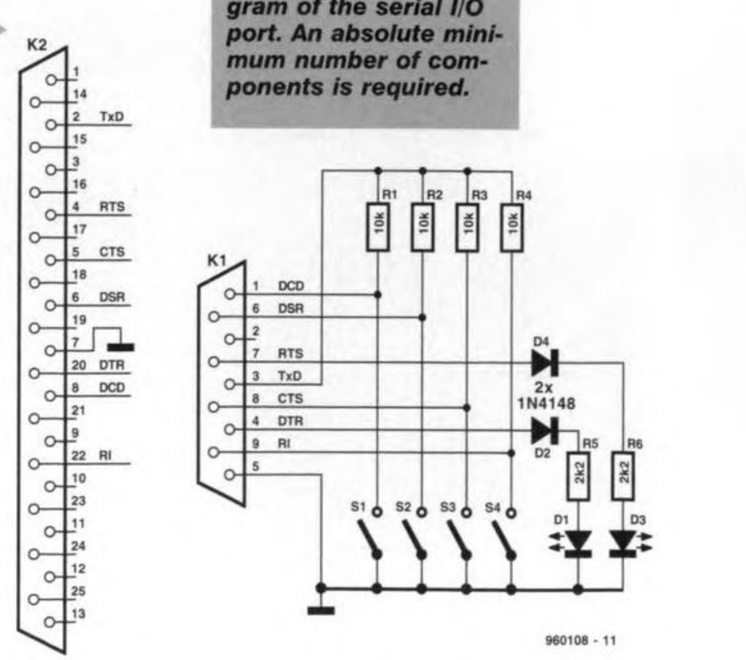


Figure 1. Circuit diagram of the serial I/O port. An absolute minimum number of components is required.

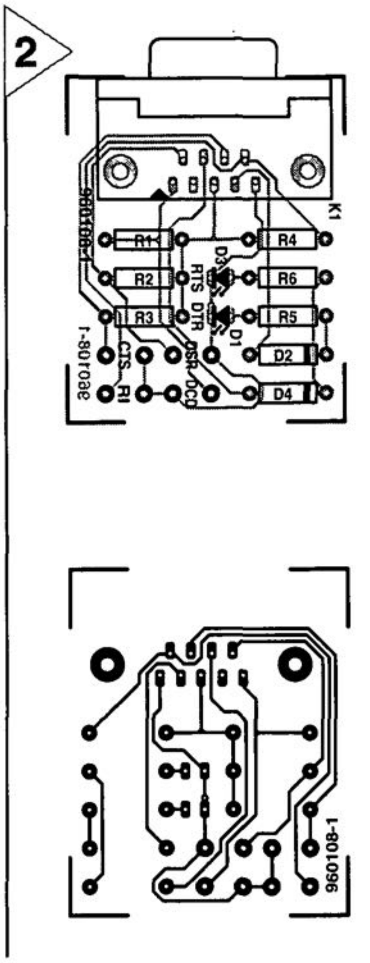


Figure 2. Track layout and component mounting plan of the printed circuit board designed for the project (board not available ready-made).

COMPONENTS LIST

Resistors:
R1,R2,R3,R4 = 10kΩ
R5,R6 = 2kΩ2

Semiconductors:
D1,D3 = LED
D2,D4 = 1N4148

Miscellaneous:
S1,S2,S3,S4 = single-pole on/off switch
K1 = 9-way sub-D socket, angled

tained in the serial controller, which is usually a UART type 16450, 16550 or 8250. These three controllers are identical as far as the register structure is concerned. The registers contain the bits that determine the logic level of each of the above mentioned I/O lines, allowing simple software to be applied to run the lot.

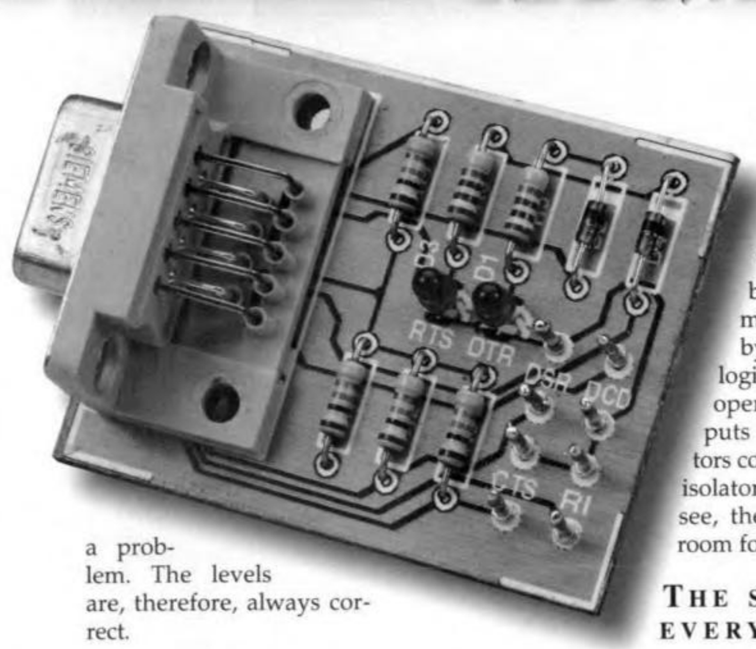
The drawing in **Figure 1** illustrates the use of the serial interface as an I/O port. The two outputs are formed by the RTS and DTR lines, the inputs, by the lines RI, CTS, DSR and DCD. Finally, TxD and GND are used to generate the necessary supply voltage. Only the RxD line is not used.

The electrical levels used by this I/O port depend on the hardware contained in the PC. A real RS232 interface uses logic levels which swing between +12 V and −12 V. There are, however, also PC manufacturers who use TTL levels instead of the ±12 V swing. Because the input levels at switches S1 through S4 is derived from the supply voltage, in other words, from the switching levels available on the RS232 interface, the absolute value will not be

Figure 3. Listing of the BASIC program which arranges all the control functions. Making your own modifications should not be a problem (program not available on disk).

3

```
10  CLS
20  ComAddress = &H2F8
40  OUT ComAddress + 3, INP(ComAddress + 3) OR 64
50  PRINT
60  PRINT TAB(24); CHR$(201); STRING$(30, CHR$(205)); CHR$(187)
70  PRINT TAB(24); CHR$(186); STRING$(30, CHR$(32)); CHR$(186)
80  PRINT TAB(24); CHR$(186); "    RS-232 Input/Output Port    "; CHR$(186)
90  PRINT TAB(24); CHR$(186); STRING$(30, CHR$(32)); CHR$(186)
100 PRINT TAB(24); CHR$(200); STRING$(30, CHR$(205)); CHR$(188)
110 PRINT
120 PRINT "Instructions:"; TAB(20); "Press 'R' to alter RTS"
130 PRINT "-------------"; TAB(20); "Press 'D' to alter DTR"
140 PRINT TAB(20); "Press 'Q' to quit"
150 PRINT : PRINT
160 PRINT "OUTPUT:", "RTS", "DTR"
170 PRINT "-------", "---", "---"
180 PRINT "State:",
190 IF INP(ComAddress + 4) AND 2 THEN PRINT "HIGH",  ELSE PRINT "LOW",
200 IF INP(ComAddress + 4) AND 1 THEN PRINT "HIGH" ELSE PRINT "LOW"
210 PRINT : PRINT
220 PRINT "INPUT", "DCD", "RI", "DSR", "CTS"
230 PRINT "-----", "---", "--", "---", "---"
240 PRINT "State:",
250 State = INP(ComAddress + 6) AND 240
260 IF State AND 128 THEN PRINT "HIGH",  ELSE PRINT "LOW",
270 IF State AND 64 THEN PRINT "HIGH",  ELSE PRINT "LOW",
280 IF State AND 32 THEN PRINT "HIGH",  ELSE PRINT "LOW",
290 IF State AND 16 THEN PRINT "HIGH" ELSE PRINT "LOW"
300 DO
310     LOCATE 20, 15
320     Previousstate = State AND 240
330     IF State <> Previousstate THEN
340         IF State AND 128 THEN PRINT "HIGH",  ELSE PRINT "LOW",
350         IF State AND 64 THEN PRINT "HIGH",  ELSE PRINT "LOW",
360         IF State AND 32 THEN PRINT "HIGH",  ELSE PRINT "LOW",
370         IF State AND 16 THEN PRINT "HIGH" ELSE PRINT "LOW"
380     END IF
390     A$ = UCASE$(INKEY$)
400     IF A$ = "R" THEN
410         LOCATE 15, 15
420         RTSState = INP(ComAddress + 4) AND 2
430         IF RTSState THEN
440            OUT ComAddress + 4, INP(ComAddress + 4) XOR 2
450            PRINT "LOW "
460         ELSE
470            OUT ComAddress + 4, INP(ComAddress + 4) XOR 2
480            PRINT "HIGH"
490         END IF
500     ELSEIF A$ = "D" THEN
510         LOCATE 15, 29
520         DTRState = INP(ComAddress + 4) AND 1
530         IF DTRState THEN
540            OUT ComAddress + 4, INP(ComAddress + 4) XOR 1
550            PRINT "LOW "
560         ELSE
570            OUT ComAddress + 4, INP(ComAddress + 4) XOR 1
580            PRINT "HIGH"
590         END IF
600     END IF
610 LOOP UNTIL A$ = "Q"
```



a problem. The levels are, therefore, always correct.

PRACTICAL MATTERS

The circuit is built on a small printed circuit board of which the track layout and component mounting plan are given in **Figure 2**. Considering the simplicity of the circuit, construction should not cause problems. Once finished, the board may be connected to the serial port on your PC. Where applicable, the switches may be replaced by end contacts, logic ports with open-collector outputs or phototransistors contained in opto-isolators. As you can see, there is plenty of room for experiments.

THE SOFTWARE: EVERYTHING IN BASIC

The (invisible) heart of the project is actually the serial controller in the PC. This device is usually mapped at one of the familiar base addresses like $2F8_H$ for COM1, and $3F8_H$ for COM2. In case you are unsure about the base address(es) used in your computer, use a hardware diagnosis program like MSD (MicroSoft Diagnostics) or CheckIt to collect relevant information. The register addresses that matter in the present application are [base+4] and [base+6]. **Table 1** tells you how the various bits contained in the registers are used to switch the I/O lines. Bit 6 at [base+3] enables the TxD line to be made high permanently ('set break'). This initialisation is performed at the start of the program.

The complete listing of the BASIC program we have in mind is given in **Figure 3**. Typing it into BASIC will not take too much time, we reckon. The base address of the COM port you intend to use is determined in line 20. The interface is switched on in line 30, when the TxD output is made permanently high.

The signal levels on the DTR and RTS lines are read in lines 190 and 200 respectively. Lines 260 through 290 enable the status of the various levels to be displayed on the monitor. The routine between lines 300 and 610 is repeated until the 'Q' key is pressed. In line 330, the software checks if the level at the inputs has changed. If so, the new states are copied to the screen. Line 390 checks to see if a key is pressed. In case the 'R' or 'D' key is pressed, the level of RTS or DSR is inverted, respectively. (960108)

Table 1. UART bit/register overview.

Address	bit 0	bit 1	bit 2	bit 3	bit 4	bit 5	bit 6	bit 7
3	WLS0	WLS1	STB	PEN	EPS	Stick parity	**Set break**	DLAB
4	**DTR**	**RTS**	Out1	Out2	Loop	0	0	0
6	Delta CTS	Delta DSR	Trailing edge RI	Delta DCD	**CTS**	**DSR**	**RI**	**DCD**

CONSTRUCTION GUIDELINES

Elektor Electronics (Publishing) does not provide **parts and components other than** PCBs, fornt panel foils and software on diskette or IC (not necessarily for all projects). Components are usually available form a number of retailers – see the adverts in the magazine.

Large and small values of components are indicated by means of one of the following prefixes :

E (exa) = 10^{18}	a (atto) = 10^{-18}
P (peta) = 10^{15}	f (femto) = 10^{-15}
T (tera) = 10^{12}	p (pico) = 10^{-12}
G (giga) = 10^{9}	n (nano) = 10^{-9}
M (mega) = 10^{6}	μ (micro) = 10^{-6}
k (kilo) = 10^{3}	m (milli) = 10^{-3}
h (hecto) = 10^{2}	c (centi) = 10^{-2}
da (deca) = 10^{1}	d (deci) = 10^{-1}

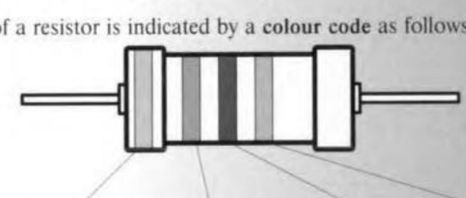
In some circuit diagrams, to avoid confusion, but contrary to IEC and BS recommandations, the value of components is given by substituting the relevant prefix for the decimal point. For example,
3k9 = 3.9 kΩ   4μ7 = 4.7 μF

Unless otherwise indicated, the tolerance of resistors is ±5% and their rating is ⅓–½ watt. The working voltage of capacitors is ≥ 50 V.

In **populating a** PCB, always start with the smallest passive components, that is, wire bridges, resistors and small capacitors; and then IC sockets, relays, electrolytic and other large capacitors, and connectors. Vulnerable semiconductors and ICs should be done last.

Soldering. Use a 15–30 W soldering iron with a fine tip and tin with a resin core (60/40) Insert the terminals of components in the board, bend them slightly, cut them short, and solder: wait 1–2 seconds for the tin to flow smoothly and remove the iron. Do not overheat, particularly when soldering ICs and semiconductors. Unsoldering is best done with a suction iron or special unsoldering braid.

The value of a resistor is indicated by a **colour code** as follows.



color	1st digit	2nd digit	mult. factor	tolerance
black	–	0	–	–
brown	1	1	$\times 10^{1}$	±1%
red	2	2	$\times 10^{2}$	±2%
orange	3	3	$\times 10^{3}$	–
yellow	4	4	$\times 10^{4}$	–
green	5	5	$\times 10^{5}$	±0,5%
blue	6	6	$\times 10^{6}$	–
violet	7	7	–	–
grey	8	8	–	–
white	9	9	–	–
gold	–	–	$\times 10^{-1}$	±5%
silver	–	–	$\times 10^{-2}$	±10%
none	–	–	–	±20%

Examples:
brown-red-brown-gold = 120 Ω, 5%
yellow-violet-orange-gold = 47 kΩ, 5%

Faultfinding. If the circuit does not work, carefully compare the populated board with the published component layout and parts list. Are all the components in the correct position? Has correct polarity been observed? Have the powerlines been reversed? Are all solder joints sound? Have any wire bridges been forgotten?

If voltage levels have been given on the circuit diagram, do those measured on the board match them – note that deviations up to ±10% from the specified values are acceptable.

Possible corrections to published projects are published from time to time in this magazine. Also, the readers letters column often contains useful comments/additions to the published projects.

50 W a.f. amplifier

uses only one IC

Although audio enthusiasts come in many sizes and colours, not many of them are prepared to spend a lot of money, time and effort to build an a.f. amplifier using up to 40 transistors to improve the distortion by a fraction of a per cent. Therefore, the amplifier described here should appeal to those enthusiasts. It is compact, presents no problems and yet has properties that make it fully suitable for all but the most demanding audio applications. In short, an amplifier that is geared to the practical audio buff.

Source: SGS Thomson

Specification

Input sensitivity:	*1.3 V (50 W into 8 Ω)*
Input impedance:	*10 kΩ*
Bandwidth:	*16 Hz – 100 kHz*
Slew rate:	*10 V μs^{-1}*
Output power:	*50 W into 8 Ω (0.1% THD)*
	82 W into 4 Ω (0.1% THD)
Signal-to-noise ratio:	*105 dBa (1 W/8 Ω)*
THD+N with 40 W into 8 Ω:	*0.002% (1 kHz)*
	< 0.04% (20 Hz – 20 kHz)

The Type TDA7294 IC from SGS-Thomson is an integrated a.f. amplifier intended for use in all sorts of hi-fi application. Its circuit diagram is shown in **Figure 1**. Its most prominent feature is the much higher power output than is usual with this kind of integrated amplifier. According to the manufacturer's data sheets, the special DMOS output stage of the 15-pin chip can deliver outputs of up to 100 watt. Considering other properties, such as low noise, low distortion and reliable short-circuit and thermal protection circuits as well, the chip is indeed an interesting one.

Having said that, power output specifications are often rather optimistic. In this instance, the 100 W appears to refer to the IEC norm for music power with 10 per cent distortion, which, as far as hi-fi applications are concerned, is not the correct way of specifying output power. Moreover, with peak supply voltages of ±40 V and a load impedance of 4 Ω, the maximum dissipation of the IC will easily be exceeded. For these reasons, the supply in the present amplifier has been kept down to a safe ±30 V. At these voltages, the chip delivers, without any difficulty, 50 W into an 8 Ω load and 80 W into a 4 Ω load. These are still very respectable figures, particularly in view of the reasonable price of the chip.

CIRCUIT DESCRIPTION

The circuit diagram of the amplifier in **Figure 2** shows that the IC needs only a small number of external components. To keep the harmonic distortion low, the amplifier has a large feedback ratio and its closed-loop gain has been restricted to only 24 dB.

The input signal is applied to pin 3 via capacitor C_1 and low-pass filter R_6-C_{10}. The filter improves the pulse response and flattens the frequency response. For minimum output offset, the values of R_1 and R_3 should be equal, so that the input impedance is 10 kΩ. The roll-off frequencies of R_1-C_1 and R_2-C_2 determine the lower bandwidth limit of the amplifier: with values a specified, this is about 16 Hz. The upper –3 dB point is at about 100 kHz.

The amplifier is muted by a relevant input to pin 10 and placed in the stand-by mode by a relevant signal at pin 9. Muting should always take place before the stand-by mode is selected. Connecting the mute and standby pins permanently to the supply line ensures that the amplifier comes on immediately the power is switched on. Any switch-on clicks may be eliminated by increasing time constants R_3-C_4 and R_5-C_5.

If large-value electrolytic capacitors are used in the power supply, switching off will be rather slow. If that is considered a nuisance, an external mains detection network may be added. This can consist of, say, two diodes and two small smoothing capacitors for rectifying the secondary voltage of the mains transformer. The board has provision for this in the form of additional soldering pins adjacent to the mute and stand-by inputs: an earth pin in case use is made of an external protection circuit and a plus pin if such protection is not foreseen.

1

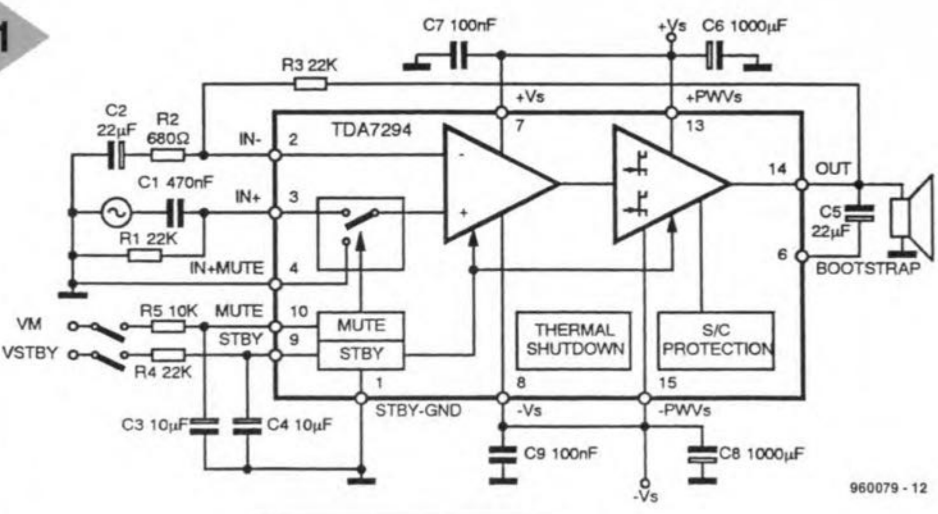
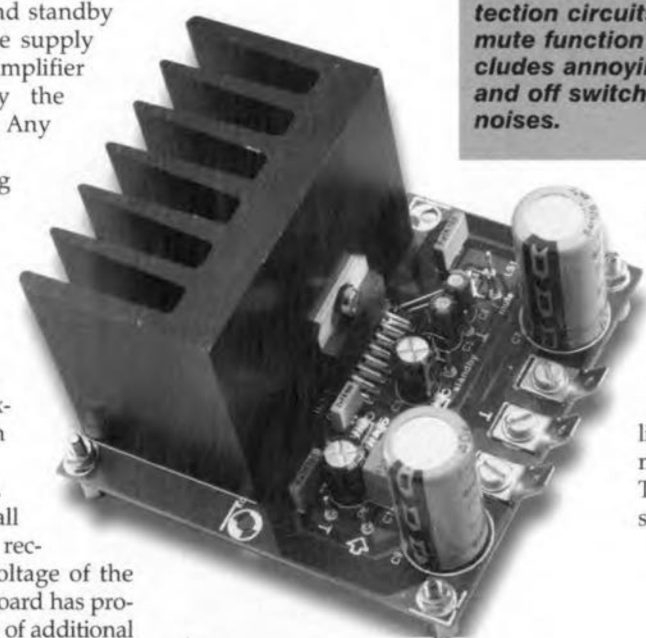


Figure 1. The TDA7294 has standard thermal and short-circuit protection circuits. The mute function precludes annoying on and off switching noises.



CONSTRUCTION

It is best to build the amplifier on the printed-circuit board shown in **Figure 3**. The illustration proves what a compact unit this amplifier is. In view of the scarcity of components, populating the board is very simple.

The back surface of the IC is linked internally to the negative supply rail. Consequently, to preclude electrical contact between the heat sink and the enclosure, the heat sink is mounted on the board. Insulating material between the heat sink and the IC is, therefore, not needed, although the use of some heat conducting paste is advisable.

In the selection of a suitable heat sink, a continuous output of 50 W into 8 Ω was assumed. The selected heat sink is also all right for music outputs of 80 W into 4 Ω. Problems caused by high temperatures are very unlikely, since the IC has internal thermal protection that causes the mute to come into operation at 145 °C and switches the amplifier to stand by at 150 °C.

Provision for connecting the power lines to the board is by three PCB terminal blocks (clamping-screw type). These ensure loss-free passage of the supply current.

The symmetrical power supply is

2

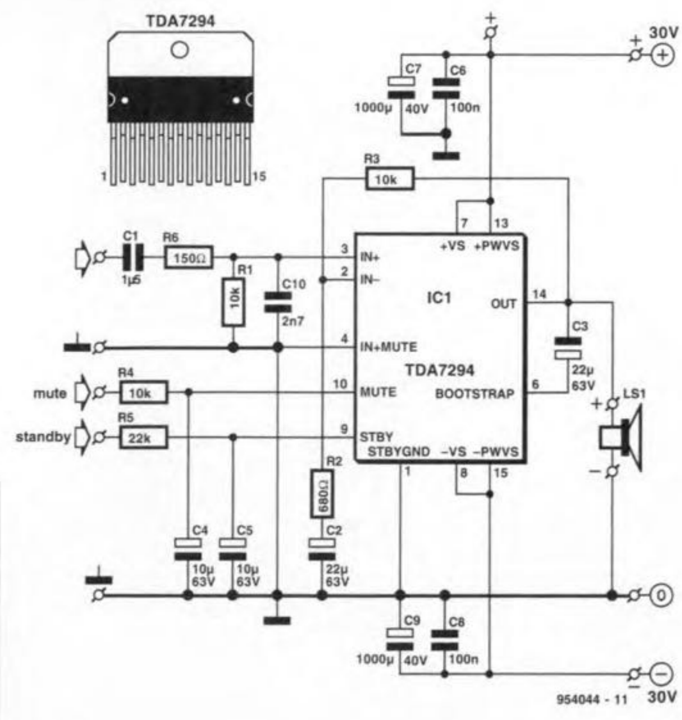


Figure 2. In the final design of the amplifier, supply voltages of ±30 V were decided upon; these are more than sufficient for a power output of 50 W into 8 Ω.

3

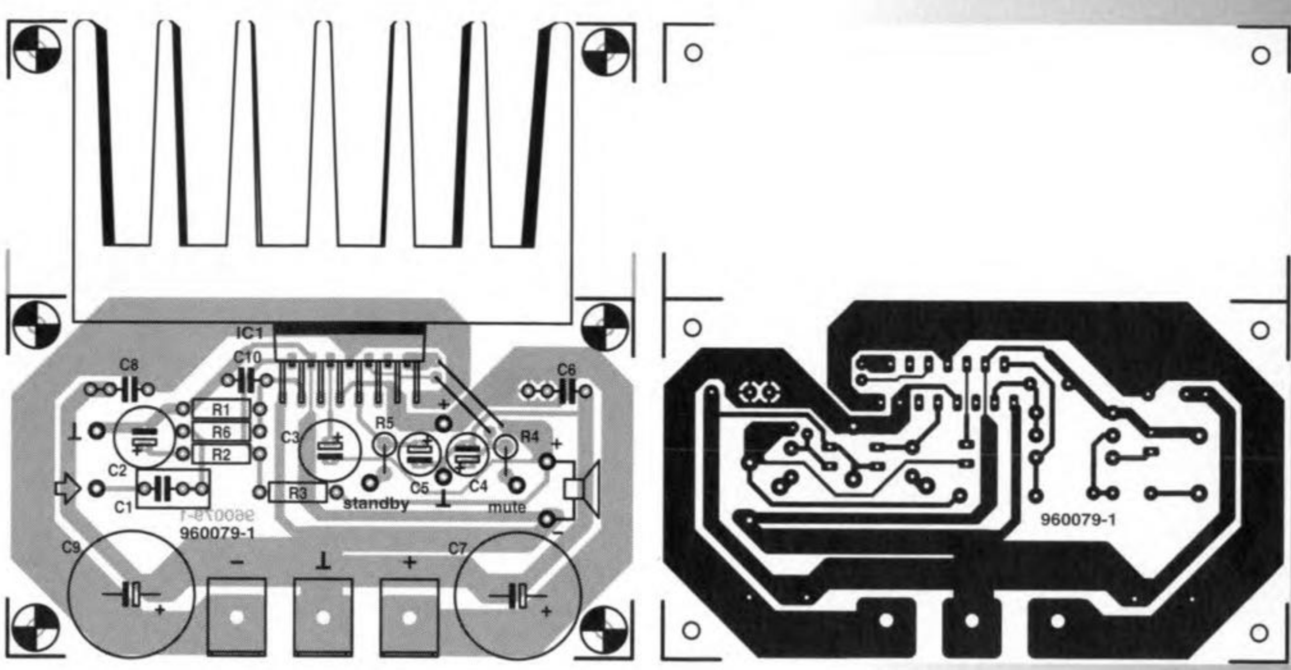


Figure 3. The printed-circuit board is very compact and even houses the requisite heat sink.

best constructed from a toroidal mains transformer, a 25 A bridge rectifier and two 10,000 µF, 50 V electrolytic capacitors.

FINALLY

As mentioned before, thanks to its good performance and high power output, the amplifier is in principle usable in virtually any hi-fi set-up. Owing to its compactness, it is particularly suitable for use in combination with a preamplifier as an integrated amplifier or as part of an active loudspeaker system where space is almost always at a premium.

For those who would like some proof of the figures given in the specification table, **Figure 4** shows the distortion characteristic of the amplifier obtained with a spectrum analyser. The measurements were carried out at an output power of 40 W into 8 Ω and a bandwidth of 80 kHz. As usual, the characteristic slopes upward at higher frequencies, but the distortion does not exceed 0.04 per cent. In a large part of the a.f. range (up to about 1 kHz), the total-harmonic-distortion-plus-noise (THD+N) does not even rise above 0.02 per cent. This sort of performance is excellent for all but the most demanding applications. [960079]

Parts list

Resistors:
R_1, R_3, R_4 = 10 kΩ
R_2 = 680 Ω
R_5 = 22 kΩ
R_6 = 150 Ω

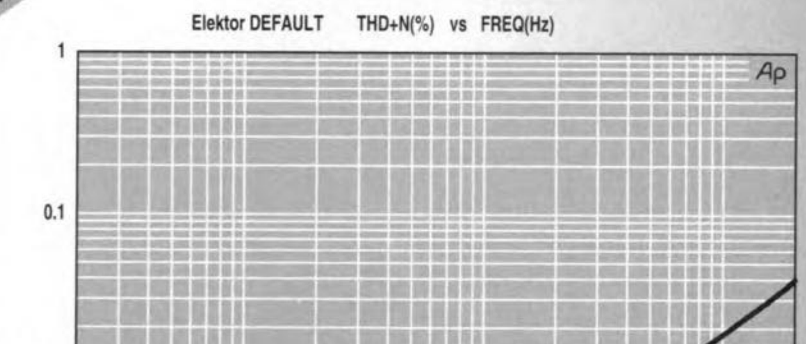
Capacitors:
C_1 = 1.5 µF, 63 V*
C_2, C_3 = 22 µF, 63 V, radial
C_4, C_5 = 10 µF, 63 V, radial
C_6, C_8 = 100 nF
C_7, C_9 = 1000 µF, 40 V, radial
C_{10} = 2.7 nF*, pitch 5 mm
* metallized polyester

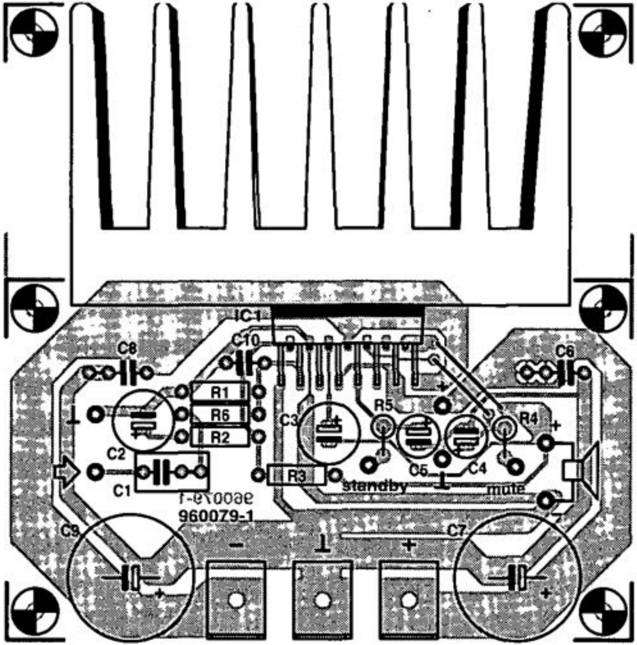
Integrated circuits:
IC_1 = TDA7294V

Miscellaneous:
3 off PCB terminal block with clamping screws
1 off heat sink, 2.5 K W^{-1} (e.g. Fischer Type SK100, available from Dau – telephone 01243 553031))
for power supply:
1 off mains transformer, 2×22 V, 80 VA
2 off electrolytic capacitor, 10,000 µF, 50 V
1 off 25 A bridge rectifier
PCB Order no 960079-1 (see Readers' Services towards the end of this issue)

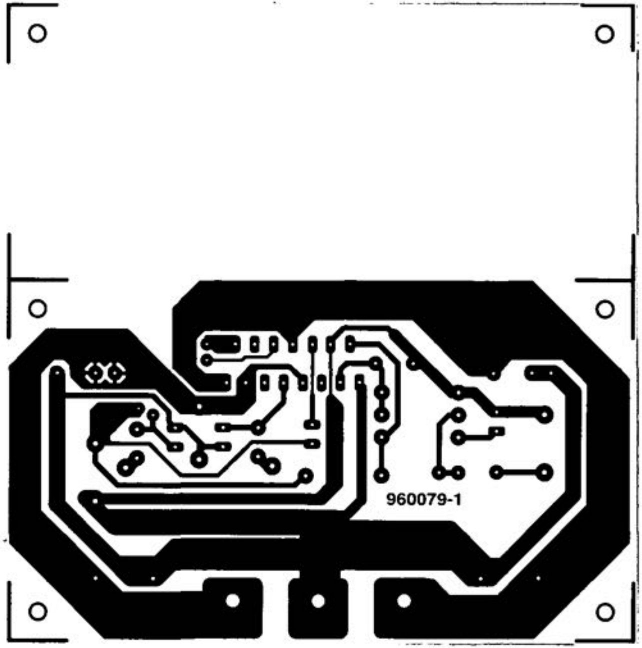
Figure 4. The distortion characteristic, measured with an output power of 40 W into 8 Ω, is excellent for this type of amplifier.

4





IC1
C10
C8
C6
R1
R6
R2
R5
R4
C3
C2
C5
C4
R3
C1
standby
mute
960079-1
C9
C7



960079-1

We can only answer questions or remarks of general interest to our readers, concerning projects not older than two years and published in *Elektor Electronics*. In view of the amount of post received, it is not possible to answer all letters, and we are unable to respond to individual wishes and requests for modifications to, or additional information about, *Elektor Electronics* projects.

Sampling rate converter

I am using the Sampling Rate Converter (October 1996) to transfer recordings from a DAT recorder (48 kHz) to a CD recorder (44.1 kHz) to burn my own CDs. This works quite well, only the track numbers seem to drop out of the copy process. How come?

A. Eggert, Germany

Your observation is correct. The SRC only converts the audio samples, that is, audio data only. As you may have seen from the circuit diagram on page 31, the Channel Status, User and Validity bits are not decoded and not transferred. The corresponding serial inputs, C U and V, of the output IC type CS8402A are tied to ground. At the output, the channel status bits may be programmed using the 7 DIP switches in S1. In this way, it is possible to redefine the channel status bits like Copybit, Category code and Generation bit and change between Professional and Consumer mode.

Mini Flash Programmer tip

While building up the Mini Flash programmer described in your October 1996 magazine I stumbled on the error mentioned in the text regarding the Centronics interface (thanks for your helpful note on the signal levels). Because I have a relatively new motherboard which I would not like to change (*never change a winning team*) I have used two gates from a 4050 package, one is inserted in the DOUT line, the other, in the BUSY line. The inputs of the other four gates in the 4050 are tied to ground. The programmer now works without problems, and without any modification to the PC.

G. Mayer, Austria

Thank you for this useful tip which we hope will benefit other readers as well.

Measuring inductance

I am still riddled by your article 'Simple Inductance Meter' in the February 1997 issue. The principle used by the author is based on measuring the resonance frequency of an L-C network. In the past, I have often measured inductances with the aid of a voltage/current diagram. In this way, one measures the inductance in series with a known (non-reactive) resistance. That allows the R-L network to be supplied with a 50-Hz test frequency using an adjustable transformer (even one for model trains is okay for this purpose). The inductors were soft iron core types with values between 0.1 mH and 0.3 mH. The transformer was set to different output voltages, whereupon the voltage across the network was measured, as well as the current through it. Using the formula

$$L = \frac{1}{\omega} \cdot \sqrt{\left(\frac{U}{I}\right)^2 - R^2}$$

I then calculated the inductance. In the equation, *U* is the voltage across the R-L network, *I* the current through the network, and *R* the non-reactive series resistance. One problems is that the inductance does not appear to be constant. Instead, it shows up small variations depending on the test current. I reckon the effect is caused by the fact that the core permeability is not constant. Consequently, I was wondering if the test current should not be stated along with the inductance.

Regarding your Magnetic-Field Meter project (January 1997), I would like to know if it is possible to extend the measuring range to 3 Tesla, in order to do measurements on large inductors, too. Can I use a pick-up coil for this purpose, or should I go for a Hall sensor?

R. Leurs (Netherlands)

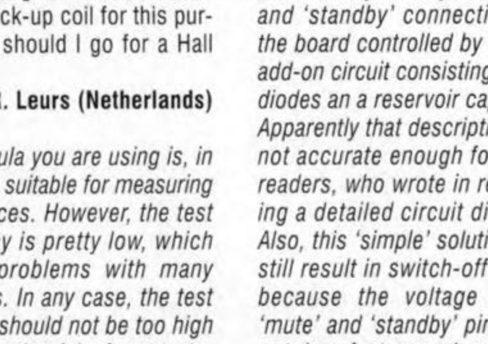
The formula you are using is, in principle, suitable for measuring inductances. However, the test frequency is pretty low, which causes problems with many inductors. In any case, the test currents should not be too high to prevent the risk of core saturation. With large inductors, say, loudspeaker filter coils, the manufacturer therefore states the maximum permissible coil current.

Extending the measurement range of the Magnetic-Field Meter is, in principle, possible by means of a corresponding reduction of the number of turns of the pick-up coil. For reliable measurements of coil inductances we do, however, recommend a dedicated and accurate test instrument like the Advanced RLC Meter described in the April, may and June 1997 issues of Elektor Electronics. This instrument is also useful for measuring unknown capacitors and resistors.

Power-off accelerator

In our article '50 W a.f. amplifier' (November 1996), an option was mentioned that would allow switch-off noises to be eliminated. This, we said, could be achieved by having the 'mute' and 'standby' connections on the board controlled by a small add-on circuit consisting of two diodes an a reservoir capacitor. Apparently that description was not accurate enough for some readers, who wrote in requesting a detailed circuit diagram. Also, this 'simple' solution may still result in switch-off noises because the voltage at the 'mute' and 'standby' pins does not drop fast enough when the amplifier is switched off.

The diagram shows a small extension circuit which does the trick. A relay is used to speed up the mute circuit in a reliable manner. Because a 24-V relay is used, it is de-actuated as soon as the transformer voltage disappears. Capacitors C4 and C5



in the amplifier circuit are then allowed to be discharged quickly via R4 or R5 and the relay contacts. The anodes of D1 and D2 are connected to the transformer secondary voltages (22 V each). Instead of the indicated relay type from Siemens (nominal coil voltage 24 V, coil resistance 2210 Ω) you may, of course, use another relay, provided the series resistor R1 is modified accordingly. A relatively light rating is sufficient for the contacts (60 V/10 mA).

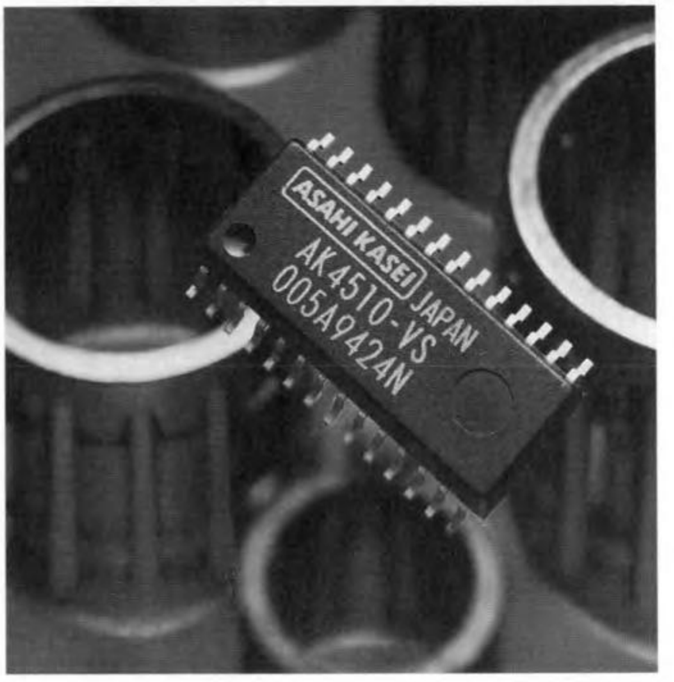
Hygrometer

Your July/August 1997 magazine had an article about a hygrometer. I would appreciate if I could get more information about capacitor C1. According to my calculations, it should have a value of the order of 150 pF. My problem is that I do not understand how a capacitor can function as a humidity sensor, because its case would have to be open to air. Please inform me where this capacitor may be obtained, is the calculated value correct, and what do you call this capacitor?

Jan Nel, South Africa.

In the circuit diagram, the functional symbol given to component C1 is that of a variable capacitor. The actual device is, however, not a capacitor but a dedicated humidity sensor type H1 from Philips Components. This device, which was alerady used in a number of our earlier designs, is normally available from our regular advertiser C-I Electronics.

ADC/DAC for Multimedia and Audio Systems



DIP International now supply the AKM AK4510 16-bit stereo A/D and D/A converter (single chip audio codec).

The design employs 4th-order delta-sigma modulation techniques resulting in high accuracy and low cost. The ADC section has on-chip anti-alias filtering, resulting in high-accuracy A/D conversion with a range of 90 dB. The DAC section boasts an on-chip post filter which tolerates system clock jitter up to 100 ns. Supplied in a 28-pin SOP package, the AK4510 has sampling rates from 4 kHz to 50 kHz. Further information from

DIP International Ltd., Sheraton House, Castle Park, Cambridge CB3 0AX. Tel. (01223) 462244, fax (01223) 467316, email 100343.304@compuserve.com.

(967066)

PICSTART Plus and MPLAB-C C Compiler

Microchip have just released PICSTART Plus, a highly flexible design toolset supporting all existing and future Microchip 8-bit one-time-programmable microcontrollers, and the MPLAB-C Universal C Compiler for PIC16/17 8-bit microcontrollers.

PICSTART Plus includes a development programmer an RS-232 cable, a 9-volt universal IEC power supply, a PIC16/17 microcontroller device sample and complete documentation from a user's guide and CD-ROM containing Microchip's databook and Embedded Control Handbook. The MPLAB-C Universal C Compiler is a complete high-level language compiler which provides powerful integration capabilities and ease-of-use features. MPLAB-C generates code directly from the compile process, eliminating the need to assemble code generated by the compiler.

PICSTART Plus and MPLAB-C run under Microchip's popular MPLAB integrated Development Environment which gives developers the flexibility to edit, compile and debug from a single user interface. MPLAB offers full source level debugging in an easy project environment, reducing overall development time and cost.

PICSTART Plus and MPLAB-C join Microchip's extensive range of PIC16/17 development tools, including PICMASTER® Universal Development System & ICEPIC – a low cost in-circuit emulator. Other tools include the MP-DriveWay™ Automatic Application Code Generator, fuzzy logic tools, MPASM assembler and the MPLAB-SIM software simulator.

Arizona Microchip Technology Ltd, Unit 6, The Courtyard, Meadowbank, Furlong Road, Bourne End, Bucks SL8 5AJ. Tel (01628) 851077, fax (01628) 850259.

(967095)

Logarithmic-Periodic Test Antenna for 200-1300 MHz

The new Model LPDA-200/1800 logarithmic-periodic test antenna is ideal for measurements according to the following standards: CISPR, VDE, MIL, VG, EN55011, EN55013, EN55015, EN55022 and MIL-STD-4561.

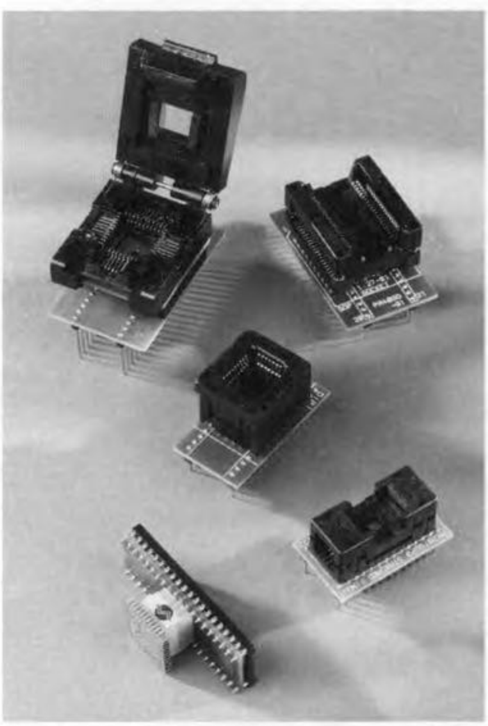
It is specified for the frequency range from 200 to 1300 MHz, but is also suitable for up to 1800 MHz. The polarisation is linear (horizontal and vertical) and the impedance is 50 ohms. The antenna can be used for RF power up to 1000 W CW. The connection is made through a female N-connector with 50-ohm impedance. Due to the excellent design, the weight of the 90 cm x 80 cm antenna is only 2.4 kg. On request the unit can be delivered calibrated and then the antenna factors will be supplied as hardcopy. In addition to this antenna Telemeter Electronic can provide a broad spectrum of EMC test equipment, including LISNs, horn antennas and absorbing clamps.
Distributors enquiries are welcome.

Telemeter Electronic GmbH, Joseph-Gansler-Strasse 10, D-86609 Donauwörth, Germany. Tel. (+49) 906 70693-0, Fax (+49) 906 70693-50.

(967093)

New range of adaptors and test sockets

Smart Communications, the leading supplier in emulators, programmers and development tools, has just launched a brand new range of adapters and test sockets to be used in development laboratories, test, service and production departments.



"SMART Communications is continually updating its product range to meet the requirements of its demanding customers. The initial reaction from the trade has been extremely positive" says Bill Upsdale, Managing Director of SMART Communications.
The SMART collection of sockets are mainly of the Zero Insertion Force (ZIF) type. They can be purchased in any one of the following styles: DIP, SDIP, PLCC, PGA, SOP/SSOP, TSOP, SOJ, SIP/SIMM and QFP. This wide selection of sockets is ideal for test applications, development projects and for use on your production boards.
The programming adapters enable you to programme your devices on a standard DIP programmer.
The prototyping adapters provide the ultimate flexibility in that they enable you to configure your development boards for production and still use them in development.
It is important to note that your development devices may well be of a different pin configuration and yet still be plugged into a production board. The special field configurable adapters and IC isolator adapters for DIP to DIP PLCC to PLCC and DIP to PLCC configurations allow you to either make up your own adapters or isolate certain pins on your device to help solve problems.
Says Bill Upsdale, "This is a major break through in the design of adapters. Prior to this, engineers very often had to design separate boards for development and final production."
The emulator adapters are equipped with a special plug and a standard DIP. This feature allows you to plug your standard emulator cables directly into your production socket.
The SMART collection has been designed with the customer in mind, providing easy to use and hassle free solutions. Nothing has been left to chance. With this in mind, every possible conceivable compatiblity problem has been considered to ensure that a suitable adapter is always available for your individual requirements.
SMART Communications is located in North London with a large office and warehouse to provide a quick turnaround service. In addition to product excellence, SMART Communications knows it offers the best prices. Let us quote for you, and see the difference!

SMART Communications, 2 Field End, Arkley, Barnet, Herts EN5 3EZ, England. Tel. (0181) 441-3890, fax (0181) 441-1843. Email: Sales@Smartcom.co.uk.

(967096)

high-efficiency power supply

single regulator: two input voltages

In a linear power supply unit that converts high input potentials into low output voltages, an appreciable part of the input energy is lost in heat dissipation. This means that if the unit does not use high-wattage components and/or heat sinks, the available output current is small when the difference between input and output voltages is great. This difficulty is obviated by the power supply unit described in this article, which, in use, automatically selects one of two (secondary) input potentials.

Design by W. Schubert

An adjustable 3-pin voltage regulator is ideal for use in a workshop power supply intended to provide output voltages of up to, say, 40 V. A Type LM317T regulator in a TO-220 case can pass a current of up to 1.5 A and, in theory and with an infinitely large heat sink, can dissipate up to 15 W. The same regulator, but in a TO-3 case (the Type LM317K), can dissipate up to 20 W. In practice, the regulator, mounted on a fairly large heat sink, can dissipate 10 W (T) or 12 W (K). This is rather lower than the theoretical value, but it ensures that the power supply can cope with all the tasks required of it (within its design specification) in the workshop.

Nevertheless, there is yet another situation in which difficulties may arise and that is when a very low output voltage is needed. Since the input potential, U_i, of the regulator is virtually constant, there is then a fairly large difference between this and the output voltage, U_o, of the regulator. **Figure 1** shows the correlation between the output current, I_o, and $U_d = U_i – U_o$. The characteristic shows that in the range 0–2 V (approx), which represents the drop-out voltage, U_r, of the regulator, no current can flow. The drop-out voltage is the sum of the loss in the internal output transistor and that in the emitter resistor. When the required U_o is higher than U_r, the regulator can deliver the maximum current permitted by its internal current limiter.

At a certain value of $U_d = U_i – U_o$, which is here about 12 V, the maximum dissipation occurs, so that the current limiter is no longer effective. The maximum current drops in proportion with falling U_o, until U_i = 40 V and $U_o \approx$ 2 V, when it is only 500 mA. All this presupposes an effective heat sink.

1

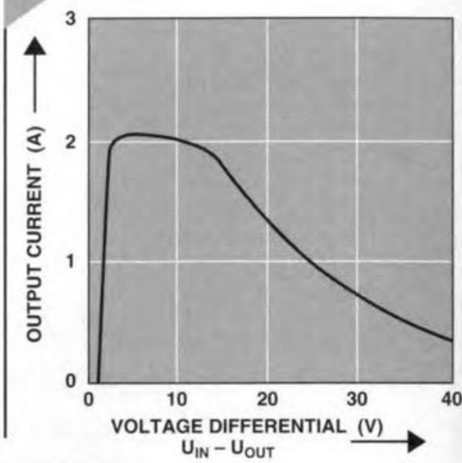


Figure 1. The maximum permissible current drops with increasing difference between input voltage and output potential.

A SOLUTION

There is a way of obviating the foregoing difficulties and that with few components and without recourse to an expensive heat sink: halving the input voltage to the regulator when a low output voltage is needed. This requires a mains transformer with two secondary windings, however.

The regulator IC in **Figure 2**, in conjunction with P_1, R_7, R_8, D_5 and C_4–C_6, is arranged in its standard application. Capacitor C_8 improves the suppression of any residual ripple.

Diode D_2 prevents the output voltage rising above the input potential when the load is capacitive or inductive. This component is linked via D_1 to a bridge rectifier and reservoir capacitor, which in turn are connected across an 18 V secondary winding of mains transformer Tr_1. The maximum attainable output voltage of this portion of the circuit is about 22 V.

The alternating voltage across the lower secondary of Tr_1 is separately rectified. The resulting direct voltage is added via T_1 to that derived from the upper secondary of Tr_1, when U_o rises above about 20 V.

The potential across R_9 and R_6 is

the heat sink

The size of the heat sink must be computed for the worst case. When the output potential ≤ 20 V, only the voltage regulator is used. The difference between input voltage and output potential, $U_d = U_i - U_o$, is not greater than 23 V (24.2 V – 1.2 V). Since the continuous dissipation of the LM317K must not exceed 20 W, the maximum output current must not be greater than 900 mA at the peak value of U_d.

The rise in temperature caused by a dissipation of 20 W must not exceed 85 K (assuming an ambient temperature of 40 °C), since the junction temperature must not rise above 125 °C.

The maximum permissible junction-to-ambient thermal resistance is thus 85/20 = 4.25 K W⁻¹.

The IC has a thermal resistance ($R_{th(j-c)}$) of 2.3 K W⁻¹, to which must be added that of the mounting surface ($R_{th(m)}$), which, depending on the degree of isolation (quality of the heat conducting paste), is somewhere between 0.2 K W⁻¹ and 0.9 K W⁻¹, say, 0.6 K W⁻¹.

Thus, the thermal resistance of the heat sink must not exceed

$$\Delta T/P_v - (R_{th(j-c)} + R_{th(m)}) =$$

$$85/20 - (2.3 + 0.6) = 1.35\ K\ W^{-1}.$$

A similar calculation must be carried out for the case when $U_o > 20$ V.

Since the emitter potential of T_1 in conduction is always $2U_{BE}$ lower than its base voltage (which is held stable by D_3), the voltage drop across T_1 is a constant 11.2 V.

The peak value of U_d is 38.7–20 = 18.7 V. The permissible dissipation is still 20 W, so that the regulator can provide a current of up to 1.1 A. The dissipation of T_1 at this current is $11.2 \times 1.1 = 12.3$ W.

It is convenient to calculate the heat sinks for IC_1 and T_1 separately, since that for the IC is already known. That for T_1 is

$$\Delta T/P_v - (R_{th(j-c)} + R_{th(m)}) =$$

$$85/12.3 - (1.92 + 0.6) = 4.4\ K\ W^{-1}$$

The total requisite thermal resistance is that for IC_1 in parallel with that for T_1, i.e.,

$$1/1.35 + 1/4.4 \approx 1\ K\ W^{-1}.$$

then high enough to enable T_3, which in turn causes T_2 and darlington T_1 to be driven into conduction. The potential at the input of IC_1 is then about 40 V. Diode D_1 is reverse-biased and prevents short-circuits.

The switching effected by T_2 and T_3 has a small hysteresis, which prevents any 'clattering' when U_o hovers around the switching level of 20 V.

The test values shown in the diagram are valid for output voltages of 10 V and 30 V respectively.

The LM317 can handle a maximum U_d of 40 V. Although the IC does not get damaged at higher differences, it simply ceases to operate. Diode D_3 therefore ensures that the base potential of T_1 cannot rise above 39 V.

The peak output voltage is a few volts lower than the zener voltage (39 V). The threshold voltage, U_s, at which the upper section of the supply is enabled is proportional to the value of R_9. When this resistor is 330 Ω as specified, U_s is 20 V; when the resistance is increased, U_s rises.

The hysteresis, which with values as specified in the diagram is 1 V, is proportional to the ratio R_9:R_1.

DISSIPATION

When the supply is required to provide high currents for short periods of time only, a fairly small heat sink of about 2 K W⁻¹ suffices.

When continuous operation is foreseen, the heat sink must be computed as relevant (see box). The LM317K (TO-3 case) has a thermal resistance (junction-to-case) of 2.3 K W⁻¹; that of the LM317T (TO-220 case) is 4 K W⁻¹.

The maximum junction temperature is 150 °C in case of the LM317K and 125 °C for the LM317T.

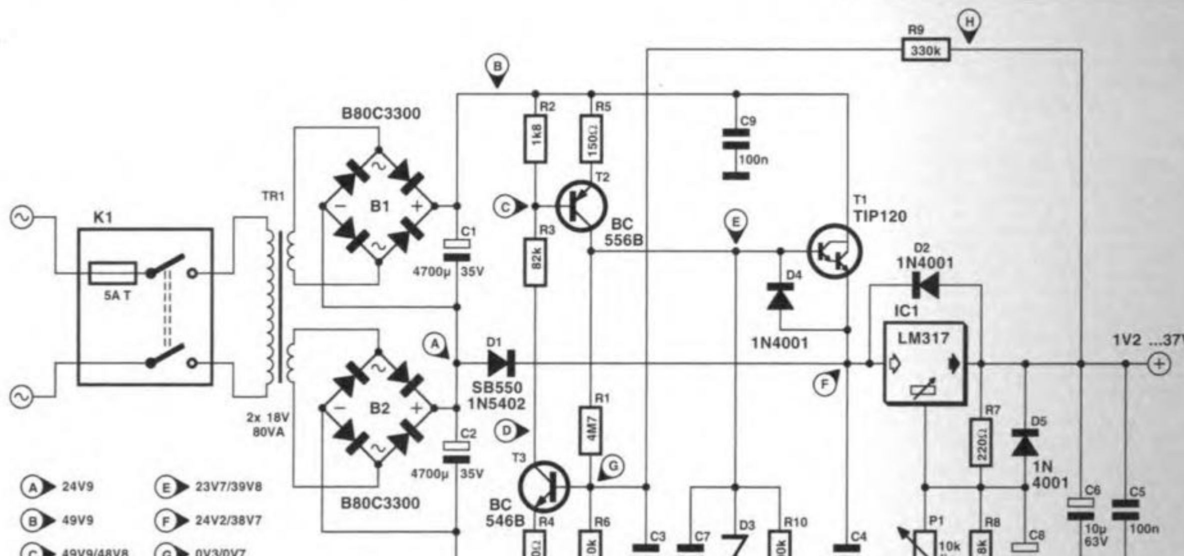
It should be borne in mind that the darlington transistor, T_1 (TO-220 case) contributes to the heat generation – some 2 K W⁻¹.

Both the voltage regulator and the darlington transistor must be isolated from the heat sink, which should be firmly strapped to ground.

[960066]

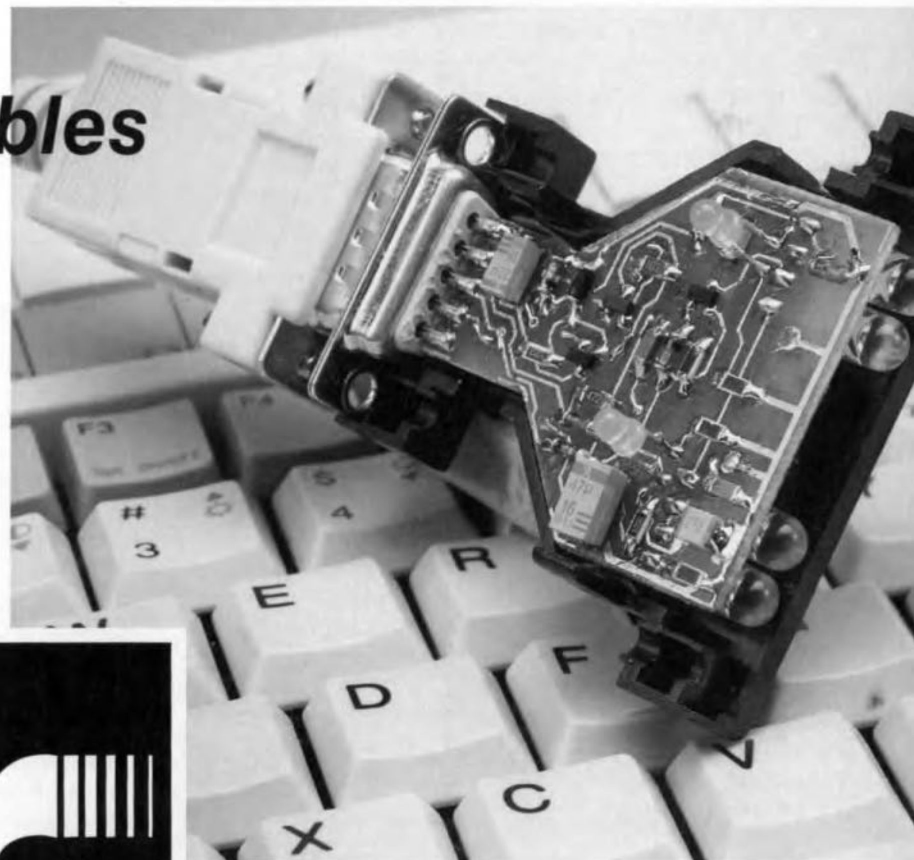
Figure 2. Only the lower part of the circuit operates (with a reduced input voltage) when the output potential is lower than 20 V. Above that level (up to 37 V), the upper part of the circuit is also enabled. Even then, the difference between input voltage and output potential is only 22 V.

2



Infra-red RS232 link

get rid of those cables



After our introductory article on IrDA data communication in the April 1996 issue we now propose a miniature IrDA transceiver which goes straight on to your PC's RS232 port. The intelligent IrDA interface conveys data at a speed of up to 115 kbit/s without using a cable connection, for example, between a desktop computer and a portable computer within a range of about 3 m. The hardware is built around a chip set from Temic, while the software runs under Windows 95, fully supporting its Plug&Play function.

Design by K. Walraven

Although serial data communication is by no means a novelty in computer land, it is now unified as regards standards, mainly as a result of the work carried out by the Infrared Data Association (IrDA), which is basically group of over 70 manufacturers in the electronics industry. The IrDA-1 standard which was published towards the end of 1995 supersedes the manufacturer-specific systems which were in use up to then, enabling infrared communication to be implemented on any device having a serial interface. The IrDA-1 standard has ramifications for the consumer as well as the professional electronics market, and its application is by no means restricted to computers and their peripherals.

Post-installing an IrDA interface on an existing piece of equipment requires at least a type 16550 compatible UART, which is currently the standard for all IBM-compatible PCs and their peripherals such as printers, scanners and modems, but also telephone systems, electronic test instruments, data loggers and organizers, to mention but a few examples. The second requirement is that the device has IrDA driver software provided by the manufacturer (firmware) or the user (as an upgrade).

Telefunken Microelectronic (Temic), being one of the leading members of the IrDA group, offers a series of special components for IrDA compatible interfaces. Components for pulse processing are produced (depending on the data rate, bits are shortened to a length of 1.41 to 22.13 μs to save power, and restored to their original length by the receiver), as well as IR modules containing receive and transmit diodes for the 850-900 nm range. Also available are single photo didoes and PIN diodes which may be used to implement infrared links with an extended range.

Interface and IR module

Thanks to these easily obtainable and relatively inexpensive components, it is possible for the advanced hobbyist to 'upgrade an existing computer device with an infrared interface, using relatively few parts only. All that is required basically is a transceiver as shown in **Figure 1**. The transceiver consists of two functional blocks, a type TOIM3232 RS232-to-IrDA interface, and an infrared receiver/transmitter module type TFDS4000.

A number of options are available as far as the **interface** is concerned. If your system has a so-called super-I/O controller, then you do not need a separate interface IC because an IR interface is already provided. The second option is the use of a TOIM3000 which is perfect for interfacing with certain UART types. The last option is the TOIM3232 which is a universal solution, really, because it is UART-independent and works with any RS232 interface. The main task of the TOIM3232 is to shorten transmitted pulses, and stretch received pulses to their original length. Two selections are available as regards the pulse length: either you use 1.617 µs, which is the default value and preferred for use with battery-operated equipment, or $\frac{3}{16}$th of the original pulse length. Another function of the TOIM3232 is the generation of a clock for the IrDA data communication, a suitable signal not being available on the standard RS232 interface. Fortunately, an IrDA clock is easily provided by adding an external 3.6864-MHz or 3.68-MHz quartz crystal or resonator, and connecting it to the internal oscillator via pins X1 and X2. Up to 14 different baudrates may be selected via the $BR/\overline{D}$ input. As shown in **Table 1**, the TOIM3232 is programmed by selecting the desired

1

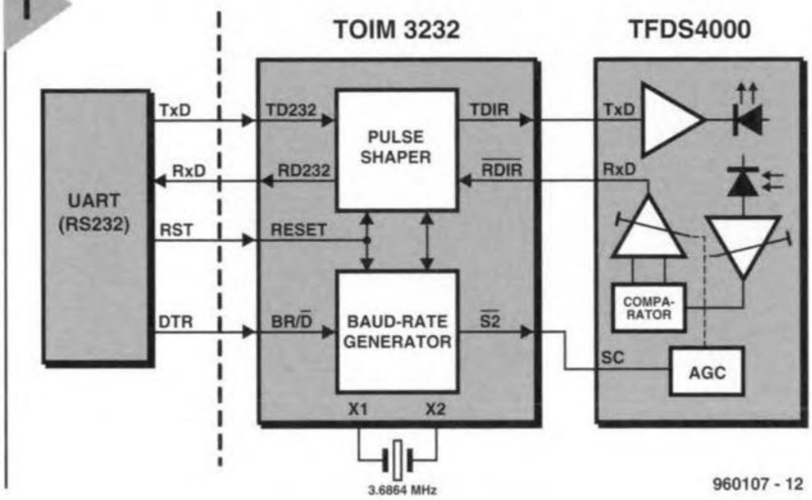


Figure 1. Block diagram of the RS232/IrDA interface which is designed to work with all 16550-compatible UARTs.

operating mode via the RS232 interface. First, the IC is reset (RESET = high-level pulse) and then the $BR/\overline{D}$ pin is pulled high. This prepares the transceiver for the acceptance of a control byte, transmitted via RS232. The control byte consists of two characters of four bits each, as shown in **Figure 2**. Bits S2 and S1 allow the levels of the outputs with the same names to be determined, for example, to switch a device function like stand-by. The present circuit uses $\overline{S2}$ only to raise the sensitivity during reception. The second character (B3-B0) sets the baudrate as shown in **Table 2**. That concludes the programming of the TOIM3232, and data may actually be transmitted as soon as $BR/\overline{D}$ is made logic low. The programming is, of course, part and parcel of the IrDA driver software, which is discussed further on. A condensed datasheet of the TOIM3232 may be found elsewhere in this issue.

The second building block is the infrared transceiver type TFDS4000. This com-

2

Figure 2. Functions of the eight bits contained in the control byte.

first character				*second character*			
x	*S2*	*S1*	*S0*	*B3*	*B2*	*B1*	*B0*

where
X: *don't care*
S1,S2: *user progammable*
S0: *pulse length 1.617 µs or $\frac{3}{16}$th bit length*
B0-B3: *baudrate, B0 = LSB*

Table 1. UART-programming

STEP	RESET	BR/D	RD_UART	TD_UART	RD_IR	TD_IR	Comments
1	High	x	x	x	x	x	Resets all internal registers. Resets IrDA default baud rate of 9600 bit/s.
2	Low	x	x	x	x	x	Wait at least 7 µs
3	Low	High	x	x	x	x	Wait at least 7 µs. The TOIM3232 now enters the control word (programming) mode.
4	Low	High	YZ with Y = 1 for 1.627 µs Y = 0 for $\frac{3}{16}$ bit length	x	x	x	Sending the control word YZ. Send '1Z' if 1.627 µs pulses are used. Otherwise send '0Z' if $\frac{3}{16}$ bit pulses are used. 'Y6' keeps the 9.6 kbit/s data rate, whereas the '0Z' selects the $\frac{3}{16}$ bit time pulses. Z = 0 sets to 115.2 kbit/s. Then wait at least 1 µs for hold-time.
5	Low	Low	DATA	DATA	DATA	DATA	Data communication between the TOIM3232 and the RS232 port has been established by BR/D LOW. The TOIM3232 now enters the data transmission mode. Both RESET and BR/D must be kept LOW ('0') during data mode. Software can reprogram a new data rate by restarting from step 3. The UART also must be set to the correct data rate ***).

Table 2. Baudrate settings

B3	B2	B1	B0	Hex	Baudrate
0	0	0	0	0	**115.2 k**
0	0	0	1	1	**57.6 k**
0	0	1	0	2	**38.4 k**
0	0	1	1	3	**19.2 k**
0	1	0	0	4	14.4 k
0	1	0	1	5	12.8 k
0	1	1	0	6	**9.6 k**
0	1	1	1	7	7.2 k
1	0	0	0	8	4.8 k
1	0	0	1	9	3.6 k
1	0	1	0	A	**2.4 k**
1	0	1	1	B	1.8 k
1	1	0	0	C	1.2 k

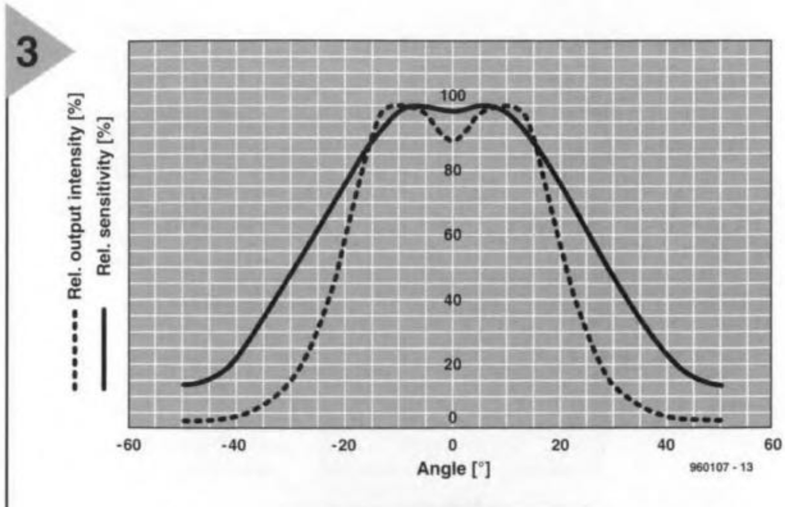


Figure 3. Directivity graph of the transmit and receive diodes in the TFDS4000.

ponent contains a transmitter and a receiver diode which are specially geared to IrDA communication. In addition to these optoelectronic parts, the TFDS4000 also contains an amplifier for the receiver diode, and two buffers which drive the transmitter diode and the received data line. An important function is assumed by the block marked *automatic gain control*, which serves to set the receiver sensitivity. The AGC enables the TFDS4000 to achieve excellent noise immunity. The threshold at which the TFDS4000 responds to an input signal is twice as high with the SC (*sensitivity control*) pin not actuated than with SC logic high.

The requirements as regards the optical range of the IR transmitter are not particularly high at just 1 m. Because the directivity of the IR diodes is relatively high (**Figure 3**), an average current of 100 mA is sufficient for the transmitter diode to achieve a radiation intensity of 150 mW/sr, which easily complies with the IrDA standard. External transmitter diodes may be connected if larger ranges need to be covered.

Circuit description

The complete circuit diagram of the IrDA interface (another first for home construction brought to you by *Elektor Electronics*) is shown in **Figure 4**. The range of the interface is boosted by the addition of a high-power infrared transmitter diode type TSHF5400 (D6), or even three more of these (D01, D02, D03). D6 is connected in series with the internal transmitter diode contained in the TFDS4000. The increased supply voltage of 6.8 V (as compared to about 5.5 V at supply voltage pin 3) raises the radiation intensity by about 25% with respect to the standard application (i.e., without D6).

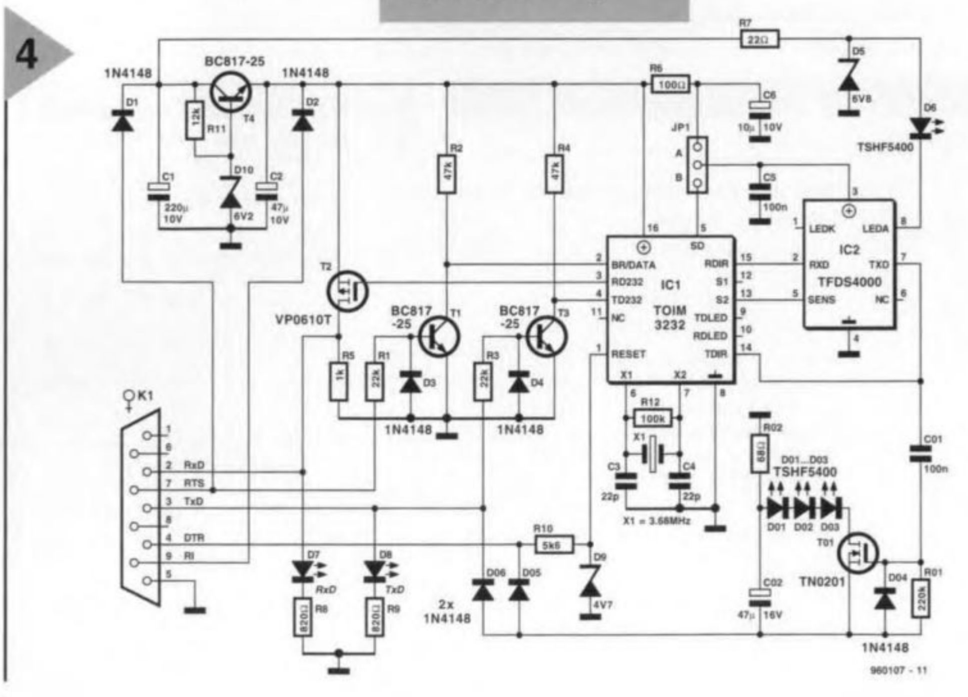
Having discussed the main functions of the IC1 and IC2, all that remains, really, are a number of supply-related sub-circuits.

The RS232/IrDA interface can only work on real RS232 ports with symmetrical line voltages (±12 to ±15 V, dropping to ±8 to ±9 V during use). If your PC uses TTL levels instead, then a level conversion circuit is required such as the MAX232.

The sub-circuit around transistor T4 forms a direct voltage source with a fixed output voltage of 5.5 V which is used to power the ICs. Diode D1 acts as a rectifier, blocking the negative potential which also occurs on the RTS line. An external supply voltage may be applied via D2. The RI line on the RS232 interface is not normally connected.

The jumper (or a switch, if you like)

Figure 4. The complete circuit of the RS232/IrDA interface. Note that this works with RS232 ports supplying symmetrical signal levels only.



COMPONENTS LIST

Resistors:
R1,R3 = 22kΩ SMD
R2 = 10kΩ SMD
R4 = 47kΩ SMD
R5 = 1kΩ SMD
R6 = 100Ω SMD
R7 = 22Ω SMD
R8,R9 = 820Ω SMD
R10 = 5k6Ω SMD
R11 = 12kΩ SMD
R12 = 100kΩ SMD

Capacitors:
C1 = 22µF 16V SMD
C2 = 47µF 10V SMD
C3,C4 = 22pF SMD
C5 = 100nF SMD
C6 = 6µF8 10V SMD, or 10µF 10V SMD

Semiconductors:
D1-D4 = 1N4148 SMD
D5 = 6V8 zener SMD
D6 = TSHF5400 (Temic)
D7 = LED yellow
D8 = LED green
D9 = 4V7 zener SMD
D10 = 6V2 zener SMD
T1,T3,T4 = BC817-25
T2 = VP0610T
IC1 = TOIM3232 (Temic)
IC2 = TFDS4000 (Temic)

Miscellaneous:
JP1 = header 3 pin
K1 = DB9 socket, straight pins
X1 = 3.68 MHz ceramic resonator, or 3.6864 quartz crystal
Printed circuit board and Temic files on disk, order code 960107-C

Optionally:
R01 = 220kΩ SMD
R02 = 68Ω SMD
D01-D03 = TSHF5400 (Temic)
D04,D05,D06 = 1N4148 SMD
T01 = TN0201
C01 = 100nF SMD
C02 = 47µF 16V SMD

5

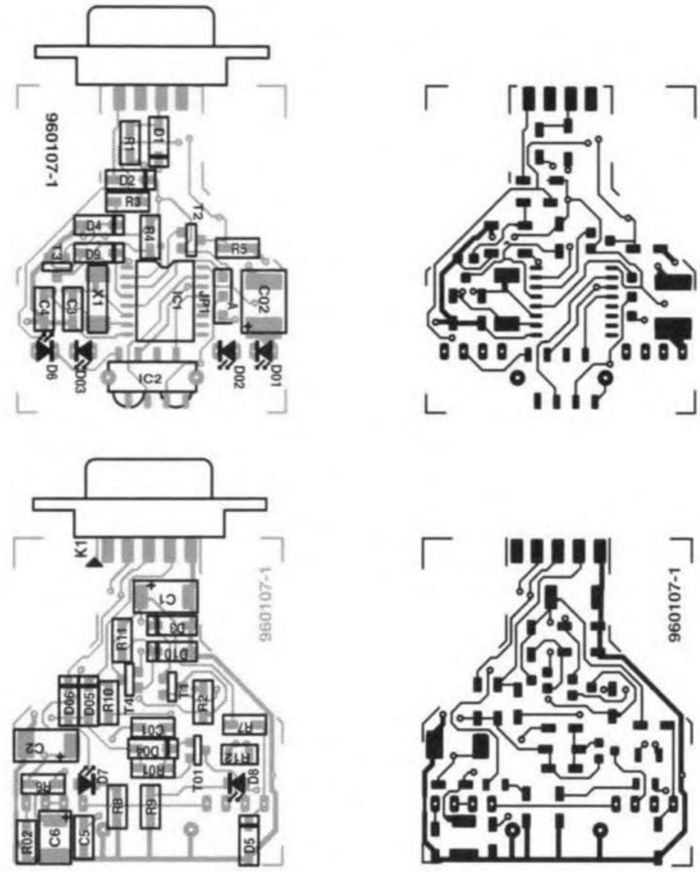


Figure 5. The double-sided board has SMDs at both sides. The pins of the 9-way sub-D connector are soldered at both sides of the circuit board.

allows you to determine whether the IR transceiver is permanently powered, or switched off via the shutdown output (SD) of the TOIM3232 when there is no data traffic on the interface. Unfortunately, this energy-saving function, which is particularly useful with battery-operated computers, is not supported by the driver software, so that you may want to fit a switch at this location instead of a jumper. As already mentioned, the two transmitter LEDs are operated at a slightly higher voltage.

The data output of the TOIM3232 (RD232) is buffered by T2 and then fed to the RxD terminal of the RS232 interface. LED D7 indicates that data is being received. Level converters can not be avoided on RTS, TxD and DTR because the Temic ICs have to be protected against the negative RS232 line potentials on these output lines. Protection is afforded by diodes D3 and D4 which divert the negative voltages to ground, via current limiter resistors R1 and R3. Transistors T1 and T3 then buffer the signals so that they remain within the proper range (max. 0.5 V below ground, and max. 0.5 V above the supply voltage) for the BR/$\overline{D}$ and TD232 inputs. The situation with the DTR line is slightly different, R10 and R9 limiting the voltage to just under 5 V, while the negative voltage reaches the (optional) transmitter power stage via D05 (or D06 when the DTR line is high, conveying a RESET).

Need more power?

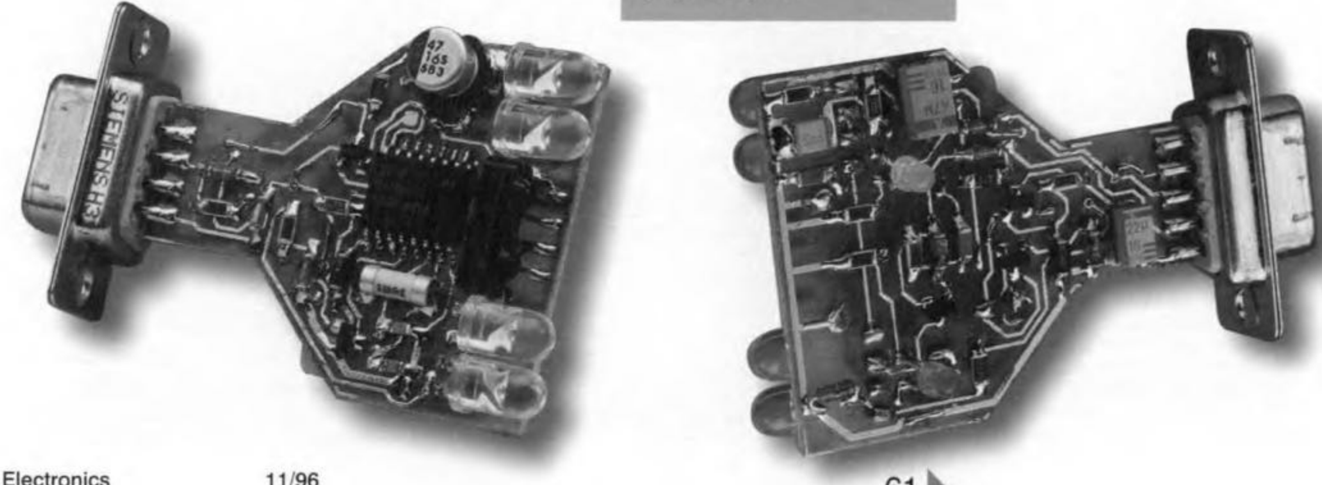
The (optional) transmitter power stage allows distances of up to 3 m to be covered by the interface. The three series-connected IREDs (of the same type as D6) are operated in parallel with the TFDS4000, and driven directly from the TDIR output of the IrDA interface. Normally, the gate of T01 is held at a negative potential via resistor R01. capacitor C01 isolates the FET gate from the IC1, so that the rectangular output signal from the TDIR output re-appears as a pulse train at the gate of the TN0201. Diode D04 short-circuits the edges which are negative with respect to the source potential. The current through the three diodes is set by resistor R02, and has a value between 100 and 150 mA depending on the exact level of the negative potential supplied by the PC's RS232 port. The optional power stage yields an extra radiation intensity of up to 150 mW/sr. Under favourable conditions (few sources of interference), it allows a distance of up to 10 m to be covered.

Construction

The circuit is by no means simple to build on the small, double-sided printed circuit board we supply ready-made through the Readers Services. All parts are SMDs (surface mount devices), and should be handled and soldered with care. If you only have a regular-sized soldering iron, a thick copper wire may be wound around the tip. This wire is all right for soldering the SMDs if you use extra-thin soldering tin. Do not panic when the odd drop of excess solder tin lands here and there on the board, or even on the IC connections, because they are easily removed

Figure 6. Both sides of the finished board (prototype) are shown here. The large component below the TOIM3232 is not a fuse, but a ceramic resonator which was used instead of a quartz crystal.

6



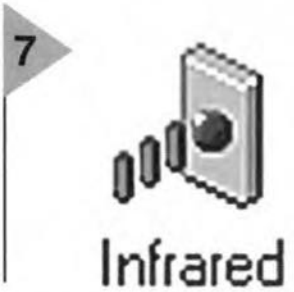


Figure 7. The IrDA symbol which appears in the Control Panels window.

using desoldering braid.

Start the construction by fitting the ICs and the parts at the centre of the board, and then work towards the edges. The polarity of some of the devices, in particular, electrolytic capacitors, is often difficult to see, and varies between manufacturers and even between types. In most cases, a band or a notch indicates the positive terminal, while a black triangle is used to mark the negative terminal. Jumper JP1 must be set to position 'A'. The 9-way sub-D connector is soldered at both sides of the board. When all parts are mounted, run a careful check on each and every solder joint. If everything is okay so far, you are ready to start using the interface. But first you need to obtain and install the

IrDA driver software

In addition to the (free) Windows 95 IrDA driver 2.0 (from Microsoft), three hardware-specific files are required for the Temic chip set.

The IrDA 2.0 driver software may be downloaded from the Microsoft support software site on the Internet, while the Temic program files may be found on a disk that may be ordered from the *Elektor Electronics* Readers Services under order code 966020-1. Mind you, the software is only suitable for use with two Windows 95 PCs. For other applications (like communication bewteen a PC and a printer) you must have IrDA driver software available in the relevant peripheral!

IrDA 2.0 may be found at **http://www.microsoft.com/windows/software/irda.htm**. On this page you only have to click on *IrDA 2.0 (Infrared Driver)*, and follow the installation instructions. After the installation, the driver files are located in a subdirectory named *msir20* on your hard disk. Next, use the Windows Explorer to copy the files *temic.vxd*, *infrared.cnt* and *infrared.inf* from the floppy disk into the msir20 subdirectory. The latter file should overwrite the one supplied by Microsoft, while the other two are simply added.

Having connected the interface (normally, you would use COM2, if available, of course), you may run *setup.exe* in the *msir20* directory. This launches a Wizard which guides you through the installation steps for the IrDA driver. Select *Manufacturer: Temic* from the menu, the type *TOIM3232* will then automatically appear in the *Models* window. In the next windows you select the COM port to which the IrDA interface is attached. The following menus indicate virtual ports via which the IrDA interface may be accessed by Windows programs. Select the default ports COM5 and LPT3 (remember, they are *virtual*). After going through two more menus, the installation is finished. The IrDA driver symbol (**Figure 7**) may then be found back in the Control Panels window (you may have to do a *Refresh* from the *View* menu). The IrDA interface is actuated by double-clicking on the symbol. The Infrared Monitor window appears (**Figure 8**) which indicates the status of the connection.

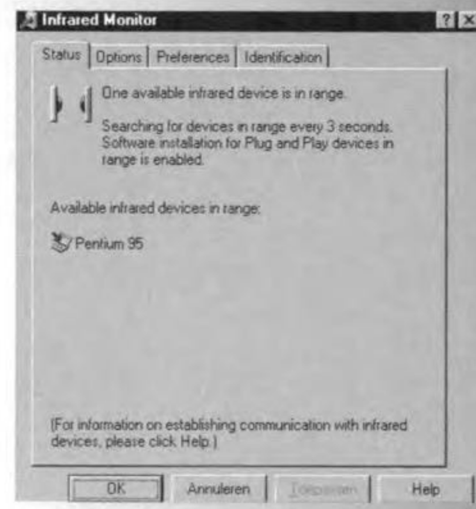


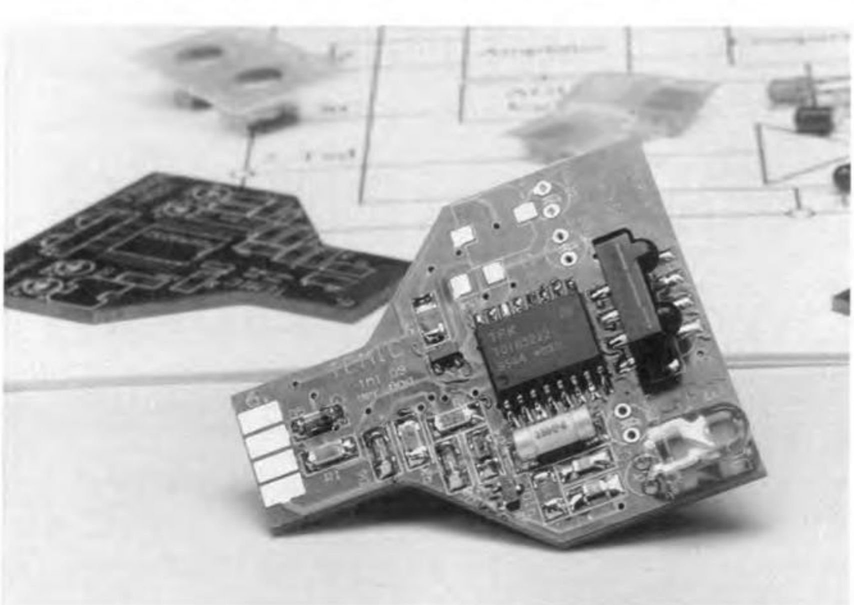
Figure 8. The IrDA Monitor window.

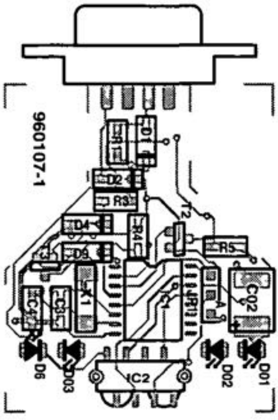
Every three seconds, the program and the interface look for other IrDA devices within range. The green LED lights on the board when the IrDA interface transmits. Similarly, the yellow LED lights when a signal is received. As soon as another IrDA interface is spotted, the name (ID) of the associated device (computer, printer, etc.) appears on the status screen. As illustrated in Figure 8, we located (within range) a computer having the ID *Pentium 95*.

If everything is okay so far, the IrDA interface may be employed to convey data with the aid of a communications program which runs under Windows 95. Whatever program you may use, be sure to select COM5 or LPT3 as the virtual communication port, this will automatically direct data to/from the IrDA interface. Activity is then indicated by beeping sounds and the IrDA device scanning symbol which appears in the right-hand bottom corner of the display. The scanning symbol (as shown in the top left-hand corner of Fig. 8) also indicates that data is being transmitted. Click on it to pop up the *Infrared Monitor*.

The *Direct Cable Connection* utility may even be used as a communication program if you want to set up a cordless connection between two PCs (say, your laptop and your desktop PC). This utility may be found on the Windows 95 CD-ROM under *Communications* in the *Add/Remove Software* section. Click on *Details*, and tick the box marked *Direct Cable Connection*. After the installation, you will find *Direct Cable Connection* under *Accessories* in the *Programs* menu. After clicking on the program, you first indicate whether the PC acts as a host or a guest. In the next menu, you select *Serial cable on COM5*, or *Parallel cable on LPT3* to implement transmission/reception via the IrDA interface.

(960107)

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D2
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T2
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R4
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C02
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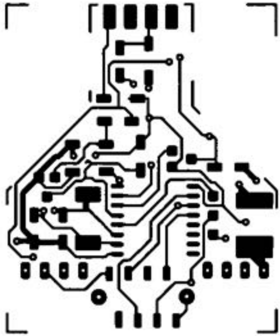
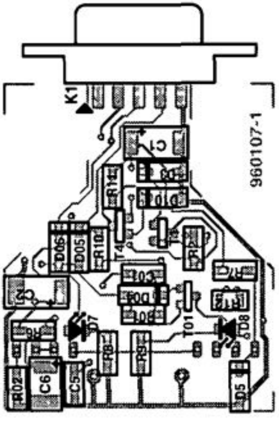
D01

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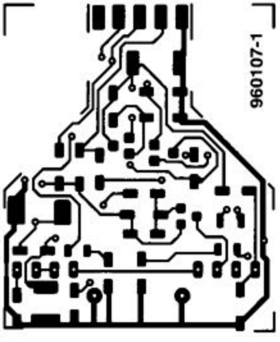
D5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elektronics on-line

repair tips

Whether involved with electronics at a professional level or just as hobby, many of you will have been tempted sometimes to have a go at repairing an electronic appliance in or around the home. Many readers will have saved on huge repair bills in this way. Unfortunately, few of you will be able to boast the experience of a professional repair technician. Just mention the TV type and make and he will tell you, for example, that a certain thyristor is prone to die in the power supply, or resistor R86 has an strange but strong tendency to burn out. Not to worry, however, if you can't find or afford a repair buff, because help for DIY repair may be found on the Internet.

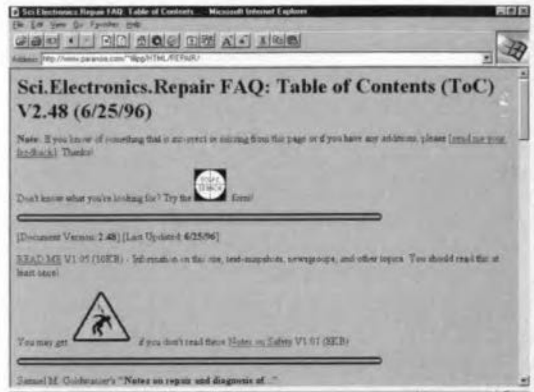
Being electronically minded, many of you will be inclined to remove the cover of, say, a video recorder when this valued equipment suddenly refuses to play tapes. These days, the average household has quite a few electronic appliances, which, as we all know, do not have eternal life. Items that come to mind in this respect are TV sets, video recorders and hifi stereo racks. Having one of these repaired professionally is usually pretty expensive. Moreover, many of you will appreciate the thrill of being able to find the fault. Repair tips and descriptions of the defective equipment are then invaluable. If you are the fortunate user of an Internet connection, this may come in handy for your repair work. This month, we found a couple of interesting addresses for you to check out and use.

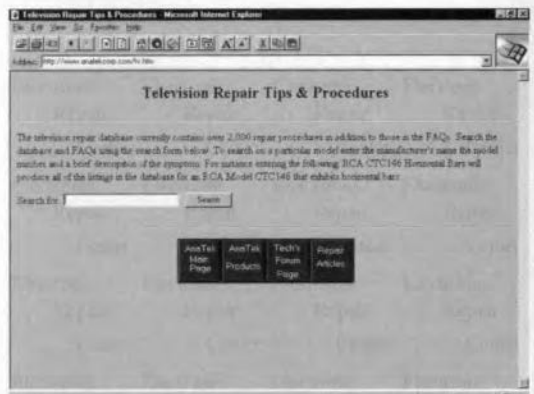
The 'Electronic Repair Tips Home Page' at www.guernsey.net/~pad/ contains many pages with tips for various types of equipment. Here you find satellite receivers, video recorders, TVs, hifi equipment, radio transmitters and receivers. If you have tips for certain items, you are invited to forward them and have them put on file.

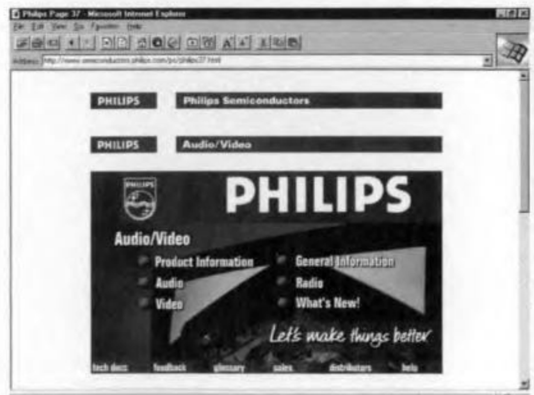
'Television Repair & Procedures' at www.anatekcorp.com./tv.htm and 'VCR Repair Tips & Procedures' at www.anatekcorp.com/vcr.htm are also interesting because of their articles on repair which may be downloaded as text files.

Another site which is also worth visiting is www.paranoia.com/~filipg/html/repair/. Many pages of repair tips are available here, including 'Samuel Goldwasser's Notes on Repair' which cover a number of apparatus. The site also offers separate repair pages on TVs, video, CD players, switch-mode power supplies, microwave ovens, household appliances, scanning receivers and PC monitors, as well as connector pinout descriptions which are indispensable for repair work.

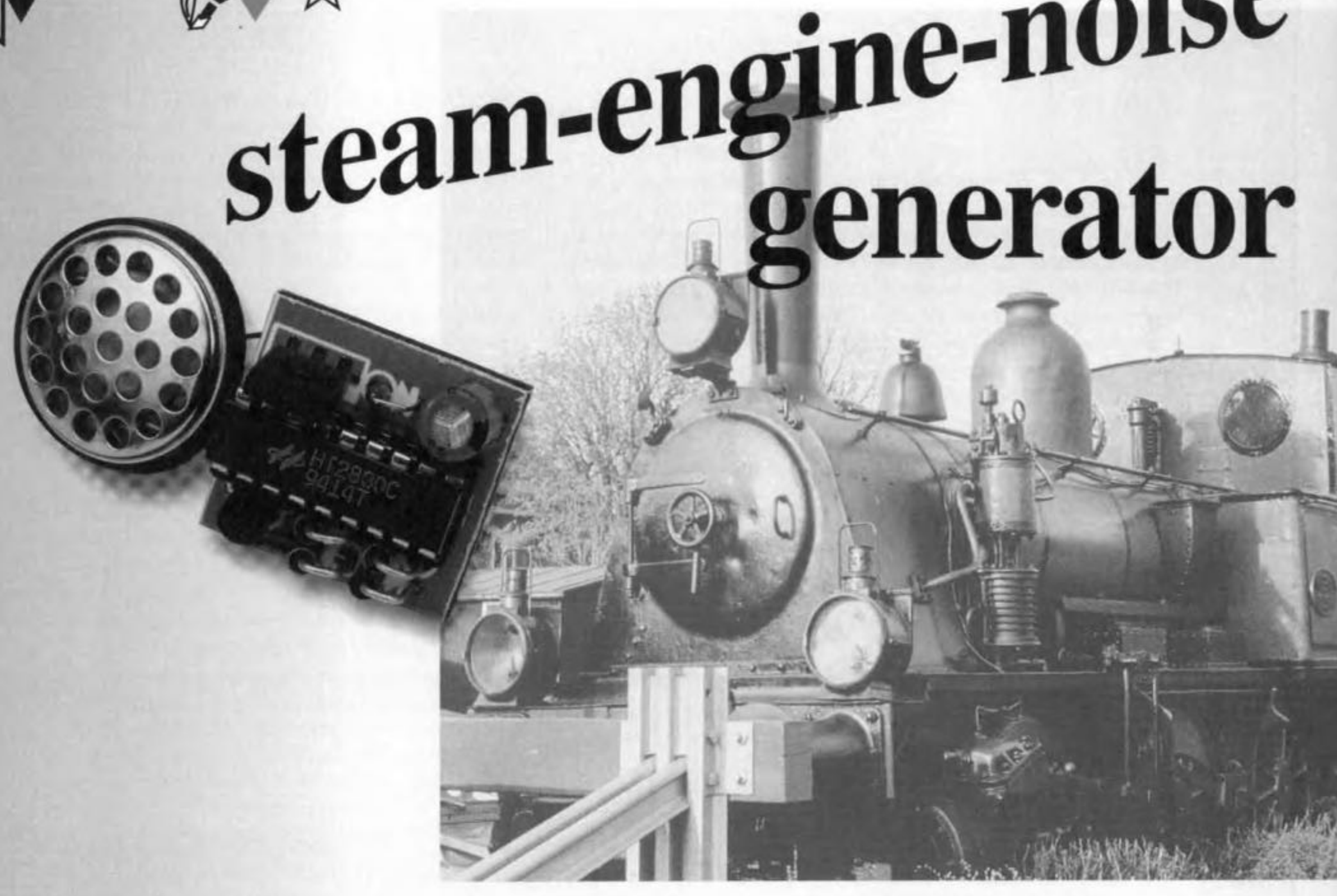
This month's column is closed off with a reference to one of the few manufacturers who provide repair tips for their own products via the Internet: Philips. Starting from the page www.semiconductors.philips.com/ps/philips37.html you may surf to product information on Philips equipment, general descriptions covering the operation of various types of audio/video apparatus (useful guidance during faultfinding) and technical documentation of Philips components. Let's hope other manufacturers of consumer electronics will follow suit for their products! For now, good luck with your repair work, and don't forget that safety is and remains your first and foremost concern! (965087)







steam-engine-noise generator



Circuits for making audible sound effects stored in an IC are nothing special any more these days. A disadvantage of many of them is, however, that they are normally far too large to be built into the model appliance they are to imitate. The dimensions of the generator described in this article are such that it can be built into a model locomotive size H0 without too much difficulty.

Design by J. Schlaich

The miniature circuit is based on the sound effects generator Type HT2830C IC from Holtek, which was specially designed for this purpose. The 18-pin chip has all the necessary facilities on board for the generation of a specific, modulated tone. Its block schematic is shown in **Figure 1**.

Central to the production of the sound are the blocks 'tone generator' and 'noise generator'. The sound of a steam engine contains much hiss, so tone and noise must be mixed carefully to arrive at the characteristic puffing sound.

The rate at which the puffs are emitted is set by the 'speed generator', which gets its clock signal from the preceding oscillator and divider.

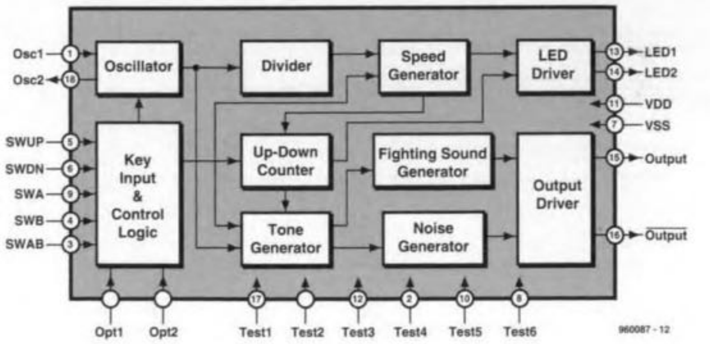
The 'LED driver' enables two LEDs to flash in rhythm with the speed modulation if desired.

The 'key input & control logic' block may be considered as a control panel from which the entire process is controlled.

Finally, there is the interestingly named 'fighting sound generator'. There are various models of the HT2830 IC. The original version (with suffix A) produces the noise of an aircraft and that with suffix B, the sound of a helicopter. This is complemented

Figure 1. The Type HT2830 IC contains all facilities for the generation of the sound of a model steam locomotive.

1



in both cases with the sound of a machine gun or rocket launcher produced by the 'fighting sound generator'.

The version of the HT2830 used in the present circuit is C, which is specifically programmed to produce the sound of a steam locomotive. Since these are not normally equipped with machine guns or rocket launchers, the 'fighting sound generator' here produces the sound of a bell and a steam whistle. Unfortunately, these sounds are not very convincing; particularly that of the whistle is poor. However, they have been left as they are. If, by the way, you wish the sounds of version A or B, the relevant ICs fit on the board without any difficulty.

CIRCUIT DESCRIPTION

If the generated sound effects are to be controlled to personal taste, this can be effected by linking the key inputs (pins 4, 5, 6 and 9) to earth via push-button switches. However, in order to keep the present circuit as tiny as possible, these options are not included. Even the LEDs have been omitted for the sake of simplicity. In short, the circuit has been kept to its essentials, that is, generating the sound of hissing steam – no whistles, no bells.

The consequent circuit, as **Figure 2** shows, is simplicity itself. Diode bridge D_2–D_5 rectifies the alternating rail voltage (in case of Märklin trains) and protects the circuit against polarity reversal of the direct rail voltage (in case of Fleischmann trains).

Voltage regulator IC_1 serves primarily as protection for the output driver in IC_2. This is necessary because in a.c. systems a voltage pulse of 24 V is placed on the rails to change over the direction of travel.

Since the supply voltage for IC_2 must not exceed 3.3 V, the power line is protected by zener diode D_1 and series resistor R_2.

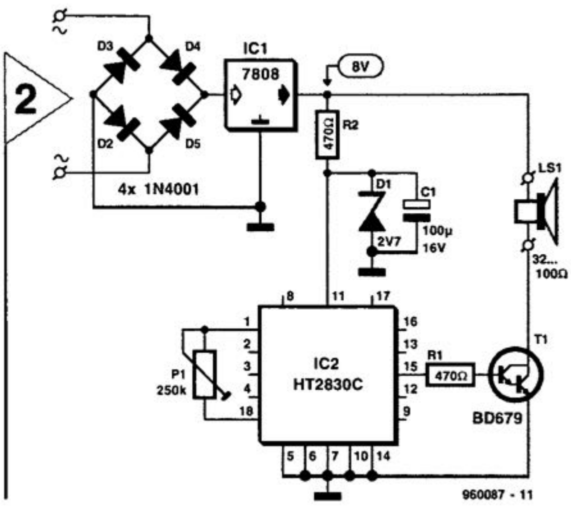
Electrolytic capacitor C_1 ensures that brief supply variations and voltage peaks on the power line have no lasting effect.

Since the output of IC_2 (pin 5) cannot drive a low-impedance load, it is followed by darlington transistor T_1.

As even miniature loudspeakers are far too large to be incorporated in a model locomotive, use is made of the insert of a 32 Ω headphone (taken from a defunct headphone, although they are also commercially available).

The speed modulation of the puffing sound is provided with a soft start by the manufacturers. This gives a very natural effect for it results in an audibly low puffing rate when the train moves away from a station. The rate increases in accordance with the time the supply voltage is switched on. At a certain point, the rate should, of course, stabilize and this can be set with P_1.

Figure 2. Since the HT2830 contains virtually all that is necessary for the generator, few external components are needed.



CONSTRUCTION

The generator is, of course, best built on the printed-circuit board shown in **Figure 3**. The board has been kept as small as possible: even fixing holes have been omitted.

The components are fitted at both sides of the board, the majority as usual at the component side, but resistors R_1 and R_2 (surface-mount devices—SMDs) at the track side.

Surface-mount devices must be soldered with a fine-tipped soldering iron and should not be over-heated. Pre-tin the terminals and solder pads beforehand. These tiny components are best kept in place during soldering with a pair of tweezers.

Preset P_1 may be a dedicated SMD, but a cheaper solution is to connect a standard preset to pins 1 and 18 via short lengths of circuit wire and adjust this to obtain the wanted frequency. Then remove it, measure the resistance between wiper and terminal and solder a resistor of the same value (SMD) between pins 1 and 18.

Fitting the board into the locomotive will be tricky in most cases. It may be necessary to file away parts of the board as close to the components as possible. Fixing it in place is best done with thermal glue – make sure that there are no short-circuits between the board and metal parts of the locomotive or engine.

Link the headphone insert direct to the collector of T_1 and the output terminal of IC_1 via flexible insulated circuit wire.

Solder the supply lines (flexible circuit wire) direct to junctions D_3-D_4 and D_2-D_5.

For clarity's sake, all connections are shown in **Figure 4**.

[960087]

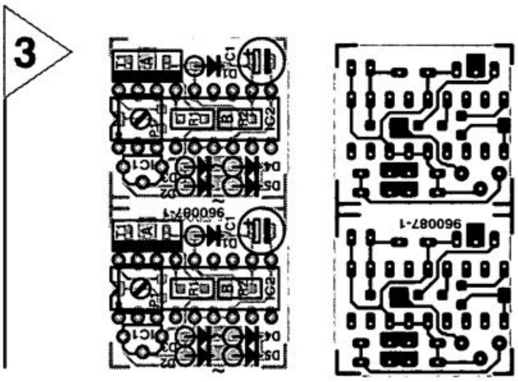


Figure 3. The printed-circuit board is not much larger than a small postage stamp. The SMD components are fitted at the track side.

Parts list

Resistors:
R_1, R_2 = 470 Ω, SMD
P_1 = 200 kΩ preset, SMD (Bourns Type 3314G001-204E) – see text

Capacitors:
C_1 = 100 µF, 16 V, radial

Semiconductors:
D_1 = zener diode 2.7 V, 500 mW
D_2–D_5 = 1N4001
T_1 = BD679

Integrated circuits:
IC_1 = 78L08
IC_2 = HT2830 (Holtek)
HT2830A = aircraft
HT2830B = helicopter
HT2830C = steam locomotive

Miscellaneous:
LS_1 = headphone insert, 32–100 Ω
PCB Order no. 960087 (see Readers' Services towards end of this issue)

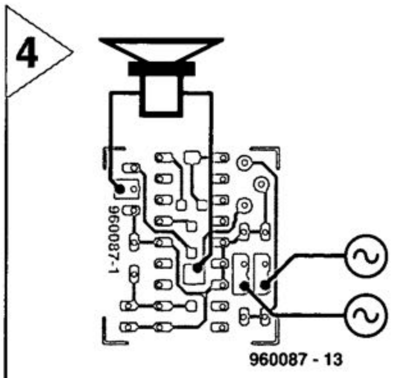


Figure 4. The connections to the headphone insert and power supply.

115.2 kbit/s Infrared IrDA Integrated Interface Circuit

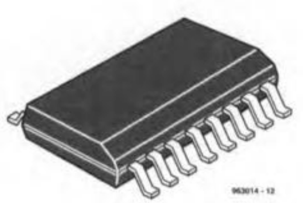
Manufacturer
TEMIC

TEMIC

Temic (Telefunken) Semiconductors, Theresienstr. 2, D-74072 Heilbronn, Germany. UK sales office tel. (01344) 485757.
Internet: www.temic.de

Description

The TOIM3xxx series ICs provide proper timing for the front end infrared transceiver TFDS3000, as specified by the IrDA standard. In the transmit mode, the TOIM3xxx provides IrDA-compatible electrical pulses to the infrared transceiver TFDS3000 on logic LOW electrical input. In the receive mode, the TOIM3xxx stretches received infrared pulses to the proper bit width at the operating bit rate. The IrDA bit rate varies from 2.4 to 115.2 kbit/s.
For the RS232 interface, the TOIM3232 uses an external crystal clock 3.6864 MHz for its pulse stretching and shortening. The TOIM3232 is programmable to operate from 1200 bit/s to 115.2 kbit/s by the communication software through the RS232 port. Output pulses are software-programmable as either 1.627 μs or 3/16 of bit time. The typical power consumption is very low at about 10 mW in operational state. It is in the microwatts range in standby mode.



Features

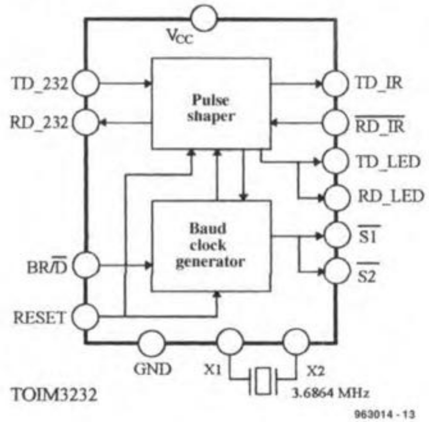
- Pulse shaping function (shortening and stretching) used in infrared IrDA standard applications
- Directly interfaces infrared transceiver type TFDS3000* to an RS232 port
- Programmable baud clock generator (1200 Hz ~ 115 kHz), 13 baud rates
- 3 V and 5 V operation
- S016L package

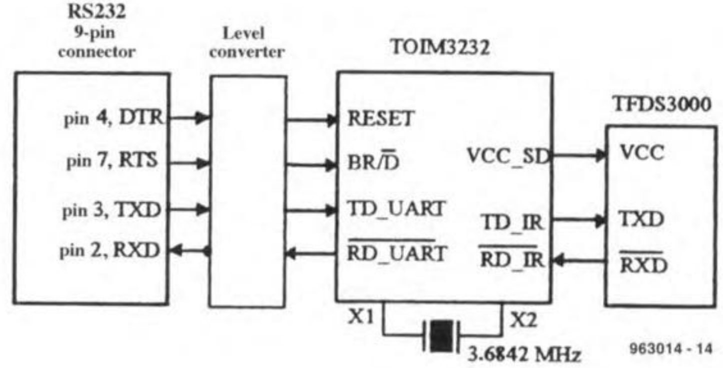
** TFDS3000 is an infrared IrDA transceiver made by TEMIC*

Application Example

Infrared RS232 interface, *Elektor Electronics* November 1996.

Block Diagram





The diagram shows a typical example of an RS232 port interface. The TOIM3232 interfaces the RS232 port to an infrared transceiver. Due to the various voltage levels, an additional level converter (discrete or integrated) is necessary. The baud rate generator is programmable. A description of programming is given in the Chapter 'Software for the TOIM3232' page 7 (IrDA Design Guide). When BR/D = 0, the TOIM3232 interprets RD_232 data as data transmitted to the TFDS3000. On the other hand, whenever BR/D = 1, the TOIM3232 interprets RD_232 as the control word. The baud rate can be programmed to operate from 1200 bit/s to 115 kbit/s. As RS232 level converter, EIA232 or MAX232 or equivalent should be used.
The output pulse length can be programmed, see 'Operation Description'. It is strongly recommended to use 1.627 μs output pulses to save battery power.

Operation Description

The baud rate at which an RS232 serial port communicates with the external adapter is programmable inside the TOIM3232. This programmable baud rate should be used when the baud clock and the UART oscillator clock are not available. When BR/D = 0, the TOIM3232 inter-prets the signals at RD_232 and RD_IR pins as data to be transmitted and received data. On the other hand, whenever BR/D = 1, the TOIM3232 interprets the seven LSBs at the RD_232 input as the control word. The operating baud rate will change to its supposedly new baud rate when the BR/D returns back to LOW ('0').

Control Byte (8 bit)

<—— First char. ——>				<—— Second char.——>			
X	S2	S1	S0	B3	B2	B1	B0

where
X: *Don't care*
S1,S2: *User-programmable bit*
S0: *IrDA pulse select, (1) = 1.627 ms output pulses; (0) = 3/16 bit time pulses *)*
B0-B3: *Baud rate selects, B0 = LSB*
**) not recommended*

Baud Rate Select Words

Note: IrDA standard only supports 2.4, 9.6, 19.2, 57.6, and 115.2 kbit/s.

B3	B2	B1	B0	Second Char.	Baud Rate
0	0	0	0	0	115.2 k
0	0	0	1	1	57.6 k
0	0	1	0	2	38.4 k
0	0	1	1	3	19.2 k
0	1	0	0	4	14.4 k
0	1	0	1	5	12.8k
0	1	1	0	6	9.6k

B3	B2	B1	B0	Second Char.	Baud Rate
0	1	1	1	7	7.2 k
1	0	0	0	8	4.8 k
1	0	0	1	9	3.6 k
1	0	1	0	A	2.4 k
1	0	1	1	B	1.8 k
1	1	0	0	C	1.2 k

Software for the TOIM3232

The control word is composed of two characters, written in hexadecimal, in format: YZ.

UART programming.

For proper operation, the RS232 must be programmed to send a START bit plus an 8 bit data word, YZ and no STOP bit for every word sent. The transfer rate for programming must be identical with the formerly programmed data rate, or after resetting the TOIM3232, the default rate of 9600 bit/s is used.

Software Algorithm

STEP	RESET	BR/D	RD_UART	TD_UART	RD_IR	TD_IR	COMMENTS
1	HIGH	X	X	X	X	X	Resets all internal registers. Resets IrDA default baud rate of 9600 bit/s.
2	LOW	X	X	X	X	X	Wait at least 7 µs.
3	LOW	HIGH	X	X	X	X	Wait at least 7 µs. The TOIM3232 now enters the control word (programming) mode.
4	LOW	HIGH	YZ with Y = 1 for 1.627 µs Y = 0 for 3/16 bit length	X	X	X	Sending the control word YZ. Send '1Z' if 1.627 µs pulses are used. Otherwise send '0Z' if 3/16 bit pulses are used. 'Y6' keeps the 9.6 kbit/s data rate, whereas the '0Z' selects the 3/16 bit time pulses. Z = 0 sets to 115.2 kbit/s. Then wait at least 1 µs for hold-time.
5	LOW	LOW	DATA	DATA	DATA	DATA	Data communication between the TOIM3232 and the RS232 port has been established by BR/D LOW. The TOIM3232 now enters the data transmission mode. Both RESET and BR/D must be kept LOW ('0') during data mode. Software can reprogram a new data rate by restarting from step 3. The UART also must be set to the correct data rate ***).

****) For programming the UART, refer to the National Semiconductor's data sheet of PC 16550 UART.*

TOIM3232

Digital Integrated Circuits

ELEKTOR ELECTRONICS

DATASHEET 11/96

Pin Description TOIM3232

Pin	Symbol	Function	I/O	Active
1	RESET	Resets all internal registers. Must be HIGH ('1') intially to reset internal registers. When HIGH, the TOIM3232 sets the IrDA default bit rate of 9600 bit/s, sets pulse width to 1.627 µs. Then the TOIM3232 enters the power-saving mode. When RESET turns to LOW, the TOIM3232 exits power-saving mode, and sets the baud rate and 1.627 µs pulse width mode. In the application, the RESET pin can be controlled by either the RTS or DTR line through RS232 level converter. Minimum hold time for reset is 1 µs.	I	HIGH
2	BR/D	Baud Rate control / Data When BR/D = 0, RD_232 data is transmitted to the IrDA transmitter pin TD_ IR, while RD_IR is routed to the transmitter pin TD_232. When BR/D = 1, data received from the RS232 port is interpreted as the control word. The control word programs the baud rate and pulse width of TD_IR signal. The new baud rate and pulse width will be effective as soon as BR/D returns to LOW.	I	
3	RD_232	Data output of stretched signal to the RS232 port (using level converter); received signal.	0	HIGH
4	TD_232	Data input from the RS232 port (passing the level converter); signal to be transmitted	I	HIGH
5	VCC_SD	VCC shut-down output function. This pin can be used to shut down a transceiver (e.g. TFDS3000). Output polarity: Inverted RESET input.	0	LOW
6	X1	Crystal input clock 3.6864 MHz	I	
7	X2	Crystal input clock	I	
8	GND	Ground in common with the RS232 port and IrDA transceiver ground		
9	TD_LED	Transmit LED indicator driver. Use 270Ω current limiting resistor in series to LED to connect to V_{CC} (V_{CC} = 5 V).	0	LOW
10	RD_LED	Receive LED indicator driver. Use 270Ω current limiting resistor in series to LED to connect to V_{CC} (V_{CC} = 5 V).	0	LOW
11	NC	No connection		
12	S1	User-programmable output. Can be used to turn a front end infrared transceiver ON/OFF (e.g. an infrared module at the adapter front).	0	LOW
13	S2	User-programmable output. Can be used to turn a front end infrared transceiver ON/OFF (e.g. an infrared module at the adapter back).	0	LOW
14	TD_IR	Data output of shortened signal to the infrared transceiver TFDS3000	0	HIGH
15	RD_IR	Data input from the infrared transceiver TFDS3000	I	LOW
16	V_{CC}	Supply voltage	I	

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By John D. Lenk
ISBN 0 7506 9510 2
Price £22·50
Butterworth-Heinemann

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By R M Marston
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By S W Amos & R S Amos
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Newnes

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