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JULY 1982 70p

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The new Oryx TC82 has features unique to any temperature controlled precision soldering iron.

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Other TC82 features include: Power-on Neon indicator in handle; burn proof cable; choice of 13 tip styles.

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The Oryx TC82 iron costs only £33.00 (+ VAT) and the power unit for 24 V operation £23.00 (+ VAT).

The TC82 240 volt is also available as a 30 watt general purpose iron at only £3.95 (+ VAT).

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NEXT MONTH

100W mosfet amplifier — John Linsley Hood concludes his three-part series with a description and full circuit and layout details of the final power amplifier design.

Metasonic high-resolution images — Mike Christeson presents expansions for the weather-satellite picture receiver to cover Metasonic's primary data.

Circuit modelling by microcomputer — the use of programming techniques to reduce computing time in circuit modelling.

Current issue price 70p, back issues £1, available at Farnell & Trade Counter, Units 1 & 2, Berkeley Industrial Centre, Bunting Street, London SE1. Available on microfilm; please contact editor.

By post, current issue £1.60, back issues if available £1.50, order and payments to EEP General Sales Dept., Cogent Magazines Ltd, Thamebury, Surry SM7 5AP.

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WWW-031 FOR FURTHER DETAILS

This page contains information about the TTS520 transmitter test set, including its capabilities and advantages. It also previewed the next month's content, which includes articles on 100W mosfet amplifier design, Metasonic high-resolution images, and circuit modelling by microcomputer. The subscription rates and distribution details are also provided.
The microprocessor controlled EP4000 will emulate and program all the popular EPROMs including the 2704, 2708, 2716(3), 2508, 2578, 2516, 2716, 2532 and 2732 devices. Personality cards and hardware changes are not required as the machine configures itself for the different devices. Other devices such as bipolar PROMs and 2764 and 2564 EPROMs are programmed with external modules.

The editing and emulation facilities, video output and serial/parallel input/output provided as standard make the EP4000 very flexible to allow its use in three main modes:

- As a stand alone unit for editing and duplicating EPROMs.

- As a slave programmer used in conjunction with a software development system or microcomputer.

- As a real time EPROM emulator for program debugging and development (standard access time of the emulator is 300ns).

Data can be loaded into the 4k x 8 static RAM from a pre-programmed EPROM, the keypad, the serial or parallel ports and an audio cassette. Keypad editing allows for data entry, shift, move, delete, store, match and scroll, and a 1k x 8 RAM allows temporary block storage. A video output for memory map display, as well as the built-in 8 digit hex display allows full use of the editing facilities to be made.

Items pictured are:
- EP4000 Emulator Programmer - £545 + £12 delivery;
- BSC buffered simulator cable - £38;
- MESA 4 multi EPROM simulator cable - £88;
- 2732A Programming adaptor - £38;
- 2764 Programming adaptor - £64;
- 2564 Programming adaptor - £84;
- BP4 (TEXAS) Bipolar PROM Programming module - £190
- Also available (not shown): VM10 Video monitor - £59;
- UV141 EPROM Eraser with timer - £78;
- GP100A 80 column Printer - £225;
- PI100 interface for EP4000 to GP100A - £65.

VAT should be added to all prices.

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A job to be done

At a press conference on mobile radio held by the UK's Electronic Engineering Association earlier this year there was much discussion on the small amount of frequency spectrum allocated to private mobile radio (p.m.r.) relative to that given to broadcasting, military communications and other services. At least, the EEA officials claimed that it was too small for the needs of the p.m.r. service as emphasized their argument with a diagram showing the p.m.r. bands as thin slices sandwiched between large chunks of other bands. One must remember, of course, that the EEA represents the mobile radio manufacturers, who have a vested interest in the frequency space available to p.m.r. But this doesn't alter the fact that nobody is in a position to refuse the EEA's assertion—only to rebut it. The whole question of what is an appropriate allocation of spectrum for a given service is entirely a matter of claim and counter claim. And, the actual decisions on allocations are made on this same basis by the activities of pressure groups in international conferences, with the ITU acting as umpire and simply confirming the results of the contest.

Of course, other methods of allocating frequencies have been proposed. One is that the spectrum space should be sold to the highest bidder. The thinking behind this is that the more you pay to occupy a piece of territory the more economic pressure there will be on you to use it efficiently. Another suggestion is to allow a free-for-all in certain bands (as in citizens' bands at present) on the principle that some kind of adjustment will occur naturally and make formal regulation unnecessary. Thankfully, neither of these unregulated methods has been considered too seriously.

The central problem, as pointed out by the chairman of the EEA's mobile radio committee, Mr. J. W. Carton, is the lack of some kind of "value analysis". In other words, frequency space would be allocated more fairly if it were done on the basis of relative social needs. But there is no objective data from which these relative needs can be calculated straightforwardly. They can only be derived from the value systems prevailing in a society. We therefore have to analyse these values in such a way that would allow us to attach numerical indices to the various needs for frequency space. To be accepted the analysis would have to be demonstrably rational and so obviously right that no reasonable person could disagree with it. Who is capable of such an analysis? At first sight the politicians and their permanent bureaucrats seem to have the necessary experience in attaching measurable quantities to social needs; but their decisions are too often a facile response to popular opinion and swayed by party dogmas. Perhaps the nearest type of analysis we have already is the mathematical model of the economy — sets of equations into which changing data are fed to obtain forecasts — because this type of model does have to take human behaviour into account. There are, however, several research organizations with particular interests in studying the interaction of technology with society. In the UK, for example, we have the Social Science Research Council and two new bodies, both of which already have some experience with telecommunications and electronics — the Technical Change Centre in London and the New Technology Research Group at Southampton University. In the USA the National Academy of Engineering has looked at the problem and at least recognized the importance of social and economic factors in spectrum management. It should not be beyond the abilities of such organizations to find a method of analysis which, if not completely rigorous, would be greatly superior as a rational basis for allocation to the empirical procedures using political and commercial pressures that we rely on at present.

Faddish people may well reject instinctively any attempt to equate quantities with qualities. This is understandable in so far as social values are subjective and rooted in the ethical or religious beliefs of individuals. But ethical are a guide to conduct: if there is no conduct resulting from them they are worthless. There is a good case for testing our values in the worldly business of sharing out a natural resource.

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A LIGHT PEN FOR MICROCOMPUTERS

Light pens provide an alternative means of interactive communication with a computer via the visual display and are often used with mainframe computers in graphics oriented applications. They are less common with microcomputers, but this article describes a simple, inexpensive light pen which can be easily adapted for use with most microcomputers which use a memory-mapped video display.

The light pen can detect individual characters on the screen and return, via two parallel 8-bit ports of the microcomputer, the address of that character. Through the use of appropriate software, individual characters may be changed or deleted or specific actions can be initiated when certain characters are detected. This capability may be used in a number of ways such as in 'menu' applications, where a large number of choices are available, in interactive games, etc.

**Video displays**

A memory-mapped video display system is shown schematically in Fig. 1. Essentially this comprises a video ram, a character generator (usually a mask-programmed rom), a shift register and associated scanning circuitry. The address and data lines of the video ram are multiplexed so that the memory can be accessed either by the c.p.u., to update or read data, or by the dedicated video circuitry which controls the display. The video ram usually occupies a 1K block of memory in the memory map of the microcomputer and stores the m lines of n characters which make up the display. Each position on the screen, (row, columns), corresponds to a unique location in the video ram. The characters are displayed as a dot matrix pattern (Fig. 2). Unless locked out by the c.p.u., the video divider chain continuously addresses the video ram in a predetermined order and, in turn, the video ram output word addresses the character generator. In addition, the divider chain sequences the row address lines of the character generator so that the output word of the generator corresponds to a particular row if the relevant character at position (row, columns).

This word is then loaded into the shift register from which the appropriate series of dots and blanks are clocked out to form part of the video signal. The shift register is typically clocked at around 8 MHz, giving a time separation between adjacent dots of say, 125 ns. The video display of most microcomputers in the UK uses a 50 Hz frame rate scanning 312 lines without interface.

**Sensor**

The light pen and its associated circuitry must detect the rising edge of phosphor emission when a dot is drawn on the screen and simultaneously latch the current address on the video ram. From this address, one can deduce the memory location corresponding to the character at the dot position, and hence the actual position of the light pen. Since we are only concerned with locating characters, not individual pixels, the particular dot detected within the character is not important. The optical sensor must have a fast risetime preferably much less than the inter-location between adjacent dots, say, much less than 10<sup>-9</sup> ns. Another requirement for a successful sensor is that it should have a field of view which is comparable to or preferably smaller than a single character when it is held on the surface of the screen. With a 1K character, a character is likely to be of the order of 5 mm square; the exact size depends on the format of the character generator, the number of characters per line, etc. Both of these requirements can be met using a polymer-fibre light guide and an associated planar silicon p-n photodiode.

The polymer-based light guide has an overall diameter of 2.2 mm and a core diameter of 1 mm; it is considerably cheaper and physically much more flexible than equivalent glass light guides. Although in attenuation is markedly greater than in glass equivalent this is not a serious problem over the length of about one metre required for this application. The photodiode has a response time of less than 5 ns and can be coupled directly onto the polymer optic using the special terminations. This does not require the use of special tools.

The use of a light guide has the advantage that a) it is inherently a sufficiently narrow field of view to preclude the need for further optics and b) it isolates the photodiode and related circuitry from the appreciable radiation fields found near the surface of a display tube.

With most opto sensors the sensitivity decreases with increasing speed of response. However, the instantaneous brightness of spots on a video screen can be very high and sufficient to give a satisfactory signal-to-noise ratio even with this otherwise relatively insensitive detector. It is, however, worth noting that the maximum instantaneous brightness is a function of the phosphor "lifetime" and for these reasons screens with short-lived phosphors are preferable. Their distinction is not visually obvious since the eye is integrating the total light output and, at least to a good approximation, is oblivious of instantaneous brightness levels.

**Circuitry**

Figure 3 shows the circuitry which detects the phosphor emission, as the electron beam draws a dot and produces the t.c.t. pulse which latches the video ram address. An n-p-n transistor in the diode produces an increased base current for Tr<sub>5</sub>. Tr<sub>5</sub> acts as an emitter follower, with R<sub>5</sub> providing some d.e. stabilization for the base of Tr<sub>5</sub>. Negative-going pulses at the inverting input of the 710 are compared with the present negative threshold voltage on the non-inverting input. The potential on R<sub>3</sub> is used as a sensitivity control for the light pen and typically the negative threshold is set at -50mV.

The first half of the 74122 inverter is directly monostable, responding to a positive going 'spot detected' pulse from the comparator and produces a 100 ns pulse used to latch the video ram address.

This section of the light pen can be checked using the led and without any connection to the microcomputer. With the screen brilliance set to a normal working level the sensitivity should be set using R<sub>5</sub> so that the led emits when the probe is placed on a character on the screen. It will be found that some characters are more easily detected than others, notably those with several contiguous horizontal dots such as E, F or T. Increasing the sensitivity too far will allow the comparator to trigger continuously on noise and a compromise setting may be necessary. Further adjustments can then be made using the brightness control of the video display.

The circuitry to latch the video ram address is shown schematically in Fig. 4. It is assumed, for simplicity, that a 1K video ram is used and that ten address lines A<sub>0</sub> - A<sub>9</sub> must be latched. The
For short ranges a simple installation using the techniques outlined in the first part of this article is effective. Outside the limits of the basic system, more elaborate equipment is needed, the remainder of the discussion being centred on this.

by D. J. R. Martin
B.Sc., Ph.D., F.Inst. P., F.I.E.E.

convenient, I suggest extending the extension of control lines and the provision of a power supply in an awkward place. The same splitting principle, it may be noted, can be used at any point in the line to serve a branch tunnel; again, strict impedance matching at such junctions is unimportant. A few other expedients may be available if the predicted range falls slightly short of requirements. Use of a lower frequency band – say, V.H.F. low band instead of V.H.F. high band – will often give a worthwhile advantage (radio regulatory considerations are not normally a restriction if the system is wholly underground); or the expensive decision could be taken to specify a heavier grade of leaky cable and so reduce line loss. It is also possible to 'guise' the feeder by using a more leaky feeder type towards the extremities of the system in an attempt to preserve the diminishing field. But generally in such circumstances one is better looking towards the active techniques to be described.

Line repeaters
Since leaky-feeder communication is basically a hybrid technology, borrowing from both electrical and radio and line transmission, it is logical to look also to the latter field for possible lower leakage than is usual nowadays. Such systems suffer the familiar land-mobile problem of 'overlap' interference in the region receiving signals from two base transmitters, resulting from lack of synchronisation. At Longnan, the line was simply gapped for a metre or so midway between base stations; by the use of frequency modulation (25 kHz channelisation) and relying on tunnel attenuation (about 0.5 dB/m) and capture effect, the extent of the overlap of signals was restricted to a few metres. Nowadays, the land-mobile technique of quasi-synchronous operation would probably be used in a multi-base system; but it would also be quite feasible to use the leaky feeder itself as a synchronisation link, passing a ready-modulated pilot signal to outlying transmitters at a frequency of one or two megahertz, where line losses are low.

Multiple base stations
When the economic limit of range from a single base station has been achieved, the obvious course left is to borrow a technique from land-mobile and aeronautical schemes and deploy further base stations, as necessary, to achieve the desired cover. This was the solution adopted in the early railway systems such as that for the New York Subway. It was also used in the first freight train system, commissioned at Longannet, Scotland, in 1970. The leaky coaxial cable serving the 9 km tunnel was divided into three sections, with a base station serving each near its centre, as shown in Fig. 4. The base stations are operated under a contract from the surface over telephone lines. Operating frequencies are in the V.H.F. range (70-90 MHz) as with all subsequent National Coal Board systems, and the cable is a braded coaxial type with a rather lower leakage than is usual nowadays.
The improvements shown in the paragraphs above include the use of spaced base stations and simple one-way repeater amplifiers to allow two-way communication (including duplex or talk-over operation) over long ranges.

**Daisy-chain systems**

The improvements shown in the paragraphs above include the use of spaced base stations and simple one-way repeater amplifiers to allow two-way communication (including duplex or talk-over operation) over long ranges.
The addition of a yet third feeder may then be worthwhile. As shown in Fig. 8, this is sectionalized and serves the two sections already coupled at 10 to 300 kVA, which is a multiple of 25 W base stations equipped with 1000 V. In this system, the feeder lengths are connected as "tailingbacks" to the repeaters, in parallel with the main feeder and extended throughout the d.c. d.c. chain, as shown in Fig. 9, with the 110 V signalling supply. Initially, single-channel operation (i.e., high power) is possible, but the adding of simple linear repeaters, and the further addition of filters linking the junctioned free tailback ends and the feeder itself gives the "double-routing" (BDR) system, which allows the bearer and transmission control to be sited at the same end of the system 9.

Operational systems

The world's largest user of feeder systems is probably still the UK National Coal Board, with over 100 mines at least partially equipped. Most of these employ one or other type of the forward-drive arrangement having proved particularly convenient and economical for small local networks. A BDR system has been in very satisfactory service at Matlock, Derbyshire, for many years, and a practical design of two-way equipment is also being evaluated for systems of modest size.

All such techniques, including j.f.e. return for multichannel use, are being taken up to a degree in a new system for coal mines known as Aristec 10. This is intended to cover a network of mine tunnels up to 100 km in total extent, with the power requirement kept within intractable limits. The key design feature of the Aristec concept is the division of the base-station carriers into two groups, according to function, spaced 6 MHz apart to ease intermediate modulation problems and allow adequate separation of groups of bandpass filters into the feeder runs. The corresponding base-receiver signals are retransmitted using a coaxial cable at intermediate frequency after conversion by the line-powered frequency converters.

British Rail users, London Transport have adopted the simple daisy-chain configuration, with linking telephone line, for the tunnel sections of the London Underground 11; this follows the abandonment of an earlier pilot scheme using a single multiple 25 W base stations each of a bifilar feeder. The new arrangement is probably unique in that the repeaters are spaced at least 50 km apart through the d.c. cable. In this network of the Great Northern line, recently taken over from London Transport 12.

Isberg 13 has made a particular study of such European DEDI-leaky feeder practice, and has himself led theparate-repeater techniques in the USA (where repeaters, to avoid confusion in the terminology, are often referred to as "signal boosters"). His papers collect together useful technical information, some of it not published elsewhere.

In Vienna 14, the single-channel high-back technique in the new U-Bahn (subway) uses a simple daisy-chain configuration with a linking telephone line; 19 are in use. This is in the case of the tunneling small holes or slits in a solid outer conductor.

Dolgeno 15 has engineered a particularly ambitious scheme in which the two-way radio channel common to road tunnels in Brussels. This one used 10 MHz in its initial stages, but the DOLGENO-Dolgeno system serves a.m. (150 kHz-500 kHz) and f.m. (67.5-108 MHz) broadcasting and the v.h.f. low (c.70 MHz) and high (c.170 MHz) mobile radio bands. The tunnels are relatively short (maximum length 395 m) and so only repeaters required are in the essential intermediate stages of the system: a simple single-channel cable and the special wide-band aerial systems. If this unique problem of system design had to be solved in this pioneering project, the far longer road tunnels in Switzerland, the PTT authority there has developed a system having a broadly similar concept, which suggests the potential for "armchair innovation", with frustratingly too few opportunities or facilities for demonstrating ideas in practical systems.

For example, feeder systems generally would benefit to the extent of simplicity of service, relatively high power per kilometer, which is so characteristic of all v.h.f. communication in enclosed or urban environment. The standard d.c. or a.c. systems were designed for conventional mobile radio systems, and many of the advanced systems that include repeaters tend themselves peculiarly to a principle known as "balanced design". It is true that the work has described an ingenious combination of space and frequency diversity particularly well suited to leaky feeder operation. The increased demands on bandwidth or spectrum made by all these proposals would not be mountable on the design.

It could similarly be speculated that a development of the e.m. system, which have been seen to have held the variation in signal level between the "spreading" effect of the feeder. So, it may be delayed, but not in a manner which is responsible for any statements or opinions expressed about equipment or systems described.

References

17 Brit. Pat. 1371291
21 J.L. Giles and R.E. Simons: The British Rail signal-box-to-radio communication system, Electronic and
Power, Vol. 27, No. 1, pp. 61-64, Sept.

Inductive Transducers is the self-explanatory title of a paper by R.D.J. Perry, Emery Leonard Ltd, Grove Street, Heath Town, Wolverhampton. The 10-page text is given for the design of precision gauging, waterproof, long rope and miniature displacement transducers and de- vice operating in electrical, mechanical, velocity and angular tilt using inductive and i.d.v. sensors.

Portsmouth is the brandname for a Texas 244 portable recording and mixing system which can record four tracks onto a standard microcassette, which is incorporated into it. It includes dft noise reduction which is described in a brochure, copies of which are available from Har- won U.K., St John's Rodes, Tyres, High, Green. Humberfield

Thomson-CSF has published a new data sheet on a new product of its electronic equipment. Use this system are in the 108-page publi- cation: Thomson-CSF, 101 avenue d'Ivry, 75781 Paris Cedex 16, France.

Burnley Ltd is a name of a new company producing connectors for shielded or coaxial cables. Their catalogue shows the full range, most of which is available from stock. Burnley Ltd, Col- ney Street, St. Albans, Herts AL1 2JD. WRO 400

Spectral Relays are manufacturers of precision tremor potentiometers, subminiature switches and multis; they have devised their products in a short catalogue which also includes technical data and information on their facilities for manufacturing special systems.

Standards from the International Electrotech- nical Commission on subminiature d.c. relays, including a table of input characteristics of metallic relay often, which is the most expensive factor when pur- chasing relays, are available on request and we will despatch them ourselves, only requiring any a further is needed to price it cost effectively on the WRO 400.

Ways & Means 1980

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An application reference book has been published by Zilgo which is of use to all employers of relay suppliers and enthusiasts. It is divided to the Z8 family, Z80 and Z800 microprocessors, and their appropriate peripheral de- vices. Other chapters cover the different parts of the static r.a.m., the Z-Bus and the applications of 8088 and 8086 microprocessors. Copies cost E 8.90 and are available from Zilgo distributors and from Zilgo (UK) Ltd, 10a Varembel, 1211 Geneva 20 Switzerland. WRO 400

Integra Microwave Catalogue (1982) gives general descriptions and specifications for microwave transistors and components. Equipment consists of wave generators, frequencies 0.01 to 100 GHz, the mixer of 500, mixer circuits and level, varactor diodes, mixer sets, c.w. generator and supplies. All equipment is comple- tely self-contained and is designed for installation from Parnell International Instruments Ltd, Weehawky, V. York, Sill 351 2DI 43, WRO 400

A very wide range of loudspeaker kits to their own designs are detailed in a catalogue from Badger Sound Systems Ltd, 66 Wood Street, Lytham St Annes, Lancs FY7 5TG. In the catalogue they point out that although loud- speaker kits are highly sophisticated, they are often easy to build and set at low cost which is the most expensive factor when pur- chasing equipment. It is pointed out that having set them oneself, only requiring any a further is needed to price it cost effectively on the www.americanradiohistory.com
WIDE-RANGE NOISE GENERATOR

Although intended to form part of an electronic organ, in which the noise simulated the sound of a pipe 'chiff', the circuit is useful in synthesizer systems. The circuit was designed some time ago and uses 74-series ICs, but nevertheless illustrates valid techniques.

by lan Hickman

Like many others, the author has been experimenting for years, on and off, with tone generators and keying circuits designed to simulate a greater or lesser degree the sound of a pipe organ. Efforts have been centred on devising an economical system using an independent free running oscillator for each note. Keying circuits were also considered necessary, as it has not proved possible to key an IC oscillator (and LC types work out more expensive and bulky, though they have other advantages) without "chirp". Attempts have also been made to key noise along with the tone, to simulate the characteristic "chiff" or starting transient of a flute pipe. The noise was obtained from a very simple noise generator consisting of a band-passfiltered rather than white noise was appropriate to the chiff circuit. Further experiments in this direction were therefore postponed whilst a versatile a.f. noise generator was produced. In addition to a maximal-length-feedback shift-register-type noise generator, a universal filter of the Sallen and Key variety was incorporated, providing low-pass, high-pass and band-pass filtering facilities.

Noise generator

The noise is generated by an n-stage feedback shift register (see Fig. 1a). This is a shift register clocked in the normal way and having for its input the output of an exclusive-Or gate. The two inputs to the exclusive-Or gate are taken from the last stage of the shift register and an earlier stage. Under these conditions, the output from the shift register is an apparently random string of 0s and 1s and the longest pseudo-random pattern results if the input is taken from the correct earlier stage. Under these conditions, the output pattern will repeat after 2^n - 1 clock pulses. When the generator is switched on, some other sequence may appear briefly, but provided at least one of the shift register stages comes on with a 1 output the maximal length pattern of 2^n - 1 digits will establish itself. (The all 0s condition would circulate indefinitely also, but is of no use to us and is avoided.) During one cycle of the complete sequence, the shift register will hold during one clock period another every possible combination of 0s and 1s, so that the longest string of 1s which occurs in a row and the longest string of 0s is (n - 1). It can be shown mathematically that the output sequence has a frequency spectrum consisting of all harmonics of (clock frequency X 2^n - 1). Thus a 10-stage register clocked at 1023 Hz would have an output spectrum consisting of all harmonics of 1023(2^10 - 1), i.e. of 1 Hz. These harmonics are all of equal amplitude up to about one sixth of the clock frequency, so up to this frequency the maximal length pattern is quite a good approximation to a source of 'white' noise.

Naturally occurring noise may or may not be 'white', but it usually has a 'Gaussian' or 'normal' amplitude distribution. This can be very closely approximated by low-pass filtering the maximal length pattern with a cut-off frequency lower than (clock frequency/n). This is shown in Fig. 2 where it is obvious that the occasional large positive and negative peaks found in random Gaussian noise correspond with the occasional long strings of 1s and 0s in the pseudo-random pattern respectively.

In the full circuit of the pseudo-random feedback shift register (Fig. 3) an additional exclusive-Or gate used as an inverter has been included in the feedback path. The effect of this is that the combination of shift register stages which does not occur in all 1s rather than all 0s. Owing to the internal architecture of the 7495 ICs (which each contain four shift-register stages plus various control gates) on switch-on, all outputs usually come up in the 0 state. Thus the maximal length pattern is self-starting. With seven 7495s, the clock frequency is 7.456 MHz, and so Gaussian white noise is available up to somewhat less than 6 MHz at approximately 200 kHz. The 5 dB attenuation frequency of R3, C3 is accordingly set at 100 kHz.

At the other end of the scale, the pattern will repeat at a frequency of 6 X (10^7/2^20 - 1) or about once every 43 seconds. So with a spectrum consisting of harmonics spaced 1/43 Hz apart, the output is a very good approximation to the continuous frequency distribution of true white noise, even when the filter is set to 10 Hz low pass. The wide band noise is not greatly filtered at all. Its level can be set with 'wide-band noise level' control Rg and it is made available at emitter-follower at Belling Lee socket SK1, as in Fig. 4. It is not Gaussian (but may be externally filtered, if desired, to make it so) but is...
PATENTING AN INVENTION

Protecting your invention is neither as simple nor as cheap as it is sometimes imagined, and the protection it affords is often illusory. Barry Fox explains the pitfalls and shows the way round them.

Pitfall 1: Drafting or Anticipating by Earlier Knowledge

Some good ideas aren't patentable. Others ideas are patentable, but not worth protecting. An idea may sometimes be patentable, but the chances are that no one has previously thought of it and therefore no one has any patent protection. As another rule of thumb, the more valuable the idea protected, the stronger the patent

Pitfall 2: Patenting an Invention That Someone Else Has Already Invented

In order to prove to the patent examiner that the invention is new, you will have to be able to show that someone else did not invent it before you. This is called an "anticipation" of your invention. If you can prove that someone else had the same idea before you, then your patent may be invalid. It is important to understand that even if you have a patent, you cannot rely on it to prevent others from using your invention. Patents are exclusive rights, but they do not give you the power to force others to stop using your invention. If you discover that someone else has already invented your invention, you should contact the U.S. Patent and Trademark Office to file a reissue or reexamination of your patent.

Pitfall 3: Patenting an Invention That Is Too Broad

A patent is only valid if it is specific enough to describe the invention clearly. It is important to make sure that your patent claims are clear and precise. If your patent claims are too broad, you may lose the right to enforce them against others.

Pitfall 4: Patenting an Invention That Is Too Narrow

A patent is only valid if it is specific enough to describe the invention clearly. It is important to make sure that your patent claims are clear and precise. If your patent claims are too narrow, you may not be able to enforce them against others.

Pitfall 5: Patenting an Invention That Is Too Obvious

A patent is only valid if it is non-obvious to a person skilled in the art. It is important to make sure that your invention is not obvious to a person skilled in the art.

Pitfall 6: Patenting an Invention That Is Too Basic

A patent is only valid if it is non-obvious to a person skilled in the art. It is important to make sure that your invention is not basic to the art.

Pitfall 7: Patenting an Invention That Is Too Temporary

A patent is only valid if it is non-obvious to a person skilled in the art. It is important to make sure that your invention is not temporary.

Pitfall 8: Patenting an Invention That Is Too Abstract

A patent is only valid if it is non-obvious to a person skilled in the art. It is important to make sure that your invention is not abstract.

Pitfall 9: Patenting an Invention That Is Too Subjective

A patent is only valid if it is non-obvious to a person skilled in the art. It is important to make sure that your invention is not subjective.

Pitfall 10: Patenting an Invention That Is Too Complex

A patent is only valid if it is non-obvious to a person skilled in the art. It is important to make sure that your invention is not complex.

Pitfall 11: Patenting an Invention That Is Too Random

A patent is only valid if it is non-obvious to a person skilled in the art. It is important to make sure that your invention is not random.

Pitfall 12: Patenting an Invention That Is Too Subjective

A patent is only valid if it is non-obvious to a person skilled in the art. It is important to make sure that your invention is not subjective.
What to patent - and what not to patent

By now it should be clear that securing a patent approval is a difficult and costly affair, even more tricky than you might think. Some people would say it is an easy way to make a fortune. Instead of providing advice, investors should seek professional advice from a qualified patent attorney. Any publisher or Office can be persuaded to grant excessive broad claims, the resulting patent will be worthless, and in any case, the Office, either directly or indirectly, will provide you with all the information which could be relevant for a patent application. But it is generally a matter of good practice to know that you have a patent in order to be able to use it in any country where the patentable subject matter exists. Therefore, it is advisable to file a patent for each country where you intend to be active. Before you file an application, you should determine the countries where you wish to be protected. This means that you should take into account the costs and the time required for each country to be protected. In general, it is advisable to file a patent application in as many countries as possible. This is because the patent protection is limited in time and may be revoked by the courts or by the patent office. Therefore, it is advisable to file a patent application as soon as possible after the invention has been made.

Taking advice

The Institute of Patent Attorneys (Stant Janes Buildings, London WC1V 7PZ) publishes a list of qualified or chartered patent agents. These agents are, like solicitors, expensive. They can charge you at least £60 or £40 an hour for advice and patent aid. This is of course only a rough estimate of the costs when you talk to a patent agent about your invention. But it is still a matter of some concern, because they are not always the best way to use your money. Even if you don’t have the money to pay for advice, there is still a possibility that you might be able to get assistance from the patent office.

Even if you take advice from a patent agent, it is possible to have some basic knowledge of the law. Apart from anything else it can cut down the time and the costs. And of course it is also possible to follow the advice of a patent agent. Just look at the fees that are charged for rough estimates of costs when you talk to a patent agent about your invention. But it is still a matter of some concern, because they are not always the best way to use your money. Even if you don’t have the money to pay for advice, there is still a possibility that you might be able to get assistance from the patent office.

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CRISIS CONTROL

In the first part of this article, R. E. Young dealt with the problems faced by control engineers in moments of data presentation and operator training.

As has already been implied, once it has been accepted that ultimate-emergency crisis-control facilities must be installed and rated in an installation, then an entirely new form of contracting work— a new 'safety regime' — is needed. This is real-time operation, in contrast to the routine control methods which are used with the 'slow-to-change' parameters of most existing public utility and like systems. There is consequently a demand for special equipment and techniques to deal with rapidly changing and unexpected situations. Examples are the 'at-the-gate' and comparable reading techniques, all aimed at producing an operator response which is in effect instantaneous and, as far as possible, error-free. Also, because of the special nature of these displays, e.g. for independent-check applications, design provision should include observation assistance to enable accurate transfers to be made between alternative types of display.

Independent-check principle

Independent-check methods, which originated in aerospace and similar industries, use the principle of a specific measurement covered by two completely separate instrumentation chains, each working on an entirely different physical basis from the other.

In many of the applications proposed for emergency control work — such as aerospace development— closed-circuit television provides the second chain, with conventional transmitters acting as the first. There are several advantages in adopting such a system both from the point of view of defence against misleading reading or equipment failure.

The main argument for independent check — again backed by aerospace experience — lies in its relative invulnerability, when compared with straightforward duplication, an obvious alternative. Taking a severe break-down condition in a duplicated system, failure of one component due to, for example, abnormal mechanical shock, will almost certainly be accompanied by the corresponding component in the other (parallel) set failing in the same way. Even the suggestion of triplication can be countered by the same reasoning: that, for example, if only one system element fails completely and the other two are on the 'hot-spot', i.e. are in a 'false indication' type of fault condition. Furthermore, it must be pointed out that the 'voting' equipment generally used in these cases is, by the same token, open to doubt in itself, and especially under far-reaching crisis conditions. Incidentally, this classic voting problem, whether it is carried out by human assessment or by some form of comparator equipment, demands for its final solution comparison with some form of basic reference.

Besides the use of c.c.t.v., alternative types of transducer can be used in the second channel. But, of course, the overall philosophy of independent check, the minimum amount of equipment

by R. E. Young.

B.Sc. (Eng.), M.R.E.E.S., F.I.E.E.
should be interpolated between the instrument output and the data presentation points. In other words, ideally no equipment (liable to cause unreliability or error by its very presence) should come between the measuring instrument and the display.

The considerations lead to the concept of working at "raw-data" level where the transducer feeds a v.d.u. and where the balanced-oscillator or other frequency output transducer, presents a sine-wave-type trace as shown in the photograph (Fig. 5). The c.r.t. trace can be backed up by a digital counter or other frequency meter, but one of the main advantages of this display is that the operator can discriminate between the required "value" signal and spurious interfering signals which can be expected during the totally abnormal conditions of crisis breakdown. For instance, under such conditions, high-energy impulsive interference alone can reach such proportions as to obviate completely a coded signal pattern.

Similar considerations apply to the use of c.r.t.s for independent checking, where it works as a telemetering medium. It has, in addition, an outstanding advantage in that once the intelligence has been in effect "encoded" in pictorial form, no further degradation in its data content can take place through the medium. Also, the ability to read through interference given by the "frequency" signal is enhanced in the television case since the operator knows what the picture should be and can read it through near-saturation interference. Furthermore -- and this is vital for a multiple breakdown due, for example, to "knock-off" fault development -- failure of the r.v. system as an instrument channel is obvious. In comparison with other chains it is effectively "fail-safe" in that no indication by an individual instrument within a televised group means that the instrument, rather than the remainder of the chain, has developed a fault.

Using these visual methods which can only be surveyed here in broad terms, does put a significant load on the observers/operators, but means for reducing this load form part of the treatment in "Control in Hazardous Environments" of control room organization which includes a "two-tier" control structure. The picture of Fig. 6 is a representation of a small, highly-trained crisis management team of engineers working under full emergency conditions at their special positions on the master consoles. The team is operating in a two-tier grouping with the senior engineer at the back in control overall, having access to all levels of information, with their selection determined by him in accordance with his "reading" of the situation. Communication is also on a two-tier basis with information "filtered" (data-masshalled) to ensure that only "mainstream" data and speech reach those concerned primarily with taking immediate decisions and crisis-control actions.

Although the preceding descriptions cover only visual analysis of raw data and similar displays, the writer has suggested that future development should include "super-software" techniques to replace routine human observation by computer interpretation of a number of raw-data telecommunication pictures. Thus, for example, a group of (say) simple instrument displays, would be kept under computer-based observation (data analysis) to detect changes, in an anticipatory control role, but this was brought into one for crisis control to take some of the load off the operators under emergency saturation conditions.

Training

These new methods of operational working place a heavy 'thinking' demand on the operators and it is suggested that the corresponding levels of training and preparation which are required are such that these tasks should be largely subliminal in nature. This means that the training mechanisms should be obvious, a "from within" type of intuitive element is needed, ideally on both sides (teacher and pupil).

That conventional methods, even most types of simulator training, should be avoided, comes out of the consideration of stress conditions. A and B are the members in which individuals enter them. As a general rule, those in condition A had developed an absorbing technical interest in it, and grasp of, the system they were operating. In condition B on the other hand, the emphasis was laid on the individual in which interaction between them in their various activities was laid more on the selection and checking.

Turning to the question of mental handicap itself, "this most mysterious of human complaints", the 'shell' effect not only represents the isolation of the hyper-auditive state, but also throws into relief the need to help the mentally handicapped person to communicate from his own point of view. The word 'shell' -- put forward by the parent of a mentally handicapped girl -- is probably unequalled to describe the state when people reach certain conditions are at all aware of their surroundings, with energy sapped by thinking fatigue, inarticulate, inadequate in conversation with no allowance made for days off, or, by various physical and mental situations apparent without warning. This need to avoid intrusion by strange visitors is not always recognized but it is understood that in at least one centre in Europe, visitors are not allowed to watch the mentally handicapped person assisting in the various activities of the house to avoid disturbing them. The two-way mirror which permits observation without causing disturbance forms an important part of the Embryo Language Laboratory shown in Fig. 6, and which in this case is being used to give the mentally handicapped the opportunity to use the telephone itself. This information is obviously of value on the mentally handicapped side, but perhaps even more to study of the 'shell' condition.

In general terms, "the mentally handicapped never look at themselves in the mirror", and the reason to which this is true for the individual shown -- looking in to the mirror -- provides additional information for the assisting instructor. The direction of the indirect methods which may be used to obtain information indirectly so as not to cause distress and to prevent the development of the shell.

Full acknowledgement must be made of the major contribution of Dr. Gordon Avery, who, District Community Physician of the Warwickshire Area Health Authority, South District, in his interest in the research programme on mental handicap.

Corresponding recognition must also be made to Professor Harold C. A. Kendrick of the University of Manchester Institute of Science and Technology for invaluable discussion of this subject.

Next Month

The final part of John Linsley Hood's series on a 100W mosfet audio amplifier contains a description of the complete design, including full circuit details and printed-board layouts. A design for the matching pre-amplifier, which possesses several novel features, will follow in an early issue.

Receiving Meteor-3a. Enhancements for Mike Christieson's high-resolution weather-satellite picture system extend its capabilities to cover primary data from Meteor-3a, launched in June 1981.

Circuit modelling by micro-computer. By repeating from a circuit modelling program and using macro-codes for certain routines, a 16-node circuit can be gain and phase parameters plotted in minutes instead of hours.

On Sale July 21
Sequential digital display for 8080A-based systems

Eight digits can be displayed sequentially in two steps using seven-segment displays. During the first step, segments a, b, c, d, e, f, and g are enabled and show the contents of the first byte assigned to this digit in the display ram. During the second step, segments c, d, e, and I are enabled and show the contents of the second byte.

When the display r.a.m. is addressed by the c.p.u. line X (one output from a memory-mapped io decoder) goes low and disables IC8 and all displays. In the meantime IC8 selects the four lowest-order bits AO-A3 of the address bus to address the required byte in the display r.a.m. IC6.

With the MEMW line low (in response to a store-in-memory instruction) the lowest-order bits D0-D3 of the data bus are stored in the addressed byte of display r.a.m. When the write operation is terminated, X goes high and the refresh circuit is enabled. Outputs of the hexadecimal counter IC6 (Q2, Q3, Q4, Q5, Q6) are selected by IC8 to address the 8-bit r.a.m. (IC8).

When Q6 is high, the output of IC6 is passed to segments e, f, g of the display chips. The seven-segment chip addressed and selected by IC6 will be the only one to respond to the output of the display r.a.m.

Decimal points are excluded in this design to permit control over decimal points, connect pin 11 of IC6 to pin 12 of IC8 and pin 11 of IC6 to the cathode of the decimal points. The circuit is expandable to display more than eight digits, but other components such as 2112-4 ram are recommended instead of a multitude of 7489 rams to reduce cost and size.

The word byte refers to a word of four bits in the display r.a.m.

G. A. M. Lahib
Heliopolis
Cairo

Loudspeaker displacement detector

Used as part of a motion-feedback system, this circuit detects the dynamic displacement of a loudspeaker optically using an led and phototransistor. The small infrared led is attached to the loudspeaker cone and the photo-transistor positioned to give between 20 and 30mA led current. Optical bias for the photo-transistor and compensation for changes in ambient lighting are provided by the op-amp. Sensitivity is high, and for practical displacements, the output is quite linear and does not require square-law conversion. Simple shielding from artificial lighting may be required to prevent 100Hz ripple on the output, and screened cable should be used for the transistor lead. Construction of the prototype is shown in the diagram. 'Blue-tack' was used to secure the led and leads to the loudspeaker. The cross-piece and transistor mountings should be as rigid as possible.

Simon Young
Cambridge

Full-wave precision rectifier

This circuit has two advantages over other forms of precision rectifier – for unity gain only two matched resistors and required, R1 and R2, and with capacitive loads, the circuit becomes peak reading. The peak-reading configuration decays time constant is defined by the capacitance, C, and the parallel combination of R2 and R3. If the rectifier is required to have gain, then R4 may be included, in which case,

\[ R_2 = \frac{R_1 \cdot R_4}{R_4} \]

The circuit is accurate at high frequencies and responds to greater than 100kHz with TL082 amplifiers. If high-frequency response is not required, D1 and D2 may be eliminated and R3 reduced to zero. Note that without D4 there must be a d.c. path at the input.

C. W. Beal
Balding
West Yorkshire

Non-polarizing R-to-V transducer

Circuit shows a resistance-to-voltage transducer designed for a soil-moisture measuring instrument. It uses complimentary i.e.e to provide positive and negative constant-current sources for R1. The resulting voltage is rectified by R4 and R2 to produce \( V = V_{\text{front}} \times R_1 \).

A. Burram
University of Exeter
Devon

As data sensed at the output of IC2 is the complement of data stored, and as seven-segment chips are common anode, a logic 1 data-bus bit (00, 01, D1, D2, D3 or all will cause the corresponding segments to light when enabled.
Connecting answering machines

This circuit connects a telephone answering machine (tam) to an exchange line and includes relay switching so that all the facilities may be used automatically, without restriction.

For automatic call answering the tam senses a.c. ring current from the line via the n.c. contacts of relay 1 and, after a predetermined period set by the user (1 to 10 rings), answers the call by connecting a d.c. loop across its terminals. After exchange of outgoing and incoming audio messages, the tam opens the d.c. loop and returns to a state of readiness. This automatic process may be interrupted at any stage by picking up the line manually and answering any of the associated telephones, energizing relay 1. If this is done before the tam answers, relay 2 does not energize. If interruption happens after the tam has answered, the d.c. loop of the tam causes relay 2 to be energized and its n.o. contacts place the attenuator, comprising relay 2 coil and 250Ω capacitor, blocking the audio path between the tam and line. Sensing the resulting silence, the tam resets and returns to readiness.

Outgoing calls may be dialed normally from any of the associated telephones; the n.o. contacts of relay 1 whose coil is slugged by 3000V and the n.c. contacts of relay 2 connect to the tam network and effectively block the 50 volt 10kHz dial pulses from falsely operating the ring-current detector. The diode in series with the coil of relay 2 stops the 250Ω capacitor discharging while dialing and so aids this blocking. The tam may be used to record both sides of a telephone input across the line via the n.c. contacts of relay 2 and the 0.33μF capacitor. The 250Ω capacitor and silicon diodes connected in parallel-opposition limit signals to some 600μV peak-to-peak but do not affect recording of conversations.

Calls being answered by the tam may be monitored by means of its internal loudspeaker and interrupted manually if desired. Monitoring may also be done from other rooms using one of the associated telephones if d.c. through the coil of relay 1 is blocked. This may be accomplished by means of a series 2μF capacitor shunted by an n.c. press switch which is pressed when it is desired only to monitor calls and released. The tam may be used to record both sides of a telephone input across the line via the n.c. contacts of relay 2 and the 0.33μF capacitor. The 250Ω capacitor and silicon diodes connected in parallel-opposition limit signals to some 600μV peak-to-peak but do not affect recording of conversations.

Poor man's current dumper

At low output levels, output current is supplied by the op-amp through a 100Ω resistor and at higher output levels, current is provided by the output transistor. The output transistor is not required.

The maximum supply voltage that can be used is limited by the op-amp, and was 5V (stabilized) for the prototype using an MC3403 with a sensor diode. The circuit may be operated with a 100Ω resistor and 3V obtained. If the supply is unstabilized, the resistor connected to ground in the input-biasing potential divider should be 100Ω.

For the circuit shown, voltage gain is about 20dB, but this may easily be increased at the expense of h.f. response by replacing the 39kΩ resistor R₂, R. C. Cross, Felstowe.

Thermometer for d.m.m.

The circuit shown can be combined with an inexpensive digital-panel meter to form a compact, accurate digital thermometer.

A dual op-amp and a PRT-100 platinum resistance thermometer, whose resistance is a linear function of temperature, are the main elements. The first op-amp is used as a precision constant-current source and the second as an amplifier. Any 3½-digit meter with a 19999V range will indicate temperature directly in degrees centigrade, from 0 to 199.9 with 0.1° resolution. The sensor is pre-calibrated and its resistance is linear from -40° to 400°C, so the circuit can be calibrated by replacing the sensor with two known resistances. First, using 100Ω, zero adjustment is made with the "O" set potentiometer (R₂=100Ω at 0°C). Next, the gain is adjusted for 200°C on the second potentiometer using 180Ω (R₂=180Ω at 200°C). This thermometer can replace thermocouples in many applications and provide better accuracy (±1%) and linearity (2%) between 0 and 200°C.

Dil Sethi Jain, Hyderabad, India.

Micro-controlled radio-code clock

Based on a 6802 microprocessor, this clock decodes and displays serial information from a v.h.f. receiver. Although requiring powerful and complex firmware for best possible performance in difficult areas, a system for non-critical applications can use only 2K of object code. This second article describes alignment and firmware for a basic clock which can be contained in a low-cost 2716. For future expansion, this ram can be replaced by link selection with a 2732 device.

by N. E. Sand

The most important part of this clock, or any other design based on a time-coded transmission, is the receiver. Although complex logic circuits use powerful software and microprocessors can be used to detect and analyse any error or noise transient in the transmitted code, unless a carefully designed receiver is used in conjunction with this processing, practically every clock or code will be rejected and the clock will suffer from the usual crystal drift over long periods, or worse still, will not be accurate.

[Fig. 1. Flow chart for the basic clock system.]

Continued on page 56
FAST AMPLITUDE STABILIZATION OF AN RC OSCILLATOR

This technique for stabilizing the output amplitude of an RC sine-wave oscillator uses a multiphase rectifier to convert the oscillator output to d.c. This voltage does not require further filtering, which results in a short amplitude settling time.

An experimental circuit demonstrates the technique.

A stable sine-wave oscillator with amplitude control usually incorporates a voltage-controlled, continuously tuned attenuator. The d.c. input to this attenuator must have a very small ripple to avoid excessive distortion of the output waveform. If this direct voltage is derived from the usual half-wave rectifier, an extremely large filter time constant is required: the oscillator output level consequently settles very slowly. This behaviour is undesirable in low-frequency applications. Several solutions have been proposed to solve these problems, one of which has been to combine analogue and digital circuitry to use amplitude sampling or correction to the capacitor initial condition. This involves relatively complicated circuits. A more direct and simpler circuit approach is to use oscillator networks with available voltage or phase output. The rectified, multiphase voltages obtained from the oscillator. The circuit proposed here also uses multiphase rectified voltages, but these voltages are obtained in a special circuit from two sinusoidal voltage levels shifted by 90°. The circuit consists of summing operational amplifiers.

The full circuit of the RC oscillator with the eight-phase rectifier is shown in Fig. 1. It includes an RC resonator (operational amplifiers A1, A2 and A3) with the voltage-controlled oscillator and transconductance amplifier connected in parallel to the transconductance amplifier and resistors R2 to R3; the control circuit with the error amplifier A0 and the two-stage multiphase rectifier (the operational amplifier A4 to A10 and diodes D1-D10) mentioned above.

Two sinusoidal voltages V1 and V2 of equal amplitudes are applied to the inputs of two inverting operational amplifiers A0 and A1 in the first stage. At the output of this first stage we obtain four sinusoidal voltages shifted with respect to each other by 90° (Fig. 2(a)). The second stage produces eight sinusoidal voltages shifted with respect to each other by 45° (Fig. 2(b)). Here we use the fact that operational amplifier produces vector summation of the voltages applied to its inverting input. For example,

\[ V_{in} = V_1 - V_2 = V_{bias} \]

where \( V_{bias} \) is the reference voltage. The amplitude control system in a Type 1 design due to the fact that an RC oscillator acts as an integrator with respect to an amplitude change \( V_1 \) in the amplitude control system.

During the static oscillations the condition

\[ R_1 = R_2, C_1 = C_2 \]

is satisfied. The transconductance \( g_m \) is determined by the d.c. control current \( I_1 \), the resistor \( R_2 \) and for the CA 3080 transconductance amplifier which we used in our experiments

\[ g_m = \frac{I_1}{V_T} \]

where \( V_T \) is threshold voltage (\( V_T \approx 20\mu V \) at 300K). The resistors \( R_1 \) and \( R_2 \) are chosen from the condition that

\[ V_1 = 2 V_2 \]

where \( V_2 \) is the amplitude of \( V_2. \) This ensures the linear operation of the transconductance amplifier. The value of \( R_1 \) was chosen in such a way that the current control \( I_1 \) (in the steady state condition) is approximately equal to one half of the maximum current control allowable for linear operation. The control input (pin 5) d.c. potential is close to the negative of the power supply for CA 3080. In this case, the linear operation will be preserved for the whole output voltage range of the error amplifier \( A_0 \) and at the same time the value of \( R_1 \) will be low. As a result the displacement of poles from the zero-axis into the left or right half plane due to the sudden change in the \( R_2 \) level will be maximum and the transient response duration will be shortened.

The output voltage of the multiphase rectifier includes the small ripple voltage also. The amplitude of the 8th harmonic equals

\[ V_h = V_1 - \sin \left( \frac{n \times \pi}{m} \right) \]

where \( n = 2 \) for example when \( m = 8 \) is equal to 0.975. Hence, such an eight-phase rectifier can be used as a unit which produces a direct voltage proportional to the oscillation amplitude and without any delay (theoretically, at least), with low harmonic content. The requirement of any additional filtering when \( m \) increases is eliminated.

The output voltage of the operational amplifier \( A_2 \) coincides in phase with \( V_2. \) We could use it and save one operational amplifier in the first stage. But the voltages \( V_1 \) and \( V_2 \) have the lowest amount of harmonics and using only these two voltages we obtain less total harmonic distortion (i.e. d.c.) at the oscillator output.

In the steady-state condition, the output voltage amplitude of the oscillator is determined by the equality

\[ V_{in} = E_R \]

where \( E_R \) is the reference voltage. The above control system is a Type 1 design due to the fact that an RC oscillator.

by I. M. Filanovskiy V. A. Piskarev and K. A. Stromsoe

* University of Alberta, Edmonton, Alberta.

\[ \text{Fig. 2. Output voltages in multiphase rectifier (a) first stage (b) second stage}\]

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References

Most of the digital playback circuitry was described in the February 1982 issue — the remaining sections are covered in this part, which is published out of order with the rest of the series.

The final block circuit diagram of the digital 'playback' electronics to be discussed in detail is the 12-bit, serial-in-parallel-out register and 12-bit latch. The I.C. used is shown in detail and no further comments about them are necessary. The NRZ serial data, output from the four temporary storage buffers in sequence, is fed into the 12-bit shift register under the control of DVC. Once the 12 bits of a data word have entered the shift register, the 12-bit parallel outputs are latched across to the 12-bit latch upon the positive transition of the Latch pulse. The 12 bits output from the latches remain for the duration of twelve IVC pulses, and are numbered in the same sequence as they were entered in the recording process. They are passed to the 'odd-bit' parity checkers of Fig. 35 and the digital-to-analogue converter circuit of Fig. 36.

Referring to Fig. 35, P1 and P2 are the two 'odd' parity bit buffers. The 'odd-bit' parity generators of Fig. 21 in the January 1981 article. The 'odd-bit' parity checkers produce logic '1' on PCl and PC2, which are both logic '1' if the parity check is GO, but logic '0' if the parity check is NO-GO. PCl and PC2 are passed to the circuit of Fig. 37 to control the transfer of analogue data to the appropriate analogue output channel.

Figure 36 is the circuit of the digital-to-analogue converter circuit using the Analogics 10-bit i2c to a converter I.C., AD561K. As shown, the circuit produces an analogue output in the range ±5 V for the full range of ten digital inputs. The AD561K is the complement of the AD717 (a-to-d converter) used in the recording digital electronics and has similar tolerances of accuracy and temperature sensitivity: the circuit of the digital-to-analogue converter as shown in Fig. 36 is that recommended by Analogics for a buffered output. The fixed resistors of 10 ohms and 24 ohms can be replaced by tristems of 20 ohms and 50 ohms, respectively, for greater accuracy: with the fixed values, scale and offset errors are typically ±0.1%. If tristems are used, then the 20 ohm trimmer should be adjusted to give a reading of ±5.000 volts with all bits OFF. Using the

by *A. J. Ewins, B.Tech.

fixed values, as shown, it is only necessary to adjust the offset zero of the op-amp to give 0.000 volts output with the m.s.b. only ON. The analogue output from the digital-to-analogue converter is passed to all six samples/hold output stages of Fig. 38, only one of which is switched to its sample mode at any one time. This is done under the control of the demultiplexer and sample/hold circuitry of Fig. 37, such that the correct, converted, analogue data is passed to the appropriate output channel.

In Fig. 37, a divide-by-6 counter, i.e. type 4522, produces sequential outputs to enable six two-input AND gates in turn. Synchronised by the DVC/72 pulse from the circuit of Fig. 30, the counter is reset via a monostable circuit, as each data frame is emitted from the temporary storage buffers. As each 12-bit data word is latched for conversion from digital to analogue form, the counter is clocked by the Latch pulse, enabling the appropriate AND gate. Provided the parity checks, PCl and PC2, are GO (at the logic level '1') the appropriate control output will go to the logic level '1' when the Latch pulse goes negative, triggering the second monostable to produce a samples/hold pulse. The logic sequence of the control pulses produced by the circuit of Fig. 37 was shown in Fig. 10. The two monostables of Fig. 37 are contained in a dual-monostable I.C., type 4538. Both monostables may be either positive or negative edge triggered, that clocked by the DVC/72 pulse being positive-edge triggered and that by the Latch pulse being negative-edge triggered. The resistor and capacitor values of both monostables are selected to produce an output pulse whose duration is equal to five IVC pulses. The six control outputs from Fig. 37 are passed to the sample/hold output stages of Fig. 38.

The six sample/hold circuits of Fig. 38 are constructed from six sample/hold I.C.s, type LF 398, which is the same device that was used in the input stages of the digital electronics. A sample/hold circuit is in its sample mode when its control input pin (3) is at the logic level '1' and in the hold mode when it is at logic '0'. The value of the hold capacitor, 0.1 µF, is chosen so as to ensure a minimum speed of sampling and minimum droop during 'hold'. The diodes connected between the various control inputs and the 8-way pin connector are included so that the effective number of channels used may be reduced from six to three, two or one. If all six channels are used, no interconnections are made between the eight pins of the 8-way pin connector. If three channels have been selected during the recording process, then the analogue inputs to the recording electronics will have been linked such that channels 1 and 4, 2 and 5 and 3 and 6 are connected together. On playback, the corresponding control lines thus need to be Oved together, producing analogue outputs from channels 1 and 2, and 3. This is achieved by connecting the following pins of the 8-way pin connector together: 3 to 6, 2 to 7 and 1 to 8.

Similarly, if two channels have been selected during the recording process, then analogue inputs to the recording electronics, 1, 3 and 5 and 2 and 4 and 6 will have been linked together. On playback, control lines 1, 3 and 5 and 2 and 4 and 6 thus need to be Oved together, producing analogue outputs from channel 1 and 2, by connecting pins 2, 4 and 6 and pins 1, 3 and 7 of the 8-way pin connector together.

If only one channel has been selected during the recording process then six analogue inputs will have been connected in parallel — all six control lines must be Oved by connecting pins 1, 2, 3, 4, 5 and 6 of the 8-way pin connector together. All the electronics of the demultiplexer, d-to-a converter and sample/hold circuits, etc., are mounted on the final six circuit boards, board 7. This continues the detailed description of the digital recording and playback electronics associated with one track of the tape-recorder.

*Research Department, London Transport

Fig. 32. 12-bit serial-in/parallel-out shift register and 12-bit latch.
automatically set after switch-on. This receiver is designed as a good compromise between the complex and more costly professional receivers and the simple phase-locked loop or r.f. l.c. designs which, due to the special interferences problems, do not operate satisfactorily at v.f.f. without careful positioning of the aerial. Provided that care is taken with construction and alignment, the receiver will provide good performance in most conditions over a long range.

The third bandwidth of the tuned circuit is about 300Hz, so if a signal generator is used it must be set to 60Hz ± 30Hz. Short the receiver input at the aerial terminals and adjust the potentiometer for 4V at the output of Ic1. Remove the short, set the aerial trimmer capacitor to the mid point, and position the aerial coil so that the centre is about 65mm from the centre of the ferrite rod. Adjust the tuning core of the transformer for maximum output at 60Hz, ensuring that a true reading is achieved by detuning well through the maximum and back again. With eccentric adjustment, or even three smaller peaks can be encountered. Carefully slide the aerial coil along the ferrite rod to maximize the output of Ic1 (usually around 1.35V) and secure the coil with melted wax. Finally, peak the tuning with the trimmer capacitor and check the adjustment of the transformer.

When directly tuned to 60Hz the receiver produces regular inverted pulses at the output. Resistors has been included to dissipate this signal, so that the value of this signal can be adjusted by placing the test probe on the emission of the ferrite coil and check that a 7Hz output is produced at pin 14. If no output is present test the receiver output, check that the supply voltage is present on all pins and check that the oscillator is operating correctly. Connect the display board and check that the correct time is loaded into the registers. This may take one or two minutes after switch-on, depending where in the code the processor starts to operate. When the correct time appears, select the date display by switching pin 10 of pin a.v. to 0V. The remaining pins on the control port have been provided for future expansion and should be left unconnected. In spurious operation occurs such that the video signal is not in the correct signal-nail position (axis pointing to the transmitter) and check for sources of local interference such as television receivers, lamp dimmers and noisy fluorescent tube fittings.

MEMOTECH 16K Memory Extension

The 64K Memopack is a pack which extends the memory of the ZX81 by a further 56K, and together with the ZX81 gives a full 64K, which is neither switched nor swapped. With the addition of the Memopack 16K your ZX81's enlarged memory capacity will enable you to execute longer and more sophisticated programs, and hold an extended database. The 16K and 64K Memopacks come in attractive custom-designed and engineered cases which it snugly fits in to the back of the ZX81 giving firm, wobble-free connections.

MEMOTECH 16K Memory Extension

The 64K Memopack is a pack which extends the memory of the ZX81 by a further 56K, and together with the ZX81 gives a full 64K, which is neither switched nor swapped, and is directly addressable. The unit is user-transparent and accepts BASIC commands such as 10 DIM A(999).

BREAKDOWN OF MEMORY AREAS

0-8K ... Sinclair ROM 8-16K ... This section of memory stores instructions or in out 4K blocks to leave space for memory mapping. Holds its contents during a power-down, allows communication between programmes, and can be used to run assembly language routines. 16-32K ... This area can be used for BASIC programs and assembly language routines, 32-64K ... 32K of RAM memory for BASIC variables and large arrays. With the Memopack 64K extension the ZX81 is transformed into a powerful computer, suitable for business, leisure and educational uses, a fraction of the cost of comparable systems.

Coming Soon...

MEMOTECH 16K Memory Extension

A complete range of ZX81 plug-in peripherals

WIRELESS WORLD JUNE 1982

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POWER TRANSISTOR FAILURE

This is in reply to your letter about transistor failures in your power amplifier, published in Wireless World, May 1982, page 60.

The most likely cause of the failures you describe is secondary breakdown of the power transistors, probably due to the large amount of transistors during the warm-up period. That would cause the already-stressed heater to be increased, and that the load point of the parallel transistors will be the one most likely to be overheated.

The aggravating factor might be unequal sharing of collector current between the two parallel transistors during the warm-up period. That would cause the already-stressed heater to be increased, and would cause the load point of one of the parallel transistors to be over-heated.

In the Motorola data sheet for the ZN5647, Fig. 13, that shows the allowed loadings, the combination of voltage and current. If the transistor operation takes place outside the lower-left border of the area, even momentarily, the transistor might be destroyed. Typically, the symptom in a collector-emitter short-circuit is especially severe, the emitter bonding wire might be melted open, so you might have to decide the transistor to make contact to the emitter bonding pad. Is that the symptom you see?

Another thought: you mention rise and fail times typically being 20nS, that seems to be unsupportable. In a typical switching would aggravate the stress on the transistors.

Nathan O. Sokol
Design Automation, Inc.
Lexington
Massachusetts

NETWORKING SMALL COMPUTERS

I have recently read an article, very similar to that by P. G. Barker in the May issue, in the Computer & PET User Group Newsletter (CPUCN). It seems that, past simply, a couple of programs that are present which convert text files into internal format files. Programs of this type have been widely published for some time and are also known as 'editor' programs for which they are usually. The best known is the 'Templar merge' - a long list of standard commands for inter-operable text files. It does not suffer from the major disadvantage of Dr Barker's program. I have written a short (21 byte) text merge program for either cassette or mass memory based text data, from which cassette file must have originated, but found that the Templar merge may not be redundant.

Unfortunately, a number of practical communication programs were not touched on in the article.

Stephen H. Blinn, Ph.D., GEWIX
Sprawley, Hall

The author replies:

I think Dr. Blinn has missed the point of my article which was to show (a) the feasibility of transferring programs via the public switched network, (b) the conversion problems likely to be encountered in target machines, and (c) the relative speeds of tape and disc loading. The existence of his loader, the 'Templar' merge or any other existing technique is totally irrelevant unless they can be shown to be substantially faster than the code which I presented.

Code compactness is not necessarily a question of size in this particular case since the 8000 series PET has a 12K memory expansion area that could be used to accommodate programs such as mine which may be a little larger than 121 bytes. As your correspondent will appreciate there is likely to be a multitude of approaches to the conversion problem. I do not claim that there is any novelty involved in the logic underlying the algorithms I have employed - but again, this was not the point of the article, which was: program transfer via the PSN.

The similar article to which Dr. Blinn referred is one which I wrote called 'Computer Networks and Program Distribution.' It is an 'official' newsletter of the PET users which has now ceased circulation. The article that was published in WF was a re-written abstract of the version of the item that appeared in CPUCN.

MICROCHIPS AND MEGADEATHS

It was interesting to read Steve Coleman's letter in April's Wireless World, assuring that other correspondents were "wrong to imagine that the refusal to fight in wars will avert their occurrence."

The world wars of the century were the first (and may be the last) in which it could be reasonably assured that "we are all fighters now" soldiers, sailors, airmen (aparrose), farmers, factory workers, transport workers, miners, doctors, nurses - everyone! Even some politicians!

To refuse to fight means to refuse to design, make, provide, transport, service, organize and use materials of war. More than that, it means to reject violence in all acceptable human behavior (some training in semantics is necessary in order to weave out every form of violence - possibly only two or three human beings have managed it to date, but millions have come so near that we know what it is like).

To refuse to fight in this sense (what other sense is there?) is the highest form of political action. When people really care enough about each other - and all create problems, dissolve, appropriate action is taken in every situation (remember semantics) and the kingdom of heaven is revealed - as it always has and always will be, in patches, in every place, in every day. Experts agree!

Ronald Gill
SilLeague
Derby

Why the Quorum gate has lapsed from favour has puzzled me, especially those types in which the inputs could be weighted to give all sorts of weird truth tables; however, a lecturer in the American Institute has assured me that they are still used in some places where they are known as voting circuits.

There was but one polarity of (cheap) transistor available in those happy days so that nobody ever had cause to mix-up all the Aand Or gates by turning the logic polarity upside-down.

John C. Rudge
Huntingdon
Middlesex

INTENTIONAL LOGIC SYMBOLS

The precaried and confused correspondence started by Tony Campen's article (WF November 1980) goes to prove the inadequacy of the new system of logic circuit symbols which has so undeservedly supplanted the old.

Mr. J. E. Kennaugh (Letters October 1981) has even gone part of the way towards reinventing the old system of logic gate symbols. I first met that system (Fig. 1) on joining an Admiralty equipment design team in 1959. All gates were represented by circles, and bistables and counters by rectangles, whereas the D symbol now used for And gates then indicated a delay circuit, a non-memory being drawn as a delay with a feedback loop. Connections could be drawn to the gates from any direction and the inputs were distinguished by arrow-heads.

These older symbols had to have the greater flexibility to meet the versatility of the usually customized circuits, most of which was derived from a famous light blue booklet on r.f. widely extended until several well-advanced design teams began to run into the same fundamental large-signal usage simultaneously.

An inhibit could be introduced by adding a single resistor to the base of the second transistor in any of these gates, and this was indicated by a smoke through the symbol as in Fig. 2 which illustrated how an exclusive-Or gate might have been achieved in the old logic if anyone had ever called for such a circuit in those days - the earlier Ex-Or gate ever was on p. 88 of Electronic Design No. 26, dated November 22, 1966.

In the debate about Nand and Nor gates, and their relationship to other gates, J. E Kennaugh (Letters, May 81) seems to imply that Nand and Nor gates only predominate in 'practical logic'.
In what might be termed "theoretical logic," Pierre P. Dujardin and his co-workers have both been put forward as candidates for the honor of being the first to demonstrate that all connectives can be derived. (The dagger is equivalent to a "begging the question" in the language of logic.) This is not merely a theoretical consideration, but it is a real fact of life experienced不幸ly by all too many owners of capacitive discharge systems. There are undoubtedly advantages in a capacitive discharge system but nowadays they can be expensive and unreliable. The question of induction and capacitive systems to give two of the world's.

A. P. M. Bull

Directors

Ela-Sparkite Ltd.

The author replies:
The observer of a car of recent manufacture might have difficulty in finding a new addition to the carbon-amber - tarpaulin seats fitted to the front and rear. The systems for the factory as a direct result of the Department of Environment's Vehicle Emission Regulations (August 1975, £2.50). To comply with the regulations it is necessary to use an exhaust gas analyser as the old methods of trial and error are no longer good enough.

This does not leave the engine designer much latitude for running the engine on weakened fuel mixture and he no longer has the free hand that Mr. Bull suggests he has in designing for a given amount of fuel efficiency. In addition to point out, our regulations are not yet as advanced as is the case in America or Japan's are yet.

Thus, the curve described in my article has been followed on several cars and it has been found that the vehicles fitted with the tarpaulin-carbonate and they all work perfectly well.

I suggest that the misfiring experienced with some models of equipment and the problems encountered on many modern cars can be solved by the vehicle manufacturers and the European market are under increasing pressure to install such equipment. The British and Japanese manufacturers, they are not faced in this way and they are not yet solving the problems encountered on many modern cars.

Vehicle manufacturers designing cars for the European market are under increasing pressure to install such equipment. The British and Japanese manufacturers, they are not faced in Europe with particularly stringent exhaust emission regulations. Sophisticated air-fuel ratio control equipment has been justified solely on improved fuel economy and not on the grounds of exhaust emission legislation and so it is that the cost of the carburettor remains a compelling attraction.

There is no doubt that the carburettor as a device for the delivery of the correct mixture of fuel to the engine and the mixture that can be controlled closely is a desirable feature of any modern engine. However, the increase in the use of electronic ignition systems in vehicles has led to a situation where the carburettor needs to be designed to work with the electronic ignition system and to provide a precise mixture of fuel and air. This is a problem that can only be solved by the development of new and improved carburettors.

The right formula:

I have been reading with considerable fascination the recent developments in the aviation industry. It seems that although there are certain problems that need to be solved, the solutions are within reach. The key to solving these problems lies in the use of new and improved materials. The use of composites, for example, has been shown to be a significant step forward in the development of aircraft. The use of carbon fibre composites in the construction of aircraft has been shown to be a significant improvement over traditional materials.

It is not possible to say with certainty what the future of the aviation industry will be, but it is clear that the use of advanced materials will play a significant role in determining the future of this industry. The use of composites, for example, has been shown to be a significant step forward in the development of aircraft. The use of carbon fibre composites in the construction of aircraft has been shown to be a significant improvement over traditional materials.

The use of composites in the construction of aircraft has been shown to be a significant improvement over traditional materials. The use of carbon fibre composites has been shown to be a significant improvement over traditional materials. The use of composites in the construction of aircraft has been shown to be a significant improvement over traditional materials. The use of carbon fibre composites has been shown to be a significant improvement over traditional materials.

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LETTERS

SYMETRICAL OUTPUT TRANSDUCERS

The symmetrical output dividers described by Gerald Girolami and Philippe Bambarger are based on a very ingenious principle – inverting the clock input for half the count. It is a pity that they then use such awkard techniques to design their dividers.

Figure 1, as shown above, is a 2−6−2 circuit with symmetrical output – this is trivial. By using the output to invert the clock input, a 2(−1)−3 circuit is produced. Using this principle, Fig. 2 shows a programmable divider which can be extended 4 bits at a time by simply cascading 24,516 counters in a standard configuration. Using decade counters produces the b.c.d. version of Fig. 3. An extra data select is required to make the least significant 2-bit counter divide by 5 rather than 16, so that the correct weightings are achieved for the inputs.

Two of these circuits give a much more easily extended and general solution than the one described in the article. They require lower device counts and only need one device rather than two – for such 4 bits added since they eliminate the need for binary comparators. In addition, the binary version gives one extra bit of binary redundancy for a divide ratio in the binary (or b.c.d.) inputs must be set to n−1. For most applications this does not matter, as the input circuitry can be adjusted accordingly, e.g. by simple relabeling a switch in the case of micropower control, by software. If absolutely necessary, 7405 chips can be used as (n−1)−all inverters, which is equivalent to subtracting 1 in two's complement arithmetic.

Philip Nye
Edinburgh

LAWS OF MOTION

In the late 1960s, Mr. Newton won her how far back the principle of inertia goes, and be suggested that Galileo might have thought of it before Newton. In her autobiography she told the story that shows that modern man is at least 100,000 years old; the laws of motion must have been thought of thousands of years ago, but the genes that contain the knowledge of how to express our thoughts.

As far as modern times are concerned (and we can say that modern times began about 100,000 years ago), there is a corpus of references on the subject which may be of interest.

Galileo died in 1642 and Newton’s laws of motion were published in 1687. In between there had been no major change in the laws of nature, save for the discovery of the Roman poet Lucretius in about 50 B.C.:

- the light and heat of the sun are
- composed of minute atoms which, when they are shoved off, lose no time in shooting right across the interstice of air in the direction impinged upon by the sun...
- A very slight impetus far away to the rear sufficed to launch them, and they continued on their course at a velocity proportional to their momentum.

All the three laws seem to be in Lucretius, even if not very well expressed. There is no doubt however that he knew that a continuous force is not necessary. He was aware, in other words, that a body continues in its state of rest or uniform motion in a straight line unless impressed upon it by an external force.

Did Newton ever read Lucretius?

S. Front
Edinburgh

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DISC DRIVES

Following the article by J. R. Wexlerkin in the March issue, I wish to comment on the conceptual ideas which make disc drives necessary. It appears that we must have a machine and storage program in it, either in the spatial sense (memorized memory) or in the temporal sense (disc drives but nonstorage programs). Due to the difficulties we have experienced with the development of programs for the solution of engineering problems, it would be enough to make the suggestion that the flow chart must be the beginning and the end of software, e.g. will be a package to be calibrated according to the conditions set by the program. This amounts, of course, to assembling the program before the computer. We hear sometimes from leaders in engineering that programming is a medieval remnant in our technology, but no alternative was forthcoming. I think this alternative is implicitly suggested in the IFW editorial of January 1982 and it was as always so close and so remote to me; it is impossible to do programming, therefore the alternative is still best used.

By the way we have speculated lately that if the concept of an example is correct (my letter in the January 1982 issue of IFW) then the initial theories experienced in running complex programs are due to the inertia of particles or waves in forming quarks, therefore this formula... software problem is really a hardware phenomenon.

G. Xerosil
Edmonton
Alberta, Canada

80-100W MOSFET AUDIO AMPLIFIER

One solution to the problem of low mosfet gm – using the mosfet with bipolar small-signal devices – was described in the first part of this article. Here, John Linsley Hood presents an alternative, which is to improve the gain of the voltage-amplifier stage.

A considerable amount of development work has been done over the past decade in the design of high gain class A amplifier stages, mainly in the evolution of integrated circuit operational amplifiers, in which the design requirements in this application are high gain, high immunity from supply line breakthrough, and wide bandwidth. In addition, there has been paid to cost-effectiveness which, in this context, usually means the use of active elements to provide the best performance for the lowest number of components.

Although this work has been done, largely, by the designers of I.C. op-amps, it is profitable to consider some of the more recent developments in high gain, low distortion component circuits to look over their shoulders to see what they are up to.

The Class 'A' amplifier stage

It is a fundamental requirement of any feedback amplifier design that it should be absolutely and unconditionally stable, and this requirement applies with as much force to audio amplifiers of this type as to closed-loop servo-mechanisms. This consideration, coupled with the need for audio-amplifier designs to operate satisfactorily with wide range of load impedances, leads to designs in which there is a substantial gain or phase margin at the unity-gain point on the Bode plot.

This requirement is easy to satisfy in a single-stage amplifier, of the type shown in Fig. 6, where it is unlikely that the internal phase shift, without feedback, will exceed 90° until the gain is reached at which the gain is very much less than unity.

However, the stage gain from such an amplifier is limited to the range 2000-3000 if a conventional resistive collector load is used. It is true that gains of several thousand can be obtained from such a stage if the collector load resistor is replaced by a constant-current source, as in the 'Linic' configuration and this figure can be increased towards the hundred thousand mark if the amplifier transistor is operated in cascode with a device such as 2N196 or 2N4136, to increase its output resistance.

Unfortunately, such high gains can only be obtained at very low collector currents, which imply very high output impedances and a relatively poor hi-fi performance, which would not allow an adequate load gain at the upper end of the audio band.

The use of a two-stage voltage amplifier gives a much greater degree of design freedom, and while such an amplifier may not automatically guarantee, under all load conditions, that the internal phase shift does not approach 180° until the open-loop gain is negligible, the necessary conditions for an adequate phase margin, at unity gain, are much easier to achieve in the context of the type of design than in circuits with more amplifier stages.

For this reason, the possibilities of two-stage voltage amplifiers have attracted the attention of many designers working in the audio and operational-amplifier fields, where large amounts of negative feedback are deliberately applied to achieve the desired transient response, and linearity.

Because of the relatively low input impedance of Trp, a simple two-stage amplifier of the type shown in Fig. 7(a) will not give a gain which is that of a single-stage amplifier, squared, but nevertheless a stage gain of about 2000-3000 can be obtained, and this can be increased by a further factor of ten if a constant-current source is used as the load for Trp instead of the load resistor Rg. Moreover, this order of stage gain can be achieved with collector currents in Trp which are high enough to allow a relatively low input impedance at Trp collector. In practice, the constant current transistor will most commonly be replaced by a long-tailed pair, as in Fig. 7(b), which reduces the effect of direct-coupled and parasitic feedback systems, in which the long-tailed pair input cancels the output voltage otherwise introduced by Trp.

Circuit configurations of this type, using one or other of the various constant-current, constant-current source, with the constant-current source sometimes replaced by a bootstrapped load by J. L. Linsley Hood

Fig. 2. Much higher gain is obtained from two-stage circuit at relatively high Trp collector currents. Long-tailed pair input at (b) reduces odd harmonics.

Fig. 7. By substituting a small-signal transistor, formed by the bulk of class A gain stages used in commercial audio amplifiers up to a few years ago. In these designs, the output-impedance transformation was accomplished by a complementary, or quasi-complementary, current-follower-pair, using bipolar junction transistors, and overall negative feedback was taken from the output to the inverting input connection. With careful design, circuits of this type gave overall harmonic distortion figures of 0.05-0.02%, as measured at 1kHz, and at a few dB below clipping point. The t.h.d. figures would worsen somewhat at lower power output levels, the signal-to-noise ratio of such an amplifier is only some 80–90dB, which means that the residual distortion is soon swamped by circuit noise.

The approach has changed somewhat in the last few years with the marketing of amplifiers, mainly of Japanese origin, having distortion levels in the 0.002–0.003% bracket, and in addition an attempt to obtain more impressive consumer reviews. In these designs, changes have been made both in the stage biasing arrangements to minimize crossover distortion, and also in the number and complexity of the preceding gain stages. Where the improvement in

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Fig. 3. Basic single-stage amplifier. At reduced input signals, constant current gain is modest, but phase shift is less than 90° at frequencies below 1 Hz.

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and I propose to consider this in greater detail.

**Higher-gain configurations**

One of the penalties in the use of a symmetrical-input long-tailed pair is that the $V_{os}$ of the input device is halved, with a consequent reduction in the gain in comparison with a similar amplifier having only a single input resistor. This loss of gain can be minimized by the use of an asymmetrical input stage, with the feedback transistor operating at a higher current than the gain transistor, as in the earlier design of my own, provided that the loss of the inherent d.c. balance is within tolerable limits.

A better approach to avoiding this loss of gain, and very commonly used in i.c. operational amplifiers such as the 741, is to use a current mirror as the load for the amplifying transistor, with the operating current being set by the feedback one. This type of arrangement is shown in Fig. 8, and was used with a constant current load — normally yet another current mirror — on the output of $T_{s}$, will give stage gains of the 50,000-100,000 range at low frequencies. Although this approach is easier to adopt in 'single-chip' fabrications, where the simultaneous fabrication of all the transistors will ensure identity of the base-emitter turn-on characteristics necessary for proper current-mirror operation, it has also been used in discrete-component designs.

This circuit employs nine transistors, and while the actual transistor count may be of little moment in an integrated circuit where the fabrication of active components presents no difficulty and little extra cost, it is nevertheless interesting to observe that a better stage gain can be obtained using the arrangement of Fig. 9, which uses one less transistor. In this circuit, the two-stage amplifier remains a symmetrical push-pull version of that shown in Fig. 7a, but with the current-mirror active load moved back to the output of the second stage. This particular version of the two-stage amplifier was used first, so far as I can discover, in the National Semiconductors L0001 low-power operational amplifier. Low-frequency small-signal voltage gains of up to 200,000 are possible using this layout.

The good gain and phase characteristics of this particular circuit arrangement have attracted the attention of Japanese designers seeking a circuit to provide enough gain to compensate for the relatively poor dynamic transfer characteristics of a simple, complementary-pair, power-mosfet source follower. The circuit design of Fig. 10a, with emitter resistors in $T_{s}$, helping to minimize $V_{os}$ differences, is normally simplified to that in Fig. 10b, which is recommended by Hitachi for use with their 25J and 25K-series complementary devices.

Because of the low impedance presented at the collector of $T_{s}$ (Fig. 10a), the input to the current-mirror active load, this circuit provides only a 'single-ended' output. This restriction may be avoided, with a further improvement in voltage gain, if the simple current mirror of Figs. 9 and 10 is replaced by the 'double-mirror' circuit shown, on its own, in Fig. 11. This provides an i.f. voltage gain in excess of 500,000, with a balanced push-pull output, which would be of advantage in circuits employing identical rather than complementary output devices.

There is, however, a point which must be borne in mind in this usage, that in any straightforward embodiment of this circuit arrangement, the d.c. output potential at the collector of the other transistor of the two-stage amplifier transistors can be controlled by the use of an alternative negative feedback path; the output potential at the collector of the other side will lie at any point between the +V and -V supply limits, which would preclude any significant undistorted output swing being obtained from the uncontrolled one. This difficulty can be removed, however, by using the output from the uncontrolled amplifier to regulate the input current supplied to the initial long-tailed pair, as shown in Fig. 12. This effectively stabilizes the output potential of this point as well, and leads to the interesting possibility of a truly symmetrical, very high-gain stage with phase differences, both of which can swing within nearly the total voltage range of the supply.

Power-mosfet amplifiers using the general circuit structure of Fig. 11 (Part 1), and any of the gain blocks of Figs. 9-12, will give very satisfactory steady-state r.h.d. and transient (step function) performance, but there is a fairly substantial snag in respect of the output stage quiescent current. This is normally controlled by some circuit arrangement such as the variable resistance in the collector circuit of $T_{s}$ in Fig. 10, which produces a suitable voltage drop to maintain an appropriate forward voltage bias on the output devices, and which may be adjusted to set the output stage quiescent current to a suitable value. This chosen value of forward bias must be stable, and maintained at the set value throughout the life of the amplifier, and affected as little as possible by changes in ambient temperature, supply line voltages or ageing of components.

Current mirrors, while providing excellent active loads to gain stages, are not, in any sense, constant-current sources, but merely circuit arrangements which reflect into the output limit the current fed into the input limit. In the circuit configuration of Fig. 10, the current through $T_{s}$ and $T_{d}$ is determined by the potential applied across the 'tail' resistance of $T_{x}$ and $T_{y}$, and the current gains and forward $V_{os}$ potentials of $T_{x}$ and $T_{y}$. In the circuit of Fig. 11, this current is determined mainly by the $V_{os}$ characteristics of $T_{x}$ and $T_{y}$ and...
the supply potential across the 22k feed resistors.

In such circuit configurations it is diffi-
cult to achieve quiescent current stability in
the output stage over the expected range
of supply voltage variations and fluctua-
tions in ambient temperature. So, with reg-
ter user's mind: how can the performance
of a constant-current source be used as a
constant-current element to T1 at 12 kV, if a
straightforward voltage droop circuit in this path was to be used to gener-
ate the feedback bias of the output devices.

While it is difficult to envisage any
standard constant-current source which
would have the same stability as a current
mirror active load, an analysis of the behav-
ior of such a load (active load) is that of a
current in resistors from (the parallel
antiparallel limbs) in an amplifier hav-
ing an overall negative feedback loop,
showing that it is possible to design circuits
for any arrangement given a similar gain in the negative feedback
within the negative feedback loop. This is a circuit technique of some antiquity
and more widely used, deliberately or inadver-
tently, than one might guess.

This realization, in addition to focusing
attention upon the possibilities and
penalties of the technique, opens the door
to the use of such a symmetrical amplifier
configuration, with each half feedback
against a standard constant-current load,
and an open-loop gain equal or greater
than that of the same circuit using a
current mirror as the second-stage load by
the use of a suitable positive-feedback
path, as shown in the circuit of Fig. 13.

In this, the polarities of the transistors
have been reversed in order to take advantage of the slightly more favorable characteristics of the p-channel junction fet constant-current source in the tail of the input long-tailed pair.

This use of positive feedback meets the
main requirements of such an application,
in that the positive feedback path is derived
from a stage operated under more
linear conditions than the main
amplifier loop, and with a wider gain/bandwidth characteristic. Since the positive feedback signal is applied to the same point at the p-channel, it can be seen as
cancelling part of the distorted signal
normally fed back, thus leaving the distortion components as a larger part
of the negative feedback input, which facilitates their reduction.

This type of circuit, as an application of
positive feedback, may be contrasted with
the very commonly employed output-stage
booster', in which the positive-feedback
signal is derived from a stage having worse linearity, and less good phase
characteristics, than the main stages.

The practical power mosfet audio
oscillator and the use of a suitable positive-feedback
amplifier stage, will be described in the
next part of this article. This circuit has an
output power of over 100 watts, depending on supply line voltage, and has very
stable operating conditions, gain and phase margins, and offers a significant advantage in audible
quality over conventional bipolar power
amplifier designs.

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To be concluded

The re-wiring of Britain

The following recommendations of the
Cabinet Office Information Technology
Advisory Panel (ITAP), the Home Secre-
tary asked Lord Hunt of Taxworth to
chair an inquiry into the implications of
cable technology and its effect on telecom-
munications policy. The inquiry is to be
completed by the end of September 1982.

Various bodies will be making
representations
to the Hunt inquiry and two
that we have received are from British Telecom
to the Department of Trade and Industry.
For once employers and employees
have found themselves accorded and their submissions are
ever so similar.

The BT and POEU submissions both point
to their equipment and technology as
advancing and new communications are
the telecommunication networks.

Multi-channel cable systems can be awarded
broadcast channels and 'now-casting', the
transmission of specialised, minority
programmes. There is a need in the near future to consider
the interest and
to watch
safety. Electronic mail systems can
direct information to one terminal or
to many if BT believes that the borderline
between broadcasting and telecom services
will be crossed.

Programme purveyors who need to
seek franchises to offer services
should not have monopoly ownership
of local broadcast networks.

All this leads, of course, to the logical
conclusion that BT should not only pro-
vide the cable network, but indeed have a
unique ability to do so. They already provide
point-to-point transmission of radio
and tv signals along their landslides. There is
an established force of engineers in the
field and the are owners of wayleaves, ducts, poles and street furniture.
They are providers of cable tv to areas including
an experimental fibre optic network in the City of Milton Keynes. Improvements to
the telecommunication network will require
a certain amount of re-cabling; if independent franchised programme
companies were to provide the cable system, unnecessary duplication would result.

Another aspect that the Hunt inquiry
has been asked to investigate is a supervi-
sory system. ITAP suggest that pro-
gramme providers should be self-regulat-
ing with a supervisory body such as the
Press Council. BT suggests that there could be an extension of the IBA's fran-
chising responsibilities.

The POEU highlights some of the
political implications. The Labour party
has promised that when they are next in
power, they will project MBs, or private
telephone network, under BT's wing. Similar policies are likely to be applied
to any cable service, and such political
uncertainty will deter potential commer-
cial providers of cable systems.

3-D tv \ did it work?

When we wrote about the TVS Real World 3-D experiments it was before the event, so we hadn't seen it. Now we have, Franco-British and the French version were the first viewings. There were some close up sequences of a man and woman looking at a computer
screen and other people poking different things out at the viewer. These were very effective but somewhat limited in applica-
tion. Other sequences of vehicles skidding on a test pad in Holland and of underwater examination of a plane (which was not so successful and offered little enhancement over conventional two-dimensional images). One possible explanation may not be because of any failure in the system but in production techniques. We also saw another transmission (in two dimen-
sions) of the Hollywood musical Kiss Me Kate when this was originally filmed. It was noticeable how often deep perspective and depth of field were employed to enhance the three-dimensional effect. When the anaglyph effects were added, the whole film must have been very spectac-
ular.

The transmission of the Real World not

WIRELESS WORLD 1982
WIRELESS WORLD 1982
Computer controlled

radio station

ATAC is a system for switching between transmitters and aerials. One to be used for the BBC’s overseas service in Cyprus will allow the director to be connected to any of 32 aerials, or to artificial loads, at a preselected time, frequency and mode dictated by operational requirements. The equipment has been designed, developed and manufactured by Drallim Davis Electronics.

Switching of the r.f. power between aerials and transmitters is accomplished by 250kW r.f. switches, pneumatically actuated and controlled by solid-state valves. Up to 250 of these switches are arranged in a matrix, housed in a special building.

Routing the signals through the matrix is achieved through a switching program module. Numbered plugs are inserted in sockets and actuate four switches corresponding to a number in b.c.d. Each group of plugs represents a code, for a transmitter mode or time switching instruction, which is stored in a computer memory. The condition of each r.f. switch is recorded by the computer which can send the appropriate signals to the actual switches that need to be switched. An important requirement is the ability to revert to manual control if needed. There is a keyswitch system which can do this and can also disconnect an aerial or transmitter for safety during maintenance.

The computer controls all the switching automatically and also maintains a record of all operations which is stored on disc and may be retrieved to diagnose, for example, any malfunction.

Drallim have supplied switching systems to all the Independent Local Radio stations. They are quick to point out that such a system, although designed for use with a radio station, is suitable for a wide range of industrial applications where the computer switches mechanical movement in a pre-arranged sequence.

Dolby for personal stereo

One recent explosive expansion in the audio industry is the development of the headphone cassette player exemplified by the Sony Walkman. With the reproduction of film-like audio on these units, Dolby Laboratories hopes to improve them by re-designing the Dolby A noise reduction system so that it can work at the lower voltages associated with the portable players. It not only needs to work at the lower voltages, but also be physically small enough to fit into these minuscule units. According to Dolby the development work is well advanced and only needs to be polished off before it starts to be marketed.

Plessey: a correction

In our March issue we reported that there is a six-month backlog in orders for the BBC computer used in conjunction with the current television service.

Our report stated that the cause of the backlog was the high drop-out rate in a gate array integrated circuit from Plessey. In fact, Plessey do not supply any gate arrays to BBC. Plessey have always been in any way concerned with their design. We apologise for any inconvenience caused and appreciate that Plessey are responsible for any delays in fulfilling orders for the BBC computer.

BBC’s micro — users comment

In this, the first BBC computer user’s newsletter, the computer will continue to adopt a reasonably neutral and objective stance on all questions relating to the BBC microcomputer. This word is used ‘reasonably’ may imply some cover for future comment but in this issue, honesty is the right attitude. Besides the usual presentation of programs and tips for using the computer, Beebbug, who calls himself the ‘registered referral centre for the BBC project’, informs readers as to how they might claim interest lost between Acorn cashing their cheque and receiving their goods, of what they might expect if the computer they eventually receive is faulty and has to be returned to the manufacturer (illustrated by a typical reader’s letter), and as to how long they might have to wait before receiving a computer ordered.

Dolby for personal stereo

A machine that can accept banknotes and reject forgeries is difficult to design because the ratio, between the acceptance of genuine notes and the rejection of forgeries and other, has to be finely adjusted. If it rejects too many genuine notes the customer becomes dissatisfied and will prefer to use some other facility. On the other hand if it accepts too many forgeries it becomes unprofitable. Landis & Gyr, a Swiss manufacturer settled on a 90% acceptance level is the right compromise. Their acceptance machine, type SN25, incorporates a microprocessor which enables it to measure the banknote and analyse the colour at pre-selected spots on the note. The computer may then be used to record the use of the machine. It monitors its own operation and adjusts its parameters on a statistical basis to give a desired range of 99.5% of all genuine notes. The machine may be fitted to a wide range of vending equipment and is intended to be of particular use in petrol vending.

Radiotelephones from Neve

When E.S.E. Ltd acquired the mobile radio systems of Neve Communications, they decided to use the existingNeve communication in their subsidiaries in a related field and launched Neve Radio Telephones. They are continuing to manufacture market and service the Neve range of mobile radios and radio telephones, but have wasted little time in getting new Neve products off the ground. One is a frequency-synthesised a.m./f.m. mobile radio telephone which is the subject of an order from the New West Gas authority and, claims Neve RT, is especially suitable for similar fuel and power customers who may have a large number of service vehicles. The mid-band model will shortly become available and is to be followed by low and high band models. The set has 80 channel capability which can be extended to 160 channels.

In brief

In order to make communications between combat aircraft more secure, an experimental Radiotelephone transmitted on an optical communication link. The system would transmit and receive a laser and non-coherent light of the infra-red range of the spectrum. Sets on each aircraft would be directed parabolically and would be usable in addition to conventional radio. Experiments are being carried out on both intensity-modulated and pulse-modulated systems.

The National Wireless Museum has recently been given a vast collection of very old service sheets, wiring diagrams and workshop manuals dealing with early radios, television receivers and even tape recorders. The Museum is willing to supply data and technical information free of charge to owners of very old equipment. The honorary curator is Douglas Byrne, 34 Pelham Road, Isle of Wight.

Enamelled steel substrates are likely to replace conventional p.c.b.s in electronic equipment of advanced design, according to a report following a nine-month evaluation by E.R.A. Technology. The principal reason is the thermal conductivity of the material which is about twice that of the enamelled substrate to withstand high temperatures. This will allow high density packing of integrated circuits with high-speed switching. Fine-line metallisation suitable for solder attachment of surface mounted devices is available; flow soldering techniques are being investigated.
There are a number of large-scale integrated circuits designed to make an instrument GPIB-compatible, so it is possible to develop an instrument interface without detailed knowledge of the protocols. Most of these are register oriented, implying the need for host processor, ram and rom circuitry. But a crude handicap will be the time required for software development. The Fairchild 96L5488 I.C. has the ability to perform a logic interface as a stand-alone unit independent of any host processor, so an interface may be quickly realised with a few logic chips, no host processor and no software development. Total chip count for the entire talker/listener unit was 14 I.C.s, including a 6402 UART for parallel/serial and serial/parallel data conversion and generator chip, MCM4411. (The serial interface used RS232C signal levels synchronized to a predetermined speed, link selectable to 1200, 600, 300 or 150 baud.) It is possible to duplicate the circuit board if fewer functions are required, for example a single keyboard might require only the talker capability. All the circuit components necessary for the complete interface were assembled with ease onto a single Eurocard prototyping board. The interface function subset incorporated in the GPIB RS232C circuit are listed as SHI source handshake AHI acceptance handshake T6 talker TE no extended talker addressing L4 listener LE0 no extended listener addressing SR1 service request RL0 remote/local C0 no controller capability. Connections of the 96L5488 to the signal lines, address and mode switches, and the clock and master reset circuitry are shown in Fig. 1. This configuration will be standard for most interface designs. The clock pulse is generated on-chip, but requires an external RC network to provide the necessary time constant for oscillation. 2001 and 220pF yield a clock of about 7MHz. The master reset pin is connected to a "power up" reset circuit using a 10kΩ resistor pull-up and 10μF capacitor to ground. The diode can be any medium current signal diode to provide a rapid discharge path for the capacitor when power is removed from the circuit. The talk and listen address assignment of the instrument is programmed on the five-way switch pack. The A1-A5 inputs to the 96L5488 will be individually set to either a logic high or low. Table 1 lists the range of addresses available. This switch pack should be located at the rear panel of the instrument chassis to make it easy to reprogram the address assignment. Table 2 shows the range of operating modes: M0-M3 inputs may be set high or low by the devices are connected in parallel, three lines subdivided into three groups data — eight signal lines byte transfer handshake — three signal lines general interface and management — five signal lines.

What is GPIB?
The general purpose instrument bus, originally defined in the Standard Digital Interface for Programmable Instrumentation ANSI/IEEE Std 488-1975, and revised in 1978 and 1980 as "Standard 488A", is now a standard instrument interface offering a universal approach to automatic operating, testing and measurement, and defines mechanical, electrical and functional specifications. It is a byte-serial, bi-directional parallel line structure organised to provide asynchronous communication of digital data between a maximum of 15 devices, called instruments, including at least one controller. They are classified into four categories:

- talks to GPIB
- listen to GPIB
- control GPIB
- sense GPIB

All instruments configured to the bus will fall into one of these categories. Electrical interconnection comprises a 16-wire structure where all the
four-way switch pack shown in Fig. 1 or, alternatively, by jumper links. The talker low or high-speed mode depends on whether the bus is configured around open-collector or three-state drivers. Table 3 shows the range of logic signals that reflect the state of the interface.

The TAD, LAD, and D/S/E outputs may be used as inputs to combinatorial logic or to drive LEDS to give visual indication of instrument status. Two additional logic outputs, not listed in Table 3, are also used to provide interface status information. The DRB output goes active low when the instrument is required to drive the bus data lines. When this output goes low it indicates that the instrument interface is either in the talker active state or in the serial poll active state. The R/L output provides remote or local status indication, but this feature is not used in the design. The talker/listener interface circuit is shown in Fig. 2. Although the data lines are connected to the 961.548 chip (necessary for message decoding) no data will pass through the device. The 6402 uart eight-bit transmit and receive register lines are connected through inverting buffer drivers to the bus data lines. The 961.548 chip provides the necessary handshake signals to ensure an synchronous transfer of data to the 6402 transmit buffer register when the interface is in the listener or talker active state, and from the 6402 receiver buffer register when the interface is in the talker active state.

When power is applied to the interface the master reset circuit resets the 961.548 chip and 6402 uart through the inverter and gate. The 74L574 latch is cleared. The Q output of this device is wired to the request service input of the 961.548. In response the 961.548 pulls the service request line low into the controller to conduct a serial poll; the line is used as wired or function for instruments configured to the bus. Any instrument requiring attention will assert this line by taking it low. The controller may then conduct a serial poll to determine the source of the service request. When initially powered the instrument will be in an off-line state, but requesting service, please see Table 3. This is to inform the controller that the interface is powered up and ready to be addressed as a talker or listener. The controller responds to the service request as follows. First the listen message is sent to all instruments, necessary to prevent listeners responding to status bytes as though they were data bytes, then the serial poll enable message is issued over the bus. The controller then issues the talk address of each instrument, and sets the attention line inactive to take the status byte of the instrument currently in serial poll active state.

When the serial interface receives its talk address the instrument enters the serial poll mode. The controller may listen to read the active low assertion of the request service output from the 961.548 chip on data line seven (the other data lines float passive high). When the controller accepts this status byte, STS will pulse high, driving STRDY low through the inverter. This illustrates the automatic response of the STS/STRDY handshake. The controller's command program may now recognize that power has been applied to the serial interface and it may be addressed as a talker or listener. The rising edge of STS will clock a high onto the Q output of the 74L574 removing the request for service.

**Listener Interface**

For a printer interface the instrument will be addressed as a listener. The LAD output goes low to illuminate the green led when the listen address is received. More than one listener may then be active on the bus at any one time but only one talker is permitted.

During the listener active state valid data on the data lines will be present at the TBR inputs of the 6402 from the outputs of the 74L5420 inverter. The 961.548 chip will decode the three-bus handshake lines to that RXST high when data has settled. The rising edge of RXST triggers the 121 nonostaible to its quasi-stable state. Its Q output will be low for a time constant of 0.7uS, then go high, the rising edge transferring data in the 6402 transmit buffer register to the internal transmitter register (delayed if the transmitter register is not empty). The 6402 serially transmits this data byte and automatically inserts the appropriate stop, start and parity bits. The format is pre-programmed by a binary data pattern set on the switch pack and resistor combination wired to the PI, EPE, SBS, CLS inputs, see Table 4. These control register inputs require that CRL be high during control register load. Data speed at the TR0 output is determined by the clock rate at the TRC input, 16 times the rate of the serialized data. The RXST/RXDRY handshake is completed when the transmit buffer register is empty, TBRE goes high informing the 961.548 chip that the port is ready to accept the next data byte for serial transmission. The local handshake is therefore achieved by RXST/BRB, and TBRE/RXDRY signals, decoded from the handshake signals. The actual speed of data byte transfer over the bus depends on the slowest active listener. If the printer interface is the only active listener, then the data lines will be ready for the talker to transmit the next data byte.

The signal conditioning and inversion required to drive the RS23C input from the 6402 output is achieved by the µA148 line driver circuit (pin 3).
Table 4. Codes required for character length and stop bit format in 6402.

<table>
<thead>
<tr>
<th>Character length (bits)</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stop bit</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

Character length selected

SBS input 5 bits 6 bits 7 bits 8 bits

P-I Parity — parity is high on this input when parity generation of a parity bit is low. A level 0 enables the generation of parity in the 6402.

EPE — parity enable — When PI is set high, a level 0 on the EPE input enables the parity enable generation. A level 0 enables odd parity checking and generation.

Talker Interface

Keyboard data may be transmitted over the data lines when the interface is addressed into the talker-active state. When the interface receives its address on the 961S48B TAD output goes low and the red led lights. When the controller drives ATN high, the TAD output goes low which will also drive the bus data and management lines and the keyboard data and activate the talker-active state. The D/S/E output will go low to 961S48B and if the bus is not busy the serial poll active state D/S/E will be high, disabling the bus driver bit and activating data line 24 driven by the RQS. The 74240 was chosen because it could drive the 6402 data line 24 for the 4mA current sink requirement of the bus electrical specifications. It also only has 7 pins and provides an interface for the often-overly-equivalent 74240.

Serial data from the RS232C interface is inverted and converted to a 6402 data line 24 parity bit automatically inserted, according to the program set on the five-way switch to the left of the 74240 (for character details). The data-ready output from the 6402 determines parity insertion or not. The 961S48B informs the controller on the bus that a data byte is present. When the data line 24 parity is even, the 961S48B asserts the TXST condition. If even parity is not used, the 961S48B asserts the TXST line high. The inverted output drives the data received during the parity generation, the data-ready output permitting the next byte to be transmitted. If parity error occurs during this time, it is assumed that the data sent was generated at the talker by the active listeners on the bus, therefore no overrun error will occur. It is up to the instrument designer to ensure a speed compatibility of instruments on the bus. If a fast talker is required to transmit data to one or more slow listeners then the listeners should have some kind of fast-end-of-frame buffer to reduce the possibility of data overrun. The talker will transfer a data string to the bus using the TXST/DRK and XR/TXRDY as local handshake.

A provision has been made for the transmission of an end-of-frame character to mark the end of a transmission. When an instrument is in the talker-active state it must set its end-of-frame character to zero (1001) when the transmission of the last byte in a transmission is complete. A low signal transmitted on the line concurrent with transmission of the final byte may be decoded by the 961S48B as an end-of-transmission character. The 961S48B is capable of decoding this message in the listener-active state, see the Serial poll active state for details. The 961S48B is capable of recognizing a unique end

no edge occurs during transmission but will go low if either a parity, framing or overflow error occurs during transmission. The 6402 status bits are latched internally, so the output of the three-input OR gate stays low as long as the 6402 receives a master reset. If the communication interface of the PEP is too low, the interface would respond by asserting its assigned data line during the parity generation period and the controller will read as this error condition, the error occurring during transmission or reception. The absence of the assigned data bit would indicate that no error had occurred during transmission or reception.

A master reset may be issued to the 6402 in the form of a device clear message or a selected device clear message. It will be necessary to clear the PE, FE or UE if one of the data bits of the 961S48B are left in the on state. The PE bit is set to 0 on to about 100 MHz were coming into memory fetching their own data from their own back yards! By the 1930s not only h.f. was opening up but "microcuits" were spanning the Earth. The channels were divided by the 961S48B, the Klystron and (later) the traveling-wave-tube opened up an extensive microwave spectrum that has opened up all of the useful frequencies. Japan now has some local urban broadband links on 40 GHz, possibly the highest frequency to be used for commercial telecommunications, and one notes that the Rutherford and Appleton Laboratories have developed methods of measuring molecular absorption by atmospheric gases in the 100 to 1000 GHz region.

Conferences galore

Over the past couple of decades, large conferences, seminars and associated trade exhibitions seem to have become more popular. These are held in a number of locations specializing. This is certainly true of the telecommunications, radio communications and other meetings held in the United States. In the space of the one month of April there was the enormous annual NAB National Association of Broadcasters Conference in Las Vegas, followed by the annual event in Dallas, Texas involving some 30000 people, where the R and D and results of these studies are of practical importance both for communications and satellite broadcasting. It is clear that these events are rather more serious than originally thought. But, at least for European DBS systems, the main technological parameters were determined in 1977 and it is now possible that the R and D results important though they are, will have only limited influence on the systems planning for the world. The Nordic NBS plans to start next year with margins etc. that theoretically should be provided in those parts of the world subject to monsoons, tropical rainfall or where ice crystals can reduce the co-channel and adjacent channel protection provided by polarization discrimination.

Modelling h.f. propagation

The conference also underlined the continued search for accurate "modeling" of h.f. propagation. Despite some 60 years of study, it is clear that nobody can yet predict accurately and with any degree of optimism working frequencies or those for ten years ahead. Neither the short-term (daily) variations of up to about 10% nor the maxima or minima of future sunspot cycles can be predicted with any degree of certainty by even the most complex, computer based models. This does not stop R and D from trying and - as usual - the conferences are full of attempts to predict remains as an uncertain as long-range weather forecasting, though one notes that one of the papers at the conference was by the Institute of Telecommunication Engineers of Canada, which uses a computer model based upon a number of transmission models and the ionosphere must be measured, quantified, and interpreted before predictions can be made. The results of these forecasts are then input to the organizers if the conferences are to be held.

Above the m.u.f.

At York University, H. P. Williams noted the way in which, at 18 MHz it is possible to use frequencies above the m.u.f. (though surprisingly be made no mention of the regular "long-path" type of chord hop propagation now well established. But he does make the interesting suggestion of using 22 MHz, 14 MHz, 2.4 GHz (commercial or military "meter-scatter" component of the DVB-RCS system), 5 GHz (v.h.f.). Some of the original investigations by Professor G. V. Villard of Stanford University were noted. It was pointed that meteors from meteor trails can be detected as an almost continuous weak-signal back- ground on frequencies down to about 4 MHz. H. P. Williams believes that meteors-burst communications at h.f. could be of practical value for medium-distance paths of about 1000 km, at times when the path was otherwise closed to ionospheric reflections.

Noted at NAB

American medium-wave (a.m.) broadcasters are worried at the prospect of reduced nighttime "clear channel" coverage following the walk-out announced by the Region 2 Planning conference after filing a plan for 187 m.u.f. stations (without directional antennas) on the 580 kHz frequency. Another problem is the FCC's decision to have the choice of an am and h.f. system to the market place while there are still four aggressively competing and one that will be "neutral" to the AM-OM, Motorola, COMA (COMA), Harris VCP and Kahn/Harwood Independent Stations.

A new development is a new category of TV broadcasting as a "Low power station" (LPS) service. These are not to be regulated regulations. Three competing systems are being investigated for multicultural sound on tv; a Japanese

www.americanradiohistory.com
First moonbounce

The ability to make worldwide contacts on v.h.f. and u.h.f. by utilizing the earth-moon-earth path continues to attract more enthusiasts into this branch of the hobby, despite the demanding requirements in terms of serials, transmitter powers and low-noise receivers. Stuart Jones, G7FJWY, near Swansea recently succeeded in being the first amateur in Wales to "work all continents" on 22 MHz moonbounce. G7HVU and G7DEarth have also successfully used a 4-metre dish aerial design, despite the limited conditions on 14.04 MHz, and this is believed to be one of the smallest dishes yet used on this band.

The well established annual amateur radio reception at NAB a plaque was presented to John De Witt, N4CB (formerly W4ER and W4FU) who as a lieutenant colonel in the U.S. Army Signal Corps was one of many units in charge of the project at the Evans Signal Laboratory that led to the first successful "moonbounce". The first contact on January 10, 1946 when a quarter-second pulse was transmitted on 111.5 MHz, and 2½ seconds later a faint returning "beep" was heard. Earlier, in May 1940 while chief engineer at the Signal Corps equipment in Nashville, Tennessee "Jack" De Witt had attempted to achieve moonbounce and shortly after V-J day he again turned his attention to the question, this time based on modified radar equipment with a 64-dipole aerial array and narrow-band quadruple-Gibert receiver tuned to take advantage of doppler frequency shift. The first engineer actually to hear the moon-echoes was Herbert Kaufman, W2OUG. The idea of hearing radio signals from the moon was even then not new. As early as September 1921, QST had warned: "A whimsical lad called Maloney, A ham in the art of Marconi, Once enjoyed to tune.... A spark from the moon."

With suspicion regarded he's now always tuned. Beware lest you follow Maloney! Fortunately many amateurs have been able to follow in the steps of Maloney, De Witt and Kaufman without incurring excessive suspicion as to their sanity. Indeed v.h.f. equipment on 22 MHz is now well established.

Amateur tv

In QST, D. J. Long, G6PTU suggests that for amateur television transmissions on bands above 432 MHz consideration should be given to frequency-modulation of the vision channel. With the approach of direct-broadcasting from satellite, componen-
ts for L-band tv receivers will be readily available. Problems may be to find 27 MHz or so of available satellite spectrum. Grant Dixon, G1GRC draws attention to the availability of on-off or analogue/digital converters (at around £60) that provides 6-bit (4-level coding), sufficient for entertainment purposes in a digital video system. The British Amateur Television Group will hold its 1982 convention at the Post House Hotel, Leicester on September 4-5. John Wood, G3YTC, editor of CQ-
TV, has started trying to compile a history of amateur television from the earliest pre-
broadcast days. Amateur tv enthusiasts in the Bath and Leicester areas are seeking to establish new tv repeaters.

It was just 30 years ago, in May 1952 that what is believed to have been the first amateur two-way high-definition tv service was established on 144 MHz in the USA. It was successful in the first half of 1952. In recent years, Jones, G3ZST of Plymouth and Fred Rose, G3BLVY who lived in Sunderland but brought his equipment by car to the Plymouth area. The a.v.t. stations had taken some three years to build.

Here and there

Just after World War II, when many ama-
teurs were eagerly buying up surplus mili-
tary equipment, there were frequent occasions that some airborne equipment con-
tained explosive devices intended to prevent the equipment falling intact into enemy hands. However, R. C. Field, G6HMP, recently had an unpleasant sur-
prise when an old IPP (Identification Friend or Foe) unit which had been in his possession for 36 years exploded without warning, wrecking his garden shed, and fortunately resulting in no human casualties.

As many amateurs are participating in a study being carried out for CCIR into the extend of v.h.f. sporadic-E propagation on the v.h.f. bands. On 144 MHz this has been found to exceed greatly that predicted by methods currently recom-
manded by CCIR. Of particular import-
tance will be the observation of the duration of such events as established by the large network of European v.h.f. enthu-
siasts.

At the recent IEE Conference on York University, R. G. Flavel, G1LTP de-
cussed the work of European amateurs in determining the limits of long-range tropo-
ospheric propagation on 144MHz and 432MHz in anticyclonic weather condi-
tions. He pointed out that although doubts had sometimes been raised on some quar-
ters back in the 1960's and 70's a distance claimed by amateurs, there was good independent evidence relating to the long distance tropospheric propagation (as recorded) achieved in a two-way contact on 144MHz between London and the Canary Islands on August 6, 1980.

The revised schedule for the British amateur radio licenses finally appeared in the London, Belfast and Edinburgh Ge-
zettes on April 16 and the Home Office has re-
sumed the issue of new licenses. The ARRL has formally asked the FCC to set up a list of amateur frequencies by American amateurs which is similar to the existing "amateur radio operators in many states' list of serially numbered frequencies which are used by operators of cable systems which 'peak' radio frequency energy on amateur frequencies, and the interference caused by operation of cable systems as a result of cable television systems are subjected to interference from amateur v.h.f. stations." It is noted that problems arise from inadequate shieldings of the cable systems, the use of poor quality components, imperfect installation procedures and that the problem cannot be resolved in the context of the present regulatory framework. The ARRL has also formally opposed the re-
placement of cable television stations which use currently limited radiation to 20W max at 100 MHz between 54 and 216MHz but which may be increased to 100W at 440 MHz.

In brief

ZD9GI a 28.212MHz beacon station on Gough Island in the South Atlantic, operated, by members of the weather station... Some Swedish ama-
teurs are active on 1.8MHz and more countries are now getting beacon on this band. The ARRL DX contests WSO-7 (World Satellite Orinda) will in March with the ARRL having already 100 stations confirmed using a 2-watt Heathkit HX68 receiver among the high-power stations in New Jersey and New York. Almost per cent of his contacts were on 21MHz, 35MHz on 432MHz and all others between 7MHz and 70MHz. New York, New York, New York... The Americans are shortly to begin operating an over-the-horizon radar between 5 and 355MHz located near Law-
cow, Maine. It will have an effective radiated power of the order of 1.5MW. The American military has promised to cooperate with h.f. users to minimize interference which should prove less than expected from the radar's "woodpecker" system... The FCC have suspended licences of two European ama-
teurs who have deliberately jammed an amateur net on 144MHz.

PAT HAWKER, G3VA

MICROCOMPUTER LINE PRINTER

Requiring 'hard copy' from a Z80-based microcomputer to aid program compilation, the author has obtained a 40-column dot-matrix printer for a dedicated controller i.e. and designed an interface around them. The result - a cost-effective line printer with few components - lends itself to modification and to other applications.

by P. L. Woods

Generally, and excluding the cassette re-
corder, a printer is the most useful peri-
pheral for a small computer. Hard copy of program listings or compiled results for documentation and dissemination pur-
poses is a simple first application. Spring to mind, but probably the most interesting aspect of a printer as far as serious microcomputer users are concerned is use as an aid to program debugging and compilation. It is far easier to find an error in a complete listing on paper than it is from a partial listing on a c.r.t. screen.

Given these merits, it is surprising to find that for some small computers, directly compatible printers are not readily available. Many complete units requiring only a standard serial or parallel interface are available, but for my purposes, they were found too expensive, too large and too heavy. For these reasons I decided to choose from several bare bone 'inexpensive' dot-matrix printers which are sold now on the market, and design an interface around it.

One of the advantages, many have only between 16 and 20 printing positions, since they are intended for use in cathode ray registers and similar equipment. For vertical row of seven solenoid-operated needles are drawn across the surface of the paper and carefully timed pulses are sent to the solenoids to leave a pattern of dots on the paper, forming the selected charac-
ter. A standard (group 24) typewriter rib-
bon is used in this case. The print head is driven along the line by a motor driven lead screw, while a timing signal derived from a pickup coil driven by this motor ensures a correctly proportioned character. The motor also drives the paper sense mechanism through a series of gears. The mechanism is quite small, measuring 5.7cm high by 15.4cm wide by 14.7cm long, and can easily be mounted in a small cabinet. My container measures 12.5cm high by 17.5cm wide by 21.5cm deep, the extra length being needed to hold the solenoid driven circuit in the bottom of the box.

Dot-matrix printers need a character generator to form the pattern of dots for the desired character set. For this mech-

by P. L. Woods


dot-matrix printer.

practical listings in Basic or assembly lan-
mence, more columns are needed. Another variable to take into account when choos-
ing a mechanism is that of paper type. Many dot-matrix printers are available, with a range of quality and price.

The final choice was a plain-paper dot-

Mechanism

The DP-8242F-24 is a 24 volt d.c. mechan-
ism capable of printing 40 characters per second on a roll of plain paper 114cm (4.5 inches) wide. This gives a character density of about 12 characters per inch, which is the same as that given by many type-

writing machines. The printer prints 6 lines per inch at about 1.2 lines per second, the actual rate depending on the microcomputer soft-
ware used. Since the number of bytes of printing provided by this unit can be obtained from the listings shown for this, and in most dot-matrix printers, a

Fig. 1. Block diagram of the printer interface.

Timers

Data bus

Control bus

Port select

Interrupt acknowledge

Buffer

Main control board

Printer controller chip

Printer drivers

Address bus

by P. L. Woods

Sunola drivers'
Fig. 2. Port select and interrupt circuits. Address decoding may be varied (see text) and in most situations, the interrupt circuits may be ignored and pin 3 of IC9 connected to ground.

Interface board. This circuit serves to connect the printer to the microprocessor. The DIN41612 connector on the left plugs into the back plane of the author's computer system and the signals to and from the printer are conveyed via the 'D' connector at the right. The large integrated circuit in the centre is the printer controller chip.

Circuit description
Figure 1 shows a block diagram of the interface, separated into two parts by a dotted line. Circuits to the left of the line form the controller and carry low-level I.C. signals, while those on the right are for driving the motor and solenoids and thus carry high-voltage high-current signals. These two sections are kept separate as the common surge caused when all the solenoids are switched on at once is around 30A. The driver circuits are mounted in the container with the printer mechanism and connected by a ribbon cable to the controller section, which is kept close to the computer.

Port-select and control logic
A detailed circuit diagram of the controller is shown in Figs 2 and 3. First consider Fig. 2. This is the printer port-select logic, and general and interrupt control logic. Although designed into the circuit, the interrupt function is not needed to successfully operate the circuit and may thus be omitted.

Z80 and 8080 devices have input/output instructions to activate their peripherals. Thus the first step in the interface design is to establish whether an I/O instruction is occurring, and whether it addressing the printer board.

IC8 and IC9 perform the address-decoding and port-select functions. Depending on the precise address required for the printer, the address lines are fed either into one of the two NOR gates, IC12 or IC10 or into the NAND gate, IC8. The RQRQ signal is active when the current instruction is an I/O instruction, and the MT signal is used for synchronisation purposes.

The controller, as shown, is set to respond to port OC (biquadratic), but any other address could be used if needed. Only the least significant lines of the address bus (A0 to A7) are used by I/O instructions. Connect any line of the address bus which must be high when the printer is to be active to an input on the NAND gate, IC8, and all of the other address lines (A0 to A7) to an input on the NOR gate, IC1. The circuit is designed such that when the port is selected, the output of IC8 (pin 8) goes low. This is the Port select signal.

IC8 buffers the Port acknowledge signal on its way back to the microprocessor, and the computer's hardware needs this signal but in most cases it will either remain unused or, in systems with a fast microprocessor such as the Z80A or Z80B, used to generate a processor wait signal.

Interrupt logic
The remainder of Fig. 2 is the interrupt handling circuit and comprises IC9a, IC9b, IC5, IC11 and S1-S4. If unwanted, this section may be omitted, in which case pin 3 of IC9 is connected to ground.

When the printer controller chip, IC14, becomes idle, a 4 ms pulse is generated by IC13 which sets an interrupt request latch formed by IC12 and IC13. This signal is buffered on its way to the microprocessor by IC5. When the Z80 microprocessor generates an interrupt acknowledge cycle, IC9a and IC9b will establish the priority of the board concerned in the interrupt priority chain, and, if selected, will send the output of IC9b (pin 12) low. This enables IC9 to connect switches S1 to S3 onto the internal data bus, and then through IC9 to the system data bus. Further, IC9a automatically clears the interrupt request latch.

Switches S1 to S4 are used to set up the interrupt reply byte to the microprocessor and serve to tell the software that it is the printer that needs attention. The value set on the switches will depend on the system software written, and so is outside the scope of this article.

To be continued

Components

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<td>115 12 V, 1 w</td>
<td>302 TIP120</td>
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</table>

Others

X1 L 6.0 MHz (HC25U)

Transformer

9V, 1A and 12V, 2A

www.americanradiohistory.com
By J. R. Watkinson*

Timing of the sector pulse occurring between data blocks is critical because this signal is used to initialize logic circuits for reading a header. There are two ways in which the timing of the pulse may be adjusted, depending on the type of drive. Sometimes a fixed transducer is used and the pulse is varied by altering the setting of a monostable circuit; in other cases, the pulse is varied by moving the transducer tangentially in relation to the disc. Whatever method is used, the adnaxial is made using a reference disc pack to ensure that all the drives concerned have exactly the same setting.

Pulses from the transducer increment the sector counter. In Fig. 3, it can be seen that the sector detection disc has a double slot at one point on its circumference. When these slots pass the detector, the timing logic circuit generates a separate pulse to reset the sector counter.

The desired-sector register is loaded from the host p.c.u. as part of the address cycle. This register is compared with the sector counter by the disc-control logic. When the two match, the desired sector is located. This process is referred to as a search, and usually takes place after a seek to the desired cylinder. Having found the correct physical block on the disc, the next step is to read the header of that block to determine all the data addresses contained in the same as the desired address. Following this confirmation the data transfer program continues. This is the case for each address on the section on disc-control logic.

The sector counter is often accessible by the host p.c.u. as the current-sector register. In a multi-drive system, part of the operation is to decide which drive to order to carry out the many data transfer requests. In Fig. 4, two drives are on the correct cylinder, waiting for the desired-sector block to come under the heads. By referring to the current-sector register in the two drives, the system can decide which data transfer to make first for maximum efficiency. For this reason the current-sector register is often called the look-ahead register.

Cooling and filtration

It has been stated that the ‘flying height’ of the head is very low indeed. Figure 5 shows how the relationship between flying height and contaminant concentration. Air in the vicinity of the disc and head must be totally free from contaminants or serious problems may result. Any particle carried under the head is likely to weld itself in place, with the head in relative speed, and acting as a nucleus for the collection of further debris. In the absence of a regular purging programme, the advent of debris continues until the flying characteristic of the head are so impaired that it can no longer function. A purging system, therefore, is a valuable addition to the disc-drive system, making a more effective treatment of the contaminant possible. This will reduce the wear and tear on the head and drive.

Most of the heat from the spindle motor, which may be up to 500W, is dissipated in the surrounding air, by the disc surface. To get the best results from the heat dissipation, a good fit of the disc to the spindle is essential and this requires that the motor to be used has suitable bearings and a good fit of the disc to the spindle. In the case of the disc-speed, this requires that the motor to be used has suitable bearings and a good fit of the disc to the spindle.

Power supplies and grounding

A typical disc drive will contain circuits of many different kinds, both analogue and digital, from low-noise linear amplifiers at the top and exhaust at the bottom. If the units are badly positioned, air can recirculate more rapidly than flow back to the air conditioner.

Squirrel-cage induction motors are most commonly used to drive the spindle. Electrical interference, mechanical noise and physical wear from brush type motors make them unacceptable for this application, and the power required to turn a relatively heavy disc pack at speeds of 3600 r.p.m. discounts shaded-pole motors. Two types of spindle motor are often encountered; one, the so-called two-phase or capacitor-run motor, has a second winding fed by a phase-advance capacitor to achieve field rotation and the other has an auxiliary starting winding switched in and out of circuit taken.

Larger drives use three-phase motors with windings designed to work at between 200 and 240V, and the windings may easily be configured to suit either 110 or 240V mains supplies. Almost every spindle is coupled to its motor by a textile belt and pulley arrangement, which may be changed to suit either 50 or 60Hz mains frequencies and thus compensate for the

*B.Sc., M.Sc., Digital Equipment Co.
the heads, to high-power e.m.a. drivers, from slow transistor logic to c.e.i. in the serial-binary data channel. Many supply rails are needed to feed the various component families, Fig. 6.

The signal from a reading head may only be a few millivolts, and in order to ensure reliable operation, the read channel has to be as noise immune as possible. In an earlier article it was explained that the read amplifiers are differential for noise rejection, the write-read matrix is usually entirely screened for the same reason. The remaining circuits must be designed to cause as little interference as possible.

Switched-mode power supplies are excluded from thedisc drives, but pulse-width modulated e.m.a. drivers are acceptable since no data transfer takes place during a seek, and the servo returns to linear operation during track following. Linear-circuit supplies usually have current feedback protection, and the circuit can usually withstand the raw supply should the regulator fail. The logic supply will, however, have an overvoltage crowbar. Some circuit breakers used have a trip coil whereby the drive can turn off its own power in the case of an over-temperature condition or insufficient airflow.

As with all mixed circuitry, the problem of ground return currents must be eliminated by careful design. Figure 7(a) shows analogue and logic signals sharing the same return. Currents from the logic inject noise into the analogue signal owing to the poor layout; Figure 7(b) shows a better layout. Many mixed-circuit modules have separate connections for logic ground and analogue ground, which may find their way to the frame through quite different back-plane routes. The usual precautions must be taken with the analogue circuitry to ensure stability, which means, for example, that e.m.a. driver currents must not cause ground potentials in the analogue servo circuit.

In some drives, the grounding is split, the disc, positioner and circuitry being grounded to the host processor, and the frame and spindle motor being grounded to the a.c. supply lead.

Figure 8 shows an emergency-rectify circuit intended to protect the heads and the circuitry in the event of a supply failure. Drastic reductions in track spacing, and hence increases in storage density, may be made if the read/write head's position is determined by information on the disc surface. Servo systems using these techniques are described in the next article.

Fig. 8. An emergency rectifier circuit. In the event of a logic circuit or low-level signal power failure, the positioner retreats by the normal means. Should the power supply to the servo amplifier fall, power is supplied to the rectifier mechanism by an NiCd battery or, in the case of larger drives, by an electrolytic capacitor.

DATA ACQUISITION UNITS

These small data-acquisition units are designed for use by experimenters and scientists who are not necessarily familiar with computers. Analogue inputs are converted to 8-bit digital information, linearized, and sent to a computer, d.v.d. or printer in serial form as ASCII characters. The linearization process, which may be bypassed, is selectable for 0%, 5%, 10%, 15% and 20%. In microcomputer systems, platinum resistance thermometers and square-law sensors seldom compensation internal but may also be bypassed. Single character commands, in ASCII form may be used to control the data flow through a 2kbit or 8kbit (RS232 is optional) to the computer. Alternatively, for applications such as data logging, data may be transmitted automatically. Up to 256 units, each with its own address may be connected to a single loop. Field Electronics Ltd, Gill House, Conwy Street, Hove, East Sussex BN3 1LW.

PPRINTER BUFFER/INTERFACE

Most microcomputers may not be used while printing. The information is stored as characters. When the printer is slow, or the amount of hard copy required is very large, a buffer memory may be used to take information from the computer, store it quickly and send it out to the printer slowly, leaving the computer free. Splitters, from Miltex, is such a buffer with RS232, Centronics and IEEE inputs and outputs that may be used in any combination. Protocol conversion, from, say ASCII to Tek's or TSS photo-erupting code, is possible and the unit may be used as an interface-standard converter. The 12k of buffer memory, the Splitter costs £25 excluding v.a.t., or with £160, £185. A 6502 microprocessor running at 2.4MHz is used in the unit: Monick, Quarry Hill, Bex, W19.

INFRA-RED THERMOMETER

A non-contact thermometer with an infra-red sensing device, from Prolog Instruments, can be used to measure temperatures from 30 to 750°C, with a resolution of 1°C. The meter has a thermocouple so put adjacency is made to suit the emissivity of the material being measured; the detectable range is 0 to 700°C. A 1mA/1°C analogue output is provided and a peak hold facility may be used to store maximum readings. Up to 100WP, the meter's readings are within 2% of the actual temperature and above 20W, ±1.5%, ±1 digit. Complete with sensor, the thermometer costs £45. Prolog Instruments Co., Greenside House, Little West, Ennef, Hans P010 7XN.

GRAPH SOFTWARE

A follow up to their recently introduced software for solving mathematical problems, I.S.M. have brought out Graphmatic, a program which turns mathematical data into graphs or diagrams. Plot charts, line graphs and bar graphs are among the examples given. At the moment, the graph software is only be run on the Apple computer but there are plans to adapt the program to run on the IBM computer and with CP/M. Mathematically, however, is available for Apple, TRS80, and IBM personal computers and for use with any Z80-based microcomputer.

Running CP/M, International Software Marketing, Hayden House, 5-6 Millmead, Guildford, Surrey GU7 5ZB.

64K DYNAMIC R.A.M.

Plastic packaged 64K d.r.a. d.u.s. for industrial use are available from Hita- chi in 150 and 300ns access time versions. The HM64464 may be used as a direct replacement for conventional ceramic-packaged types and costs £6.89 or £6.47 to 10-off quantities for the 150ns and 200ns types respectively. Hitachi (UK) Ltd, Hicine House, 211-225 Station Road, Harrow, Middlesex.

WIDEWAVE ANTENNA

A relatively small 50W wideband antenna with a frequency range of 150 to 2000MHz is produced by Applied Communications. With a gain approximately equal to a half-wave dipole, the 9041 has circular polarization and is suitable for use with both, receiving and transmitting. The manufacturers claim that the antenna may be used with frequencies from 70 to 3000MHz. With its fibre-glass housing, the 9041 measures 650 by 600 by 40mm and weighs 5.8kg. Applications include widespread laboratory measurements and general surveillance. Applied Communications (UK), Tower Street, Coventry CV1 1JP.

WORLD PRODUCTS

WIRELESS WORLD JULY 1982

heat sink. Richo International have introduced a glass-filled nylon plate that will replace these four shoulder washers. Richo International, West Street, Exeter, Kent DA1 1AA.

PCB PROTOTYPING AID

Boards fitted with numerous pillars are the heart of BICC-Verso's Speedwire system. On the component side of the board, these pillars form selectively gold-plated contacts into which the leads of chips or discrete components are inserted. Each pillar is terminated by an insulating plug in place for point-to-point wiring on the underside of the board, the times are reusable and can accept two wires.

WIRELESS WORLD JULY 1982

Initially, two kits are being offered. One kit contains a 100 by 150mm Eurocard, a binding wire and pins, and contacts with a miniature insering tool. A more comprehensive kit comprises a plated-through-hole Eurocard fitted with contacts, wiring pin and wire. BICC-Verso Packaging, Industrial Estate, Chellaston Ford, Eastleigh, Hants SO5 5ZS.

WW306
NEW PRODUCTS

HARMONIC SCALES
Digital displays are accurately readable, can contain as many digits as the associated electronics can support and give the impression (though not always the reality) of authority. For many purposes they are ideal; for others they cannot be used at all. If the reading changes, the display can be confusing and give a poor indication of the direction of change, its speed or of what proportion of full scale the reading occupies. In these circumstances, an analogue indicator of some kind is a great deal more informative, so that the use of two meters is the ideal.

In a development claimed by Si-fem to be unique, both kinds of indicator are used in one instrument. The Harmony is a multi-purpose meter which possesses the usual kind of liquid-crystal, numerical display (albeit in several colours), but with an associated bar indicator on the same panel. Measurement accuracy is the province of the digital readout, the function of the bar being to indicate the reading fairly quickly, following changes to show the direction and rate of change and the position of the digital reading against a background of full scale. The bar can be left, right, centre or offset zero, and both displays may be of the suppressed-zero type.

By means of a built-in microprocessor and e.p.r.o.m., the meter can be used for a variety of functions, can display any desired unit, and can cope with non-linear characteristics. Relevant information on ranges, units in use, decimal-point position and function selected appears on the display.

Harmony is made by Si-fem Ltd, Woodland Road, Torquay, Devon TQ2 7AY and costs £35 in small quantities.

WWW309

BRIGHT LEDS
Seven-segment L.C.D. displays giving light outputs in excess of 5mcd at 3Vdc/21mA are available through IMI Electronics. Both common-anode and common-cathode types are available in heights of 8, 10, 12.5 and 15mm. Pin spacings of the 6000 series displays conform to the standard 0.1-in matrix. These displays are "two times brighter than other manufacturers' equivalents", and "have an unexcelled uniformity of brilliance", claims the distributor. IMI will not say who manufactures these LEDs, but they assure them that they are made in Japan. We measured exactly the same response when we approached the blue LED's distributor (JFP, May) but we are almost certain that there are only two major Japanese manufacturers making blue LEDs - Matsushita and Sanyo (neither UK subsidiary has these blue LEDs or any knowledge of a deal). Finding out who might manufacture these seven-segment displays is going to be a harder task. IMI Electronics Ltd, 100 North Circular Road, Staples Corner, London NW2 1JP.

WWW310

16K STATIC R.A.M.
A second-source device, the MV516 c.m.o.s. static r.a.m., is the first large-scale integrated memory to appear from Hewlett Packard Semiconductors. The manufacturer says that their 2K by 8-bit word memory will be attractive to UK buyers requiring large quantities and reliable after-sales back up. Two chip-enable inputs are used, one for memory access in 250ns and the second, for 0.25µs power consumption in standby mode. While operating, the device consumes around 200µW. The 24-pin package has the same configuration as the 2716 e.p.r.o.m., and its outputs and inputs are i.e. compatible. Hewlett Packard Semiconductors Ltd, Cheyney Manor, Swindon, Wilts SN2 2QW.

WWW311

RESIDUAL-GAS ANALYSER
Sputtering vacuum impurities cause problems in semiconductor manufacturing processes. According to CVC, manufacturers of the Miniquad gas analyser, total-pressure gauges often used to judge impurities in this application have limitations in that they are not capable of measuring individual residual gases accurately. Their instrument will detect partial pressures of all gases of interest and can be used to initiate a sputtering process automatically once a desired partial pressure has been reached. Besides gas analysis, the apparatus adds detection of leaks, vacuum pressure and impurities. Detector heads are interchangeable so the unit may be used for monitoring in different types of system. CVC Scientific Products Ltd, Earlsfield Avenue, Wokingham, Berks RG11 2PW.

WWW312

WWW - 909 FOR FURTHER DETAILS

WIRELESS WORLD JULY 1982

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TELECO

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- OEC, HNC, or A Level qualifications, but good relevant experience would outweigh any lack of formal qualifications;
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- Good personal skills for working with customers;
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Appointments Vacant Advertisements appear on pages 103-111

WIRELESS WORLD JULY 1982

TEK MULTIPLE OSCILLOSCOPES

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The Tektronix 2200 Series. Simply great.

Tektronix traditions of excellence in designing and manufacturing oscilloscopes are recognised all over the world. But with the 2131 and 2215 at £600*, these 60 MHz dual trace oscilloscopes are an entirely new form of instrument.

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Tektronix UK Limited

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Regional Telephone Numbers: Maidenhead (0688) 73211, Manchester 061 428 0799, Livingston 031 327600, Dublin 004655, 900579

WIRELESS WORLD JULY 1982

TEK MULTIPURPOSE OSCILLOSCOPES

SO ADVANCED THEY COST YOU LESS

The Tektronix 2200 Series. Simply great.

Tektronix traditions of excellence in designing and manufacturing oscilloscopes are recognised all over the world. But with the 2131 and 2215 at £600*, these 60 MHz dual trace oscilloscopes are an entirely new form of instrument.

Their most remarkable characteristic is the way in which major design advances have provided full-range capabilities at prices significantly below what you would expect to pay. How has this been accomplished? To begin with we have reduced the number of mechanical parts by more than half. This not only saves manufacturing time, it lowers costs and improves reliability.

Board construction has been greatly simplified and the number of boards reduced. Board connectors have also been reduced substantially and cabling out by an amazing 90%.

The 2131 and 2215 have a high efficiency regulated power supply which does away with the need for a heavy power transformer. There are no line-voltage adjustments. Just plug the instrument into a power socket supplying anything from 90 to 250 volts, 46-62 Hz, switch on and you are ready to use. Power saving circuitry has eliminated the cooling fan, resulting in further economies in size and weight.

These scopes have it all. Dual trace. Delayed sweep for fast, accurate timing measurements. Single time base in the 2131, dual time bases in the 2215. An advanced triggering system: automatic focus and intensity. Beam finder — and much more.

Interested? Then why not telephone your nearest Tektronix office or circle the enquiry number for further information.

Performance Specifications

- Bandwidth: Two channels, DC-60 MHz to 20 mV/div, 50 MHz to 2 mV/div.
- Light Weight: 6.1 kg (13 lb), 6.8 kg (15 lb) with cover and punch.
- Sweep Speeds: Sweep from 0.5 to 0.05 μs (to 5 ns/div with ×10 magnification).
- Sensitivity: Scale factors from 100 V/div (10x probe) to 2 mV/div (100x probe). Accuracy to ±3% at DC coupling.
- Also available from Electroplan.

* Prices subject to change without notice.

Tektronix UK Limited

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WIRELESS WORLD JULY 1982
Now there is another choice in high quality solder. The new Oryx resin cored solder. Try it and you will find it spreads easier than the solder you are using.

Specially formulated for fast precision solder work, it is 60% tin, 40% lead alloy with quality flux construction and melts at 183°C.

Two gauges are available - 18 SWG (1.2mm) and 22 SWG (0.71mm) in 2.5kg, 500g, 250g and 100g reels. Pocket size dispenser with 10 feet of Oryx 1mm solder is also available at only 68p (+VAT).

Oryx is competitively priced - write now for details and technical information.

Greenwood Electronics
Greenwood Electronics Limited, Portman Road, Reading, Berkshire RG3 1NE. Telephone: (0734) 595844. Telex: 848659

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The TC82-a significant development in temperature controlled soldering

The new Oryx TC 82 has features unique to any temperature controlled precision soldering iron. Available in 24 V, 50 V, 115 V and 210/240 V models, the TC 82 has a facility allowing the user to accurately dial any tip temperature between 260°C and 420°C by setting a dial in the handle without changing tips.

This eliminates the need for temperature measuring equipment. You get faster and better soldering.

For 24 V models a special Oryx power unit connects directly to the iron and contains fully isolated transformer to BS3535, a safety stand, tip clean facility and illuminated mains socket switch.

The Oryx TC 82 is also extra-safe. Removing the handle automatically disconnects the iron from power source.

Other TC 82 features include: Power-on Neon indicator in handle; burn proof cable; choice of 13 tip styles.

And more good news
The Oryx TC 82 iron costs only £13.00 (+VAT) and the power unit for 24 V operation £23.00 (+VAT). The TC82 240 volt is also available as a 30 watt general purpose iron at only £3.95 (+VAT).

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