wireless world

AUGUST 1978 40p

Waveform generator
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Alternator regulator

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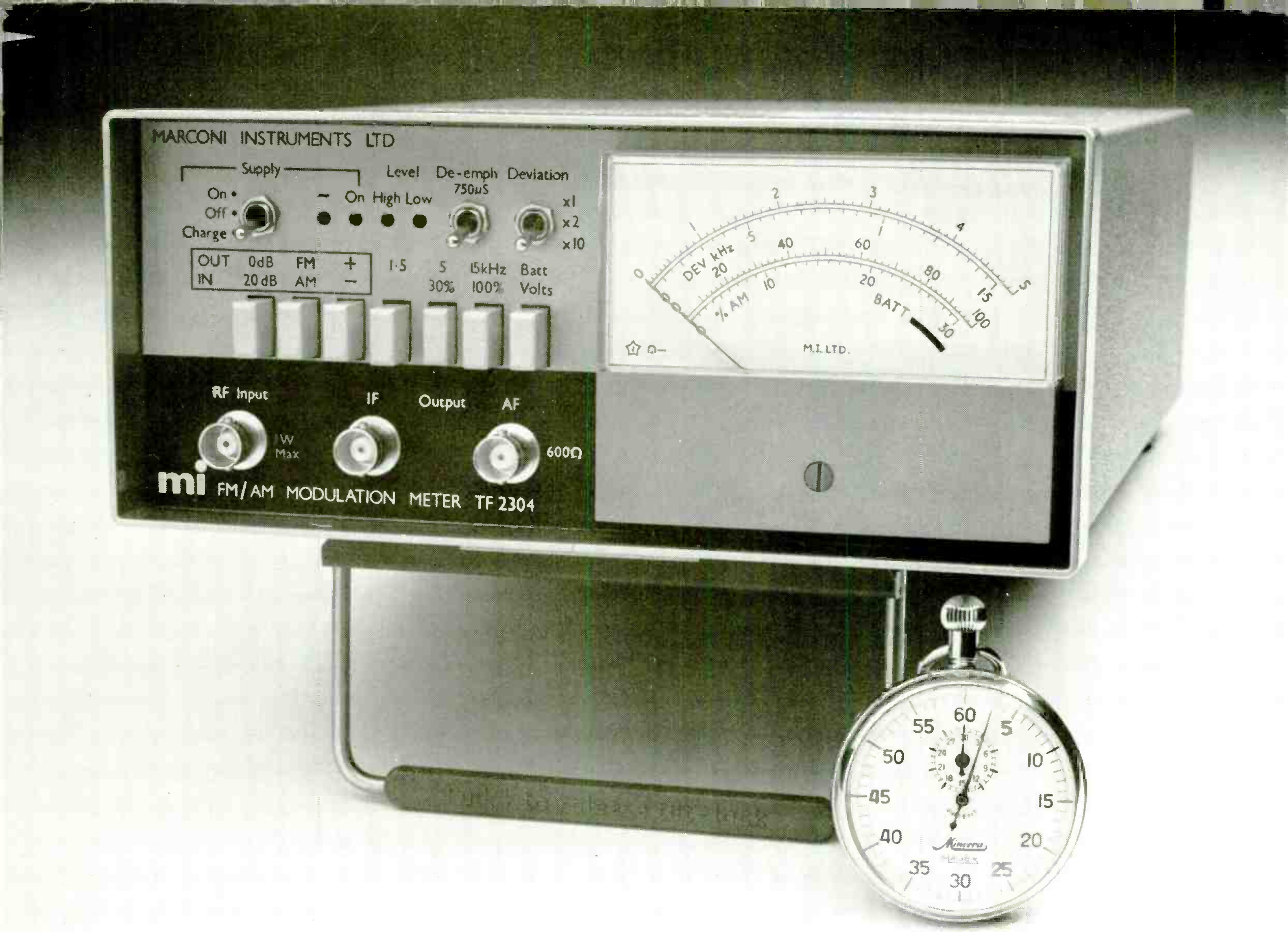

Automatic fm/am Modulation Meter

How long does it take for you to make a series of modulation tests with the meter you are using? The **mi** TF 2304 Automatic Modulation Meter eliminates at least five manual operations for each test and even more per test when a series of measurements is to be made. That can save you hours in a production day.

When connected to a transmitter, the TF 2304 automatically tunes to the carrier frequency and automatically sets the level, all within a few seconds. Exceptionally efficient screening and a very low distortion mixer ensure locking to the wanted signal. It is only necessary to select the required mode and range and the meter will read either deviation or % depth. L.E.D. lamps indicate if the signal level is too high or low and a push-button inserts a 20 dB attenuator to extend the maximum input level to 1 watt.

The basic frequency range is 25-1000 MHz and there are 8 peak deviation ranges covering 1.5 kHz f.s.d. to 150 kHz f.s.d. and a.m. depth ranges of 30% and 100% f.s.d. all with a modulation frequency range of 50 Hz to 9 kHz. Modulation symmetry can be checked by push-button selection of positive or negative deviation and peak or trough amplitude.

The accuracy of modulation measurement is ± 3% of full scale so transmitter deviation can now be set close to the permitted maximum with a consequent increase in efficiency.

The TF 2304 can be operated either from mains or internal rechargeable battery. It's small and light and there's a comprehensive range of accessories including a carrying case.

The price will pleasantly surprise you. Ask for full details.

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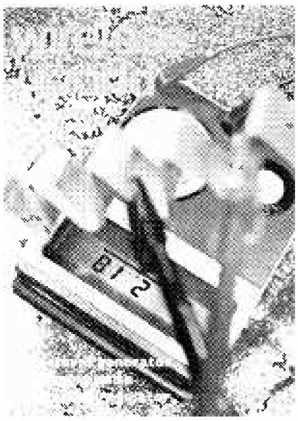

Front cover shows Avo's latest digital multimeter DA116 connected to a model resistor symbol. Photographed by Paul Brierley.

F. m. tuner design **uses latest i.f. and stereo decoder i.cs with a pre-aligned f.e.t. front end to give s/n of —30dB for 1.2μV input.**

Microprocessor survey. **Design and application trends in the various categories from 4- to 16-bit including bit-slice systems.**

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ELECTRONICS/TELEVISION/RADIO/AUDIO

AUGUST 1978 vol 84 N 1512

Instant LCR Answers.

The B424 is an easy-to-operate component meter, providing accurate measurements over an extremely wide range for under £600.

For every type of component: capacitor, resistor or inductor, the liquid crystal display shows the value in full. The decimal point is shown in position and the numerical readout is followed directly by the appropriate symbol for each range. No multiplying or scaling factors are ever needed, eliminating a prime source of operator error.

The meter automatically selects the test signal level and frequency, so that the operator doesn't have to calculate and reset for each type of measurement. The range finder will indicate on the display when a higher or lower range could give a more precise readout.

...with the right contacts

In addition to the basic meter, a component jig, the CA4, is now available for rapid connection of components with axial, radial or pre-formed leads. The CA4 has built-in limits circuits for an automatic indication of 'Low,' 'Pass' or 'High' as each component is connected. Setting of the limits takes only a few seconds, no external equipment or standards being necessary.

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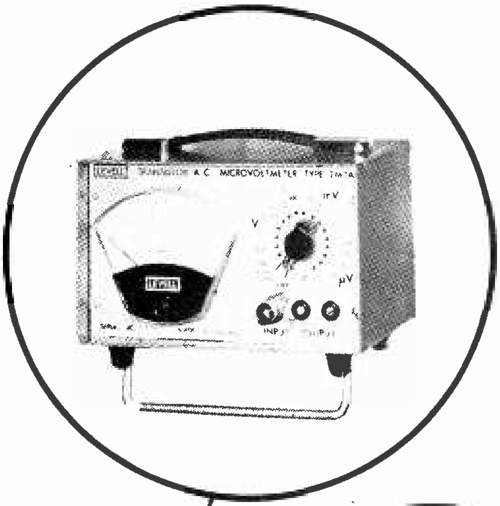

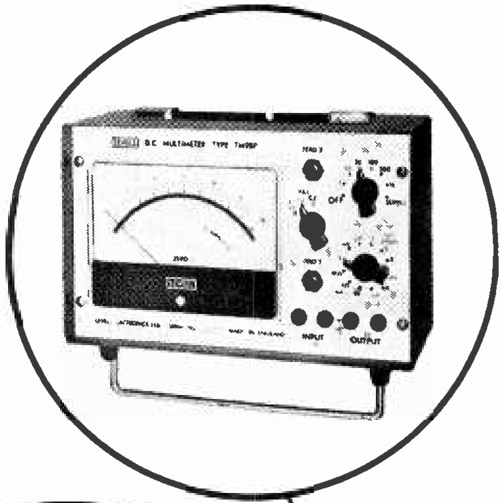

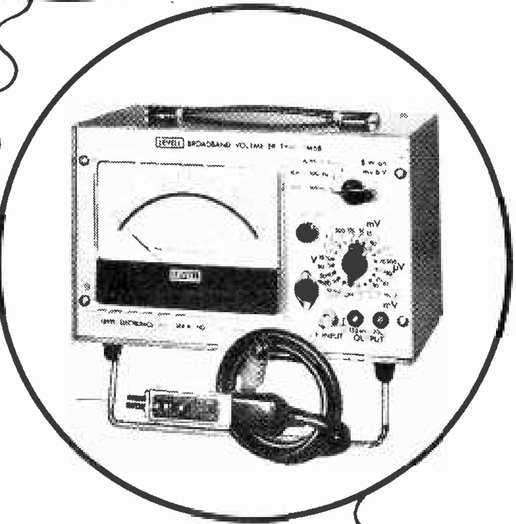

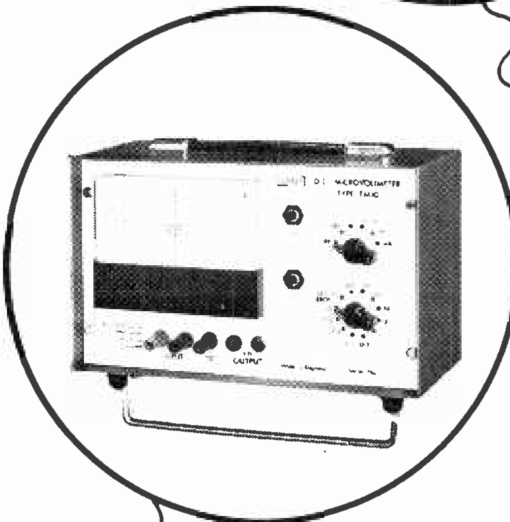

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L.F.RANGES: As TM3 except for the omission of 15µV and 150µV
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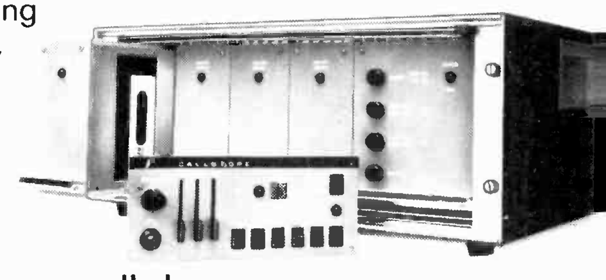

Callstore, from Racal-Thermionic, answers all the questions.

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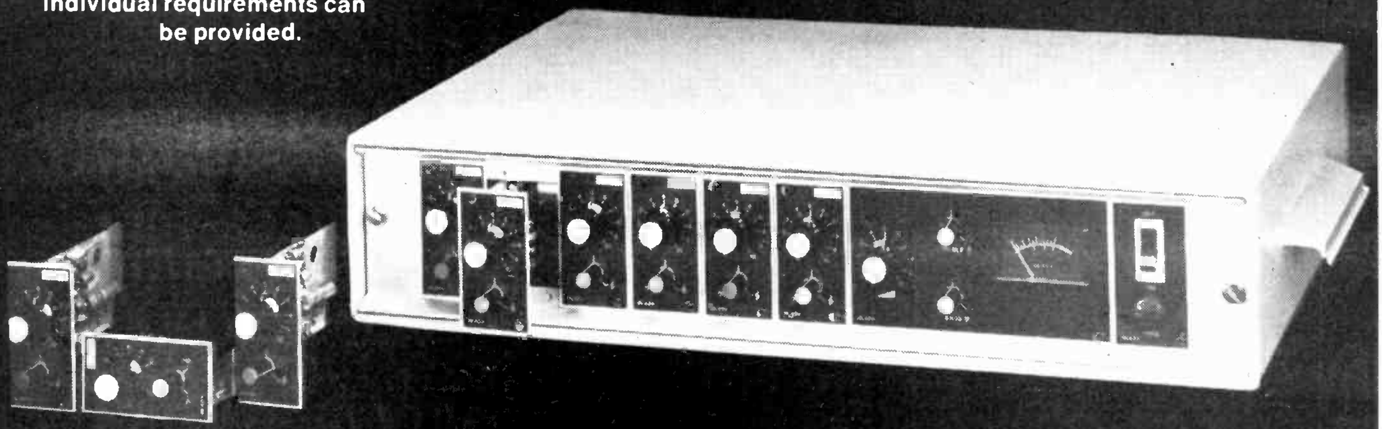

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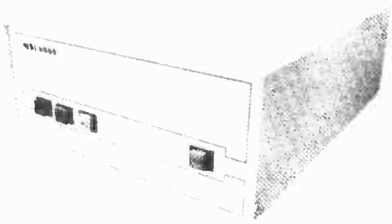

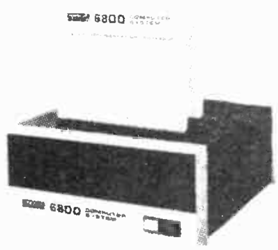

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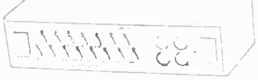

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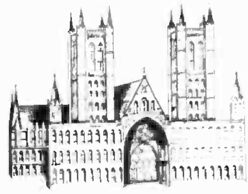

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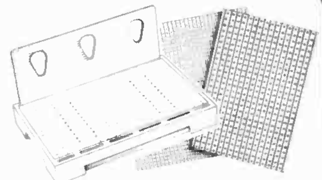

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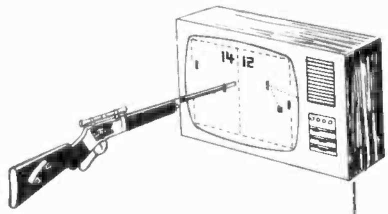

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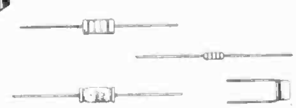

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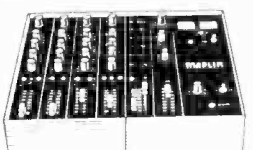

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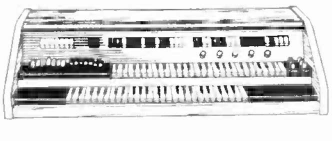

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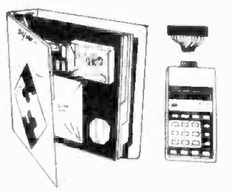

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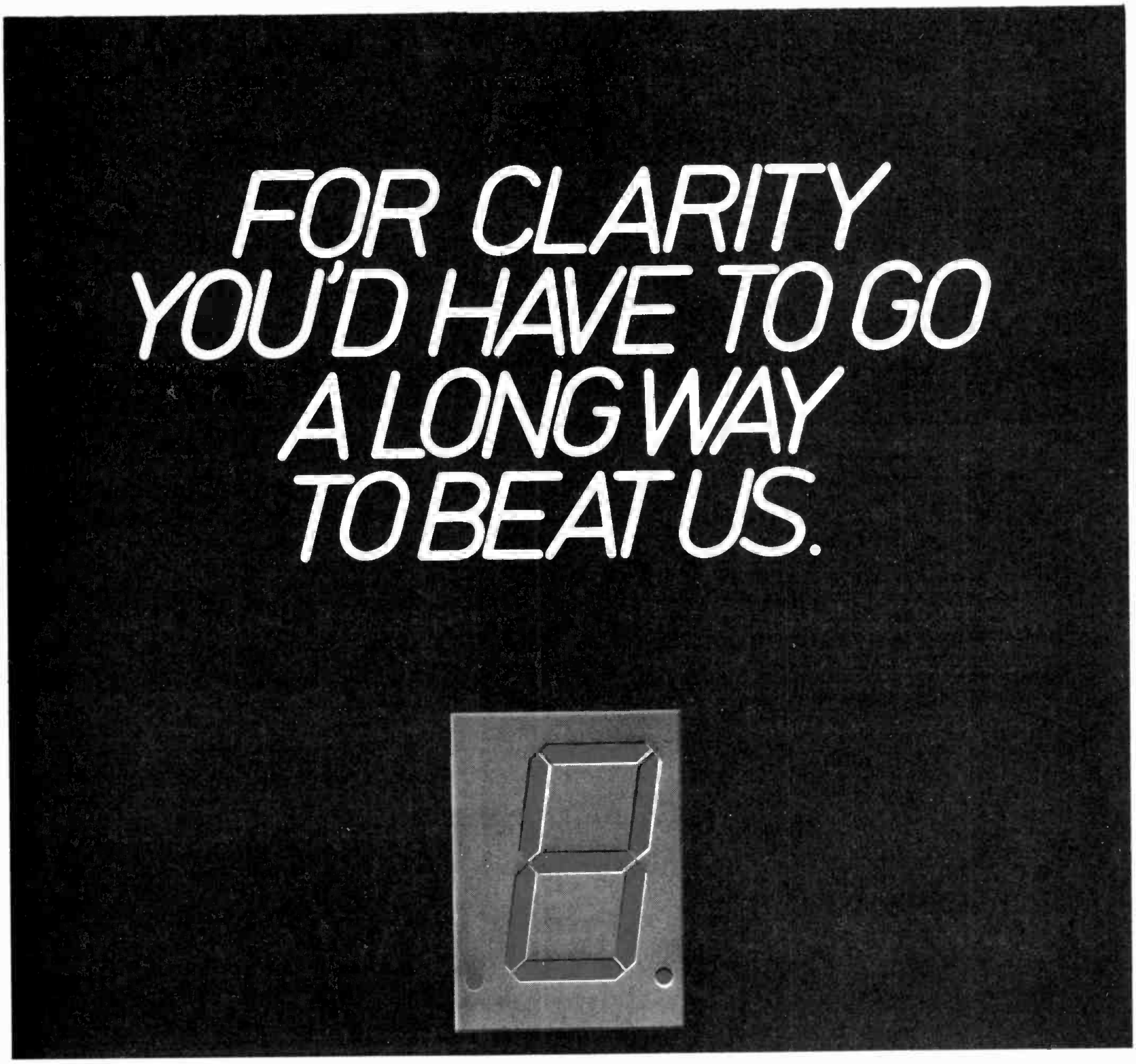

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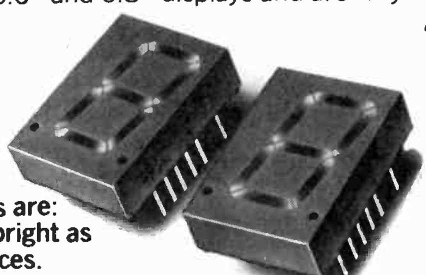

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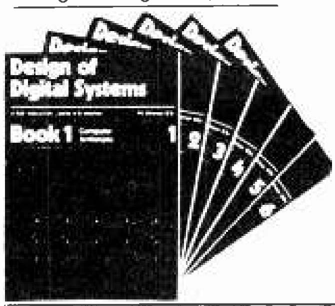

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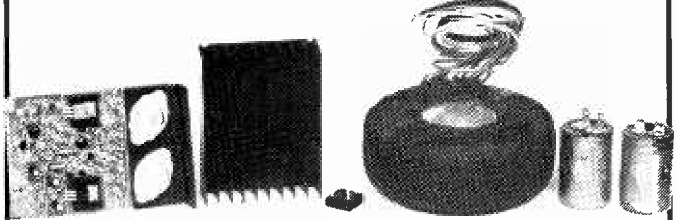

By popular demand we have designed higher powered versions of our well known modules. The CE 1704 which gives 170W into 4 ohms and the CE 1708 which gives 170W into 8 ohms are physically similar to the orginal types and have the same combination of compatible performance features which makes CRIMSON amplification audibly superior to the competition and the only choice if you have an ear for music. We have also produced suitable power supplies which again use our superb TOROIDAL TRANSFORMERS only 50mm high, with a 120-240 primary and single bolt fixing.
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Recommended for improved reliability		
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T.H.D.		Typically .01% any power. 1kHz. 8 ohms
T.I.D.	:	Insignificant
Slew rate limit	:	25V/μS
S/N ratio	:	110dB
Freq. response	:	10Hz-35kHz. 3dB
Stability	:	Unconditional
Protection	:	Drives any load Safely
Sensitivity	:	775mV (250mV or 100mV on request)
Size	:	120 x 80 x 25mm

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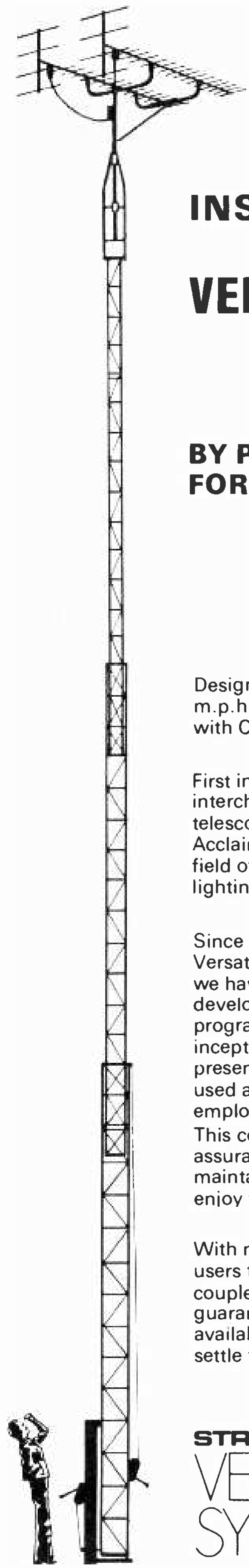

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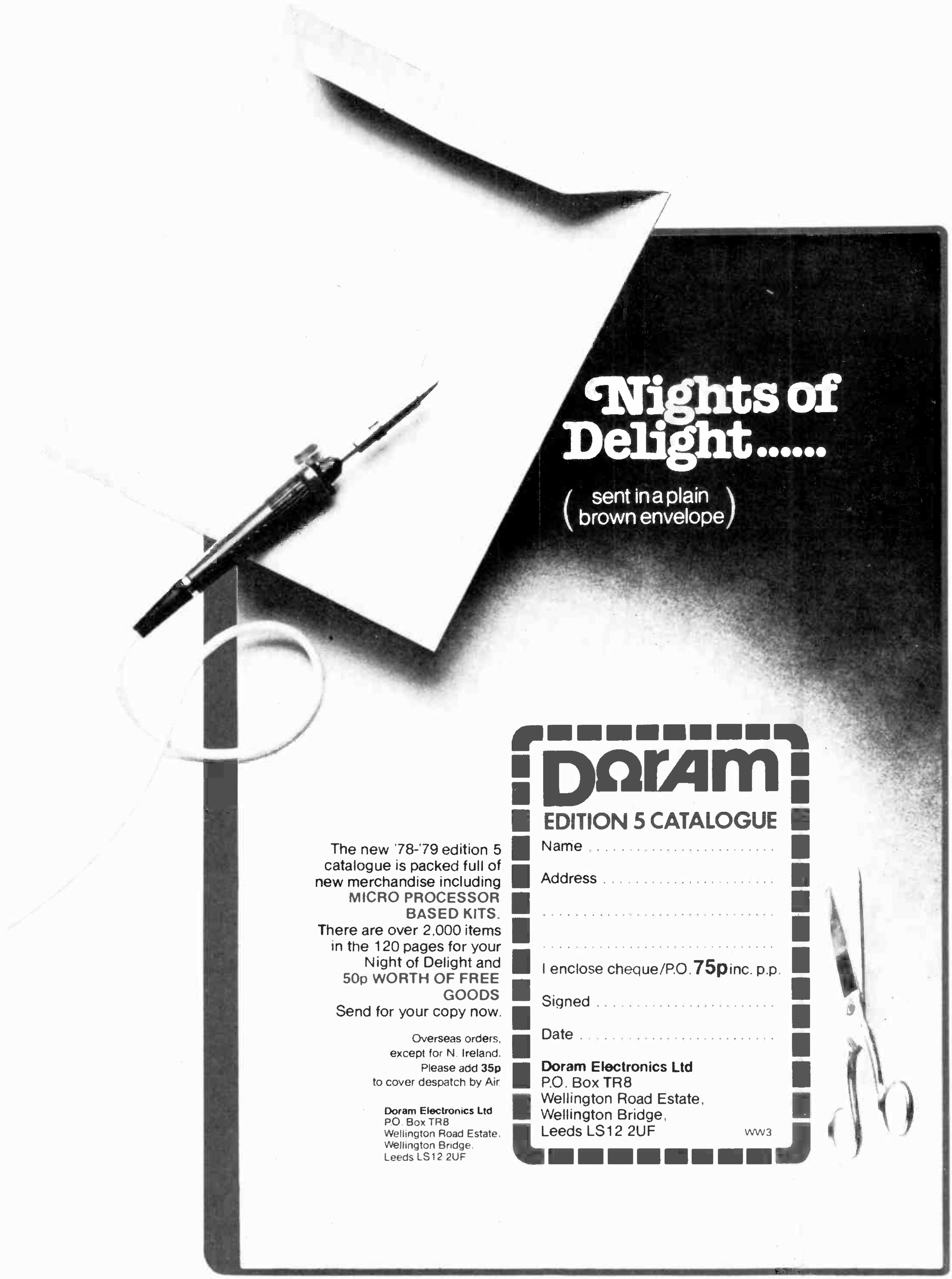

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4022	.88★	7402	.16★	74121	.27★
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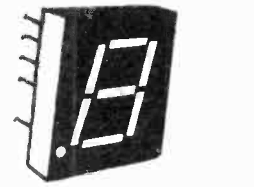

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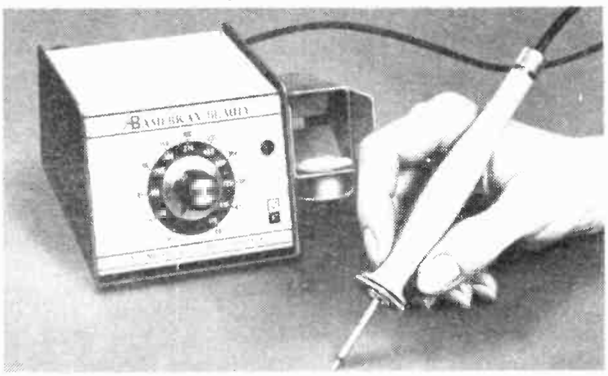

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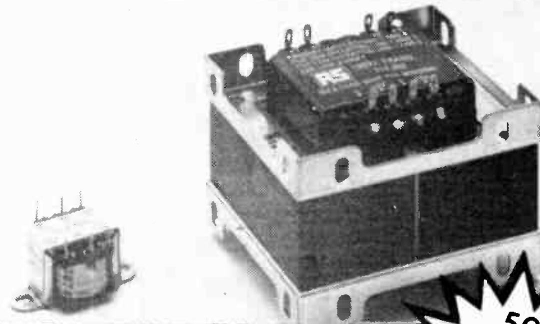

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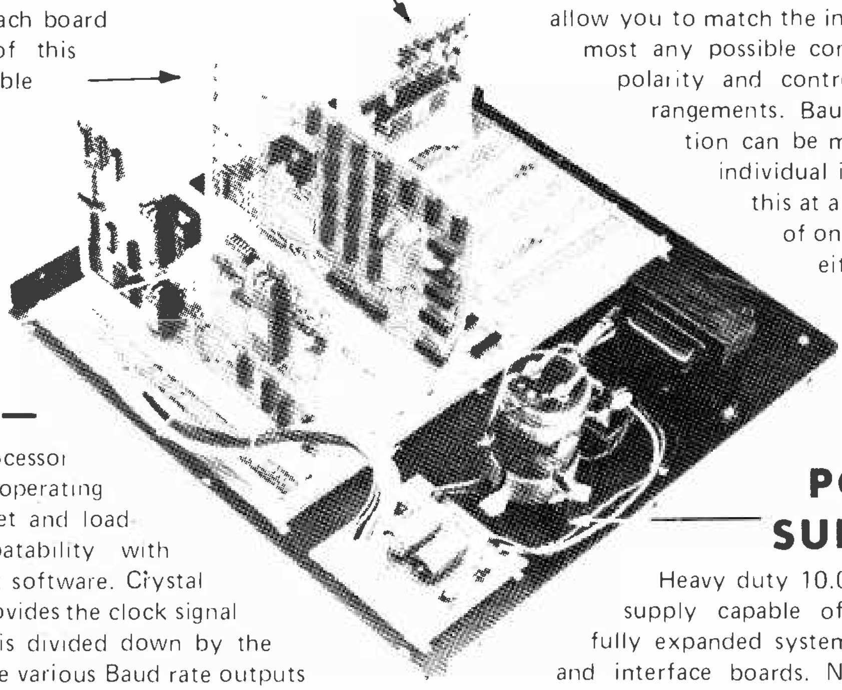

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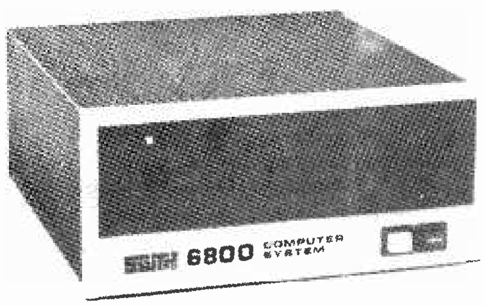

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7404	14p	29p	7473	32p		74142	265p		74198	150p	
7405	18p	29p	7474	27p	56p	74143	312p		74199	160p	
7406	38p		7475	38p		74144	312p		74251		153p
7407	38p		7476	37p		74145	65p		74253		153p
7408	17p	29p	7480	48p		74147	175p		74257		153p
7409	17p	29p	7481	86p		74148	109p		74258		153p
7410	15p	26p	7482	69p		74150	99p		74259		420p
7411	20p	29p	7484	97p		74151	64p	120p	74260		26p
7412	17p		7485	104p	141p	74153	64p	120p	74266		59p
7413	30p		7486	31p	59p	74154	96p		74279		73p
7414	51p		7489	205p		74155	54p	120p	74290		134p
7416	30p		7490	33p	99p	74156	80p	120p	74293		134p
7417	30p		7491	76p		74157	67p	120p	74295		196p
7420	16p	26p	7492	38p	99p	74158		120p	74298		176p
7421	29p	26p	7493	32p	99p	74159	210p		74365		72p
7422	24p	26p	7494	78p		74160	82p	165p	74366		72p
7423	27p		7495	65p	119p	74161	92p	165p	74367		72p
7425	27p		7496	58p		74162	92p	165p	74368		72p
7426	36p		7497	185p		74162	92p	165p	74670		421p
7427	27p	29p	74100	119p		74163	92p	165p			
7428	35p		74104	63p		74164	104p				
7430	17p	26p	74105	62p		74165	105p				
7432	25p	26p	74107	32p		74167	20p				
7433	40p		74109	63p	56p	74170	230p				
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7442	70p	114p	74118	83p		74176	75p				
7443	115p		74119	119p		74177	78p				
7444	112p		74120	115p		74180	85p				
7445	94p		74121	25p		74181	165p	491p			
7446	94p		74122	46p		74182	160p				
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4009	58p	4069	20p	4510	99p
4010	58p	4070	20p	4511	149p
4011	17p	4071	20p	4512	98p
4012	17p	4072	20p	4513	206p
4013	55p	4073	20p	4514	260p
4016	52p	4075	20p	4515	300p
4017	80p	4076	90p	4516	125p
4018	80p	4077	20p	4517	382p
4019	60p	4078	20p	4518	103p
4020	93p	4081	20p	4519	57p
4021	82p	4082	20p	4520	109p
4022	90p	4085	82p	4521	236p
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4026	180p	4094	190p	4529	141p
4027	55p	4096	105p	4530	90p
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4029	100p	4098	110p	4532	125p
4030	58p	4099	122p	4534	614p
4031	250p	4160	90p	4536	380p
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4033	145p	4162	90p	4539	110p
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4035	120p	4174	104p	4543	174p
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4037	100p	4194	95p	4553	440p
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4047	99p	4516	128p	4568	281p
4048	60p	4517	403p	4569	303p
4049	55p	4518	119p	4572	25p
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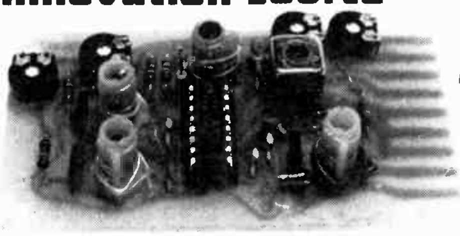

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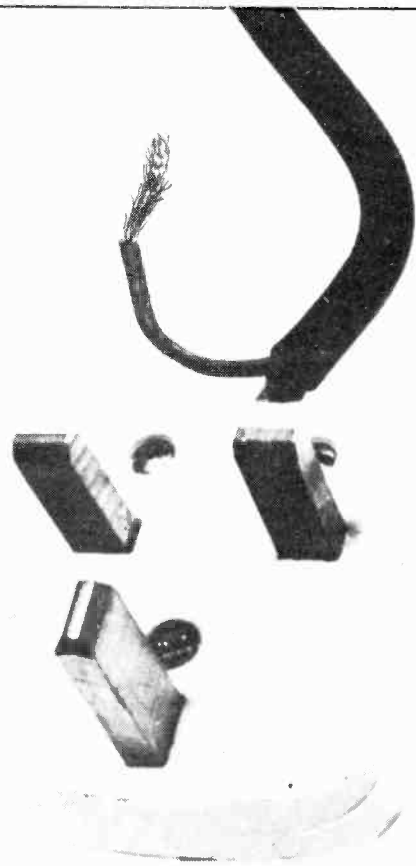

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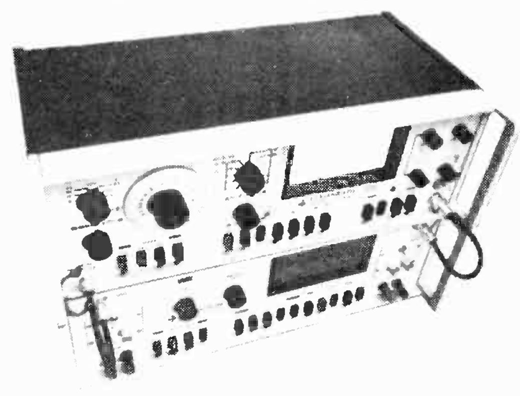

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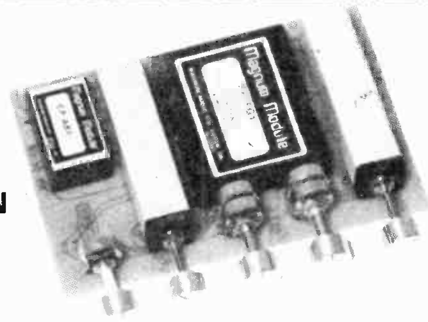

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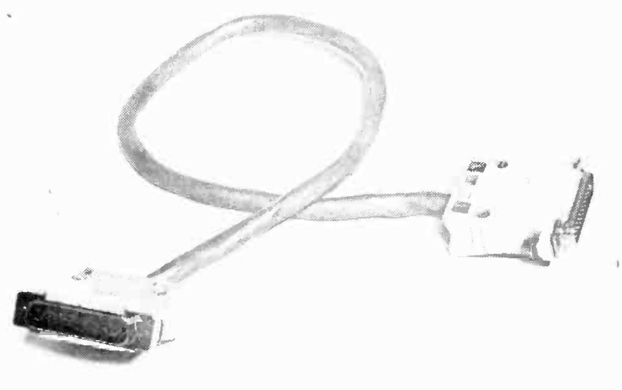

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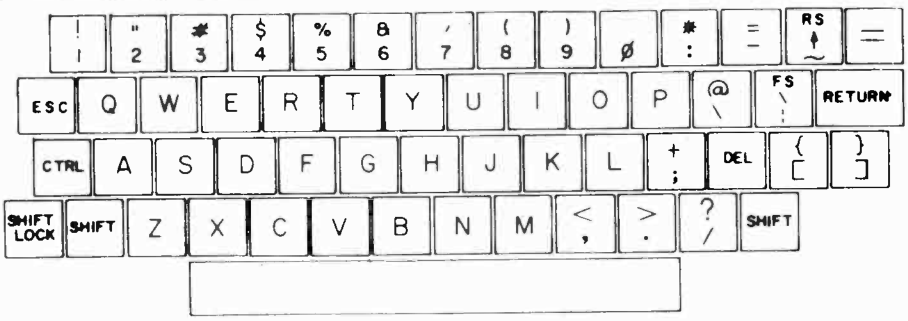

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A decade of indecision

AT LAST the UK electronics industry and the government seem to have woken up to the fact that integrated circuits are important — to the electronics firms themselves, to manufacturers of other products who must use the most advanced automation techniques (such as microprocessors) in order to remain competitive, and hence to the British economy as a whole. In the past few months we have seen the Department of Industry announcing further financial help for the semiconductor firms, a report that GEC and Fairchild are jointly setting up a new microelectronics company, Racal and International Computers starting in-house manufacturing of i.cs and the National Enterprise Board negotiating with a group of engineers in America's "Silicon Valley" to set up a v.l.s.i. (very large scale integration) factory in the UK. And as we go to press we learn of a new NEDO report which advocates that Britain should go into high-volume manufacture of standard i.cs with £220m of government support spread over a five-year programme.

This is all good news, but to some of us it seems like a last, desperate attempt to jump on the fast-moving vehicle of i.c. technology before it accelerates away to an impossible speed. The effort should have been made long ago. Everyone was aware of the dominance of American technology and marketing at least a decade ago, for in the late 1960s the US semiconductor firms had already captured about 80% of the British market. At one point things looked so bleak that GEC decided to close down their brand new £2m Marconi-Elliott Microelectronics plant at Witham, Essex, before it had even started production. The Industrial Reorganisation Corporation recommended to the government that the British-owned semiconductor firms should join forces to form a single organisation that could more effectively meet the competition, but the companies concerned were not willing and preferred to operate independently. The government then tried to help by providing financial support. In 1970 they supplied £5m to assist research and development on a broad front, and in 1973 they added a further £10m for work on specific projects. Last year the UK components industry as a whole received £20m of government support and probably about a third of this has gone to the semiconductor firms.

During this ten-year period the scale of integration has steadily increased from simple i.cs such as gates through m.s.i. to l.s.i. and now v.l.s.i. The microprocessor has arrived as a standard component and there are semiconductor memories of ever increasing capacity on the market. The result, as the NEDC recently noted, is that more and more of the design work and value-added in electronic equipment is passing into the hands of the component supplier. In Britain this means that the manufacture of electronic equipment is becoming increasingly dependent on the American i.c. companies. The withdrawal of a particular i.c. by a mere stroke of a pen in Dallas or some other headquarters in the States could be a disastrous event for equipment makers in the UK. In a few years' time we could be saying the same thing about headquarters in Tokyo or Osaka, for Japan has set up a formidable, highly disciplined association of semiconductor manufacturers and government agencies to produce v.l.s.i. devices which is frightening even the Americans.

It is against this background that the latest efforts are being made in Britain to retain some small degree of self-sufficiency in integrated circuits, and perhaps a thin slice of the estimated £2000m world market in these devices. Let us hope they will not be too late.

Regulator circuit for car alternator

Replaces electro-mechanical regulator

by **J. R. Watkinson,** M.Sc.; University of Southampton now with Digital Equipment Co. Ltd.

The alternators operation in cars depends on semiconductor devices which have only recently become economic. Its introduction is timely, as the pressures of modern traffic conditions are too great for the once-universal dynamo. The theory behind the change to the alternator is explained, and a practical circuit for a regulator given, in which the ignition light is used in a novel way.

ELECTRONIC REGULATORS for alternators are available ready-made commercially, so why build your own? Firstly, not all alternators are furnished with electronic regulators, and many people might wish to replace a mechanical regulator. Purchasing a commercial electronic regulator for a different alternator is fraught with difficulty. The units are usually sealed, with lettered terminals, which is fine for the building brick approach of the garage mechanic, but of no use in establishing some concept of a circuit. There is no general standard for connections either. If faced with a sealed commercial electronic regulator which breaks down, the only course is replacement. The device described may be built for about half the cost of a commercial unit. And should it break down, it can be repaired for a trivial amount. Lastly, many enthusiasts will build electronic equipment for the satisfaction it gives, without economic constraints, and often they will produce devices technically superior to the cost-conscious commercial article.

Alternators have been fitted to vehicles for long enough for plenty to have found their way into scrap yards. Most of these are of the slip-ring field type with separate regulators. In conjunction with this regulator, and an ex-scrapyard alternator, it should be possible to replace an existing dynamo system with an alternator for between ten and fifteen pounds, about half the cost of a new alternator. Sale of the dynamo reduces the cost further.

The design philosophy behind the circuit shown here is that of reasonable simplicity, coupled with readily available components. Reliability is essential, and the mechanical design emphasises robustness.

The circuit of the regulator is shown in Fig. 1. The field current flows through Tr_3 to earth. Diode D_3 is placed across the field winding which is inductive, and acts as a conventional flywheel diode, protecting Tr_3 from excessive voltage. The regulation action is as follows:

The pre-set R_9 acts as a potential divider in conjuction with R_4 and R_5. Transistor Tr_1 is an emitter follower stage which presents a high impedance to the wiper of R_9 to avoid loading the divider. When the alternator starts to supply sufficient current, the voltage across the battery rises. When the voltage at the base of Tr_1 exceeds 7.5 + V_{be1} + V_{be2} volts, i.e. about 8.5V, both transistors start to conduct. Transistor Tr_2 then shunts away the base current of Tr_3, provided by R_1 and thus the field current is reduced.

Because of the inductance of the field winding, the transfer function of an alternator has poor bandwidth, and so for stability the bandwidth of the regulator must be reduced. This is achieved by C_1 whose value must be established by trial and error, as different alternators will have different field inductances. The prototype used a 0.2μF with a Lucas 11 AC alternator. The 7.5V zener diode is chosen because its temperature coefficient is of the same magnitude as, and of the opposite sense to, the temperature coefficient of two silicon base-emitter junctions in series. This makes the regulator temperature stable.

The ignition light circuit is a departure from usual practice, as it is operated by battery voltage. It was common practice, with dynamos, for the ignition light to be wired across the

Why alternators?

BEFORE THE ADVENT of semiconductor devices the dynamo and alternator were supreme in their own fields, and neither could offer a challenge to the other. The basic difficulty lay in rectification. The dynamo has a built-in mechanical rectifier: the commutator. Without semiconductors, the only efficient power rectifier available was the mercury arc type. The mercury arc rectifier enjoyed success providing d.c. power for tram traction motors at high voltage, from an easily-transmitted alternating supply, but its bulk and delicacy ruled it out for mobile use in vehicles. It is only since the development of reliable, economic, high current semiconductor diodes that the alternator could be considered for motor vehicles.

Most automotive alternators are three-phase, and use an array of six power diodes for rectification, Fig. A. The commutator and high-current brushes, both sources of unreliability, are thus eliminated. The power windings are stationary, and not subject to rotational forces. Their construction is therefore less critical, and being nearer the outside of the unit, they are more easily cooled. Theoretically, therefore, an alternator of this type should have a better power/weight ratio and power/volume ratio than a dynamo. This is not the most important consideration, however. As the rotor provides only the steady field, it does not need to be laminated, and can be made from solid iron, carrying a low-current coil fed from light sliprings. It is this robust rotor construction which gives the alternator its potential for use in vehicles, Fig. B.

As development of the piston engine proceeds, the trend is to produce more power from a given engine capacity by increasing rotational speed. This means that the dynamic range between tick-over and maximum revolutions is widening. The armature of a dynamo, containing heavy conductors in weak laminations, has a speed limit above which it will disintegrate. As the dynamic range of drive speed increases, its output at the low speed end deteriorates; as the dynamo top speed cannot be increased, the dynamo speed at tick-over must be reduced. In ever denser traffic, the speed/time history of a dynamo becomes such that it is not possible to maintain an adequate state of charge in the battery as well as powering all of the accessories. Darkness and/or fog aggravate this situation. The strength of the rotor in the alternator means that it can run at considerably higher speeds without disintegration. It can be driven from the engine at a higher ratio, which means that it can still provide useful output at engine tick-over speeds.

In general, the dynamo rotor is carried on a ball race at the drive end, to

It is of course possible to construct an alternator in which the field is formed by the stator. This resembles a dynamo, and has most of its drawbacks, including sliprings which carry the main load current from the rotor. For this reason it finds no application in vehicles.

resist the side-thrust from the drive belt, and the commutator end runs in a sintered bush. In the alternator the bush is replaced by a second ball or needle-roller race, because of the higher angular velocity encountered in service. Rectifier diodes are mounted on heat sinks at one end and the high current flowing in these diodes causes heat to be generated. The use of press-fit diodes is common: they have approximately one-half the thermal resistance of comparable stud mounting devices. Cooling air is drawn over the heat sinks, through the stator coils and rotor, and expelled, by the fan — usually mounted next to the drive pulley. As the bulk of the alternator is easily cooled, it is less necessary to design for low iron and copper losses, and it is possible for this and other reasons to make an alternator around one half of the weight of an equivalent dynamo.

This reasoning exposes the only drawback of the alternator; owing to the heat generated in the diodes and the stator, the alternator is less efficient than the dynamo. The extra heat is dissipated with the help of the fan, which experiences very high revolutions due to the drive ratio employed. As a result a loud whine is radiated. As the electrical system of the average car consumes only one or two percent of the engine power, efficiency is of little consequence. The noise problem can be overcome by the use of aerodynamically designed fans with shaped blades, instead of the pressed steel economy versions mostly fitted at present.

Control of most alternators is by way of the field current, as the peak e.m.f. is proportional to the product of rotational speed and field current. The current is fed to the rotor by light brushes and sliprings. Unlike the commutator in a dynamo, sliprings have no discontinuities, and as the field current is only a few amperes, brush life can be very long.

A different technique exists for alternators which use a permanent-magnet rotor. Three of the diodes in the bridge are replaced by thyristors which control the output directly. Because the frequency of the output is proportional to rotational speed it is difficult to arrange phase control of the s.c.rs, so the practice is to fire them for integral half-cycles. It is left to the battery to average out the voltage. Such a regulation circuit may be built into the alternator body, which makes for simple installation, but in the case of a failure the entire unit must be replaced. The main advantage of this type of alternator is that there are no brushes, and the life of the unit before maintenance is governed by the bearings.

Returning to the conventional type, the field current is controlled by the regulator, which senses the output voltage. Many makers use a mechanical regulator similar to the type used with dynamos. This is not good practice as the improved reliability of the alternator is marred by the inherent unreliability of the mechanical regulator. A better approach is to use a power transistor to control the field current, in conjunction with a zener diode reference circuit, Fig. C. This type of circuit can also be built into the alternator body. The circuit does not have the current limiting action required with most dynamos. The reason for this is the different characteristics of the alternator. The output is alternating, and the source impedance is inductive, Fig. D. At maximum field current, the peak e.m.f. available is proportional to rotational speed; the frequency of the output is also proportional to r.p.m. so that as the e.m.f. rises so also does the internal impedance. Overload current capability is thus essentially independent of rotational speed. The maximum field current case must be taken, as the voltage regulator will increase the field current under overload conditions to attempt to maintain the output voltage.

The current in each phase of the stator windings is not sinusoidal, but is high in harmonic content due to the diodes conducting on peaks. As the load current rises, this effect becomes more pronounced, until the current is controlled only by the impedance. The maximum current an alternator will deliver is thus fixed at the design stage to be within safe limits, usually governed by dissipation.

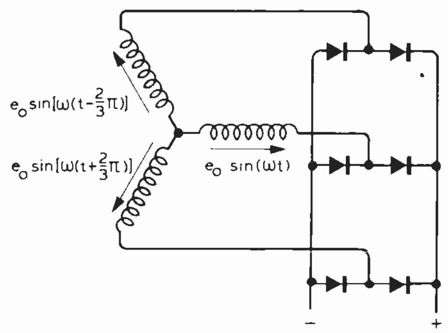


Fig. A. *Six-phase rectification provides d.c. from the alternator output. For alternators with a permanent-magnet motor, the three right-hand diodes are replaced by s.c.rs.*

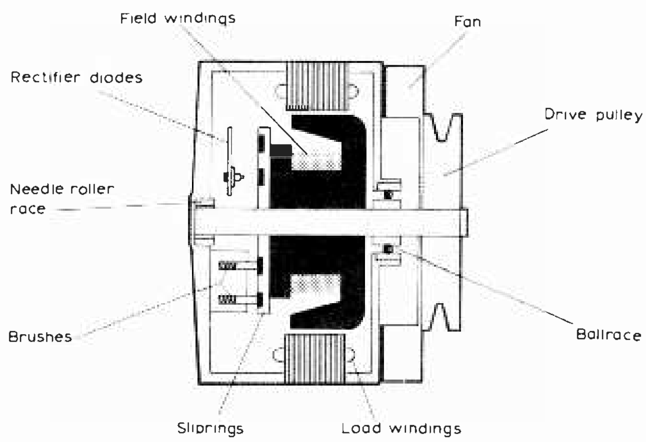


Fig. B. *By making power windings in alternator stationary a better power/weight ratio is obtained. Rotor provides a steady field, therefore laminations are not needed, and slip-rings are low-current.*

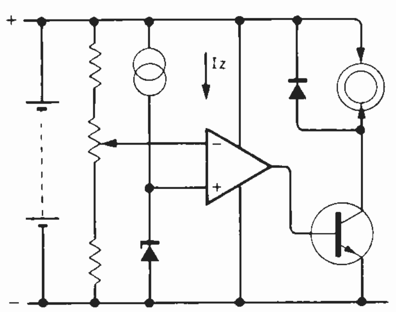


Fig. C. *Electronic control circuit can be built into alternator body and is more reliable than electro-mechanical types.*

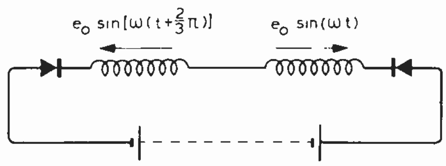


Fig. D. *Equivalent circuit of one rectification path, neglecting second order effects. Diodes cause high peak content current; inductance limits peaks, protecting diodes and windings from overload.*

cut-out, so that it would glow when the cut-out opened. The diodes in an alternator eliminate the cut-out and there is no obvious place to connect an ignition light. Many regulators employ tortuous means to control a light, some require a relay in addition to the regulator.

The circuit shown here is in fact a separate unit, and simply shares the regulator circuit board for convenience. There is no theoretical reason why the circuit should not be built near the ignition light in the dashboard. On most vehicles, however, the wire from the earthy side of the ignition light is brought out near the regulator.

When the battery voltage is 12 volts or less, negligible current flows through D_2, and Tr_4 is switched off. Thus current flows through R_5 into the base of Tr_5 and the ignition light is on. When the battery voltage rises above 12 volts, Tr_4 turns on and Tr_5 off, and the light is extinguished.

Construction

The engine compartment of a motor vehicle is the exact opposite of the ideal environment for electronic equipment, and this must be considered in the design stage. The worst enemies are vibration and shock, and any steps taken to reduce the effects of these will result in improved reliability. To achieve reliability in this device, the following steps should be taken.

- Fit the 2N3053 transistors with TO-5 mounting pads to give rigid support.
- Mount R_1 (a 3-watt wire wound type and conservatively rated for reliability) to the circuit board with loops in the leads to allow for movement due to expansion, and to give resistance against shock to the brittle glass construction. The heat developed in R_1 is useful in driving out moisture from the circuitry.
- Choose cermet construction for R_9.
- Make remaining resistors ½-watt 5% types. None dissipate their rated power, but ½-watt devices are mechanically robust.
- Install the zener diodes snugly in contact with the p.c. board. When bending the leads, take care not to place any stress on the glass-to-metal seals where the leads enter the body. Unnoticed damage to these could cause unpredictable failure subsequently.
- Specify high quality glass fibre for the printed circuit board; it has to support the connections to the vehicle wiring.

Connections can be made using RS Components Barrier blades type 1 with one end cut off. The blades can be fixed to the board with two 4BA screws and nuts, and are compatible with standard ¼-in automotive push-on connectors. The earth blade screws are countersunk into the lid of the diecast case, and the p.c. board mounts on them using

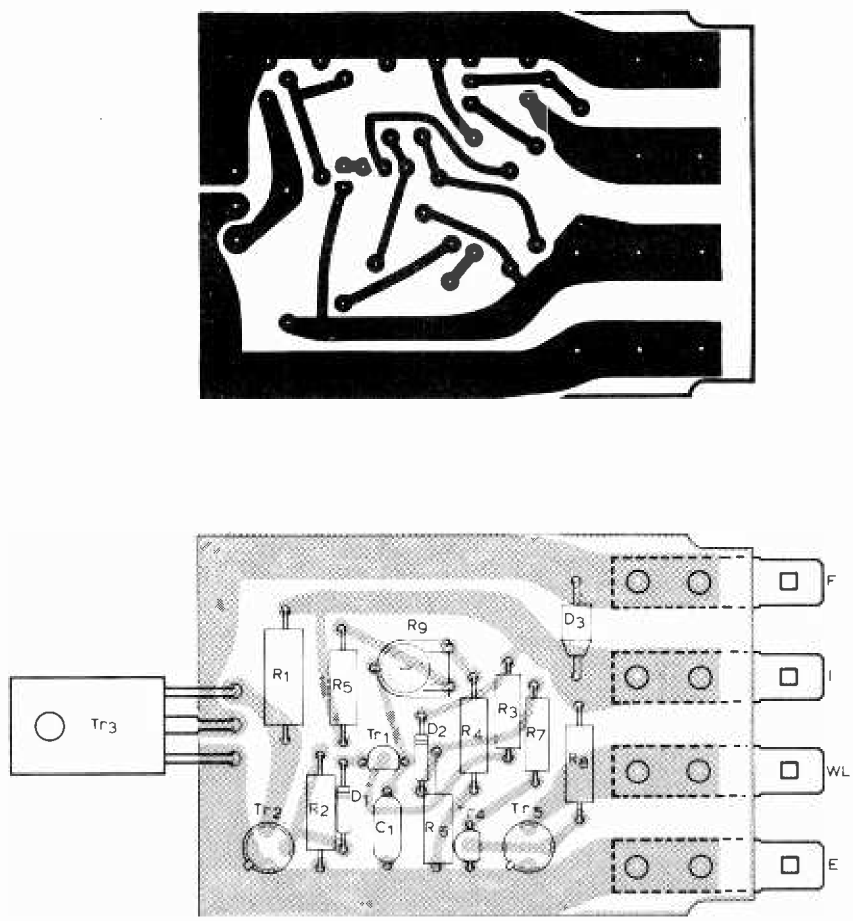


Fig. 2. *Component-mounting board is mounted in die-cast box which is also used as heat dissipator for Tr_3 (insulated by mica washer). M. R. Sagin, of 23 Keyes Road, London, NW2 plans to supply boards for £1.65 inclusive.*

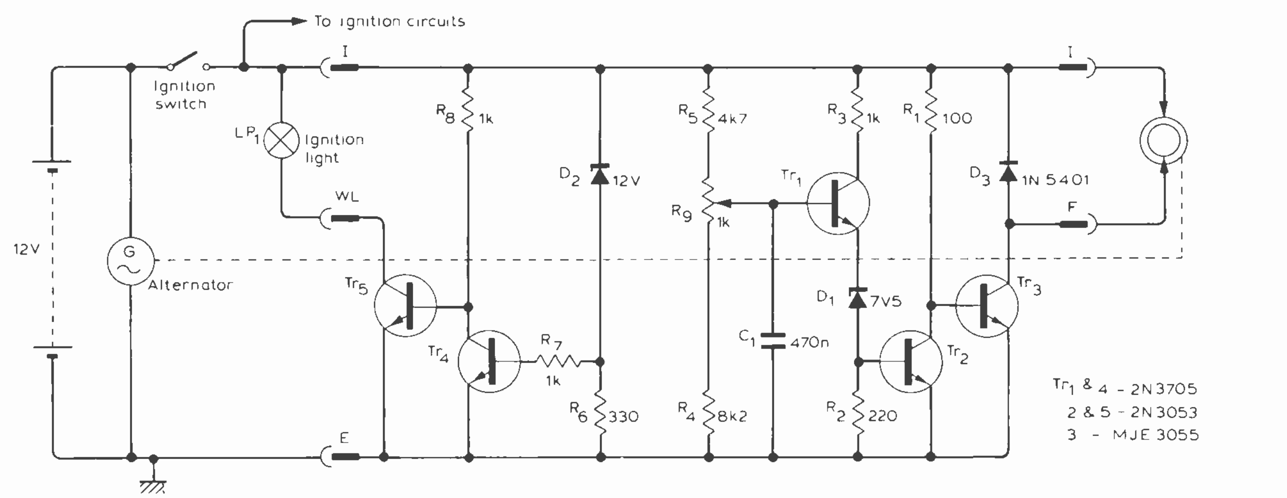


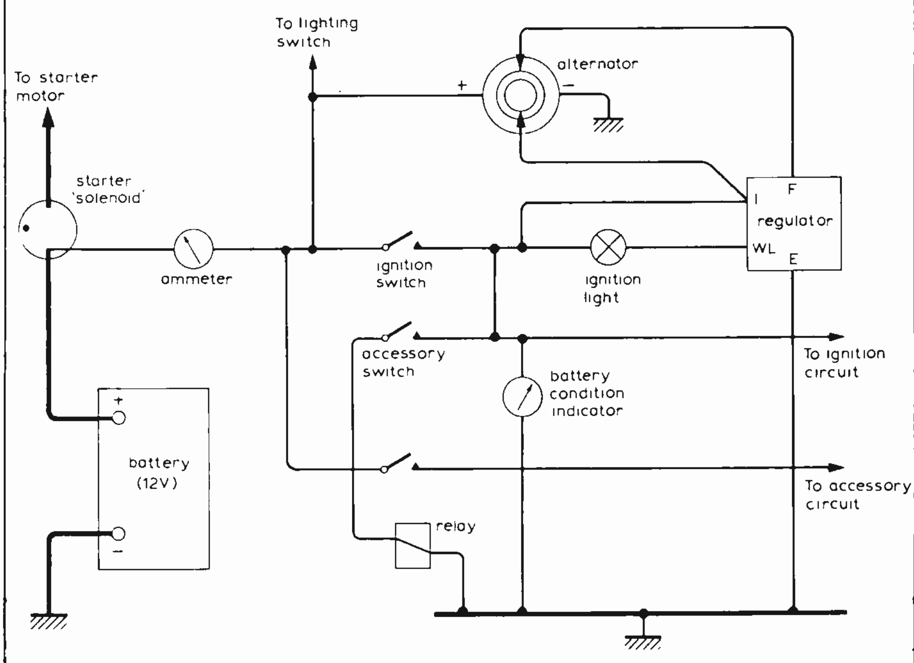
Fig. 1. *Electronic alternator circuit can be used with most automotive alternators and is built into RS Components diecast box, type 993.*

spacers or full nuts. The "ign" blade is actually two blades mounted one above the other on the same pair of screws, again with suitable spacers. The wire from the ignition switch provides power to the circuit via one blade, the other blade supplies a positive feed to the alternator field coil. The opposite end of the circuit board is held by the substantial leads of the MJE3055 power transistor, suitably bent, which is held to the case by a countersunk screw and insulated by a mica washer.

Testing

When the regulator is complete

- —Connect a dummy ignition light (12V 3W bulb) from I to WL.
- —Connect a dummy field load (12V 24W bulb) from I to F.
- —Connect variable 3A power supply*, + to I, — to E.
- —Set R_9 to mid-range and switch on at 12V. Both lamps should be on, and increasing supply to 13V should extinguish ignition light.
- —Adjust R_9 so that 24W lamp is just extinquished at 14.4V.



Circuit shows position of alternator and regulator described in typical installation, position of battery condition indicator and ammeter, and how to connect a powerful accessory (e.g. heated rear window) which is to switch off with the ignition. Ignition light acts as go/no-go battery condition indicator with the regulator circuit described.

Installation

If the unit is to replace a mechanical regulator on an existing alternator system, it only now remains to make the necessary wiring changes and install it. The case must be provided with suitable cut-outs to clear the blades when the lid is installed. It is advisable to make the clearance as small as is practicable, to resist ingress of oil or water, consistent with ensuring that under no circumstances can a short circuit to the case occur. The empty case is mounted to the vehicle with grommets for vibration isolation, and then the circuitry, mounted on the lid, is fitted to the case. The mounting position must be chosen so that the unit is not subject to direct radiant heat from the exhaust manifold, nor exposed to road spray entering the grille.

Installing the alternator

It is difficult to give specific directions, as there are as many variations on installation as there are vehicle types. Obviously the crankshaft pulley and the alternator pulley must lie in the same plane, if the drive belt is not to suffer. The sizes of these two pulleys must be in the inverse ratio of engine and alternator max. rotational speed, so that the alternator is driven as fast as possible at tickover. To achieve this, the alternator pulley is removable, and different sizes are to be had. In some cases a belt of different length may be needed to accommodate the change.

The main output feed from the alternator should be taken direct to the ammeter terminal, or, for those who are not prepared to fit one, direct to the terminal on the starter solenoid. Remember to disconnect the battery first, or you may be reminded in forceful terms. The feed wire may seem of gargantuan proportions to those more familiar with electronics than with cars, but is it necessary because of the heavy, peaky, current; similarly all connections must be made in the same spirit. Fortunately, the field wiring is less formidable, and this should be hooked up (referring to boxed wiring diagram) using ¼-in blade receptacles and stranded wire adequate for the field current of about 3A. The earth wire to the E terminal should be of heavy gauge to prevent instability, as it carries field current and is the zero reference to the regulator. Similarly, the I wire to the ignition switch must feed only the regulator (and the field) so that the voltage at the I terminal is the same as the battery voltage, apart from a small drop in the ignition switch itself, which is insignificant if vehicle wiring is sensibly laid out. Any heavy loads should be switched by relay direct from the ammeter or solenoid terminal (see boxed diagram).

It is easy to arrange for these loads to switch off with the ignition if desired by supplying the coil current from switches fed by the ignition switch. In this way the ignition switch contacts are relieved of wear and the operation of the regulator is not impaired. Provided that the regulator worked on test, and the installation is correct, it should work immediately in the vehicle.

Reconnect the battery and switch on the ignition. The light should be on. On starting the engine the light should go out as the revs are increased. The battery voltage should be re-checked and R_9 re-adjusted if necessary. If a suitable ammeter is available it can be placed temporarily in the field circuit, when the field current will diminish as revs increase. Do not disconnect the field circuit when the ignition is on; the collapsing flux in the field can impart a nasty shock. With the ignition as the only load, the warning light should not come on at tickover, it may not come on if sidelights are switched on. The light should come on if headlights are switched on at tickover, and should of course be extinguished as soon as revs are increased. This serves as a useful reminder not to leave on the head lights of a stationary vehicle.

Application

The circuit shown here will operate all negative-earth alternators on which there is access to both ends of the field winding. Apart from the output terminal, any other connections may be ignored. A few types may have one end of the field earthed, and if the alternator cannot be modified, the regulator may be rebuilt in complementary fashion to provide a positive output rather than a current sink. The ignition light circuit can be left as shown. A few positive earth alternators were made, and the entire circuit may be rebuilt using complementary devices. □

*Failing a variable supply, a car battery can be used, in conjunction with a couple of ordinary U2 cells in series to increase the voltage.

A versatile waveform generator

Trapezoidal waveform with variable ramps and plateaus

by **N. H. Sabah,** Ph.D., M.I.E.E. **and M. Adham,** Department of Electrical Engineering
American University of Beirut

Although originally intended for driving electromechanical devices in medical research, this circuit produces a number of waveforms which are useful as a teaching aid or for studying the steady state and transient responses of electronic circuits. The output can be free running or externally triggered to produce an integral number of cycles.

A BLOCK diagram of the waveform generator is shown in Fig. 2. Integration current, I_i, for the integrate-and-hold circuit is supplied from a gated hysteresis switch whose output is either $+V_h$ or $-V_h$. An output $-V_h$ causes the integrator output to rise linearly until it reaches a predetermined positive hold level, $+V_d$. At this point the output of the positive limit detector changes from its negative to its positive limit. With S_2 in the "up" position, this change is transmitted to input E after a preselected delay which determines the duration of positive hold. During this time, input F is at its positive limit. When E also turns positive, output H changes from $-V_h$ to $+V_h$ provided that S_5 is in the grounded or free-running position. This reverses the polarity of I_i and causes the integrator output to fall linearly. As the integrator output falls, output B changes from its positive to its negative limit and transmits the change to input E. When the integrator output reaches a predetermined negative hold level, $-V_d$, output B changes from its positive to its negative limit. With S_3 in the "up" position, this change is transmitted to input F after a preselected delay which determines the duration of negative hold. When F goes negative, and with E now negative, output H goes from $+V_h$ to $-V_h$, again reversing the polarity of I_i. The integrator output rises linearly from negative hold, and the

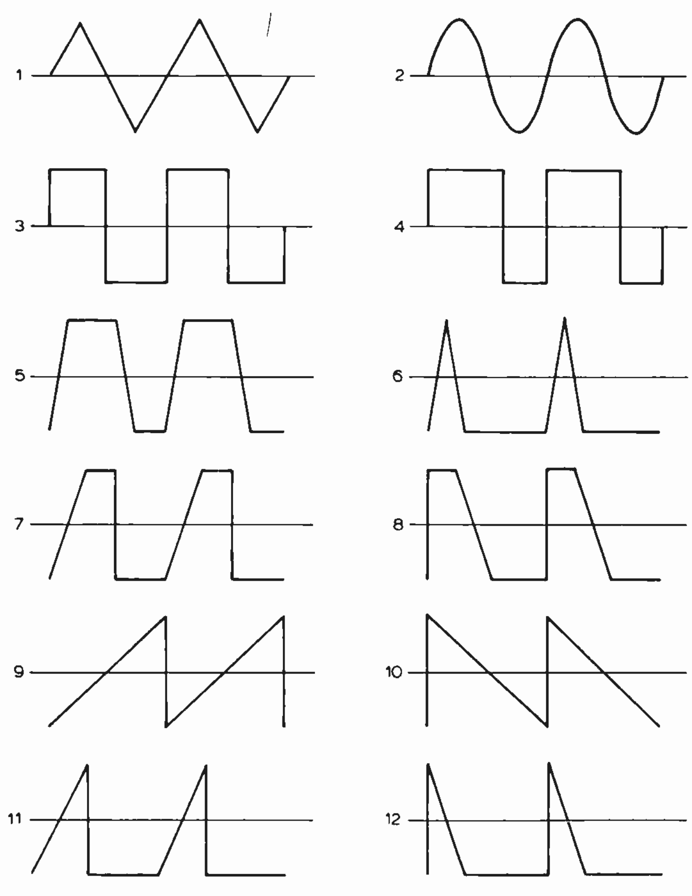


Fig. 1 *Waveforms provided by the generator.*

Specifications

Frequency range: Durations of ramp portions, positive and negative plateaus are independently variable from 0.5ms to 50s in five decade steps with a 1:12 continuous variation over each range. Standard frequency range for triangular, sinusoidal and square waveforms is 0.01 to 1000Hz, and 0.005 to 500Hz for rectangular and trapezoidal waveforms. Both ranges may be extended by at least one decade by increasing the value of the integration capacitance.

Output level: Continuously variable up to a maximum of ± 10V pk-to-pk.

Unwanted signal in output: less than 5mV pk-to-pk.

Output symmetry: Within 1% for all waveforms.

Variation of output amplitude between waveforms: less than 1%.

Frequency response: Within 0.2% over the specified frequency range.

Output resistance: less than 10 Ω.

Minimum load resistance: 1k Ω.

Triggered mode: A single waveform cycle at a preset delay, or an adjustable, integral number of cycles. Every cycle begins and ends at the most negative level. Manual triggering facility also provided.

Linearity of ramp portions: within 0.5%.

Distortion in sinusoidal output: less than 1%.

Square and rectangular rise and fall times; less than 1μs with no overshoot at maximum output level into a 10k Ω resistive load.

Setting error of timing ranges: less than ± 0.5%

Frequency stability: short term drift — less than ± 0.1% of setting for 20 min. Long term drift — less than ± 0.5% of setting for 24 hrs.

Output stability: drift less than ± 0.25% of pk-to-pk amplitude for 24hrs.

Temperature stability from 0 to 50°C: frequency — less than 0.02% per °C. amplitudes — less than 0.01% per °C.

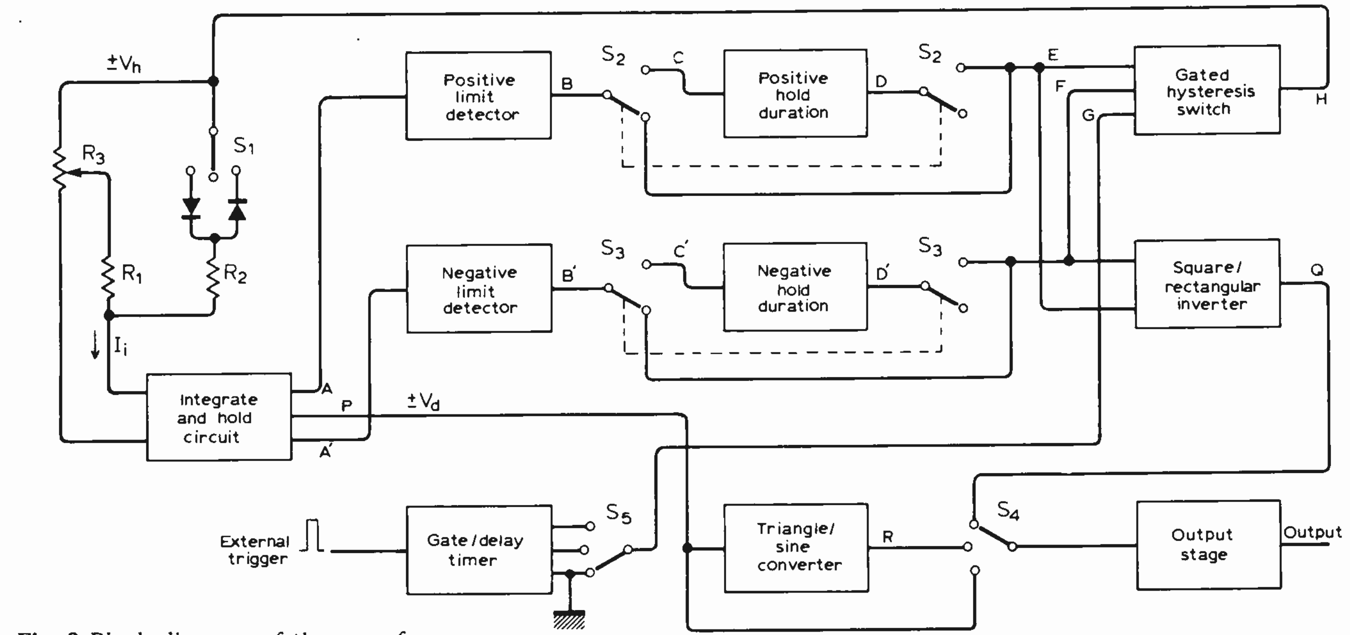


Fig. 2 *Block diagram of the waveform generator.*

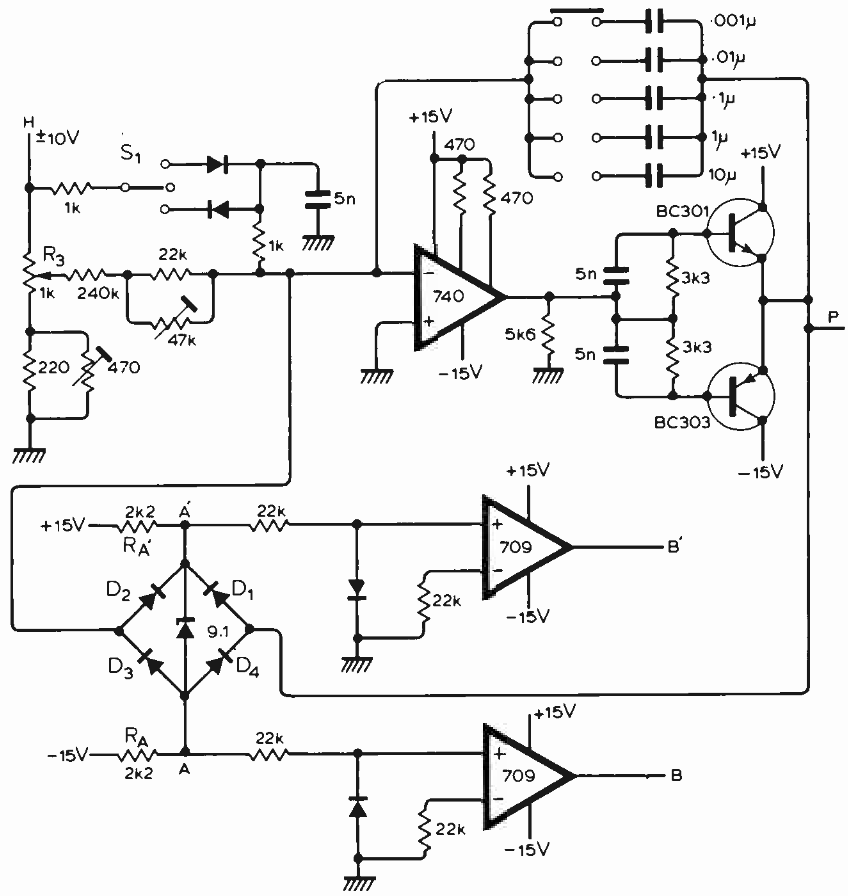


Fig. 3 *Integrate-and-hold circuit and limit detectors.*

voltage at F turns positive so that the cycle is repeated indefinitely. Output P is a trapezoidal waveform with the durations of the positive and negative plateaus determined by the positive and negative-hold duration timers. Either or both of these plateaus may be eliminated by switching S_2 or S_3 to their down position. The integrator rise and fall times are determined by the values of the integrator capacitance and I_i. With S_1 open, the magnitude of I_i, as determined by R_3, will be the same for $+V_h$ and $-V_h$, thereby giving equal rise and fall times. If S_1 is in the left position, then because $R_2<R_1$, the fall time of the integrator will be smaller than the rise time. The converse is true when S_1 is in the right position. With S_2 and S_3 in the down position and S_1 open, the integrator output at P will be a triangular waveform of equal rise and fall times. A sine-shaping network converts this to a sinusoidal waveform, and a square-wave output is available at Q as an inverted version of output H. If S_2 and S_3 are moved to the up position, a trapezoidal waveform appears at P and the rectangular waveform at Q. With only S_2 in the down position, waveform 6 appears at P. If S_1 is in the left position, waveforms 7, 9 or 11 will be generated, depending on the positions of S_2 and S_3. Similarly, waveforms 8, 10 or 12 will be generated when S_1 is in the right position. The output waveforms are fed through a selector switch S_4 to the output stage. Switches S_1 to S_4 can be combined into a single twelve-position waveform selector switch.

When S_5 is in the up position, input G is at its most positive level and output H will be forced to remain at $+V_h$. Also, the output of the integrate-and-hold circuit will be maintained at negative hold. If an external trigger pulse is received, G is grounded for a period set by the gate/delay timer and, during this period, the circuit operates in the free-running mode. At the end of the timing interval, G reverts to its positive limit, the circuit completes the cycle and latches at negative hold. Therefore, an integral number of waveform cycles will be generated following an external trigger, and the number will depend upon the gate/delay timer and the period of the generated waveform. When S_5 is in the middle position and a trigger pulse is applied, a single waveform cycle is generated after a delay set by the gate/delay timer.

The insertion of positive and negative-hold delays between the limit detectors and the hysteresis switch allows independent setting of the positive and negative plateaus, irrespective of the duration of the ramp portions. Each of these durations is variable between 0.5ms and 50s. Unlike many conventional waveform generators, the duration of any part of the waveform cannot exceed the period.

Integrate-and-hold circuit

Integration is performed in a conventional manner by a μA740 f.e.t. operational amplifier with capacitance shunt feedback and a complementary emitter follower in the feedback loop as shown in Fig. 3. The integration time is varied in five decade steps by switching different values of capacitance. Continuous variation over each decade step is achieved by means of R_3, which varies the integration current between approximately 3.5μA and 40μA. The total range of integration time is 0.5ms to 50s. With the two 1kΩ resistor switched in by S_1, the integration current becomes 5mA. Therefore, the duration of the fast-changing integrator output is less than 1% of the ramp time determined by R_3.

The hold circuit consists of a diode bridge network[2] whose diodes remain non-conducting as long as the integrator output remains between $-V_z/2$ and $+V_z/2$ where V_z is the zener diode voltage. As the integrator output increases beyond $+V_z/2$, D_1 conducts to reduce the current in $R_A{}'$ and increase it in R_A. The voltages at points A and A′ will therefore increase with the integrator output until the voltage at A reaches the turn-on voltage of D_3 plus the negligible voltage of the virtual earth. Diode D_3 then conducts and diverts the integration current to the integrator output, which is therefore held at a level equal to the sum of V_z plus the voltage of drops of D_1 and D_5.

The voltages at points A and A′ pass through zero just before the integrator output reaches its positive and negative limits respectively. The two limits can therefore be simply detected by voltage comparators. Uncompensated 709 op-amps are used for this purpose.

Hold duration circuits

When the output of the positive limit detector changes from its negative to its positive limit, the output of the positive-hold duration circuit in Fig. 4 follows after a preselected delay. In the reverse mode the output of the positive-hold duration circuit follows without a delay. The input is inverted by a p-channel f.e.t. and then applied to an n-channel f.e.t. connected as a switch across the timing capacitor. When the potential at point C is at its negative limit, both f.e.ts are turned on and the timing capacitor is short-circuited. When the voltage at C changes to its positive limit, both f.e.ts are turned off and the timing capacitor is charged by the f.e.t. current source. A programmable unijunction transistor is triggered when its anode voltage exceeds the gate voltage by about 0.8V. Before this occurs, the isolating f.e.t. connected to the voltage divider is cut-off so that

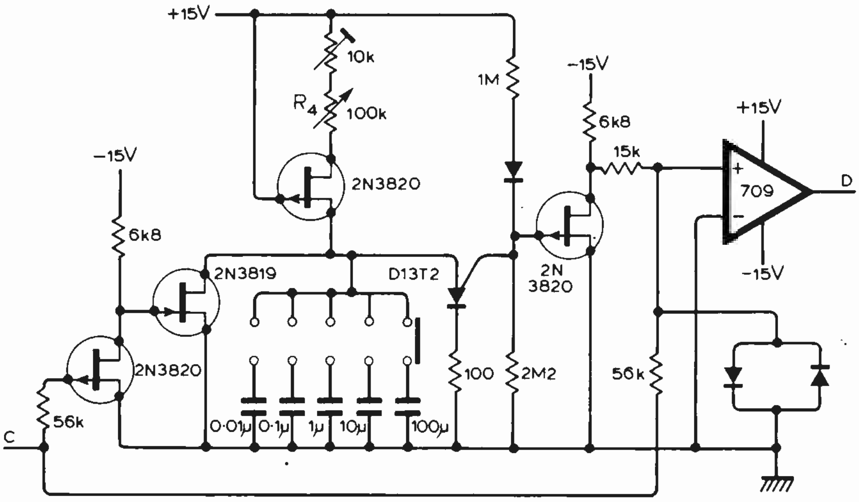


Fig. 4 *Positive-hold duration circuit.*

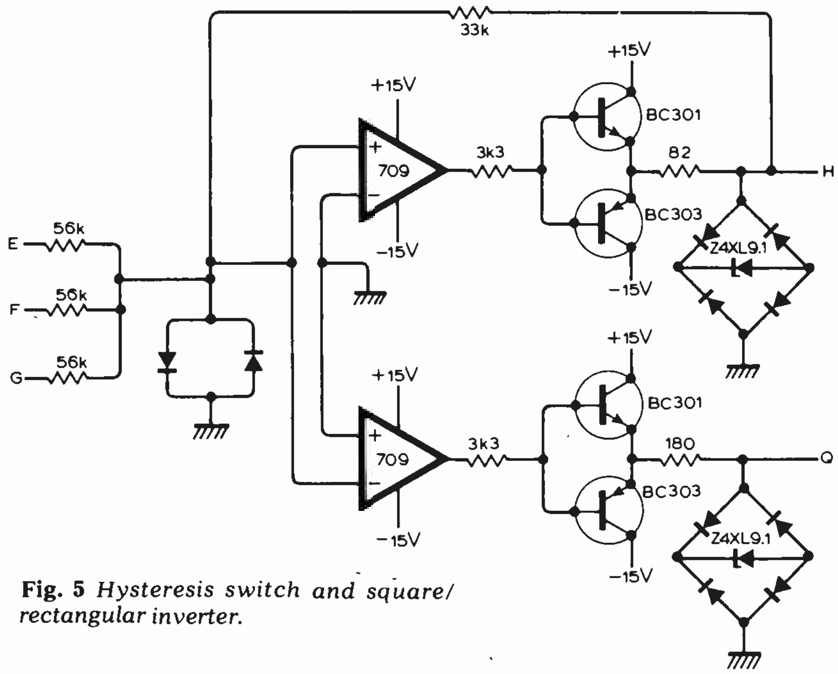


Fig. 5 *Hysteresis switch and square/rectangular inverter.*

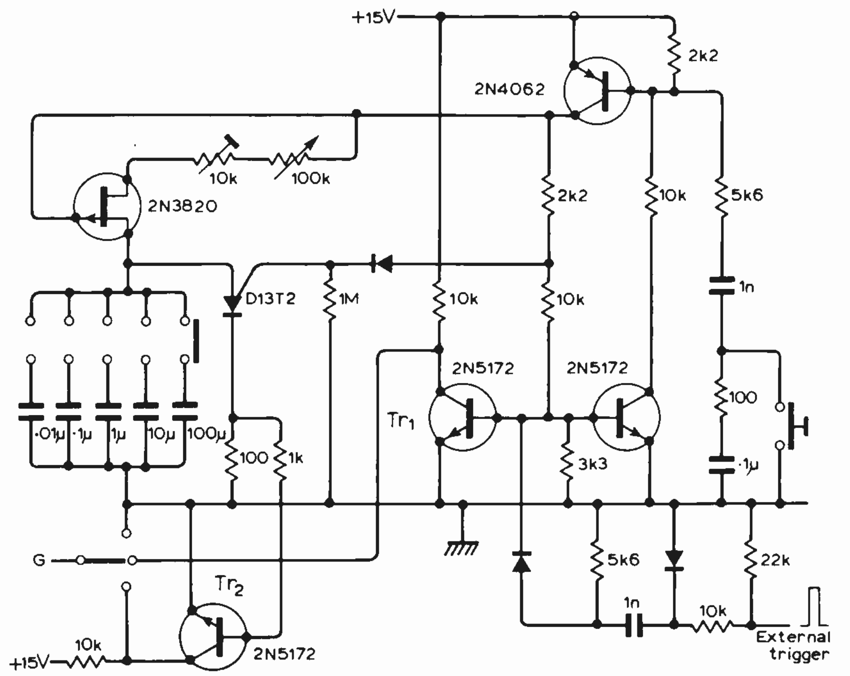


Fig. 6 *Gate/delay timer.*

the non-inverting input of the op-amp is connected to −15V and to the positive potential at C. The net potential at the input of the op-amp is negative and the output of the op-amp is at its negative limit. When the u.j.t. fires, the isolating f.e.t. conducts and the output of the op-amp switches to its positive limit. When the voltage at C changes to its negative limit, the op-amp output will switch immediately to its negative limit. Simultaneously, the u.j.t. is turned off and the circuit is reset.

It is advantageous to use a programmable u.j.t. for the timing device because it reduces the peak current to less than 0.2μA. Because the minimum current from the f.e.t. source is about 20μA, charging of the timing capacitor is linear. The total delay for the hold duration circuit is variable from 0.5ms to 50s. The negative hold circuit is very similar to Fig. 4 except that the p-channel f.e.t. inverter at the input is omitted and the isolating f.e.t. connected to the voltage divider is an n-channel source follower.

Hysteresis switch

The hysteresis switch in Fig. 5 consists of two 709 op-amps with complementary emitter followers. The integrate-and-hold circuit is supplied from point H, across a zener diode in a bridge configuration. The non-inverting input of the amplifier is connected to inputs E, F and G through 56kΩ resistors and to point H through a 33kΩ feedback resistor which introduces hysteresis. The second op-amp is paralleled with the input of the hysteresis switch so that the voltage at Q is the negative of that at H. When the integrator output is at negative hold, H will be +10V. Hence, the square and rectangular waveforms should be taken from Q if all waveforms are to be at their most negative level when input G is at +15V.

Gate/delay timer

In the timer circuit of Fig. 6 two complementary transistors are connected as a regenerative pair. Normally these transistors are in the off state and are switched on by the leading edge of a 10V positive trigger pulse. When the regenerative pair switches on, the timing capacitor is charged by the f.e.t. current source. The programmable u.j.t. fires when its anode potential exceeds the gate potential, and diverts current from the base of the n-p-n transistor This switches the regenerative pair off and resets the timer.

During gated operation, point G of the hysteresis switch is connected to the collector of Tr_1 so that once the circuit has been triggered, point G will be grounded throughout the timing interval. During this period, an integral number of waveform cycles will be generated. At the end of the timing interval the potential at point G reverts to +15V, and the output of the hysteresis switch latches at its negative limit after completing a waveform cycle. For single-cycle operation, point G of the hysteresis switch is connected to the collector of Tr_2 so that once the circuit is triggered, point G will be only momentarily grounded at the end of the timing interval. A single waveform cycle will then be generated, after a delay equal to the timing interval. The timing interval is also variable from 0.5ms to 50s. Provision is made for manual triggering in single-cycle or gated operation by a push-button switch.

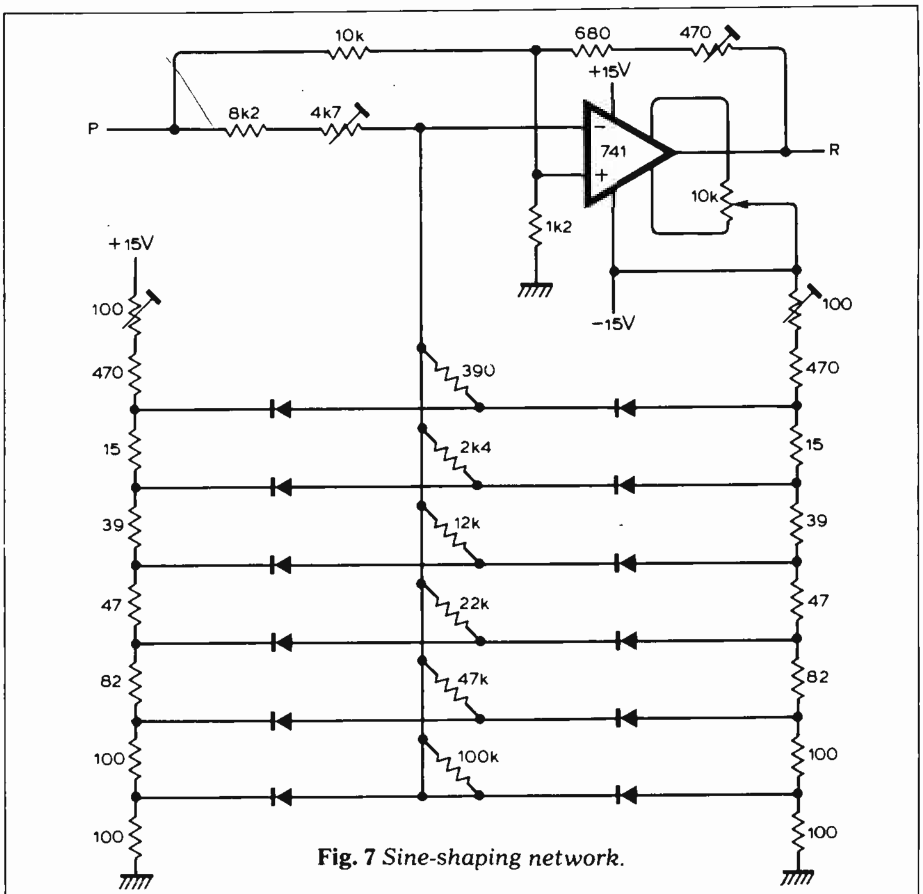


Fig. 7 *Sine-shaping network.*

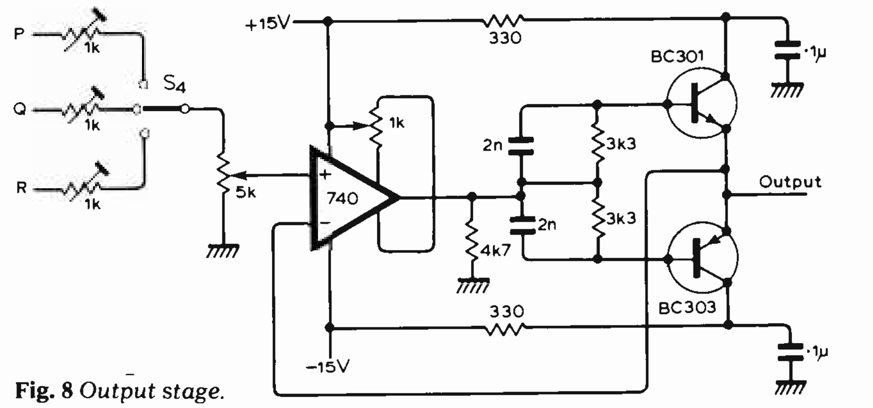


Fig. 8 *Output stage.*

Sine-shaping network and output stage

The sine-shaping circuit in Fig. 7 uses a diode/resistor network between the non-inverting input of an op-amp and ground. Each quarter cycle of the sinusoid is approximated by seven segments and the 4.7kΩ variable resistors are adjusted to give the closest approximation to a sinusoid. The 470Ω variable resistor adjusts the amplitude of the output waveform.

The output stage in Fig. 8 uses a μA740 f.e.t. op-amp as a unity-gain follower, with a complementary emitter follower within the feedback loop. The 1kΩ variable resistors are adjusted so that all of the output waveforms have a maximum pk-to-pk amplitude of 20V. A 5kΩ potentiometer varies the output amplitude between zero and the maximum value. The output is short-circuit-proof and can supply a peak current of about 15mA.

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NEWS OF THE MONTH

C.b. "should be introduced"— NEC

"A HIGH quality form of citizens' band radio service should be introduced in the United Kingdom," according to a report by a working party of the National Electronics Council. "The service should operate in a specially-allocated frequency band somewhere between 100MHz and 500MHz." The technical needs of such a service "should be included in the brief for the United Kingdom delegation to the 1979 World Administrative Radio Conference (WARC)."

The working party, set up in July 1977, comprised members from the British Radio Equipment Manufacturers' Association, the IEE, the IERE, the Electronic Engineering Association and GEC, under the chairmanship of Mr A. L. Witham of the IBA. Representatives from the Home Office and the Post Office also attended as observers but, hardly surprisingly, disassociated themselves from the working party's report. The paper notes, however, that they did provide information to the working party.

The report, published in the May-June issue of the National Electronics Review, details two possible kinds of modulation for the service. Amplitude modulation is unacceptable because of the interference it may cause to tv sets, radios and audio equipment. It notes the considerable interference problems that have occurred in the United States, Italy and Holland. The preferred system is narrow-band frequency modulation (n.b.f.m.), which is already proven, relatively cheap and economical in bandwidth. Single-sideband suppressed carrier modulation (s.s.b.s.c.) may be a better system in terms of lower power requirement, the elimination of audible beat frequencies from interfering adjacent carriers, and its need for only about half the bandwidth of n.b.f.m., but s.s.b.s.c. is a technique which is still only experimental at u.h.f. It also needs careful design to avoid intermodulation interference and, for the moment, is more expensive than n.b.f.m.

The working party also say that each s.s.b.s.c. transceiver would have to be locked to the national 200kHz frequency transmissions from Droitwich. An appendix to the report by Professor W. Gosling of Bath University notes that s.s.b.s.c. at 200 MHz requires a frequency stability such that an oven-maintained crystal oscillator would be required. "This approach must therefore be rejected".

The report proposes that power output should be limited to 2-5W, lower for hand portables. Acceptable speech quality could be obtained with 10-12.5 kHz channels. "Assuming one c.b. radio per ten inhabitants, a five mile communications range and a typical urban population density, 50 channels would be required. Even allowing for possible future expansion to 100 channels a total spectrum usage of 1MHz (or 1.25 MHz) only is required."

Type approval would have to include the antenna used and spurious emissions would have to be limited to 100nW, achieved with a helical filter in the aerial feed.

The American experience suggests a possible market here for 8 million sets. However, simple four channel sets sell in the United States for £25 or less and the higher specification set which has been considered for this country is likely to cost substantially more than this. For comparison there are about 300,000 p.m.r. transmitting and receiving units in use in this country and the cheapest set costs about £250.

The size of the c.b market, the report argues, is more likely be near that of the hi fi industry, at £600 million. The total market is thus likely to be around three million sets. If each lasts ten years that provides an annual sale of 300,000 sets, worth a total of £40-£50 million at £100 to £200 a set. At that price, c.b. would need to offer the user the same attraction as now offered by hi fi.

There seems little doubt that the manufacturers of p.m.r. equipment keenly await the arrival of c.b. Their attitude is that it will create renewed demand for the higher specification p.m.r. equipment. They are concerned, therefore, that the specifications of the sets in use should be less designed to provide the best service for c.b. users than protect the home market from foreign competition and, somehow, also provide a large export market.

"The use of frequencies other than 27 MHz would avoid the risk of the British market being flooded by low priced equipment made primarily for the United States market. Similarly the need for type approval to a fairly high specification would require that equipment was specially designed for the United Kingdom market. Whilst this would discourage overseas competition it also introduces the risk that our own manufacturers would find no overseas market for their products. It should be the aim therefore to encourage other countries in Europe and elsewhere to have already introduced c.b, or similar services at around 27MHz, to reconsider their policy in favour of a higher grade of service of the type discussed here."

This report must be considered a major setback in the Home Office's opposition to citizens' band. For one thing the NEC is immensely prestigious. Its president is Lord Mountbatten, and the chairman is the Duke of Kent, who has taken a great interest in the electionics industry. Its membership includes top civil servants from the seven most important government departments, and representatives from the universities, the National Economic Development Office, the trade unions, the professional institutions, the BBC and IBA, EMI, Ferranti, GEC, ICL, and STC, all represented at the highest levels. Moreover, the council is not just, as might be expected, "considering the working party's report," but is itself now recommending the commencement of a c.b.service.

The situation is that two members of the Royal Family as well as around ten of the highest ranking members of our non-political civil service have aligned themselves in opposition to Government policy on radio communications. A number of implications flow from that. One is that the evidence in favour of c.b. is overwhelming.

It is especially significant that the NEC insists that citizens' band, contrary to the Home Office view, *is* a matter suitable for discussion by the WARC in 1969. The Home Office has always maintained that this and other controversial matters are inappropriate for discussion by WARC, but are matters for national PTTs to decide on their own.

The document also contains many other points of interest. Although they say that the c.b service should be placed between 100MHz and 500MHz, they add that frequencies above 200 MHz may be unsuitable because the required transmitter power for a given range rises steeply above 200 MHz. It so happens that the military communication band from which many advocates of c.b.have said the frequencies could be taken extends, according to the Home Office, from 225MHz to 400MHz. We are therefore left with frequencies up to 200MHz or a little above.

But the Council refines its remarks further: "The type of c.b. service envisaged falls within the general category of the Land Mobile service although its use for leisure craft in inshore waters should not be ruled out. The United Kingdom delegation will go to . . . WARC with a brief to seek an overall increase in the frequencies allocated to the Land Mobile Service and there seems little reason why part of this should not be set aside for the application discussed in this report. Even 50 channels would occupy only 500 kHz and total increases of 70MHz are being sought." Clearly the broadcasters, who include the working party's chairman, have argued that, since the mobile radio lobby will benefit ultimately from much increased business they ought to forfeit the necessary frequencies. It would be a great pity of the project were to founder on that argument.

Lastly, the proposal to lock the transceivers to the Droitwich or some other standard frequency transmission seems a little naive. It is not just that a failure in such a transmitter would put all the c.b. radios off the air, or that not all of the transmitters have back-ups for the frequent maintenance periods. The use of the transmissions for hand-held portable transceivers is very different from the stationary laboratory equipment that the transmissions now benefit. The transceivers would need ferrite rod aerials, which are directional, something like 7in long. Has account been taken of the directions of polarisation of these various standard frequency transmissions all over the world? If, like the Rugby transmitter, they are horizontally polarised that makes for a very wide transceiver. The signal is not received everywhere, and must be monitored to make sure that a good signal is being received. How will the transmitters operate in buildings which act as effective electronic screens? There are many other problems. Suppose that some local interference is generated at or around 200 kHz, for example. All of them can be overcome, but they require the use of a refined and so expensive receiver. □

Government thinking on microelectronics begins to emerge

A DOWNING Street statement issued on June 19 has confirmed recent press reports that the Government is backing the National Enterprise Board's proposal to set up a UK factory for the manufacture of microcircuits. The Central Policy Review Staff, better known as the Government "Think Tank", has been instructed to study the social and economic implications of micro-electronics, and to make sure that all the other Government departments are aware of those implications.

At the beginning of the year three working parties were set up under the auspices of the Advisory Council for Applied Research and Development (ACARD). One, under Sir James Menter, is to study the social, educational and manpower consequences of new technologies in general and microelectronics in particular. Another, under R. J. Clayton, (see *WW* News, October '76, p.46) is looking at the microelectronics and semiconductor industries, and how they will affect costs and the development of new consumer and capital goods, and a third is to study research and development needs. The first two are expected to report before the end of this parliamentary session. It will be the job of the Think Tank to make sure that government departments take any proposals that result from the deliberations of these working parties on board, and the Prime Minister appears to have demonstrated his awareness of the importance of the electronics industry by associating himself closely with all these activities.

The Industry Minister, Mr Varley, is expected to announce a support programme for the microelectronics industry before this issue is published. His recommendations will follow closely those of the components sector working party of the NEDC. The figures will be less than the £80 million and higher than the £65 million predicted elsewhere, probably nearer £73 million or so. The aim is to embark on a programme which creates an infrastructure for the microelectronics industry, providing, perhaps, electron beam, ion implantation and microlithographic equipment and the skills to operate them, the latter to be an important part of Varley's package.

It is not expected that our photolithographic needs will be met with men and machinery entirely in this country, but the DoI appear to believe that we have adequate skills in the other two areas to meet our needs. The industry ought to be able to offer a wide range of design, process (m.o.s, c.m.o.s, bipolar and c.d.i. techniques, for example), mask-making and computer-aided test facilities to industry. Industry will be provided, initially, with £15 million as an encouragement to make use of microprocessor techniques, it was announced on July 4.

Some £55 million of the DoI's package will be earmarked for creating these facilities, including £15 million for the infrastructure. Investment from other sources should bring the total to £100 million. Another £20 million of government help will be devoted to investment in the production of such standard devices as memories and microprocessors, later microcomputers, as a means of import substitution, with a view to getting 10% to 15% of the world market. Investment here would total £120-£140 million.

Some clues as to how the Industry Department views the uses of electronics were offered in a little-noticed speech by Parliamentary Under Secretary of State Les Huckfield at a seminar held in Birmingham by the Institute of Production Engineers on May 25. He said Britain was not doing enough to develop microelectronic techniques. The opportunities microelectronics offered to industrial production were every bit as great as those offered the service sector in pocket calculators, petrol pumps and cash registers. Some of these opportunities had been grasped: "Yet at present, apart from numerically controlled machine tools, which have been around for some time, there is little other use of computing technology on the shop floor in the engineering industries. The impact on product testing, quality control, inspection and automatic assembly is negligible in this country.

"For its part my Department has long recognised the importance of microprocessors in the industrial context. The various industry requirements boards have come more recently to involve manufacturing industry directly with Government research establishments in project work. In terms of financial assistance there are schemes available, including the product and process development scheme, which it is hoped will encourage the design and production by UK manufacturers of equipment incorporating microprocessors. Effectively the PPD scheme has been fully operational only since the beginning of this year but industrial interest has been gathering in recent weeks and the Department has 221 applications in the pipeline, including some for microprocessor applications, which if approved, could represent as much as £46 million of additional investment in UK industry.

"In addition, my Department is examining carefully the ways in which additional specific support may be given for tackling the three main areas where positive encouragement from Government may help to guide this new industrial revolution along the right lines: education and training; consulting facilities; and applications of microprocessors and project support."

The Downing Street statement mentioned the NEB proposals as one of three solutions to the problems posed by the need to build up a successful micro-electronics industry: the first is to develop a manufacturing base for the supply of microcircuits; the second is to encourage British industry to take full advantage of the new technology and to apply it fully in a wide range of possible uses. The third problem to be tackled is the largely unknown effect that microelectronics and changing technology will have on employment and other things, and how society is to adapt itself to these changes. This is the reason for the Prime Minister's calling in the Think Tank.

Meanwhile GEC and Fairchild are planning to set up a microelectronics company in competition with that which the NEB may fund. The initial capital would also be £50 million. GEC have led the criticism of the NEB project saying, along with Tory spokesman Sir Keith Joseph, that such ventures should be undertaken by private enterprise. (If so, why haven't they been?) The American, French, German, and Japanese Governments have put huge sums into microelectronics.

The National Economic Development Office's working party on electronic components has just produced a report (June 23) saying that the NEB's choice to set up a new company with expertise from the United States is the riskiest and most expensive option open to the electronics industry. The other choices are for an established British company to move from specialised components into mass production i.cs, and for a British company to link up with an American company in a joint venture, as GEC and Fairchild are doing. The report does not firmly advocate one course rather than another. British companies have not been too willing to move into mass-production i.cs.

Whatever the outcome of all these plans and proposals there is no doubt at all that the NEB plan has shaken the British electronics industry to the core. Depending, of course, on the result of the coming general election, the future for Britain's electronics engineers looks quite a bit brighter. □

Optical record players soon?

"ROLL ON ALP" is how we forecast the coming of a high-density audio disc, when reporting the emergence of the Philips VLP video disc system. Now, five years later, Philips announce ALP under the name Compact Disc, saying a player will be demonstrated in September.

Based on VLP techniques, the disc revolves with constant tangential volocity of 1.5m/s (VLP playing time was extended last year to one hour by using the constant tangential speed mode). But because the storage density for audio is not so critical, it has been possible to trade some of this capability, firstly for size — the ALP is 4in or 110mm in diameter — and secondly for a lower recorded bit rate (Philips won't give the exact figure), which means the lower-wavelength gallium arsenide diode laser can be used instead of the helium-neon laser still used in VLP. And as the modulation is a 14-bit linear pulse code all the usual benefits of digital systems will accrue.

● Pioneer Electronic Corp. has just announced a 50:50 joint venture with MCA Inc, called Universal Pioneer Corporation to develop and manufacture an optical video disc based on a helium-neon laser and of 30cm diameter.

The new company is scheduled to produce players and discs for the industrial market late in 1978. Pioneer say they will also produce players for the consumer market "sometime in 1979" but MCA will not be supplying discs for this market, because of the exclusive agreement with Philips. (Philips say they have not yet granted licences for making VLP players). MCA Disco-Vision Inc are supporting introduction of VLP players in the USA this autumn with between 200 and 300 titles at a price "somewhat higher than an audio l.p., but not too much higher." □

Systems rivalry for international viewdata and teletext

THE UK Post Office is going ahead with its public viewdata service in early 1979 in spite of the fact that the system they have developed, now called Prestel, may not be acceptable as a European and international standard. It is important that there should be a standardized international system of viewdata/teletext, first to allow the information retrieval to operate across national frontiers so that users have access to much more than just their own country's data banks, and secondly to allow a standard design of Viewdata/teletext terminal so that the tv set manufacturers can produce them more economically.

A rival to Britain's Prestel/Ceefax/Oracle system is the French system Antiope, which was developed by the CCETT (Centre Commun d'Etudes de Télévision et Télécommunications) at Rennes, a research organization representing both the Post Office and the broadcasting interests in France. The differences between the two systems are explained in the box on this page. A crucial difference is that Antiope allows more than one set of alphabetical characters to be used, so that all European languages can be catered for. A CCETT report indicates, in fact, that seven sets of characters are needed to cover the major European requirements. However, there is a British proposal for a modified version of Prestel/Ceefax/Oracle which meets these European requirements and this was put forward by the British contingent at a CCITT working party held in Munich at the end of June. The CCITT (International Telegraph and Telephone Consultative Committee) is the arm of the ITU which looks after international standards in line communications.

An extraordinary situation arose earlier this year from which it appears that the British Post Office was in a divided state of mind. We understand that at a meeting in Rennes between the British and German Post Offices and the CCETT, proposals were made for standardization of viewdata codes which, if adopted, would be totally incompatible with the present UK teletext system and the British Post Office specification for the Prestel service due to start in 1979 — a specification agreed finally with the British set makers in February of this year. These proposals would also be incompatible with the i.cs and modules being developed by the British components manufacturers for use in the sets. The proposals were, however, fully compatible with the French Antiope system.

The French are pressing ahead with selling Antiope which is not yet publicly available though it has been in use on the Paris Bourse for a year and in French banks. They have also run trials in New Orleans, Montreal, Toronto, Buenos Aires and Peru. But what may be more worrying for the British is what one French source described as "a 90% cer-

The Antiope System

Antiope is one application of the French Didon data communication system, and is the French equivalent of Ceefax/Oracle teletext and the Post Office Prestel (formerly known as Viewdata). Development was started later than that on the British systems, and it is claimed that, having the benefit of the British work, the French were able to produce an improved concept. Advantages put forward for Antiope include greater flexibility in the characters displayed and compatibility between broadcast and interactive services.

An important feature of Antiope, which is otherwise broadly similar to the UK teletext system, is that page and row starts are explicit. The system is independent of line syncs. provided by the receiver, unlike UK teletext, but transmits page and row flags as ordinary eight-bit bytes. In this way, the data on one line of the television signal is not positionally related to the characters on one row of the display. Data is transmitted in blocks from several sources, which are identified by the decoder, the flags enabling the decoder to organize the characters into the correct arrangement. The name adopted for the principle is "packaged data".

In the same way as in the UK, Antiope data is normally transmitted on "spare" lines during the vertical fly-back interval, or on picture lines if a television programme is not being transmitted. A packet of data contained on one line contains the data block itself, of 32 bytes, and a prefix containing "management" information relevant to the data. Two bytes are used as a clock run-in, in a similar manner to the UK c.r.i., followed by a one-byte framing code for byte sync. A further three-bytes constitute an identification signal to determine to which communication channel the following data block belongs. A continuity index in one byte keeps count of the number of packets of data from the desired channel that have been received, as a check against transmission errors, and a last prefix byte, the format index, is a number equal to the number of bytes in use in the data block.

Control characters in the data stream indicate the start, finish and the number of each page, page numbers being Hamming protected. Each row is preceded by a row flag and/or a row number, also Hamming protected. Empty rows or the unused ends of rows can be ignored and the flag used to start a new row.

The page header contains the familiar page number, service name, date and time information, but also flags to indicate whether multiple alphabets are to be used, whether the following page is a control and not to be displayed and which main alphabet is in use.

Graphics are selected by control characters in the familiar way, as is the colour of the succeeding character. Alternative alphabets are commanded by code sequences (escape sequences) and it is possible to transmit a new alphabet on a control page. The familiar facilities — double-height characters, conceal, flashing, boxes, etc., are provided.

There appears to be a lack of understanding between UK and French systems engineers on the capabilities and even requirements of each other's systems. The present situation is that, since Ceefax/Oracle and Prestel have been designed to work in the UK, in their own media, they have been optimized for the purpose and work extremely well. They are intended to do one job, which is what they do. The French seem to view this as a shortcoming, and are determinedly oblivious to the views of UK engineers that to use the UK system on the Continent requires easily-incorporated changes. Even the multi-language capability of Antiope is simply obtainable by UK equipment, rather more cheaply than in Antiope.

It has been said by CCETT that UK teletext can only use eight information channels. This does not appear to be correct, since the use of existing bytes can provide eight magazines of 100 pages, each in 3200 different versions — more than ample, one would think. The French system is said to be flexible because of its package-data principle and time-division multiplexing, and so it is, but at the expense of robustness of the data. UK workers have taken advantage of the available line syncs. which provide a high degree of protection of synchronism. A missing or mutilated flag in Antiope could be disastrous.

Proposals by UK engineers to bring Ceefax/Oracle/Prestel into line with Continental requirements have been set out in a recent report. In particular, the multi-language feature has been studied and methods proposed.

Three control bits, C_{12-14}, in the page header are unused at present and it is suggested that they be used to call up eight sets of characters, seven of them covering most of the central and western European languages and the eighth a non-displayed page which would contain any other language, to be stored in an extra 1.6K r.a.m. This r.a.m. would also make possible the display of much more advanced graphics. The r.o.m. size to include all seven sets of characters would be less than twice the size currently used. By employing a small r.a.m. of 72 bits capacity, each row could use a different character set and it is even possible to use a different set for each character by calling into play a second header addressed as row 25. (Rows 24-31 are not at present used, and the use of 24, 25 and 26 would enable the above facilities to be provided.)

All these methods of extension of the system to employ different character sets can be made compatible with existing decoders, although they would not, of course, be able to respond to the new character codes.

tainty" that Antiope will be the teletext system in use giving results and information at the Olympic Games in Moscow in 1980. It would be a big contract for the firms involved — Marconi are supplying television equipment for the games — but for Antiope it would also be a major propaganda coup.

According to Keith Jones of Thorn, chairman of the newly-formed International Viewdata Teletext Co-ordinating Group, the British interested parties are united thanks to the mediation of BREMA between the broadcasters and the Post Office. The broadcasters have less reason to be committed to internationalism than the Post Office, because the wired and broadcast information systems are being ever more clearly seen as having different, though complementary functions. There is little evidence of a need for exchanged broadcast information, and what evidence there is suggests that it is much more likely to be demanded on the continent than in the UK, partly because of the legendary poverty of our scholarship of languages.

Shared standards

The Post Office, however, is, according to one observer, "committed to an international standard up to the eyeballs", since telephonic communication, which is what viewdata is, is inherently international. Viewdata is more likely to be suited to business use, and the disappointing consumer market has caused the manufacturers to turn their hopes towards the business market. The makers want a set which will receive both teletext and viewdata so that, if an unofficial promise by the Post Office to connect tv sets to the telephone network free of charge for the reception of viewdata is carried out, customers can, it is hoped by 1980, be lured towards the buying of decoder sets by the suggestion that teletext will cost them nothing off-air, and free connection to viewdata will make that too available at only the cost of the data they use. All that will be needed to push the boat out, they think, is one of those frequent Fleet Street strikes. The broadcasters, the Post Office and the makers thus have a shared interest in standardisation.

The Post Office are hoping to sell viewdata software widely abroad. Viewdata is now the general name given to a system for providing tv-displayed information disseminated by telephone lines. Prestel is the name of the service the Post Office is providing in this country. So far the Post Office have announced sales of some of their viewdata pilot trial computer programmes to West Germany and the Netherlands. A Post Office spokesman said discussions about possible sales were going on with other European countries, but these could not be named as yet. "The contract with the Netherlands," said Post Office Telecommunications managing director Peter Benton in a statement, "is another step towards world standards for viewdata visual information systems. Such standards will be of immense benefit for electronics and tv firms as well as for telecommunication authorities." (Obviously the adoption of a common standard would create much larger exports.)

The statement continued that a common display standard had been agreed by the BBC, IBA, BREMA and the Post Office, allowing the electronics in the set to be used for either teletext or viewdata. "The contracts with West Germany and the Netherlands could lay the foundation for comparable harmony among future viewdata systems adopted in Western Europe. It would be of twofold value: it would ensure a common standard; it would benefit Europe's electronics industry by resulting in one basic integrated circuit design capable of international application."

When the British teletext system was first demonstrated it had a system of alphanumerics that was far from the internationally agreed ISO standard for alphabets. Although it is now in line, that will not solve the latest international difficulties. The English alphabet does not cover the alphabets of all the other countries in Europe, partly because of special symbols like the German 'ss' but mainly because of the need to provide extra symbols where letters have accents or other added marks. At first the Germans were pleased to go along with the British alphabet, according to the chairman of the newly-formed pressure group International Teletext Viewdata Co-ordination Group, Mr Keith Jones of Thorn. The French, however, objected that to leave off the grave, acute and circumflex accents would pollute (and further anglicise) the French language. They began to persuade the Germans that they should insist on umlauts and other special characters.

The British response was to suggest the dissenters take advantage of the provision in ISO standard 646 for opting nationally for their own variations. This, however, would have had serious effects on the wired systems, always regarded as more international in character, which would need to provide information from, say, foreign stock exchanges if they were to offer an attractive and complete service.

In mid-June the answer to this proposal by Geoffrey Crowther of Philips was that international sets should be capable of dealing with all alphabets, especially since the sets were likely to be made by international companies such as Philips and ITT.

The British attitude now is that that would put up the cost of the set because of the larger-sized character storage capacity needed. The new fully-international viewdata set has to be based on a previous pattern, and that which they are putting forward is the "GO" set now in wide use in Britain. GO is the name given to a "normal" character set. A further character set, G1, can be defined by the use of an escape sequence and the two then selected at will by control characters.

The International Teletext Viewdata Co-ordinating Group is, at the time of writing, pressing for the adoption of the GO set as the basis of the international set at the CCITT working party eight meeting in Munich. They hope that they will have the support of Philips ITT and the Germans and Dutch representatives, and Gerald Crowther of Mullard (Philips), and George McKenzie of the IBA flew to Munich on June 20 to put the British view.

Bearing in mind the timing of the UK market trial, to which the Post Office are now committed, it would seem inconvenient for them if changes were now introduced. The broadcasters would also find changes unwelcome in view of their commitment to a standard teletext-viewdata set.

It seems just as likely that any international agreement reached will be so outside inside the CCITT. The next plenary session of the CCITT is not until 1980, and for the French that is too long to wait. The CCITT have set up a number of working parties, about a dozen, to deal with text transmission systems of various kinds, but most of them concern purely telephone issues. The two crucial working parties are those that deal with international alphabets.

In addition, an ad hoc EBU working party was set up last year to study data transmission systems of all kinds, but its discussions are likely to be influenced considerably by the CCITT working party meetings.

No dramatic announcements are expected from the CCITT at least until the plenary session in 1980, and many observers feel that their recommendations will be too widely drafted. Michel Barda echoed the French view that decisions had to be taken well before that time, and that the multinational companies who are to make the sets would be the most influential group to determine the eventual design of the decoders. Official bodies like the CCITT were too ready, he said, to "start talking about the shape of the table."

High prices

Part of the keenness to expand the data text market arises because of the effect of high prices on the sales of decoders. At the moment chip costs are such that the manufacturer has to pay £100 for the decoder hardware, and this translates itself to an extra £300 on the cost of the set in the shops. The only market which can support such a price is the upper end of the colour tv market, with the possibility that reasonable volumes could also be found in the traditionally-British rental sector. Chip costs are unlikely to come down unless the makers are prepared to order 100,000-off quantities, which would bring the cost to them to £25, adding £75 to the set price. At the moment, however, quantities ordered are no higher than 1000-off.

Antiope developed as a result of work at the massive CCETT research centre at Rennes, in Brittany. Keith Jones thinks history is repeating itself." The French for a long time have been doing a Secam and have produced a system different in every respect from teletext and viewdata .... They have produced a system which is all things to all people without getting anything off the ground." The French were way behind us in teletext, he said, because last November they had been talking about public field trials "in the next two years." Jones makes clear, however, that the two systems have been moving closer together, and he cites the bit rate as an example.

The attitude among the ten or so French manufacturers involved in Antiope is to play down the differences between the English and French systems. "It's not that different," said Michel Barda of Unitell who he says will have a microprocessor-based decoder by the end of the year. "We're not competing with the English system. We want to combine the French and English systems to get the best one. We will then have a product that will have no nationality." Citing the SECAM example he said that "It's a bad war and everyone loses by it. It's a silly war. We want to have a standard which even the Japanese will use, and it could be 80% English and 20% French, we don't mind."

● Delegation sources say the Munich meeting gave them greater hope that the GO set might be adopted, another study group being set up to study the mattter. It will meet first in the autumn. The German and British related systems performed well but the French suffered from a communication breakdown with the computer. The meeting's progress seems to have pleased the British delegates, who appeared to benefit from presenting a united case. □

Radiating cable system

Proposal for multiple-diversity voice or data communication

by K. F. Treen

The author presents a scheme for producing a multiple-diversity system, suitable for long-haul, restricted-range voice or data communication. It is economical in the use of the frequency spectrum and employs the property of 'image acceptance' instead of the more usually sought 'image rejection'.

RADIATING CABLE SYSTEMS are becoming established as means of radio-communication over defined yet restricted ranges. The great advantage of their adoption lies in a more beneficial use of the frequency spectrum. By careful system design it is possible to use and re-use the same frequency in close geographical proximity without the problems of mutual interference.

For 'long-thin' radio ranges, as experienced in railway and road transport, the radiating cable has many advantages over free-radiation. Not only is the signal restricted largely to the required path but it can be guided through cuttings and tunnels in which normal free radiation is not possible.

The longitudinal range is limited by the insertion (end to end) loss of the radiating cable. Ranges of two to four kilometres can be obtained with reasonable ease, but beyond this the signal strength has to be augmented by the installation of a second system similar to the first and identically modulated. Alternatively one may use repeating amplifiers joining the end of one length of cable to the beginning of another. Such repeaters are simple amplifiers with no frequency generating means; several may be cascaded in one system, making possible the ability to communicate without signal regeneration over some scores of kilometres.

Signal variations

Examination of the radiated signal strength along a path approximately parallel to the cable discloses large differences in amplitude. Superimposed on a cyclic variation of some 10 to 20dB are fairly regular, topographically stable, deep cusps in which the signal level is reduced to values which can be low enough to jeopardize adequate signal reception. The space occupancy of these cusps is quite small and consequently, from the viewpoint of a moving vehicle, the time occupancy is equally small. For speech communication the presence of the deep cusps is of little importance due to the large amount of redundancy in normal speech. For data transmission, however, even momentary loss of signal can give rise to significant, possibly intolerable errors.

A feasible solution to the problem is the use of diversity reception. In its simplest form this comprises two antennas, spaced a little distance apart on the vehicle, with each antenna coupled to its own receiver (or to the relevant inputs of a double-headed receiver). The output signals of the receivers are combined by one of the recognized methods.

The improvement in reliability of reception brought about by this means can be equivalent, when compared to a single antenna-receiver scheme, to increasing the transmitter power by some 30dB. A simple coupling of the two antennas, via a hybrid, to a single receiver brings no improvement. Experiments have shown that there is a mean loss of some 3 or 4dB and no improvement in the deep cusp which generally shifts slightly in its apparent position. This is explained by the fact that as the vehicle moves through a cusp region a situation exists where the amplitudes of the signals from the antennas can be approximately equal, but the phase angle between them approaches 180 degrees. The signals thus tend to cancel at the receiver port. Measurements of phase angle between the signals picked up by the two antennas show a randomness and rapidity of change of phase which would frustrate any simple means of beneficial additive combination.

In the reverse direction, from vehicle to radiating cable, a similar problem arises when the latter is acting as a receiving antenna. To duplicate the radiating cable and thus reproduce the two-receiver, two-antenna scheme of the 'forward' direction would be impracticable and economically unsound. The alternative of providing one transmitter on the vehicle and splitting its output to two spaced antennas results in something similar to the equivalent receive case mentioned above in which the two antenna inputs are combined in the hybrid then fed to a single receiver.

Probably the surest solution in the vehicle-to-base direction lies in the use of two transmitters on the vehicle, working at different radio frequencies but with common modulation. The radiating cable would be connected to two suitable receivers and the receiver outputs would be combined by an appropriate method. Since each transmitter would feed both the vehicle antennas, we would have a fourfold diversity arrangement.

What is now postulated is a scheme in which two frequencies are required in the vehicle to base direction. If we also use two frequencies in the reverse direction and again two antennas connected to two receivers on the vehicle we have fourfold diversity in both directions.

Fourfold diversity

The system outlined below permits the simultaneous transmission of two channels of intelligence (say one channel of speech and one channel of data) using the two radio frequencies and at the same time affords fourfold diversity. From a spectrum usage viewpoint it is no different from the normal use of one radio frequency per intelligence channel, which would provide only dual diversity in one direction and no diversity in the other. A block diagram of the system in the direction base to vehicle is shown in Fig. 1.

Tx_1 and Tx_2 are two independent-sideband transmitters operating at say, 46MHz and 46.5MHz. M_1 and M_2 are two sources of modulation, one of which may be speech and the other data. Each transmitter is modulated with both signals, such that M_1 will produce the upper sideband of Tx_1 and the lower sideband of Tx_2. M_2 will produce the lower sideband of Tx_1 and the upper sideband of Tx_2. The output signals of the transmitters are fed to the hybrid H_1 and the combined signals at the hybrid output ports are fed to the radiating cables, the first of which may be in one direction and the second in the other direction, there being no significant loss of transmitter power by this means.

In the vehicle we have two double receivers of which only one is shown. A_1 represents one of the two receiver antennas used on the vehicle. The output

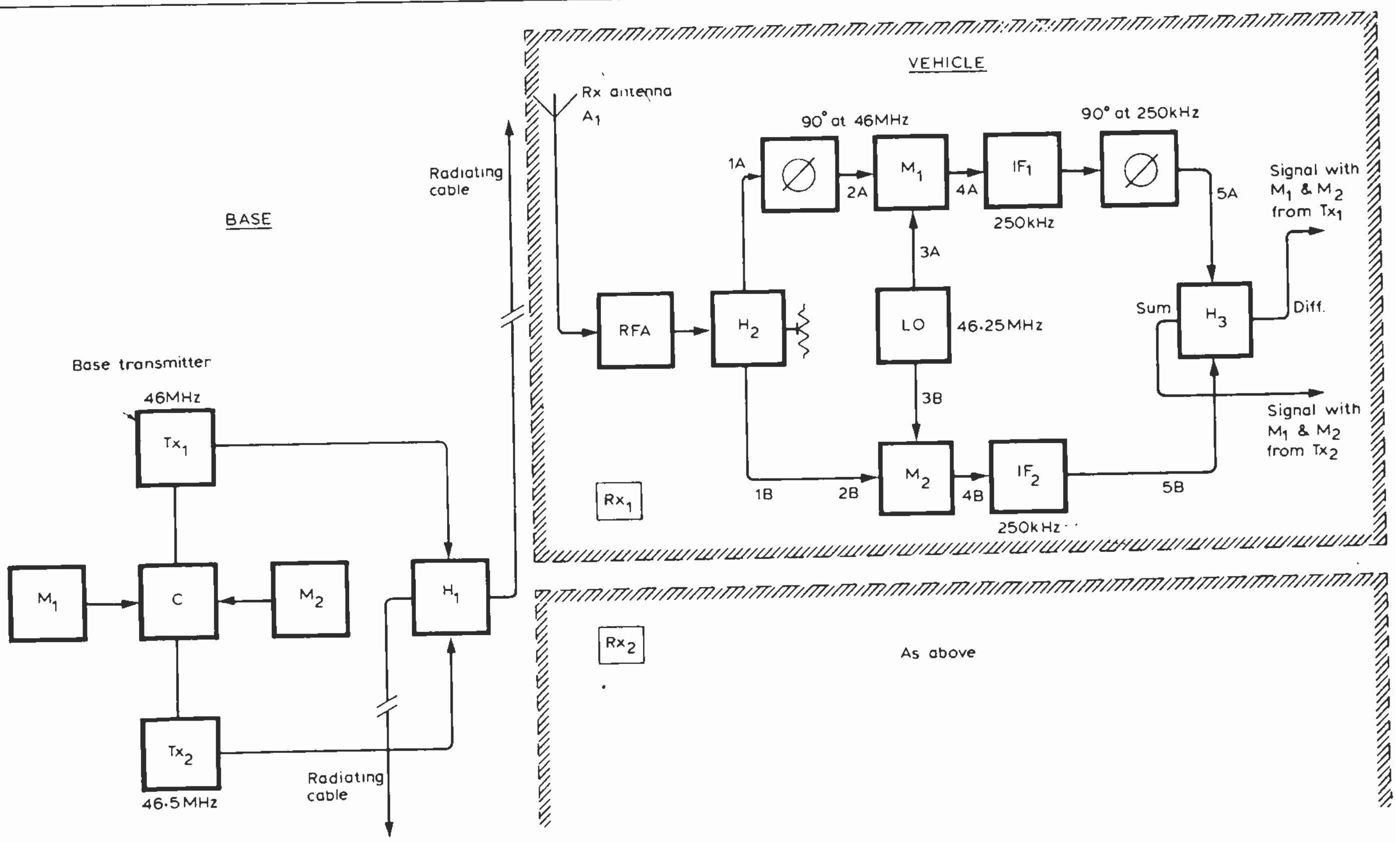


Fig. 1. *Block diagram of base to vehicle system.*

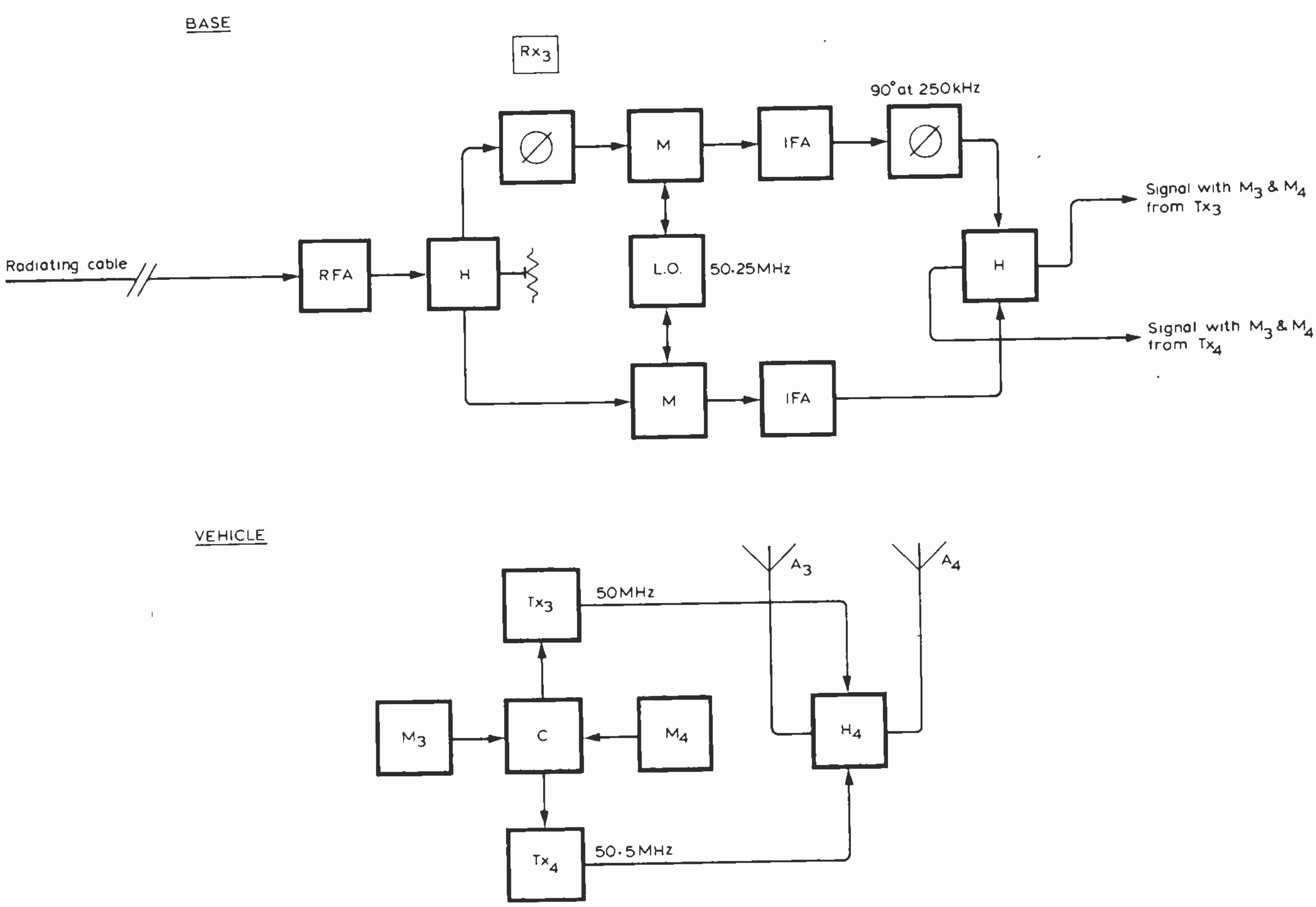


Fig. 2. *Block diagram of vehicle to base system.*

of A_1 consists of signals from Tx_1 and Tx_2 at 46.0 and 46.5MHz respectively. A common radio-frequency amplifier is used to amplify both signals. The output of the r.f. amplifier is divided at hybrid H_2, one output going via a 90° phase shift network to mixer M_1 and the other output direct to mixer M_2. Both mixers are fed with a common local oscillator operating at 46.25MHz. (Note that the local oscillator frequency is half way between the frequencies of the two base transmitters, hence as seen by the receiver one transmitter frequency is the image of the other.) The intermediate-frequency signal output at 250kHz from each mixer is amplified in IF_1 and IF_2 respectively. The output from IF_1 is fed via a 90° phase shift network (at 250kHz) to hybrid H_3 and the output from IF_2 to H_3. The 'sum' output from hybrid H_3 comprises the signal due to transmitter Tx_2, similarly the 'difference' output from the hybrid comprises the signal due to Tx_1. Since both transmitters carry both modulation signals we are left with two 250kHz independent-sideband signals, both of which contain the two modulations.

A second identical receiver connected to a second antenna produces similar output signals. Various forms of combination (for example at intermediate frequency) can be adopted at the final output, after detection to separate the upper and lower sideband modulations, to produce two signals of acceptable signal-to-noise ratio.

Figure 2 shows the block for the direction vehicle to base. Tx_3 and Tx_4 are two independent-sideband transmitters, the outputs of which are combined in hybrid H_4. The two output ports of the hybrid are connected to the vehicle antennas A_3 and A_4. The two modulation sources M_3 and M_4 (again there could be, for example, one speech and one data) are combined in C and serve to modulate the transmitters, such that M_3 produces say, the upper sideband of Tx_3 and the lower sideband of Tx_4 and M_4 produces the lower sideband of Tx_3 and the upper sideband of Tx_4. For the example in this case Tx_3 has been allocated a frequency of 50MHz and Tx_4 50.5MHz. Frequency allocations of this sort would allow duplex working. For simplex working the frequencies shown for the base transmitters in Figure 1 could be used.

The base receiver Rx_3 is connected to the end of the radiating cable and is the same (except possibly for frequencies) as that used in the vehicle, though only one is used in this case. The two intermediate-frequency outputs, both of which carry the two intelligence signals can again be combined in some suitable manner and demodulated to produce the required signals.

The author wishes to thank the management of Redifon Telecommunications Ltd, for facilities provided and for permission to publish this paper.

Appendix A. Mathematical relationships of the signals showing how separation is brought about.

Transmitters Tx_1 and Tx_2 are quite independent of each other and unmodulated, for simplicity. The local oscillator is set midway in frequency between the frequencies of Tx_1 and Tx_2 and Tx_1 is lower in frequency than Tx_2. Let these frequencies be represented by $\omega_1 t$ and $\omega_2 t$ respectively. Further assume that the gains and losses of mixers, amplifiers, etc. are the same for the different signals and that the losses in phase-shifters, hybrids, etc. are negligible.

First consider the signal received from transmitter Tx_1. At 1A and 1B in Fig. 1 signals are equal in amplitude and phase, which can be expressed as $K_1 E \sin\omega_1 t$.

At 2A one half signal has gone through a phase delay of 90° ($\pi/2$), so at 2A the signal is $K_1 E \sin(\omega_1 t - \pi/2)$, which equals $-K_1 E \cos\omega_1 t$, whereas at 2B it is still $K_1 E \sin\omega_1 t$.

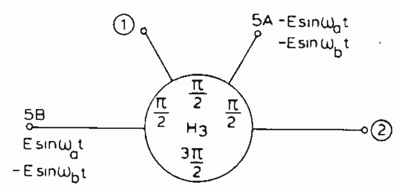
Let the local oscillator signal be split such that at 3A and 3B both samples are equal to $K_2 E \sin\omega_{LO} t$. These samples are applied to the mixers M_1 and M_2.

When K_2 is much greater than K_1 the amplitude of the mixer output signal at intermediate frequency is directly proportional to K_1. The constants can henceforward be ignored.

After the mixer, at 4A we have, therefore, $-E\cos(\omega_{LO} - \omega_1)t$ and similarly, at 4B, $E\sin(\omega_{LO} - \omega_1)t$.

Now consider the signal from Tx_2. At 1A and 1B signals are again equal in amplitude and phase expressed as $E\sin\omega_2 t$. *At 2A the* 90° phase delay has been introduced so the signal at 2A is $E\sin(\omega_2 t - \pi/2)$, which is equal to $-E\cos\omega_2 t$. At 2B it is still $E\sin\omega_2 t$.

After the mixer at 4A we have $-E\cos(\omega_2 - \omega_{LO})t$, and at 4B, $E\sin(\omega_2 - \omega_{LO})t$.



Summarizing, the signals are as follows:

From Tx_1
At 4A, $-E\cos(\omega_{LO} - \omega_1)t$.
At 4B, $E\sin(\omega_{LO} - \omega_1)t$.

From Tx_2
At 4A, $-E\cos(\omega_2 - \omega_{LO})t$. .... (1)
At 4B, $E\sin(\omega_2 - \omega_{LO})t$. .... (2)

We can rewrite expression (1) as
$E\cos-(\omega_{LO} - \omega_2)t$.
which is equal to
$-E\cos(\omega_{LO} - \omega_2)t$.
Expression (2) can be rewritten as
$E\sin-(\omega_{LO} - \omega_2)t$.
which is equal to,
$-E\sin(\omega_{LO} - \omega_2)t$.

Again summarizing:

From Tx_1
At 4A, $-E\cos(\omega_{LO} - \omega_1)t$. .... (3)
At 4B, $E\sin(\omega_{LO} - \omega_1)t$. .... (4)

From Tx_2
At 4A, $-E\cos(\omega_{LO} - \omega_2)t$. .... (5)
At 4B, $-E\sin(\omega_{LO} - \omega_2)t$. .... (6)

Now ω_{LO} is a common signal in equal phase to all parts, so the phase of the intermediate frequency signal is dependent on the phase of the radio frequency signal which gives rise to it.

Now let $(\omega_{LO} - \omega_1) = \omega_a t$
and $(\omega_{LO} - \omega_2)t = \omega_b t$.

Then from (3) and (5) we have, at 4A, $-E\cos\omega_a t$ and $-E\cos\omega_b t$ and from (4) and (6) we have, at 4B,

$E\sin\omega_a t$ and $-E\sin\omega_b t$ .... (7)

The 4A signals go through a further phase delay of 90°, so that at 5A we have $-E\cos(\omega_a t - \pi/2)$ and $-E\cos(\omega_b t - \pi/2)$.

These are equal to $-E\sin\omega_a t$ and $-E\sin\omega_b t$ respectively. At 5B we have the same as at 4B shown at (7) above.

Hybrid H_3, is shown in Fig. 3 as a hybrid ring with three arms equal in length to $\pi/2$ and one arm equal to $3\pi/2$.

The two $-E\sin\omega_b t$ signals combine in port 1 and cancel in port 2. The $-E\sin\omega_a t$ and the $E\sin\omega_a t$ signals combine in port 2 and cancel in port 1. □

The author

Kenneth F. Treen was born in London in 1911. He first received a classical education before turning to the study of mathematics and physics. He joined the General Electric Company in 1936 where he was engaged in the development of test and measuring apparatus for television equipment. After a period with the Air Ministry during the war he joined the Radio Division of Standard Telephones and Cables Limited in 1945 where he took charge of the measurements and test design laboratories. In 1950 he joined a development group concerned with radar, navigational aids and high power microwave communication systems. In 1964 he was appointed Chief Engineer, Ground Navigational Aids, and in 1965 Chief Engineer S.H.F. Systems. On the formation of the Mobile Radiotelephone Division he became Manager, Technical Planning. In 1973 he joined Redifon Telecommunications Ltd. as a senior systems engineer, retiring in 1976.

Mr Treen has been actively engaged in related work of an international character. He has been a member of CCIR Study Group 8 and of several BSI and IEC Committees and Working Groups, being sometime Chairman of the IEC Working Group concerned with transmitter measurements. He is the author of a number of patents, mainly in the microwave field.

The subject of this paper has been filed with the British Patent Office and has been accorded the number 50616/76.

Electrical noise measurement in audio engineering

Importance of meter characteristics in assessment of signal-to-noise ratios

by James Moir, F.I.E.E.

A contribution in the December 1976 issue of *Wireless World* discussed the measurement of acoustic noise. In the article, special reference was made to the multiplicity of variants on the decibel that have appeared in an attempt to achieve agreement between an objective measurement and the subjective impression of the loudness of the same noise. It was noted in the conclusions that many other units had not been discussed and one field left without any discussion was the measurement of the electrical noise present in a sound circuit carrying signals that would subsequently be converted to an acoustic signal by a loudspeaker. A recent commission obliged the author's organisation to look more closely at the problem of measuring the noise in an electrical circuit, and it was felt that a discussion of this would be of general interest.

SUPERFICIALLY the problem of measuring electrical noise appears to be no different from the problem of achieving agreement between the objective measurement and subjective opinion of the noisiness or annoyance of a simple acoustic noise. However, the large number of different international and national standards that exist, all attempting to solve the problem but all with different solutions, suggests that there are some difficulties additional to those present when measuring the loudness of an acoustic noise directly. It is this aspect that is the subject of the present discussion and it is important because of the large differences that appear in measured signal/noise ratios when the techniques specified by the various standards are followed.

Any approach based on measuring the power or pressure (voltage) characteristics of an electrical noise signal has proved to be totally inadquate and was discarded long ago. It fails because there are four other factors that a simple power or pressure measurement ignores. These other effects will be given individual consideration, the first being the effect of the sensitivity/frequency relationship of the human hearing system.

The ear's sensitivity/frequency relationship

It is well-established that the sensitivity of the hearing system is not uniform over the audio frequency band, the relative sensitivity falling away at both low frequencies and high frequencies. This is simply indicated by reference to the Robinson-Dadson curves in Fig. 1, the well-established equal loudness curves. Each curve is a contour showing the sound pressure required to produce the same subjectively-judged loudness at all frequencies in the audio range. Each curve slopes upwards at both low and high frequencies, indicating that the hearing system is less sensitive at the extremes of the band.

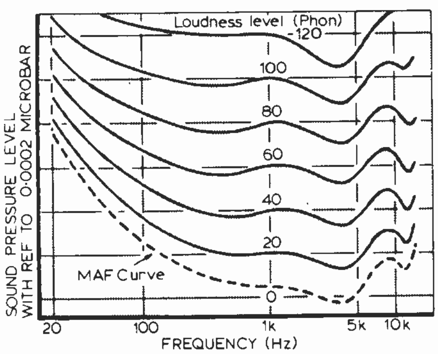


Fig. 1. *Robinson-Dadson loudness curves. Each curve joins sound-pressure-level/ frequency points having the same subjectively-judged loudness.*

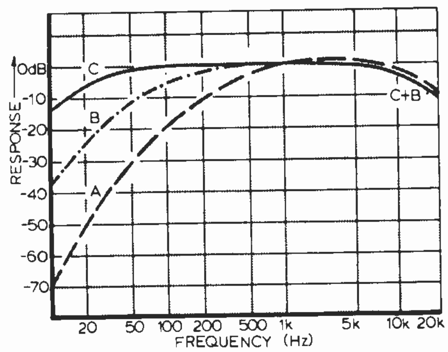


Fig. 2. *Graph showing the A, B and C weighting characteristics provided in almost all sound level instruments. In Britain, curve A is generally used when measuring acoustic noise.*

The curves do more than just this; they indicate that the relationship between sound intensity and subjectively-judged loudness varies with the absolute intensity. Thus at a loudness of 90 phon, the sound pressure levels required to produce equally loud sounds at say 100 and 1000Hz, differ by only 5dB. At a much lower level, 30 phon for example, the sound pressure required at a frequency of 100Hz is 15dB higher than the sound pressure required at a frequency of 1,000Hz, for the same loudness.

These particular curves apply specifically to the situation when pure tones are involved, but they are approximately true when bands of noise are being measured, and the same conclusions apply. This change in hearing sensitivity with frequency is taken care of when measuring the noisiness or loudness of noise, by modifying the frequency response of the meter amplifier in the instrument to correct the changes in the sensitivity/frequency relative to the absolute sound level. The frequency weighting network is modified in three stages to give the well known A, B, and C weighting curves provided in almost all sound level meters. These three weighting curves are shown in Fig. 2. A fourth weighting curve, the D curve, is sometimes provided for use when measuring noise from jet aircraft. So far, the problem does not differ from that of measuring acoustic noise. British practice (as specified by BS 3860 and BS5428), when measuring noise in an electrical circuit, is to employ the weighting curve standardised for use when measuring acoustic noise, generally the A curve. Circumstances arise when the C curve, or even no weighting curve, has to be used.

Transducer response

However, there is a second aspect of the problem that needs consideration. When the acoustic effect of the electrical signal is being assessed, it is clearly necessary to take the response of the transducer system into account. Until relatively recently the only transducers that were of importance in converting an electrical noise signal into acoustic noise, were telephones having a frequency response that was moderately uniform only over the frequency band between 300 and 3,000Hz. As the performance of

Table 1 Meter response on a single tone burst

Burst duration (ms)		1	2	5	10	20	50	100	200
Amplitude reference steady signal reading	(%)	17.0	26.6	40.0	48.0	52.0	59.0	68.0	80.0
	(dB)	−15.4	−11.5	−8.0	−6.4	−5.7	−4.6	−3.3	−1.9

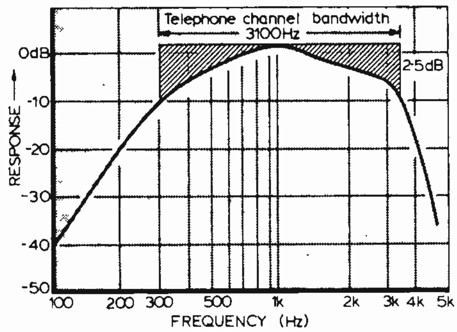


Fig. 3. *Research was carried out to determine the degree of transmission impairment caused by noise interfering with speech within the limited band (300Hz to 3,400Hz) of a telephone channel, in the case of the CCITT weighting curve, the interfering tones were compared in power with an 800Hz tone. The resulting curve, shown, is known as the 'psophometric weighting curve'.*

telephones was improved over the years, the frequency response of the weighting network was modified in well defined stages, and early examples of electrical noise weighting curves employed a weighting intended to duplicate the response of telephones then in use. There are many variants that appear in national and international standards, a typical curve being that specified by CCITT and shown in Fig. 3.

On the appearance of broadcasting and the development of loudspeaker systems that had a substantially uniform response between say 20Hz and 20,000Hz, it became necessary to make a major change in the shape of the weighting curve to improve the agreement between the electrically measured and the subjectively-assessed noisiness of the noise. The earlier weighting relationships, such as those of Fig. 2, completely ignored the contribution of the high frequency "hiss" components of the electrical noise signals that are subjectively so annoying. In a well-designed and engineered amplifier, the basic noise is due to thermal agitation in the resistive component of the input circuit impedance. Its value can be calculated from the Nyquist equation, from which it will be appreciated that the noise power is constant per unit of bandwidth. When measured through an analyser having the usual constant percentage bandwidth characteristics, the frequency spectrum is typically that of Fig. 4. Any weighting curve will clearly have to reflect the predominance of the high frequency hiss components in the noise encountered in amplifier and telephone systems.

Masking effects

Experience soon indicated that a mere extension of the frequency bandwidth of the weighting relationship was insufficient to bring objective measurements and subjective opinion into agreement. The noise is not heard in isolation as it is when measuring acoustic noise, instead the noise is heard as a background to a programme of music of speech. Both types of programme have their energy peaks in the low and middle frequencies. Except at intervals in the programme, any acoustic noise due to the low and middle frequency components of the electrical noise are masked by the programme signal components in the same frequency band. It is characteristic of electrical noise that most of the energy is concentrated in the higher frequencies. Thus, while the programme energy per octave band is decreasing with increasing frequency, the energy in the intruding noise is increasing with increase in frequency, with the result that the higher frequency components of the noise are much more obviously intrusive than the low frequency components. This aspect is taken care of by increasing the sensitivity of the noise measuring instrument to the higher frequencies.

Intermittent noise

White noise is a smooth sounding sort of noise, but many types of intruding noises do not have this smooth characteristic. Interference from many types of electrical equipment is characteristically intermittent or 'spikey', and this is found to be more annoying per unit of noise power than a smooth noise. Similar comments apply to many other forms of interference noise that appear

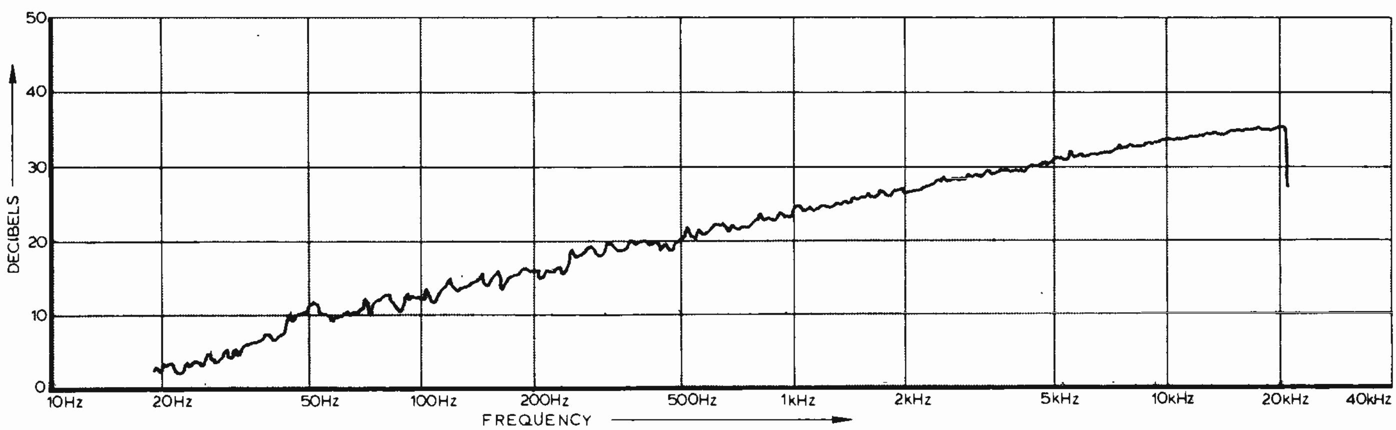


Fig. 4. *Typical frequency spectrum of white noise.*

Since preparing this article on noise measurement, a situation already confused, has been further complicated by the publication of an AES paper (AES Pre-print 1353) by Dolby, Robinson & Gundry providing details of yet another 'standard' for noise measuring meters. This is primarily intended for use in those field's such as tape recording where the noise to be measured does not include any significant amount of energy due to short spiky transient clicks.

The meter and circuit time constants specified by CCIR 468-1 and 468-2 have quasi-peak characteristics intended to ensure that the meter indication is adequately representative of noise signals that contain these short time transients, but such a meter is expensive. In consequence Dolby suggest a metering combination that includes the CCIR 468-1 frequency weighting network in conjunction with a meter having a deflection that is proportional to the 'average' voltage (0.636 × peak). This has the unfortunate result of providing readings that, on typical tape type noise, are some 6dB lower than the CCIR quasi-peak meter. To correct this they now propose to shift the reference frequency from 1kHz to 2kHz.

The advantages of such an instrument are largely commercial. A noise measuring system can be produced by adding a frequency weighting network in front of almost any millivoltmeter, and the Dolby organization have such a weighting network available. (Their Cat. No. 98A). They have standardised the instrument for use in all technical discussions between themselves and their many licencees and are thus in a powerful position to influence the market. The cost savings are considerable because the network sells for £145 and there must be few laboratories who don't have a millivoltmeter that must be used with the weighting network. Instruments meeting CCIR 468-1 or 2 are currently selling for prices around £800 to £1,000.

The disadvantages are equally obvious. We have yet one more standard to which noise measurements can be made and as the readings obtained depend on the frequency spectrum of the noise — information that is not usually available — there is significant chance of obtaining the 'wrong' readings without this being apparent to the user.

A consensus opinion is difficult to define. The cost of the existing meters is not of any significance to more professional users, such as the telecommunication and broadcasting organizations, so the new proposals are of little direct interest to them. Manufacturers of audio equipment do not have this financial advantage and are more likely to favour the Dolby proposals. These have the additional commercial advantage of providing lower readings on 'spiky noise' and in consequence result in a higher value for the measured signal/noise ratio. The Dolby proposals may sharply divide users into two groups, the professionals who will continue to use the meter to CCIR 468-1 and 468-2 and the consumer product organizations who will be biased towards the use of a measuring system satisfying the Dolby proposals. Only some long term exposure to the market forces will clarify the situation.

James Moir

in transmission circuits. There are so many varieties of noise that it is perhaps not surprising that all the current attempts to obtain a universally approved noise weighting curve have been based on an experimental approach.

Weighting curves

Most of the experiments employed panels of listeners to assess the intrusiveness of various kinds of noise buried in programme material and thus the relationship derived is a weighting curve that takes all four aspects of the problem into account. The resulting curve is that given in IEC Recommendation 468 and shown in Fig. 5. It will be seen that this is a curve having a uniform slope of about 6dB per octave below about 4kHz, rising to a peak of about 12dB at 7 to 8kHz, and then falling away very rapidly above this frequency. Such a weighting curve reduces the contribution of the low frequency components to the total measured noise level, and emphasises the contribution of the 'hiss' components in the 5 to 10kHz region.

Meter characteristics

Two other characteristics of the measuring equipment need to be taken into account in assessing the performance of the actual instrument and the circuit by which it is driven. Neglecting the digital approach, all the pointer-type instruments employed in noise meters are basically d.c. moving-coil types preceded by a rectifier circuit to convert the output signal voltage from the weighting amplifier to d.c. These circuits can be designed to produce a meter current that is proportional to the average, r.m.s., peak or any intermediate value of the applied voltage. British practice, as exemplified by BS 3860, or European practice, covered by IEC 268-3, specifies a meter giving readings proportional to the r.m.s. value of the applied voltage when used to measure sinusoidal signals. This is the type of meter used in standard sound-level meters meeting BS 4197.

Experience and experiment appears to indicate that the subjectively-judged annoyance aroused by a noise that is intermittent or peaky in character is more closely proportional to something nearer the peak value of the noise, rather than the r.m.s. value. To include this effect, the German DIN 45,450, or the IEC Recommendation 468, specifies the use of a quasi-peak (near peak) reading circuit to drive the meter movement.

However, the final deflection is also a function of the meter movement ballistics, for a heavy and sluggish meter movement might not indicate the peak or quasi-peak value of a signal unless that signal was continuously repetitive. Thus, it is also necessary to specify the meter ballistics. This is usually achieved by a table listing the fraction of the final deflection that will be reached by pulsed signals of various burst lengths. Table 1 quotes the values likely to be required by CCIR 468-2 when it is adopted next year. The values for burst lengths of 10ms and above are those currently specified by 468-1.

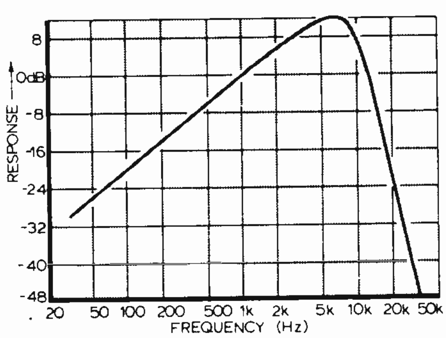


Fig. 5. *Weighting curve as given in IEC Recommendation 468. This curve was derived in an attempt to obtain a universally-approved noise weighting characteristic.*

Table 2. Approximate relationship between 'A' and 468-1 weighting

Noise type	'A' weighted	468-1 r.m.s. meter	Weighted quasi-peak meter
White	0	+8.5	+12
Pink	0	+6.0	+11
Tape	0	+7.0	+12
Amplifier	0	+8.5	+12

This is all rather confusing so it is worth looking at some of the practical consequences. If the noise to be measured is a simple single frequency sinusoidal signal, then meters meeting any of the standards will unambiguously read the same. It is of no consequence whether the meter current is proportional to the average, r.m.s., or peak value of the applied voltage, the scale can be calibrated in r.m.s. volts or any other parameter required, because the mean, r.m.s. and peak values of a sinusoidal voltage have fixed relationships between them.

If the applied voltage is random noise of either the white or pink variety, the relationship between the mean, r.m.s. and quasi-peak can also be specified with adequate accuracy. If the noise is of unknown composition, then the relationship between the readings from the various types of meter cannot be specified with any accuracy. In consequence, it is necessary to specify the Standard to which the instrument complies when quoting the value of any noise voltages.

In an amplifier of good design the residual noise should all be due to thermal agitation in the resistive component of the input impedance and it will have the equal-energy-per-cycle characteristic of white noise. Few amplifiers are quite so perfect as this, and there may be additional noise components, proportional to *1/f*, with some contribution from mains frequency harmonics and from mains borne components at higher frequencies.

Table 2 lists the approximate relationships between instruments having weighting characteristics, specified to the most important of the current Standards, when they are used to measure noise of various types. The last lines are average values of the readings taken across the output terminals of several high quality amplifiers and tape recorders. The reference value is read from a standard sound level meter, using A weighting to BS 4197, connected in parallel. These relationships should be used as an approximate guide only, for the frequency spectrum of the noise on the amplifier and tape recorder outputs was not analysed. However, as the readings were averaged for several different models, the relationships are thought to be typical.

Earlier in this discussion it was pointed out that the accurate measurement of electrical noise was important because of its application to the quotation of signal/noise ratios. When evaluating the signal/noise ratio of a system the test signal voltage is almost invariably a simple, single frequency sine wave and there is little ambiguity about its measurement. Readings of the residual noise in the absence of the test signal will vary by up to 10 to 12 dB depending on the meter and weighting network employed. The reading will, in almost all situations, be higher than that given by an A-weighted sound level meter, to BS 4197, connected in parallel, and in consequence the signal/noise ratio will be lower (worse) by amounts roughly indicated by the values quoted in Table 2.

In a situation that can hardly be claimed as crystal clear, there is the additional complication that commercial noise meters are available in which the frequency weighting network complies with one standard, generally IEC 468-1. The actual meter, however, may be an r.m.s. type or a peak programme type complying with BS 4297. The only commercial instruments known to the writer that comply with IEC 468-1 are the Brüel & Kjaer Type 2429, and the Rhode & Schwarz Type UPGR psophometer. Both instruments provide a switch-selected choice of r.m.s. and quasi-peak detectors and employ meters complying with the ballistic requirements of IEC 468-1, but it is expected that the ballistic specification now included in 468-1 will be tightened in IEC 468-2, nominally due for issue in 1978. However, this change is unlikely to have any significant effect, except when measuring noise of the switch click or car ignition types. Quoted signal/noise ratios should, therefore always be viewed with great suspicion unless the performance of the noise measuring instrument is defined, preferably by reference to some Standard.

James Moir, F.I.E.E.
James Moir, who says that his consulting practice, formed 18 years ago, is his only spare time interest, was for about 12 years head of a team responsible for the design and running of equipment used in Royal Command Film Performances in the 'fifties. Another, more treacherous, duty was to measure electronically deflections in the wings of Sunderland flying boats, made to dive and ascend under full power. James Moir, perhaps best known for his book 'High Quality Sound Reproduction,' referees IEE papers on acoustics and noise and holds 107 patents, most of which he gained at British Thomson Houston. For the three years prior to forming his own company, which has carried out noise surveys in numerous environments, and is currently involved in the acoustic design of a bank, a university and six power stations, he was technical director of Goodmans Industries.

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CCITT – A psophometer for telephone Circuits, p53.

CCIR Recommendation 468—Study Programme 2A/10.

Hertz, AES Preprint, 56th Convention—Psophometric Measurement of Noise.

Marconi Instruments, St. Albans—Measuretest No. 10.

Nyquist. Thermal Agitation in Conductors—*Phys. Review* Vol. 32, p110.

CCITT Red Book Vol. 1—December 1956, p135, Annex. 1.

LITERATURE RECEIVED

D.c. servomotors, produced by Moore Reed, described in a leaflet giving electrical and mechanical characteristics. Moore Reed & Co. Ltd, Walworth, Andover, Hants WW401

Liquid dispensers, for precision air-pulsed application of adhesives, solder paste etc, briefly described in short catalogue from Interfax Ltd, (17a) Kings Road, Sutton Coldfield, West Midlands B73 5AB WW402

Common-mode noise is discussed and traditional and novel methods of its reduction, with particular reference to X-Y recorders, are offered by Hewlett-Packard in Application Note AN214-3. Obtainable from H-P at King Street Lane, Winnersh, Wokingham, Berkshire RG11 5AR WW403

Capacitors, in chip and encapsulated forms of monolithic, high-V, high-stability ceramic, are listed in a Semtech catalogue from Bourns (Trimpot) Ltd, Hodford House, 17/27 High Street, Hounslow, Middx TW3 1TE WW404

Measuring instruments in the Marconi range are briefly specified in the 1978 short catalogue, obtainable from Marconi Instruments Ltd, Longacres, St. Albans, Herts AL4 0JN WW405

M.o.s. field-effect transistors from RCA are described generally and specifically in brochure MOS-160D, obtainable from RCA Ltd, Solid State-Europe, Sunbury-on-Thames, Middx TW16 7HW WW406

Digital Instrument Course, part 3, from Philips is concerned with design and use of digital meters. Reprinted series from Philips T and M News, part 1 being on binary theory and logic and part 2 a discussion of digital counters and timers. Each part £2.40 from Pye Unicam, York Street, Cambridge CB1 2PX.

Approved components, to BS9000, CECC or MoD specification are listed by Mullard in a new booklet, together with information on "High-Rel" screening and information on Clansman components. Central Enquiry Handling Unit, Mullard Ltd, New Road, Mitcham, Surrey WW407

Digital panel meter DPM2 is the subject of leaflet D2 from Farnell Instruments Ltd, Sandbeck Way, Wetherby LS22 4DH WW408

M.o.s. integrated circuits for industrial and consumer application are briefly specified in a condensed catalogue from AMI Microsystems Ltd, 108(a) Commercial Road, Swindon, Wiltshire WW409

Field-effect transistors from Mullard are listed on a wall-chart, which covers junction f.e.ts, dual types, m.o.s.f.e.ts and a dual m.o.s.t. Important electrical and mechanical data is presented. Central Enquiry Handling Unit, Mullard Ltd, New Road, Mitcham, Surrey. WW410

Mobile radio in 1978

Some mobile radio topics from the Communications '78 conference

by Ray Ashmore

Predictably, the main concern among the mobile radio fraternity at the Communications '78 conference was again that of frequency spectrum congestion; a problem that has no simple solution and which will always be with us. From much of the following text, which is all based on papers from the conference, one can see that the academics, the engineers and the administrators, if not trying to find the simple solution, are at least working very hard to minimize the problem.

ACCORDING to Professor W. Gosling of the University of Bath, in his overview address[1] on fixed and mobile communications, the problem of spectrum congestion is now presenting itself in almost every field of radio engineering. He pointed out that the whole of radio communication was still constrained between about 10kHz, below which aerial structures were impracticable, and 20GHz or so, where water and atmospheric absorption became severe. His view on the millimetre wave bands was that they did not represent an extension to the usable spectrum, because their application was not in substitution for lower frequencies, but principally for new purposes. One millimetre wave application he did highlight was that of providing a communication system which could offer privacy by ensuring that nothing could be heard outside a relatively small boundary. This system would exploit the fact that millimetre waves have an extremely limited range due to atmospheric absorption.

Rapid growth

While reminding delegates that the growth in radio use was very rapid — with land mobile radio growth in excess of 10% per annum over virtually the whole developed world — Professor Gosling suggested that the effect would be very different in the high and low frequency bands. Some parts of the world, because of their population density, would never be too badly affected in the v.h.f. bands and above, but in others such as Western Europe where population exceeds 100 persons per square kilometre, congestion would be severe once the level of technical development passed a certain threshold.

In contrast, congestion of the v.l.f. to h.f. bands was world-wide and it was necessary to ask if h.f. should still be regarded as an intercontinental transmission band in view of the disadvantages of this mode of use. However, Professor Gosling concluded that h.f. was far from dead, and spectrum congestion still posed enormous problems, which were compounded by the emergence of very high power, over-the-horizon radar (see p35, Jan 78 issue).

Satellite technology

On the subject of satellite technology, he said that the opportunity for much further development had presented itself due to the reduction in cost expected as a result of the development of the space shuttle. As far as satellite broadcasting, which enabled a dramatic reduction in the amount of spectrum used for a given number of channels, was concerned, it was a matter of policy whether it would free spectrum space for other users, but it could.

The future

In looking at future spectrum use, and not only at broadcasting, there was a general tendency to suppose that changes in spectrum use were more easily achieved than was likely to be the case. Large investments had rightly introduced a good deal of inertia into proposals for radical technical change and problems would have to be approached with this in mind.

There were some kinds of radio which were so localised geographically that any use of geostationary satellites in those services seemed improbable, so for many important short-range radio users it was terrestrial radio which would be important in the foreseeable future, and no magic solution to the spectrum congestion problem was around the corner.

Even for those who used satellites, spectrum congestion problems were not permanently at an end. The microwave bands were already congested and suitable satellite frequencies were likely to be ever more vulnerable to co-channel interference in the future.

The proper management of the electromagnetic spectrum was going to be a continuing preoccupation of communications engineers into the far foreseeable future and there was no single technical revolution ahead which was going to make this particular problem go away. Indeed, it could get more acute.

There were two fundamental approaches to this problem. The government official whose task was spectrum management was likely to take the view that the allocation of a scarce resource to a growing demand was rightly dealt with by rationing and a calculus of priorities. Plausible as this may have seemed, it was of course a policy of restriction. It could not but have had its impact on the economy, and that impact, difficult to quantify though it may have been, must necessarily have been negative.

At the opposite pole was the view of the majority of the radio manufacturing industry, which believed that by deploying all the technical resources at its disposal, the problem of congestion could be contained into the foreseeable future at a level of utilization far above that which now ruled.

Professor Gosling stated that there was clear evidence that the period of exponential growth in radio use in the developed world was now beginning to slow down. As yet the effect was small, but there was ground for saying that if we could struggle through to the end of the present century, or a little beyond, the phase of growth could then be drawing to a close, and a relatively stable epoch could replace it. "Thus, what we are really faced with may be something more like a quarter-century bridging operation, after which the technology we are left with may be with us for a very long time," he said.

He then continued to say that for a generation radio engineering had been a discipline subject to orderly development, not revolutionary change, and the period of orderly development was now drawing to a close. Under the combined impact of the demands created by spectrum congestion and the opportunities jointly created by microelectronics and space technology, radio engineering was about to be reforged on the anvil of world economic development. It would become better adapted to our needs than anything we had had before, and he should be surprised if, in the process, innovations did not result which were so radical that their impact would be just as strongly felt in the conservative low-congestion markets also.

Spread spectrum communication

In the UK some 35MHz of spectrum is allocated to land mobile radio compared with about 400MHz allocated to television broadcasting, including 42MHz for the v.h.f. Band 3 channels. In terrestrial broadcasting, to avoid co-channel effects which would occur if the same carrier frequency was used by spatially adjacent transmitters, the transmission of a single television channel requires a number of different frequencies. Therefore, in most allocated bands, at any given location, only relatively weak signals from distant transmitters are present, and these are not used as part of the local broadcasting service.

According to one paper — Spread spectrum communication in the land mobile services[2] — it is natural to consider the possibility that these fallow channels might be used for private mobile radio (p.m.r.) services, if it could be done without disturbing tv viewers. There is already limited non-interference-basis (n.i.b.) use of tv bands for land mobile radio, both in the USA and by the broadcasting authorities in the UK, and the purpose of the paper was to contend that if this use was to become more extensive, broadband modulation techniques would need to be used. If it was judiciously applied it could result in an effective doubling of the available p.m.r. spectrum.

Broadband techniques for radio communication of speech have been known for some time[3] and their use in land mobile radio has been proposed before[4, 5]. Unfortunately, the number of speakers per MHz of occupied bandwidth of practical spread spectrum systems is lower, by a factor of six or more, than with conventional amplitude modulated (a.m.) or narrow-band frequency modulated (n.b.f.m.) systems, and it is this relative inefficiency that has seemed to preclude the possibility of widespread adoption of spread spectrum communication in p.m.r.

In his paper[2] Mr R. F. Ormondrou said that because the tv signal was essentially broadband, the power per unit bandwidth was much smaller than the total power received. Therefore, if interference from a.m.- or n.b.f.m.-type signals occurred, the power density per unit bandwidth would rival that of the tv signal, even when the p.m.r. signal was very weak, and the visible effect would be relatively marked. The tv signal was also particularly sensitive to signals close to the carrier frequencies.

In a test with a.m. interference centred on the video carrier and 5dB below the peak carrier signal level, the visible effect was high-contrast wavy lines right across the screen. By contrast, a spread-spectrum signal of comparable power produced only random-like effects on the picture (snow). Because this type of interference was better tolerated by the viewer, a lower protection ratio (tv signal power against interfering spread-spectrum p.m.r. signal power) was acceptable in such cases. The protection ratio of 10dB, assuming equal bandwidths of tv and spread-spectrum telephony signals, previously suggested[6], was in agreement with results obtained in Mr Ormondroyd's experiments at the University of Bath. In essence, by making the wanted and unwanted signals more alike in spectrum width, the asymmetry which enhanced the ability of the p.m.r. signal to degrade tv reception was removed.

In the experiments carried out by Bath, only systems which used conventional amplitude modulation or frequency modulation of an r.f. carrier were considered so that they would be based to the largest possible extent on existing system components. The spectrum was then spread by multiplying by a function immediately prior to transmission. Fig. 1 shows a typical spread spectrum transmitter system.

Generation of the transmitted signal required spreading by digital modulation (d.p.s.k.) of a narrow band transmitter output, which could have been at a level of tens of watts. Research had yet to determine whether the optimum solution was modulation at a high level or low level spreading followed by linear amplification.

At the receiver the r.f. signal was filtered to optimise the received signal-to-noise ratio and then it was translated down to an intermediate frequency. The i.f. information was then de-spread by being multiplied by another function after which it was passed through a conventional demodulator. Therefore, according to the paper, all that was required for this system, in addition to a simple, single-channel transmitter and receiver set, was synchronous spread and de-spread circuits.

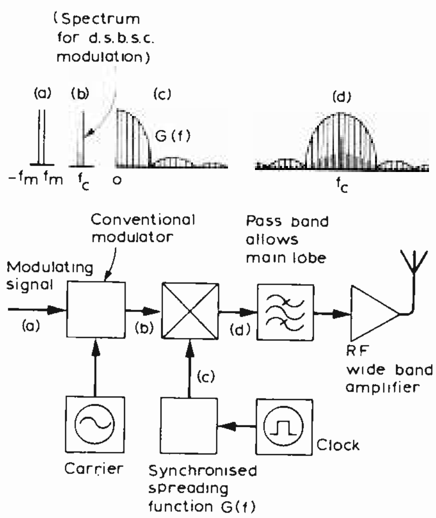

Fig. 1. *Typical spread-spectrum transmitter system which enables mobile radio communications in the television bands, with relatively little interference. Waveforms correspond to the relative points a,b,c and d. Because both the transmitter and the television are broadband, the interference power per unit bandwidth is smaller than the power received per unit bandwidth.*

In his overview address[1], Professor Gosling called this a provocative paper and said that putting land mobile radio in the television bands could only come to pass if a mobile radio system with the right characteristics for n.i.b. working could be devised: the television standards could not be altered to accommodate mobile radio.

Trunking systems for land mobiles

The use of channel sharing for land mobile radio is one effective way of reducing the congestion of those particular portions of the radio spectrum. Although this means that a user, who has to share a channel with several other people, gets a reduced grade of service, in the sense that he or she may often have to wait for some time for the channel to become free, the channel itself is more effectively utilized. However, the inconvenience involved can be quite unacceptable, even on moderately busy channels, and telephone traffic theory suggests that better channel utilization, and a much better grade of service, could be obtained if users were given access to several shared channels. Systems of this kind are called 'trunking' or 'dynamic channel assignment' systems. In mobile radio, according to a paper — Studies of small trunking systems for mobile radio[7] — the critical question is whether the performance of multichannel trunked systems will be enough of an improvement over single channel systems to make the extra complexity worthwhile, and if so, how many channels will be needed.

The above paper reports some results of a trunking system study, carried out by Philips Research Laboratories, aimed at finding out whether the benefits promised by telephone theory really could be obtained in the very different circumstances of mobile radio. It concerned itself with traffic handling, rather than with hardware or signalling, and concentrated on systems which required the user to queue until a channel became free.

To obtain adequate information about the use which land mobile radio users make of their channels, the study team set out to monitor the behaviour of a representative group of 15 users in the Home Counties. The information obtained from this exercise included the lengths of transmissions and conversations, the variation of channels used in relation to time, the amount, type and time of occurrence of interference, and the proportion of failed calls from base to mobile. These figures were then analysed to obtain the general features of the behaviour of unbalanced* queues, and the size of errors in system descriptors introduced by employing calculations which use a balanced system to predict the behaviour of an unbalanced system.

The study showed that small mobile

radio trunking systems would generally involve quite small numbers of users, all offering different amounts of traffic. In the paper the authors claim to have developed a new theory for predicting the behaviour of these systems, and this shows that, for a given traffic load, trunking systems actually work more effectively in land mobile radio than telephone theory would suggest.

The study is not yet complete and further work is in hand.

*A balanced queue is one in which all the users, on average, utilize channels in the same way — same number of calls, duration and frequency.

Traffic measurements

In the UK at the present time there are approximately 16000 licensed base stations using 800 channels available in the v.h.f. and u.h.f. land mobile radio bands, and demand is greatest in areas such as London, the Midlands and South Lancashire. In the majority of cases several different types of user organizations share a single channel in order to aid the conservation of the frequency spectrum. Any method of enabling several users within a given area to share the same radio channel must be based on the statistics of traffic occupancy.

In one paper[8] the Home Office Directorate of Radio Technology describes a method they used to obtain channel occupancy measurements for private mobile radio. This method used an automatic scanning receiver. The paper also discusses the extent of traffic congestion on private mobile radio channels used in the London area.

The equipment used by the Home Office acted as an on-line, real-time, data capture facility for v.h.f. and u.h.f. spectrum surveillance. It enabled up to 80 channels to be scanned per second. The system comprised a computer, a magnetic tape transport, a teletypewriter, an X-Y plotter and a double superheterodyne radio receiver with a programmable signal generator.

In operation, the computer generated the required frequencies for a v.f.o. which controlled the receiving equipment. A voltage, proportional to the carrier level on each channel, was produced at the output of the receiver, by a logarithmic amplifier, and digitized before being recorded on the magnetic tape. The computer also compared the measured carrier level for each channel with a list, contained within its memory, defining the limits above which the channel was considered to be occupied. Short term occupancy could be printed at fixed time intervals on the teletypewriter. These results included the percentage time occupancy of each channel, the number of calls, the mean duration of calls and the mean time between calls. Variations and relationships of some of the results could be analysed by a separate computer programme and displayed on the X-Y plotter.

The site used by the Home Office for their own monitoring exercise was Alexandra Palace in North London. This gave good coverage of the London area. Each channel was monitored during April and May of 1977 for a period of 24 hours during a normal working weekday.

The results showed that there were 167 channels where, for any fifteen minute interval, the average traffic occupancy did not exceed 12.5%. Since total traffic was assumed to be divided equally between base stations and mobiles a channel was said to be saturated when the average traffic occupancy was about 40%.

In conclusion, the paper said that certain channels in the London area were heavily used but the majority of channels were by no means heavily loaded. The most heavily loaded band appeared to be the High Band but only 18% of channels had occupancies exceeding 39% at certain times. However, the authors stressed that no firm conclusions should be drawn from the exercise as it was only a representative sample.

According to the paper, spectrum surveillance is now a regular feature of the Directorate's work and it is expected that in the next twelve months certain trends, and areas of possible congestion which are lightly loaded, can be identified and these results used in conjunction with the Home Office's computerised frequency assignment facility to offer the most suitable channels to potential users of private mobile radio.

Underground communications

A communication system which will work in an underground tunnel is a convenience for daily activities, but in emergencies it may become vital for survival. Consequently, the subject has created great interest among communications design engineers and, in a paper[9] entitled 'Radiocommunication in the tunnel and underground street', five Japanese authors have again shown that communication by radio waves in a tunnel is fully possible.

During experiments carried out by the Japanese team, the straight, 1470m-long concrete tunnel which they were using, acted as a high pass transmission line, similar to a circular waveguide. The main purposes for the study, in addition to proving yet again that tunnel communications were possible, was to obtain the attenuation and phase constants of the 'waveguide', theoretically and experimentally.

The tunnel had a radius of 4.8m and a flat base on a chord of 8.8m. Its upper-semicircular surface included a steel frame made from 20cm I-beams spaced at least 1.2m apart, and its base was reinforced with 20cm-cube caging made from 19mm diameter iron rod.

The transmitter and receiver set was of the taxicab type and was used at a frequency of 470MHz with a transmitter power of 0.5W. With the fixed station antenna in the tunnel, communications, according to the team, were as good as with a public telephone, and because large variations in communication could not be found when the distance between the transmitting and receiving antennae were varied, they believed it conceivable that even in a longer tunnel complete communication was possible.

In order to determine the attenuation constant, a fixed station and antenna were set up 30m outside the entrance of the tunnel and the radio wave sent into the tunnel. A truck carrying a mobile station and its antenna was then moved along the tunnel and the variation in the output field strength at the receiver relative to distance was recorded on a pen recorder. From these results, the attenuation constant was determined using the method of least squares. It was these results that showed that the tunnel was a kind of high pass transmission line similar to a circular waveguide, and according to theoretical considerations, the experimental results corresponded to the theoretical value of the TE_{01} mode configuration.

To obtain the wavelength in the tunnel, a screen reflector was placed across the entrance and a radio wave was transmitted, from a fixed station inside the tunnel, towards the screen. The receiver and its antenna were then moved along the tunnel and the receiver's output was traced on the pen recorder to obtain the standing wave, and hence the wavelength. The experimental values agreed well with the theoretical results and the lowest cutoff frequency was found to be 23.5MHz.

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* IEE Conference Publication No 162, Communications 78, Communications equipment and systems, 1978.

LETTERS TO THE EDITOR

FREQUENCIES IN DEVELOPING COUNTRIES

I would like to refer to the comments published in your April 1978 issue entitled 'Developing countries "deplore" Western retention of frequencies' (News p.51). In the sixth paragraph of these comments a reference appears to have been made to my article published in the *Asia-Pacific Broadcasting Union (ABU) Technical Review* for January 1978. The comments as made in *Wireless World* are likely to create certain misunderstandings, which I would like to clarify as follows.

It has to be recognised that the comments attributed to me about broadcasting occupying 9.5% of spectrum pertain only to the h.f. band extending from 4 to 27.5 MHz. A comparison of this claim with the allocation to broadcasting in the bands above 30 MHz is hardly relevant. It is not correct to compare two different things.

The paragraph in question also mentions that "there is little indication of the way the proportions allocated to each use within the h.f. band have been worked out". The way in which the proportions allocated to each use is clearly indicated in the notes accompanying the PIE chart appearing in Figure 1 of my article in the *Technical Review* of the ABU to which a reference appears to have been made. Furthermore, the table of frequency allocations in the Radio Regulations is a matter of open book.

I hope that you will kindly clarify the above position in order to remove the misunderstanding.

Irfan Ullah
Director of Engineering
Pakistan Broadcasting Corporation
Headquarters
Rawalpindi
Pakistan

PROGRAMMING MICROCOMPUTERS

I would like to put the letter from Dr D. P. C. Thackeray (June issue) into context as it reflects an approach to programming which I believe to be out of place except perhaps for the "hobby programmer".

When a computer programme is to be used in more than one place, or by more than one person, or for more than one purpose, then the requirements are very demanding; even in the "one off" case, coming back to an undocumented programme after a few months can demonstrate the need for good software standards. To be useful, a computer programme must be well defined, documented, structured, and complete. These characteristics then contribute to making it testable, maintainable, modifiable, and extendable; these "buzzwords" of modern software production have a very real impact on the value of the end product.

It is here, then, that I take issue with Dr Thackeray, for learning to dispense with flow diagrams is but the first step to discovering their value! By forcing the programmer to put his ideas down in a formalized way, the probability of producing complete software is greatly increased. Additionally, much of the documentation (otherwise left until last, and therefore inadequately done because of lack of time and immediate incentive) is already there. It is then but a short step to applying the rules of structure and modularity proposed by Dijkstra *et al*, and one has a useful software product as opposed to a computer programme.

This is not the whole story of course: one should also address the problems of software security, fault tolerance, data ownership, and so on, but first must come the recognition of the need. An "optimistic view of errors" is (by definition!) unrealistic, as becomes apparent as soon as one starts to use more than a couple of dozen lines of code. Because of the inherent flexibility of software it is never completely testable and one has to learn to live with faults; even when all the rules of good software production have been followed bugs still remain, sometimes for years, waiting for the right set of conditions to bring them to life.

On the subject of naked microprocessors, I think we must ask "What are they for?" They have been produced in response to a need for programmable logic, and are not really designed for use as "computers". If one chooses to use them as such, then one must accept the inconveniences of nakedness as the price for cheaply available, man produced, hardware. The "naked microprocessor" will not go away!

K. G. Parr
Mühlacker
West Germany

NOSTALGIA CORNER

The interesting contribution in the June issue, "The Morsemaker" reminded me of the simple morse sending device which was used during the early war years at No. 2 Radio School, Yatesbury, Wilts to train wireless operator/air gunners to become familiar with the airborne receiver, type R1082.

The R1082 training laboratory was housed in Hut S82, and consisted of about ten R1082s mounted on benches round the room, and the training exercise involved the trainee in tuning the receiver to selected frequencies of station 'S7L' set by the instructor so that the would-be flyers could learn how to change coils, frequencies, and were initiated into the mysteries of knowing how to receive c.w. on the straight t.r.f. type receiver by means of two tuning controls, the oscillator control and, of course, the "o.t.p." (oscillator-test-point) on the receiver front panel.

The actual radio station 'S7L' was, in fact, concealed on a table in the centre of the laboratory and consisted of an oscillating R1082, with the morse interrupter in series with the 120-volt dry battery, which powered the receiver. The morse sender was an old fashioned penny with the morse characters 'S7L' filed into the edge. This was soldered on to the drive spindle of an old 12-volt motor car Klaxon motor suitably speed controlled by a rheostat in series with a 12-volt aircraft accumulator. A piece of springy brass made contact with the raised morse characters on the rotating penny edge which interrupted the h.t. current to the oscillating detector in the R1082. I feel sure that many wartime flying wireless operators will remember this and must have wondered where station 'S7L' was located.

While still at R.A.F. Yatesbury, it is worth mentioning that in Hut S84, the school common room close by, *Wireless World* contributor M. G. Scroggie held his popular weekly music circle evening, classical mono record concerts (stereo had yet to arrive!), which provided a much appreciated haven away from the rigours of a "war-torn" radio school. But, however, let me hasten to add that Squadron Leader Scroggie, as he was in those days, had much more important duties to attend to during the day at the highly secure No. 8 Radio School, also at Yatesbury, where radiolocation (later radar) was being taught, but that is another story!

E. J. Williams, G2AKY
Emsworth
Hants

DIRECT PERCEPTION OF RADIO WAVES?

Your interesting correspondence on this subject reminds me of two events that happened in pre-war days. Remarkable events, albeit not of my own experience.

In Huizen, Holland, there was a toolshed just underneath the antenna of the powerful broadcast transmitter. On some occasions, when everything was very quiet, one could hear faint music. Strictly speaking this was not "direct perception": the shed acted as a receiver. Maybe an h.f. voltage was induced between two parts very close together. The electrostatic attraction could have "detected" the signal and at the same time created the mechanical force for sound production. This is a radio receiver stripped down to bare essentials: a parallel plate capacitor being aerial, (square law) detector and (electrostatic) loudspeaker all in one.

Or maybe it was not voltage but current that did the trick: h.f. current rectified in rusty (semiconductor) joints giving rise to modulated d.c. that, with steel parts, could produce sound.

The second case of direct perception happened in the old days in Boston, USA. A man suddenly started humming tunes. All day long. Quite exasperating for the family. His wife was remarkably quick in convincing the family doctor to fill out the necessary forms. But even when the strong men in the white jackets arrived our man went on singing.

On the analyst's couch a lot of data emerged most of which are not suitable for *WW* columns. But the relevant fact was that our friend had started his singing after a visit to his dentist. The analyst was also a radio amateur and he was able to follow this clue. The dentist had filled a hole in a tooth and for this job he had used a carborundum grinding stone. A tiny carborundum crystal was left

behind in the hole. And so when the dentist placed the metal filling in the hole a crystal receiver was formed that was in intimate contact with the tooth's nerve. This nerve conducted the programme of the local transmitter straight into our friend's subconscious mind.
S. L. Boersma
Delft
Holland

SYNTHESIZED F.M. TRANSCEIVER

May I make some comments on Mr Forrester's design (November 1977 issue) and Mr Short's letter (February 1978 issue)?

Firstly, the designer has reversed the present convention in amateur usage with regard to the designation of repeater channels. In Mr Forrester's design, the channel select switches must be set to the repeater output frequency (e.g. channel "31"), whereas repeaters are usually referred to by their input frequency (e.g. channel "7" for a repeater on "R7"). It would obviously make more sense if the channel select switches were set to the repeater input channel so that the convention is observed. To do this in Mr Forrester's design requires that the diode matrix be changed to give the following:

	Transmit	Receive
Simplex	5800	5372
Repeater	5800	5396
Reverse repeater	5824	5372

The 4046 i.c. has a useful output called "phase pulses" which pulses high when the loop is locked. It may be possible to use this signal to operate an inhibit circuit to prevent transmission when the loop is unlocked, as when the transceiver is switched from receive to transmit. This would answer one of Mr Short's points.

The synthesizer lock-up time between transmit and receive could be reduced by using a diode switch to place a padding capacitor across the oscillator tuned circuit on "receive" so as to sidestep the oscillator by approximately 10.7MHz (after multiplication). This would reduce the amount of correction to be done by the phase-lock, and hence reduce the lock-up time.

Mr Forrester's reference divider is over-complex. A simpler, and cheaper, circuit to give the required ÷960 would use a 4013 dual bi-stable with a 4520 dual binary counter in a ÷ 4, ÷ 16 and ÷ 15 sequence. The spare 4520 could then be used to give a crystal controlled toneburst feature (required for accessing repeaters by dividing the 250kHz divider signal by 143 to give 1748 Hz.

Another point in Mr Forrester's design concerns his way of interfacing between t.t.l. and c.m.o.s. I feel sure that a pull-up resistor to +15V from the totem-pole output of the t.t.l. must exceed the voltage ratings of the t.t.l. device. A single transistor interface stage would be more satisfactory.

Finally, with regard to Mr Short's deprecation of the use of a 24MHz oscillator frequency, the level of spurious outputs will stand a good chance of being a lot lower than those of many crystal controlled transceivers in use. These have 12, 8 or even 4MHz oscillator frequencies, so the unwanted harmonics are even more difficult to reject than in the case of a 24MHz oscillator. From a purely economic point of view, spending an extra £8 or so on a v.h.f. prescaler would seem somewhat wasteful.

Despite these points, Mr Forrester is to be congratulated on the basic concept of his synthesized transceiver. I certainly found it very interesting reading.
P. D. Lee
Penrith
Cumbria

Editor's note: We agree that it would be convenient, even desirable, to have the numbers on the thumbwheel switches corresponding to the input (transmit) frequencies on the repeater channels while the receiver monitors the output (receive) frequencies. On the simplex channels, of course, the same frequency is used for both transmit and receive anyway. It is really a matter of preference. Operators who use v.f.o. transceivers which tune to the output frequencies during normal repeater working usually have no difficulty in finding the repeater channels — that R7 is on 145.775MHz, for example — and there is no reason why one cannot learn that 31 is the R7 output.

For the benefit of readers who are not familiar with the channel allocations for simplex and repeater f.m. operations in the 144MHz band, the following table shows the principal frequencies:

Frequency MHz	Repeater transmit	Simplex channel	Thumb-wheel position
145.000	R0	S0	00
145.025	R1	—	01
145.050	R2	—	02
145.075	R3	—	03
145.100	R4	—	04
145.125	R5	—	05
145.150	R6	—	06
145.175	R7	—	07
145.200	R8	—	08
145.225	R9	—	09
145.250	—	—	10
145.275	—	—	11
—	—	—	—
—	**Repeater**	—	—
—	**receive**	—	—
145.500	—	S20	20
145.525	—	S21	21
145.550	—	S22	22
145.575	—	S23	23
145.600	R0	S24	24
145.625	R1	—	25
145.650	R2	—	26
145.675	R3	—	27
145.700	R4	—	28
145.725	R5	—	29
145.750	R6	—	30
145.775	R7	—	31
145.800	R8	—	32
145.825	R9	—	33

GAMES CHIP CONFUSION

I have noted with growing concern the various comments in your journal regarding our tv game circuit AY-3-8710. I believe it is time that the record is set straight.

Firstly it should be noted that whilst Marshalls provide a valuable service in the UK they are not a franchised GIM distributor. Neither for that matter are JSH a franchised distributor in the United States. This surely has to be the start of the confusion.

Now for the details on the chip itself. The AY-3-8700 in 625-line form was first delivered to GIM franchised distributors in the UK on 8th February 1978 and has been available from Teleplay — our authorised distributor — ever since, including of course to Marshalls. At about the same time we carried out some internal modifications to the device to improve manufacturing and re-numbered the part to AY-3-8710. As far as the user is concerned both of these parts are interchangeable.

Shipments of these parts to Teleplay and Watford Electronics started in early March and have been available ever since. These are the facts of the situation and I cannot understand how anyone can claim to have been misled.

Taking up your point on pin compatibility leads into a far wider field. None of our games chips are pin compatible! Compatibility lies in the ability to use the same power supply, peripheral controls, clock oscillator etc., and to this extent the AY-3-8710 is not compatible with the newer chips being released during 1978. This fact has never been disguised or hidden from any potential user.

Perhaps the moral to this saga is to use a franchised or authorised distributor.
A. J. Shipton
General Instrument Microelectronics Ltd
London W1

PROGRAM-ME

Your justification, in reply to your correspondent Mr Watt, of your insistence on the spelling "programme" in a computing context is misconceived and not a little pompous. While the spelling "program" was no doubt an Americanism originally, it has proved very convenient to have a distinct term to signify "programme for computer," in contrast to a teaching programme, say, or a television programme.

Your efforts in defence of the English language would be better applied in combating the widespread but barbarous, illiterate and misleading use of the term "statement" for an imperative constituent of a computer program, in flat contradiction to ordinary natural usage.
Benedict Nixon
Department of Statistics
and Computer Science
University College London

Congratulations! At last we have someone who really cares about the English language. We are subjected these days to so many verbal onslaughts, with the government the principal instigator in its misuse of the billion instead of thousand million, flammable instead of inflammable and those nauseating . . . persons, that it is a refreshing change to find a concern about the English spelling of a word. Isn't Mr Watt aware that "program" is an American word, and that in the UK we speak English, not American?
Peter J. Whyer
Wooburn Town
High Wycombe
Bucks

PENNY-PINCHING IN AUDIO AMPLIFIERS

Mr Jones of California raises some very important points in his letter in the June issue on penny pinching in audio amplifiers. There is far more to the design of audio amplifiers than basic circuit design. Power supply design has an important influence on the performance of an amplifier. If the mains transformer or supply capacitors are low in their rating, the amplifier will not be able to maintain its power response to very low frequencies. It will also sound inferior to a similar circuit with a more powerful supply because the dynamic crosstalk between channels will be greater. Even with a mono amplifier the variation in the power supply voltage will modulate the output.

Another area of amplifier design which requires careful design is the earthing circuitry. For example, one amplifier I built in which I took some care in the earth connections started to oscillate at supersonic frequencies when the two earths at the phono input (insulated from the chassis) were connected. The answer was to separate the signal earths from the smoothing earths.

Mr Jones also mentions cheap speaker switches which make better diode detectors than switches. The same comment also applies to 90 per cent of all the phono sockets which are sold to constructors. These sockets are always a chore to solder, as they have to be scraped to give a clean surface for the solder. I have noticed audible differences between amplifiers which cannot be explained from the circuitry, but can be explained from the type of phono socket. The cheaper socket sounds harsher by comparison. Yet I cannot think of any current advertiser in your journal who is able to supply the decent sockets.

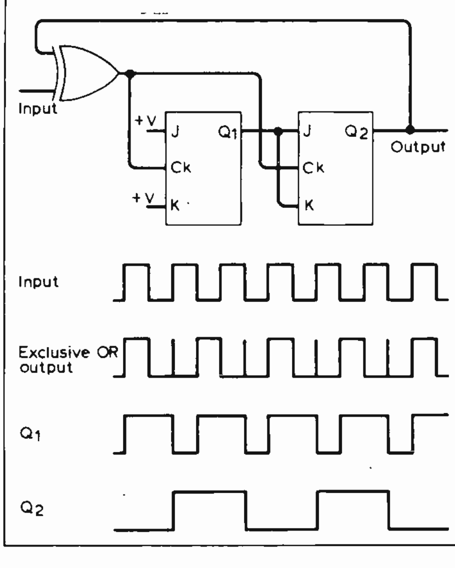
Graham Nalty
Borrowash
Derby

DIVIDE-BY-THREE SIMPLIFIED

In reply to Mr D. J. Eaton's divide by three circuit in the June issue (Circuit Ideas, p.66) the accompanying circuit accomplishes the same divide by three with an accurate unity mark/space ratio, but uses only two packages and no passive components.

It will be seen that this enables the circuit to operate without adjustment over the entire frequency range of the logic used. It has the further advantage of being a synchronous system.

D. Stuart Smith
Cupar
Fife



AUDIBLE AMPLIFIER DISTORTION

Hi-fi readers of hi-fi subjects will be well aware from my writings [1, 2, 3, etc.] of my placement in the controversy currently raging between all those in favour of listening assessment of hi-fi equipment – and to hell with lab measurements — and those who place a far greater regard on carefully conducted instrument measurements, with a properly controlled subjective evaluation as a back-up. In the second group we find a majority of professional engineers.

I would like to make it clear that I do not subscribe to the view that has appeared in some mysterious way recently that hi-fi-equipment can only be evaluated meaningfully by listening to it. In my judgement and experience if one amplifier auditions differently from another then this difference is measurable in the lab.

Even if it were possible to be subjectively sure that one amplifier produces a different sound from another, there are no universally-proclaimed adjectives suitable for describing the differences. Consequently, and as so clearly demonstrated by Reg Williamson[4], a whole range of often highly ambiguous adjectives is brought into play. Real damage can then result to a manufacturer, designer or company which is so totally out of scale with the real performance of the equipment. A small firm could easily end up in queer street from a solitary, opinionated judgement.

It is true that the nature of a review and the positive or negative bias applied to it can significantly influence the subsequent magnitude of sales. Conversely, therefore, a rave review given to a piece of equipment which is relatively poor in design and engineering could have just as grave consequences on competing manufacturers of similar type and price equipment but of superior design and engineering.

A competent reviewer, of course, will have his audio-buying readers always in mind, and he is aware that it would be grossly unfair to them to recommend a piece of equipment which has obvious shortcomings. He thus requires a very balanced outlook with adequate backing experience in order to present the equipment in an accurate light.

The great danger lies with the pseudo-review which delves insufficiently deeply into all the important aspects and then concludes with highly decorated and glossy language. This sort of review might place outrageous emphasis on a minor point which has little moment on the designed-for use of the equipment[5]. The reader might thus react in error. Happily, from the many letters I receive from readers over the years it is becoming apparent that the hi-fi-buying public and enthusiasts are fast learning to discriminate against (or, at least, taking little heed of) reviews such as these.

Carefully controlled listening tests with a skilled and musically-adept panel (each member being prior examined with "confusion matrix") nevertheless have their place in hi-fi equipment evaluation. From our own experience of using a panel of this kind over a number of years many of the points exposed by Peter Baxandall[6] have been substantiated. Indeed, our panel tests in conjunction with lab work have revealed areas of subjective/objective correlation, and one of our published lists[1] covers pretty well all the points (and others) brought out by Mr Baxandall.

A professional, detailed review, of course, is costly to prepare and is apparently not within the scope of all magazines to commission Moreover, reviewers with the necessary background experience and training and possessing suitably-equipped laboratories are scarce. Hence the evolution of the reviewer whose prime tools are ambiguous adjectives and emotive terminology derived from highly debatable observations and listening experiences.

Little wonder, then, that manufacturers and distributors are beginning to look in detail at the reviewers who will be handling their equipment before submitting it to the magazines. (This letter was submitted Oct. 1977.)

Gordon J. King
Brixham
Devon

References
1. Gordon J. King, "Old wives tales," *Hi-Fi for Pleasure*, March 1977.
2. Gordon J. King, "Amplifiers – measuring what we can hear," *Hi-Fi News & RR*, July 1977.
3. Gordon J. King, "Three tuners," *Hi-Fi News & RR*, August, 1977.
4. Reg Williamson, "The language of hi-fi," letter *Wireless World*, October 1977.
6. Peter J. Baxandall, "Audible amplifier distortion is not a mystery," *Wireless World*, November 1977.
5. J. E. Gardner, "Onset of lunacy," *Hi-Fi News and RR*, letter, November 1977.

CIRCUIT ACTION AND PROGRAMME SIGNALS

In reply to Mr Hamman's letter (June issue), I feel he is mistaken in thinking that the use of the more complicated equation for the complex impedance of an ideal capacitance is necessary. The usual equation $Z = 1/j\omega C$ is perfectly valid. However, the ω used in the equation is the angular frequency of a steady, continuous, unmodulated sinusoidal waveform. Any other type of waveform can be Fourier analysed into an integral sum of such waveforms, with a continuous spectrum of values of ω (if non-periodic).

i.e. $V(t) = \text{Re} \int_0^\infty A(\omega)e^{j\omega t}d\omega$ ($A(\omega)$ is complex)

$$\therefore \frac{dV}{dt} = \text{Re} \int_0^\infty A(\omega) j\omega e^{j\omega t} dw$$

$$\therefore I = C\frac{dV}{dt} = \text{Re} \int_0^\infty j\omega C A(\omega) e^{j\omega t} d\omega$$

I itself can be Fourier analysed, so obviously, considering just one component of the waveform of angular frequency ω, the amplitude $I_\omega = A(\omega)\, j\omega C$

$$\text{impedance is } \frac{1}{j\omega C}$$

The waveforms suggested by Mr Hannam therefore do not use ω as defined for use in the above equation, but each spectral component does. The use of the equation derived by Mr Hannam is therefore unnecessary.

M. J. Scoltock
St Catherine's College
Oxford

Microcomputer design — 5

Visual display and video r.a.m.

by **C. D. Shelton,** B.Sc. (Eng), ACGI, M.Phil, Ph.D. in association with Shelton Instruments Ltd and NASCO LTD

IN ANY computer system of this type the user has to be presented with data from the machine. For programme development this may require the presentation of several hundred characters. At the same time the cost of displaying alphanumeric characters should be minimised. The method chosen for the microcomputer project is a "memory plane peripheral". This is not sited on ports as conventional input/output but consists of logic which shares a section of the memory. This logic is designed to present an r.f. modulated composite video signal to a domestic television receiver in such a way that the contents of this memory section are interpreted as characters.

Any possible conflict of access to the memory between the processor and the logic has been resolved by giving the processor absolute priority. As a concession to appearance the video signal is blanked during access to the c.p.u. It is as though a section of memory is exactly mapped on to a visible plane. The position of a symbol on the screen is a function of the address in the memory and the symbol itself is a function of the least significant 7 bits of the data at that location. Extensive software routines have been written in a monitor programme (held in an e.p.r.o.m.) to pre-

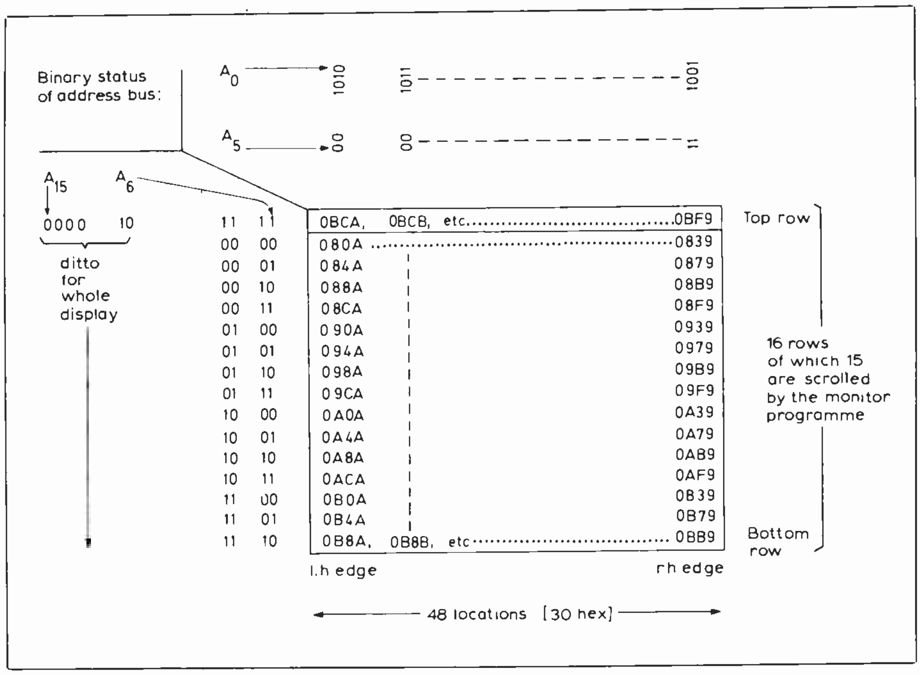
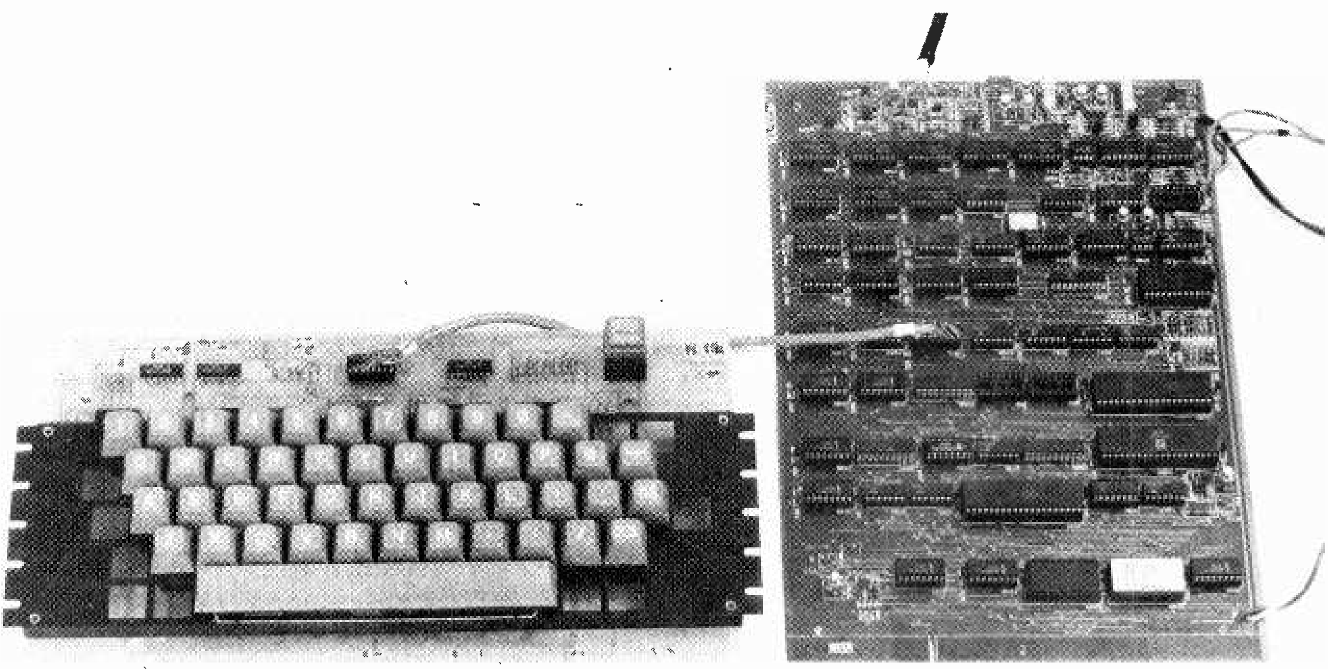


Fig. 1. *Video r.a.m. display adressing. 256 bytes of the 1024 bytes in the video r.a.m. are lost in the margins and are therefore not displayed. These comprise the initial ten memory locations (0800-0809), the last six (OBFA-OBFF) and 15 groups of 16 bytes between the lines.*

The complete microcomputer on which this series of articles is based, as supplied by Lynx Electronics (London) Ltd.



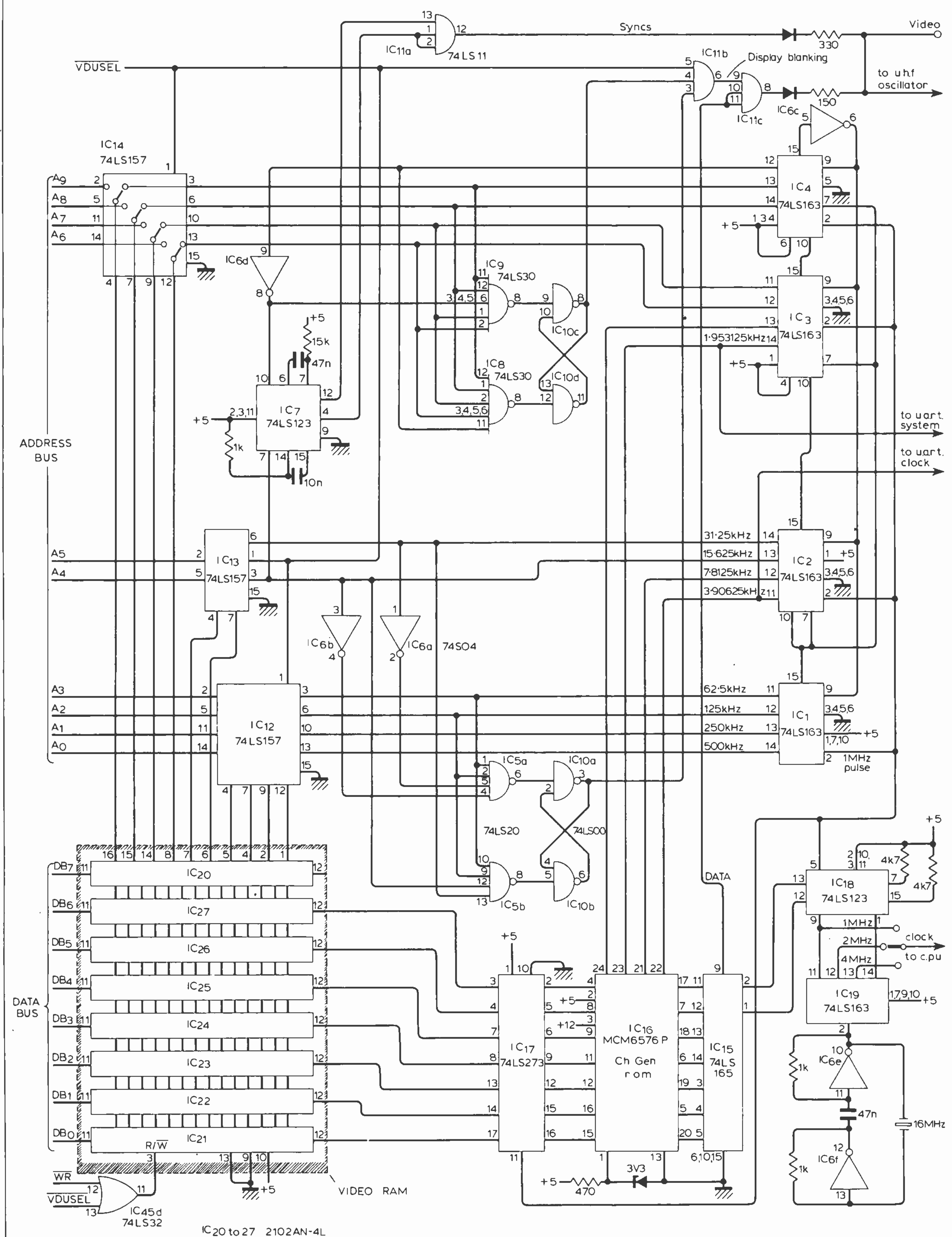


Fig. 2. *The video r.a.m. section of the computer and associated logic.*

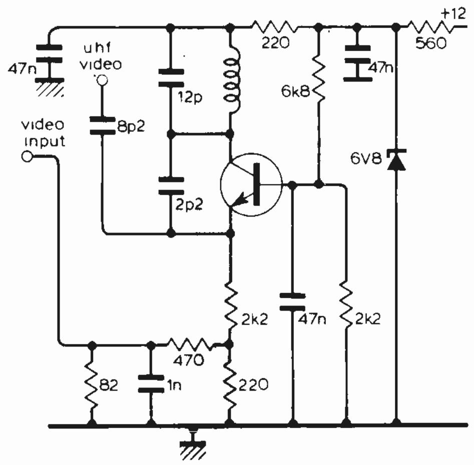


Fig. 3. *Circuit of the u.h.f. oscillator providing a signal for the tv set.*

sent data of the right type in the right locations so that the tv set acts as a v.d.u. This assumes that the memory section is not required for any other purpose, but if it is it behaves to the c.p.u. like normal memory and the user would not be any the wiser if he turned off his tv set. This section of the computer is called a video r.a.m. (see right-hand side of block diagram Fig. 1 in the January 1978 issue, p. 75). Details of the video r.a.m. display addressing are shown in Fig. 1.

The video r.a.m. itself, shown in Fig. 2, is operated by switching the memory i.c. address lines between the c.p.u. address bus and a counter/divider chain so that hardware continuously cycles the address lines to the memory. The memory packages themselves, IC_{20} to IC_{27}, are continuously selected so that their output is always available. This is prevented from jamming the c.p.u. data bus by placing a transmission gate, 81LS97 (not shown), between the data bus and the output pins. For each address the output is latched in IC_{17} and used as the address of a large r.o.m. called a character generator (IC_{16}). The output of this r.o.m. has been programmed to be the video dot pattern of part of a character, according to the raster row number and the character. The 8-bit output is loaded into IC_{15} (a parallel-in, serial-out shift register). The output of this is the black and white information for the tv set. The i.cs IC_{1-4}, IC_{18} and IC_{19} divide the 16MHz crystal oscillator frequency to provide the correct cycling of the memory address lines, and the shifting of video from IC_{15}, and by means of other gates they generate video blanking, frame sync and line sync at the appropriate intervals.

Compatibility with a tv set is further assured by the u.h.f. oscillator shown in Fig. 3. Composite video is also available for driving a television monitor to give a sharper image. The character organisation and size have been designed to optimise legibility on a domestic tv set. The i.cs IC_{12}, IC_{13} and IC_{14} are normally held in the state which connects the memory address lines to the counter/dividers. If the c.p.u. requires to read from or write to the memory these i.cs switch the memory address lines to the c.p.u. address bus.

To be continued. The next article will deal with the Z80 microprocessor used as the c.p.u.

Microprocessor application creates more jobs

A BRITISH fruit machine company is buying £350,000 worth of microprocessors from the British subsidiary of Motorola Inc. The orders, for the 6800, is the biggest to have been placed outside the United States, say Motorola.

At a press conference John Marshall, managing director of Barcrest Ltd, said "Microprocessors are the logical answer to making fruit machines." The industry was highly competitive, and new machines had to be produced all the time. He told *Wireless World* that machines were replaced, on average, once every seven to ten weeks. In addition, saturation had been reached in that there were likely to be few new locations for the machines. In that situation a company had to keep ahead by continually producing new models.

Exporting to Europe was made difficult by different legal requirements in the various countries – "UK machines are not exportable" – and because of the high complexity that market required, especially in West Germany. "Each country generates its own fashions, needing perhaps 20 different machines in a year." Models needed to be produced at very short notice. Engineers needed to be trained quickly to service them, and the buyers of the machines wanted rapid service when the machines went wrong, sometimes within the hour. This created a large spares requirement.

The machines are working in a hostile environment. If they are installed in pubs there is usually electrical interference from electric beer pumps, and some gamblers carry electrical noise generators to try to make the machine malfunction.

Ten years ago, he said, they began to use logic circuitry on plug-in boards, and engineers would carry a set of boards for a range of machines. Then about three years ago they put the common features of the machines on i.c. chips, and Marshall estimated that about 10,000 of these machines were now in use.

"The microprocessor took us a lot further. It enabled us to use a single control system for all the machines. Internally they are identical, or virtually identical, but outside they are different. The difference is in the plug-in programme." They could increase the rate at which they produced new machines, but the bulk of the product remained standard. Each machine contains a central processor chip, two peripheral interface adaptors, and a r.a.m. chip, besides the plug-in combined r.o.m. and p.r.o.m. "Now as machines become obsolete we can change them instantly and, in many cases, on site".

For the last 12 months almost all of Barcrest's output had been microprocessor-based. Over the last eighteen months they had increased their staff by 35%, and several thousand of the machines were now installed throughout Europe.

Barcrest's chief engineer, John Wain, explained that they had been able to make the change over the past two years. The attraction was that microprocessors offered standardised hardware, simple testing in production and in the field, easy programing, a good range of interface chips, an interrupt facility, and second sourcing. In addition to those advantages, he said, automatic test equipment could do a quarter of a million tests on the machines in 7s, as part of the plug in p.r.o.m. programme.

Motorola UK marketing director Mike Alderson announced at the press conference that their 16K r.a.m. chips were now available in quantity and would cost less than £5 each in bulk by the end of the year. The East Kilbride factory was also producing the 6800 microprocessor on 4in wafers. The Barcrest order is an indication that Motorola is firmly committed to the consumer market as the only likely market large enough to drive chip costs down. Chips had to be made and sold by the million, he said, and that meant they had to be very widely used. The chips were expensive to make because they were extremely complex. By definition, he went on, large use "means consumer products. That means driving the 6800 products down the learning curve." One of the biggest markets would be for automotive products in the USA. □

Discriminative metal detector — points arising

In the circuit diagram on page 45 of the July issue the values of C_1, C_7 and C_{14} were not listed. These components will depend upon the coils used in parallel with them. If the Waddington search coil is constructed, C_1 should be 1000pF and C_{14} should be a 7 to 75pF variable capacitor. If an Ambit i.f. coil, type YXRS 17065, is used for L_2, a 470pF capacitor for C_7 will give an oscillator frequency of 89kHz.

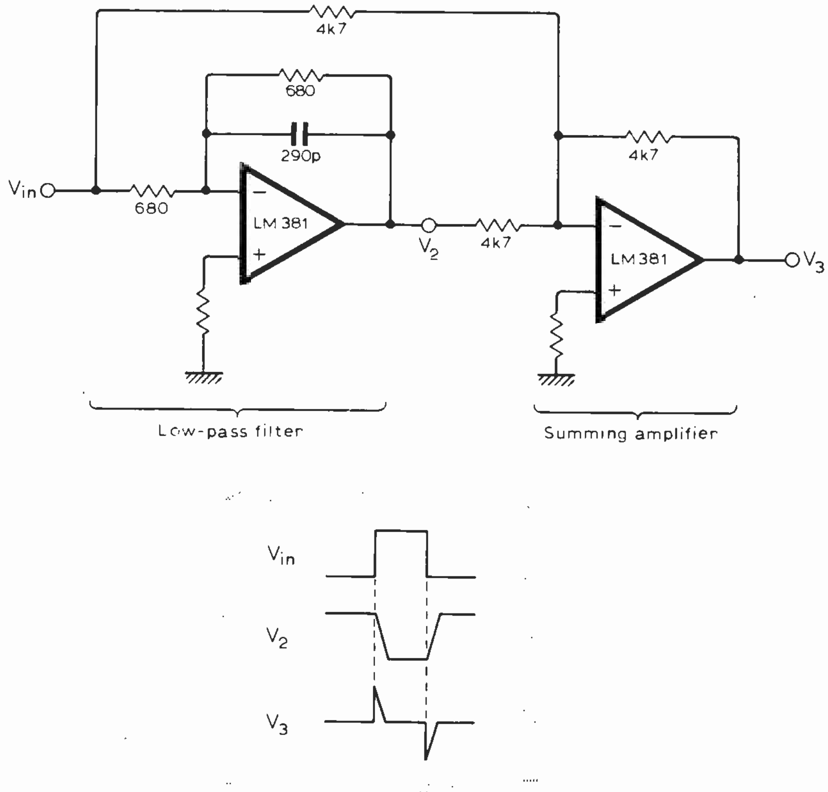
The logic gates used for both oscillators can be either NOR types such as the 4001 or NAND types such as the 4011. The gates used for driving the l.e.ds should be 4001 NOR types.

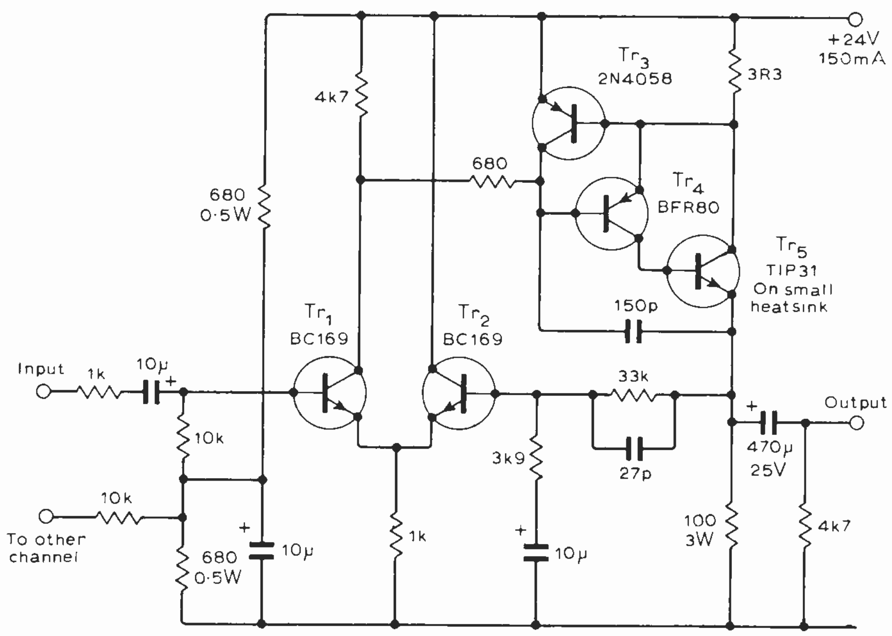
CIRCUIT IDEAS

High frequency differentiator

The differentiator function is used in many signal processing applications and can be achieved by using a series RC network or a simple op-amp stage. Because a differentiator has a gain proportional to frequency, instability can occur at high frequencies. Also, the signal-to-noise ratio can be poor. The circuit shown overcomes these problems and is based on a low-pass filter which restricts the slope of high frequency edges. When the output of the filter is subtracted from the original signal, a differentiator type output is produced at V_3. The circuit operates at frequencies up to 5MHz with the component values shown.

S. Cussons,
Portsmouth,
Hants.





Class A headphone amplifier

This circuit was developed for use with headphones or as a line amplifier. Discrete components are used instead of i.cs to improve the slew-rate performance. Overload protection is provided by Tr_3 and operates at 180mA. The gain of the amplifier is 9.5, and the input impedance is 11kΩ. A resistor in series with the input prevents r.f. pickup. Both channels are biased from a common potential divider at the input.

J. Vincent
Ilford,
Essex.

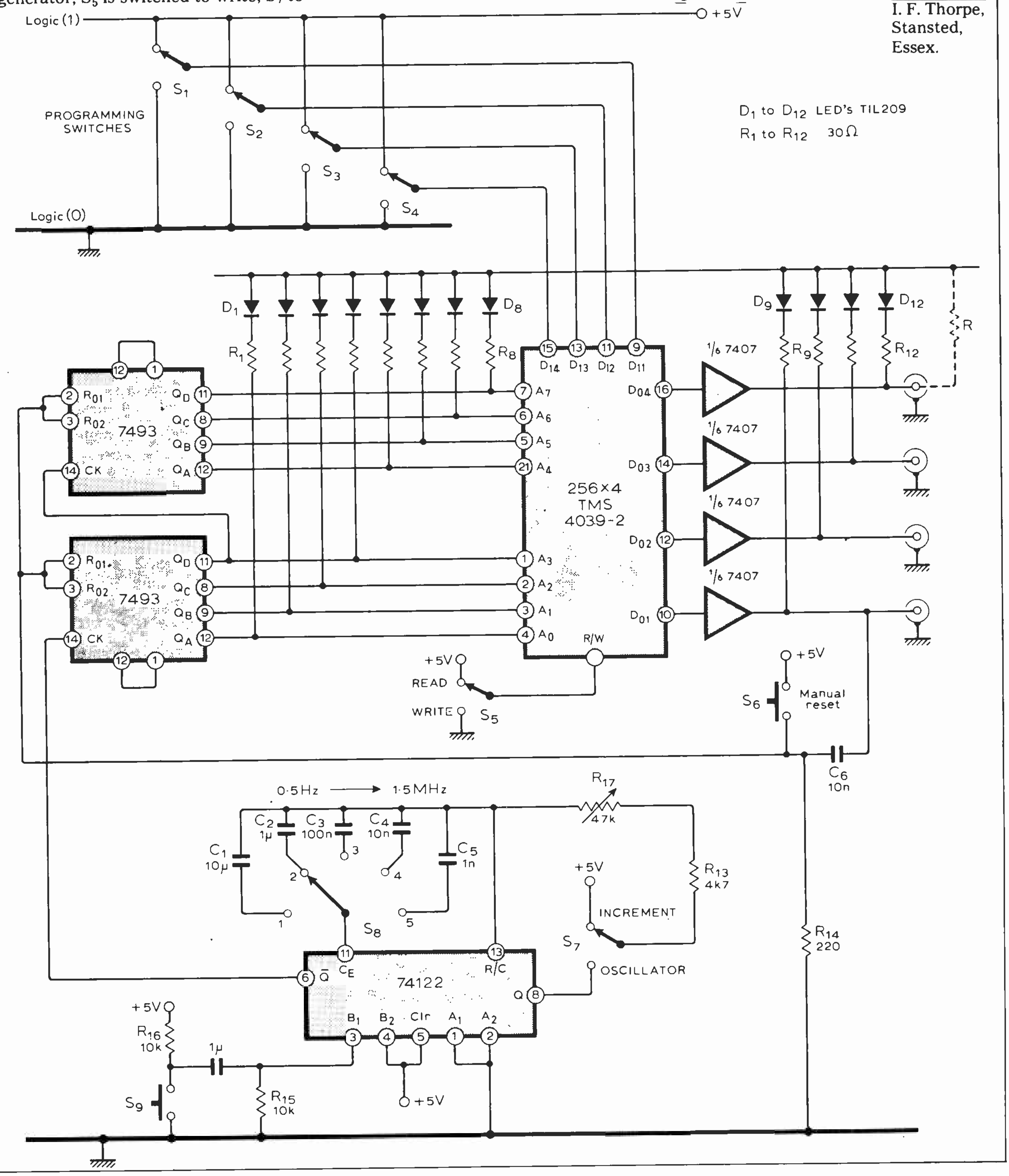
Programmable data generator

This data generator is suitable for design and development work and is particularly useful in high frequency data rates, 4 bit data inputs, and mark-space generator applications.

The generator consists of a 256 × 4-bit r.a.m. addressed by two 4-bit counters which are clocked by a 74122 monostable. The clock frequency is adjustable by selecting C_1 to C_5 and adjusting R_{17}. To programme the generator, S_5 is switched to write, S_7 to increment, and S_8 to C_1. Switch S_6 is then depressed which resets the counters to zero, and S_1 to S_4 are programmed to give the required logic levels. With S_7 in the increment position, S_9 triggers the 74122 which increments the counter and loads the data into the r.a.m. Switches S_1 to S_4 are then re-programmed and again clocked into the r.a.m. by S_9. This continues until the complete programme has been written. If the reset line D_{01} is used, zeros are programmed by S_1 and a 1 is programmed when the reset is required. This positive edge will then reset the counters.

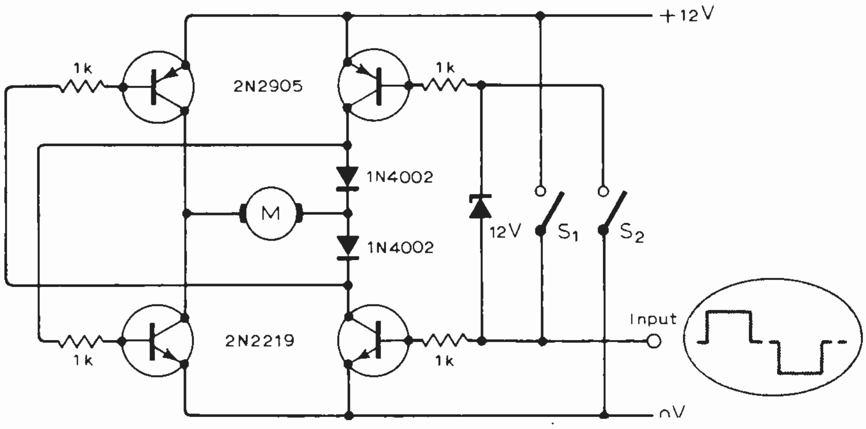
To playback the programme, S_7 is switched to oscillator, S_8 and R_{17} are adjusted to give the correct frequency. If the reset line is not required, C_6 can be omitted. Diodes D_1 to D_{12} are l.e.ds and indicate the state of the counter and outputs. The l.e.ds are on when a zero is present. Note that a pull-up resistor is required on the output of the 7407 if the generator is to be fed into t.t.l.

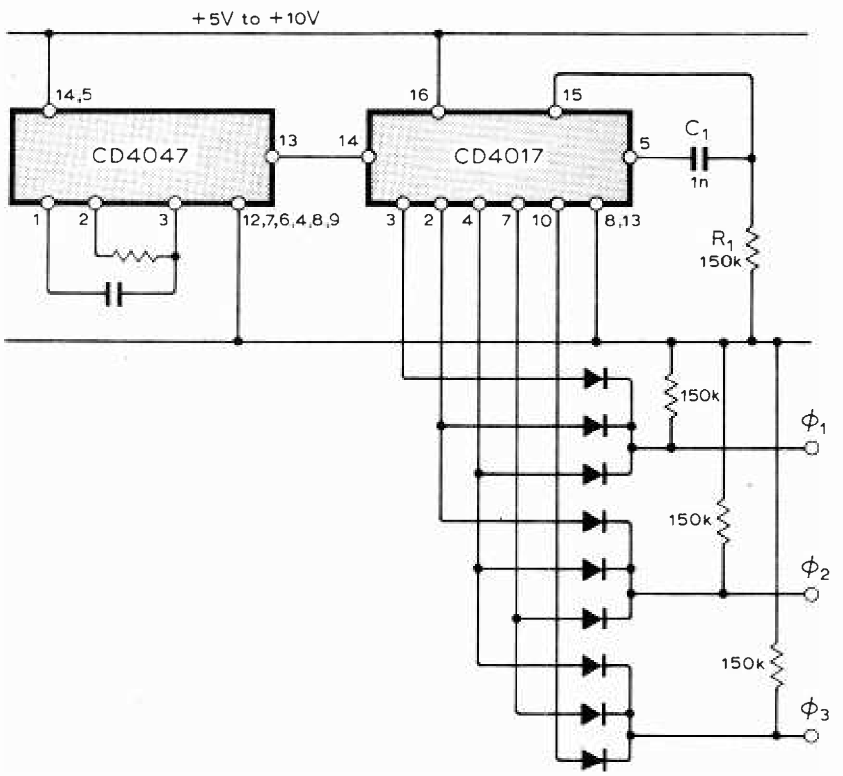
I. F. Thorpe,
Stansted,
Essex.



D.c. motor control

This circuit uses a bridge configuration to control a d.c. motor in both rotational directions. When a positive or negative pulse is received the appropriate pair of transistors conduct and supply current to the motor. If S_1 and S_2 are activated by a cam on the motor shaft, a latch facility can be produced for accurately driving the motor through a part or whole revolution.
Rusman Rusyadi,
Indonesia.



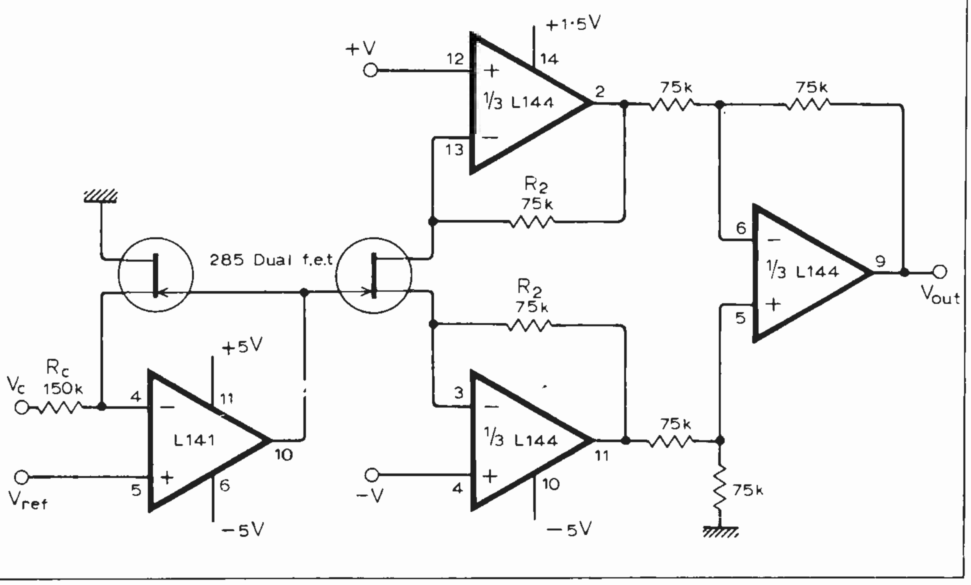


Three phase generator

This circuit was designed to provide three outputs, phase shifted by 120°, to drive a low voltage three-phase supply for a linear motor. The CD4047 is used as a clock at six times the required frequency. This drives a one-of-ten decoded counter which is reset after a count of 6 by R_1 and C_1. The appropriate outputs of the CD4017 are combined via diodes to produce three phase-shifted square waves. The circuit can easily be adapted to give a wide range of phase related outputs by altering the diode network and reset pulse.
A. J. Richardson,
Newport,
Isle of Wight.

Instrumentation amplifier with voltage-controlled gain

In this instrumentation amplifier a resistor, which is normally between the inverting inputs of the op-amps, is replaced by a dual f.e.t. Assuming that $R_c = 2R_2$, the output voltage is given by V_c/V_{ref} V. The gain of the amplifier can be varied by adjusting the ratio of these two voltages.
Kamil Kraus,
Rokycany,
Czechoslovakia.



Measuring transducer directivity

Equipment for measuring microphone or loudspeaker polar response in a reverberant room by gated tone burst

by **Peter D. Hiscocks,** Ryerson Polytechnical Institute, Toronto

The anechoic chambers commonly used to measure loudspeaker and microphone polar response are impracticably expensive for many institutions. This article describes the equipment built to implement the tone burst sampling method of measuring directivity. Included in the equipment is a polar-to-rectangular converter which enables polar plots to be made on an x-y recorder.

EQUIPMENT DESCRIBED in this article was originally developed to measure the polar response of a directional loudspeaker to be used in acoustic radar experiments. It has also proven useful for the measurement of domestic high fidelity loudspeaker polar patterns and directive microphone polar patterns, and might prove useful in demonstrating the basics of directional radio antennas.

An anechoic chamber, in which these measurements are usually performed, was unavailable. However, Capetanopoulos[1] has described a method by which the polar response may be measured in an ordinary room (see box). A block diagram of the basic technique shown measuring a loudspeaker is shown in Figure 1. A sine wave generator at some frequency is gated on and off by a tone burst gate. The tone burst is amplified and applied to the loudspeaker under test.

The tone burst is picked up by a sound level meter and filtered by a bandpass filter, which attenuates both the harmonics generated by the gating process and the room ambient noise. A sampling

Gated polar response measurement

Until recently frequency and polar response tests of loudspeakers and microphones were conducted in anechoic chambers, where highly sound-absorbent glass-fibre wedges prevent the formation of standing waves. Capetanopulous suggested that this type of measurement could be made in an ordinary room by gating a short burst of the test tone supplied to the loudspeaker. The measuring microphone is gated on at the precise instant the direct unreflected sound arrives at the microphone from the loudspeaker. Reflections from the room surfaces arrive after the direct sound, but the microphone is now off and so ignores the room reflections. After a short pause to allow the room reflections to die away the process is repeated.

In practice, there is a lower limit to the test frequency used in this technique, set by the requirement that the arrival of the direct sound at the measuring microphone not overlap the arrival of reflected sound from the roof surfaces. This is of the order of 100Hz for typical rooms and microphone-speaker spacing.

The same basic technique may be used for loudspeaker frequency response measurements, and Bruel & Kjaer now market equipment for this purpose.

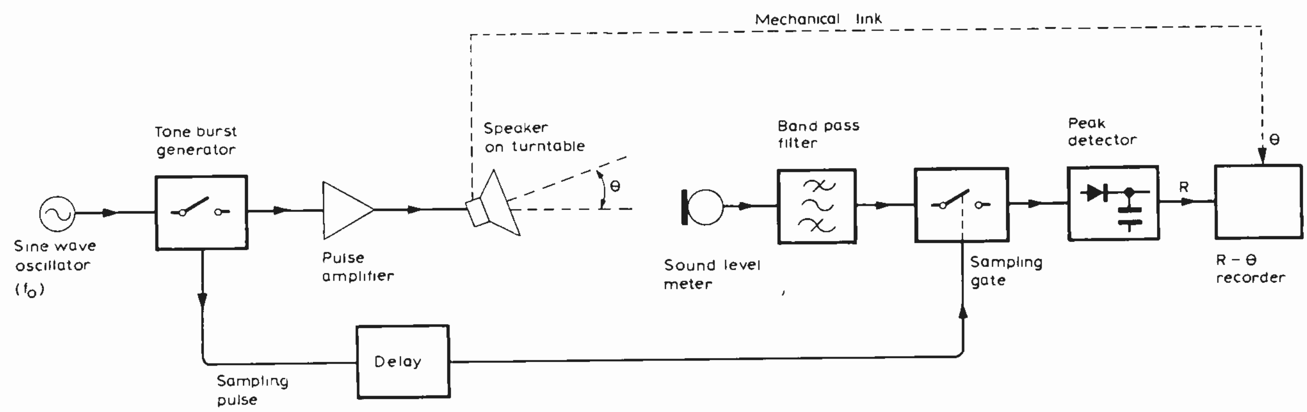


Fig. 1. *In the gated tone burst method, a signal from a sound level meter is gated on when the initial sound burst reaches it, and off when room reflections reach it. Delay is conveniently obtained from a delayed-sweep oscilloscope.*

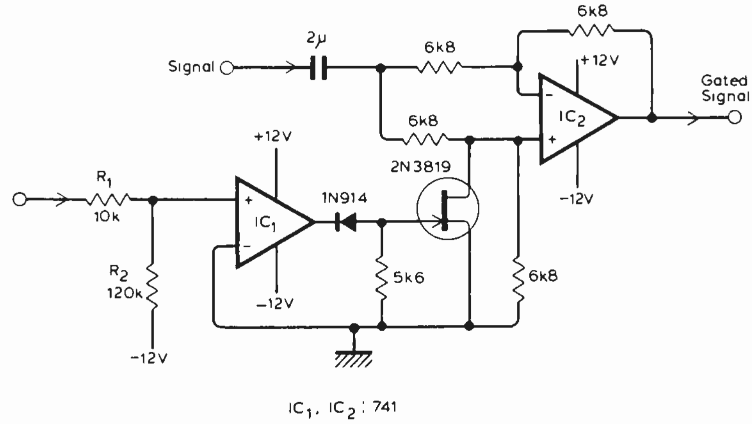
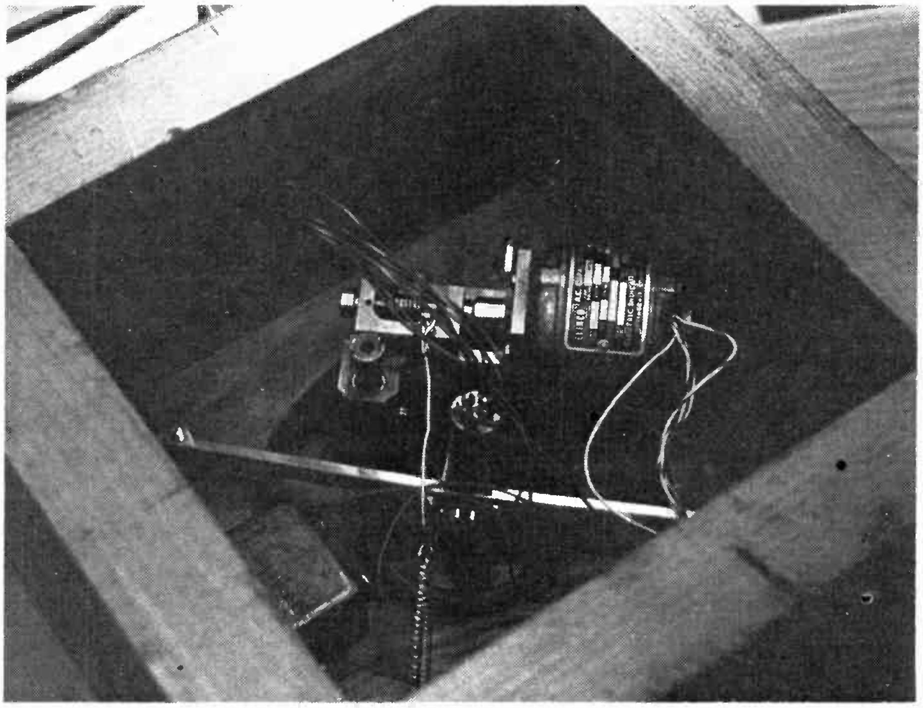


Fig. 2. *In this gating circuit, resistors R_1 and R_2 suit a delayed gated signal from an oscilloscope, in this case the 0 to +2V signal of the Tektronix 453.*



Underside of turntable, showing drive motor and gearbox. Resolver is mounted on a piece of aluminium angle and coupled to the turntable by a short piece of rubber tubing. Motor mount is spring loaded (lower centre) to keep it in contact with the output gear in spite of eccentricity in the table mounting.

switch is adjusted to close only when the initial sound burst reaches the sound level meter — the switch is open when the room reflections reach the sound level meter. A peak detector stores the peak value of the tone burst.

The amplitude of the tone burst versus angle is plotted on an r,θ recorder; the angle of the loudspeaker is mechanically transmitted from a motorized turntable to the plotter turntable.

The sine wave generator, tone burst gate and power amplifier are all standard lab equipment. The delay function may be provided by the "delayed gate" output of an oscilloscope with delayed sweep. By viewing the sound level meter output on the oscilloscope, the oscilloscope may be adjusted to gate only the direct burst from the loudspeaker.

The electronic gate is shown in Fig. 2. Operational amplifier IC_1 conditions the delayed gate signal from the oscilloscope to a form suitable to drive the f.e.t. With the f.e.t. off, amplifier IC_2 and its associated resistors form a differential amplifier with the input signal applied to both inputs; consequently, there is no output signal. With the f.e.t. on, IC_2 becomes a unity-gain inverting amplifier, and passes the input signal. Resistors R_1 and R_2 must be suitable for the oscilloscope delayed gate signal. The values shown are appropriate for the 0 to +2 volt signal of the Tektronix 453.

A suitable peak detector is shown in Fig. 3. The op-amp compares the output of the peak detector with the input signal. If the input signal is more negative than the output is positive, then IC_1 pumps current into the capacitor C. The rate of decay of stored voltage is controlled by R_D. The f.e.t. output is then positive and equal to the most negative value of the input voltage.

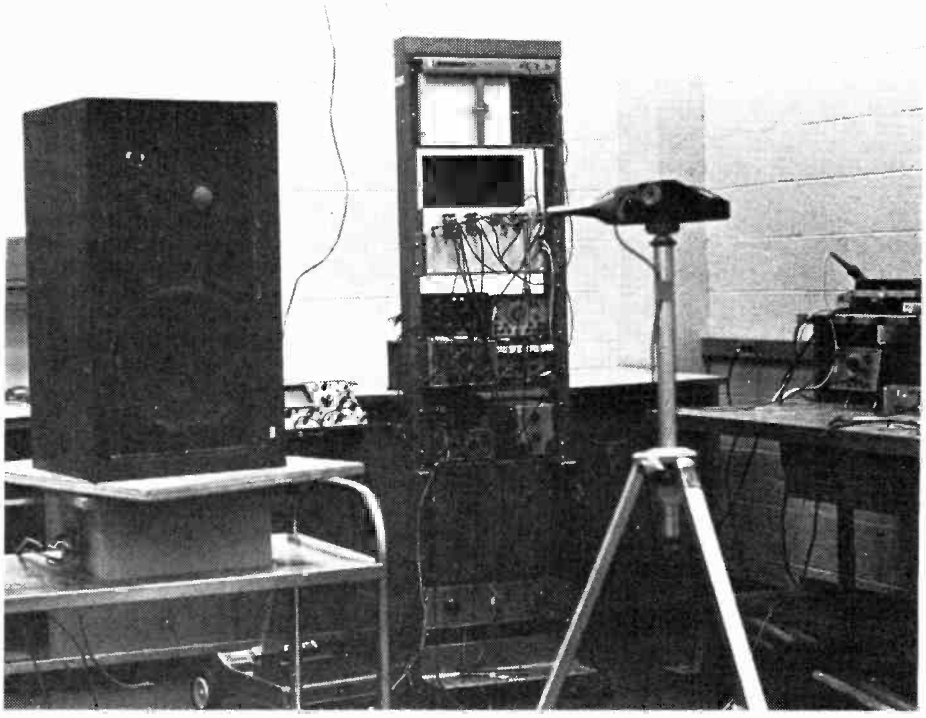
The decay rate of the peak detector must be long enough that the stored voltage does not decay significantly between tone bursts. However, it must be short enough that decreasing output from the loudspeaker, as it rotates, can be properly followed by the recorder.

To convert the received signal into decibels, a logarithmic amplifier is required somewhere in the signal processing circuitry. A convenient place is after the bandpass filter; this location reduces the dynamic range of the signal that the electronic gate and peak detector have to handle. A suitable amplifier is shown in Fig. 4. The output signal is proportional to the logarithm of the input over approximately a 30dB range. Below the logarithmic region the transfer characteristic becomes linear. The circuit is designed around the Texas Instruments SN76502, which is capable of an 80dB dynamic range and operation up to 10MHz in the proper circuit. The r.f. filter shown in the positive and negative supply lines proved necessary to reduce r.f. detection problems in the 741 operational amplifiers.

A simple method of testing the log. amp. is as follows: Couple the amplifier via a 30-nF capacitor to a square wave generator. Set the generator at 120Hz repetition rate, and superpose the waveforms at point A and the amplifier output. The waveform at point A will be a spike with exponential decay. The waveform at the output should be of similar shape, but with a linear decay followed by an exponential decay. The logarithmic dynamic range of the amplifier may be calculated by comparing the two waveforms.

This amplifier has proven useful in other acoustic work — the measurement of room reverberation time, and in tone burst testing for echoes.

This completes the basic system, if one has an r-θ type of recorder. However, x-y recorders are much more common, and, at a pinch, even an



AR3a loudspeaker on turntable with B & K sound level meter, Tektronix oscilloscope, and equipment rack housing chart recorder and electronics.

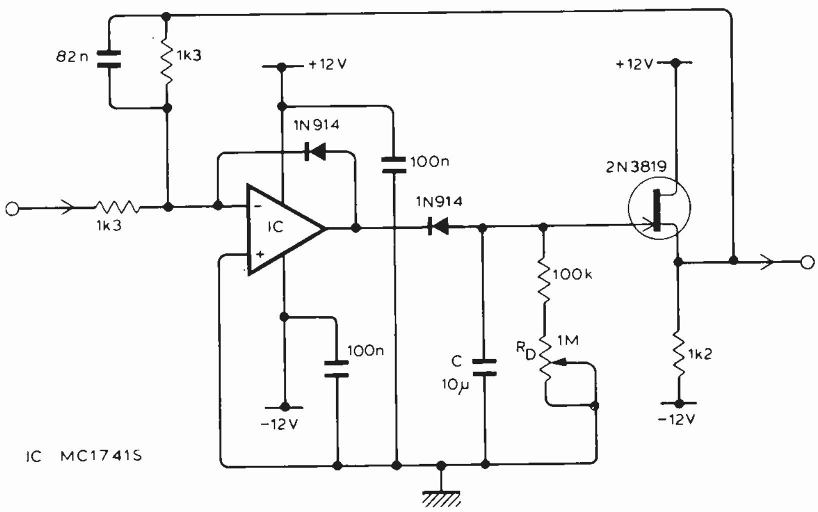


Fig. 3. *F.e.t. output in this peak detector is equal to the most negative value of the input voltage. IC is high slew-rate op-amp, 714S e.g. Motorola ML1741S.*

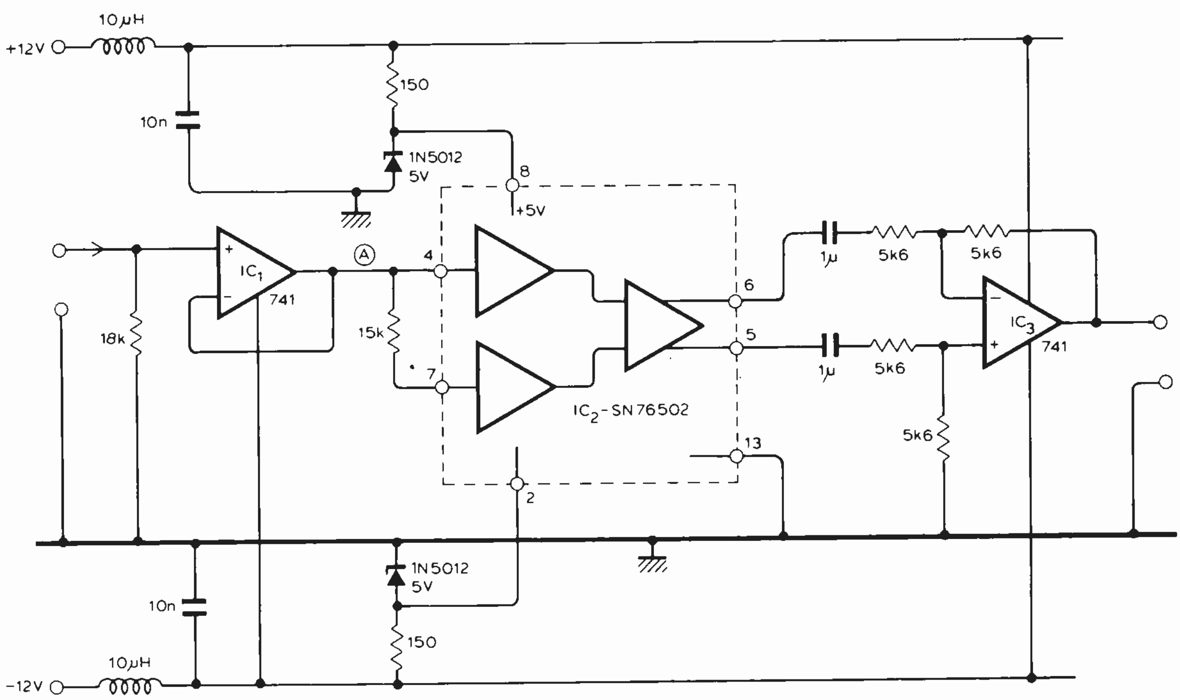


Fig. 4. *Situating logarithmic amplifier for decibel scale before gate and peak detector reduces dynamic range demand.*

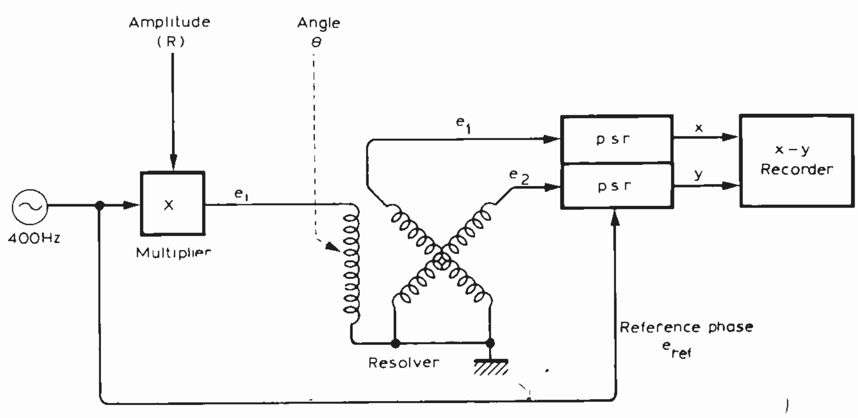


Fig. 5. *In the absence of a polar r-θ recorder, an oscilloscope or x-y recorder may be used together with a converter as shown. Phase sensitive rectifier circuit is given in Fig. 6.*

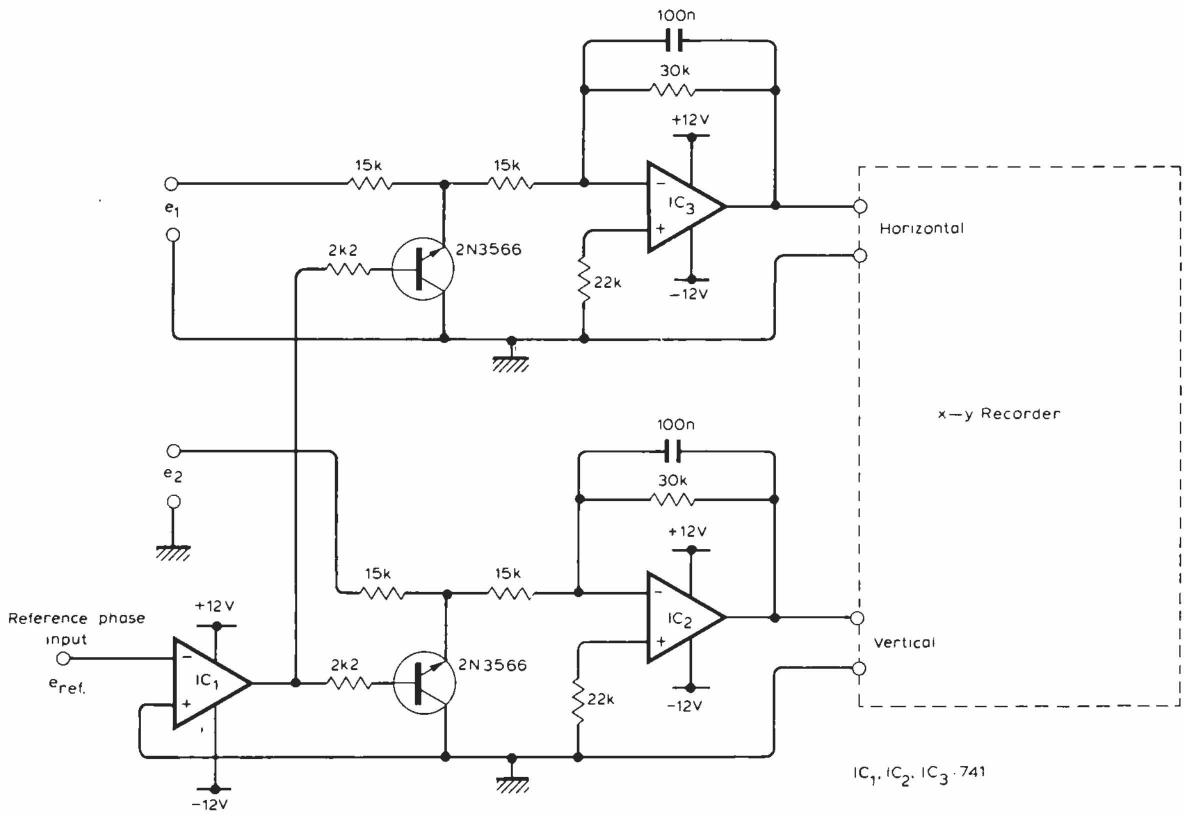


Fig. 6. *Depending on the relative phase of a stator voltage, see Fig. 5, the filter stages will produce a positive or negative output.*

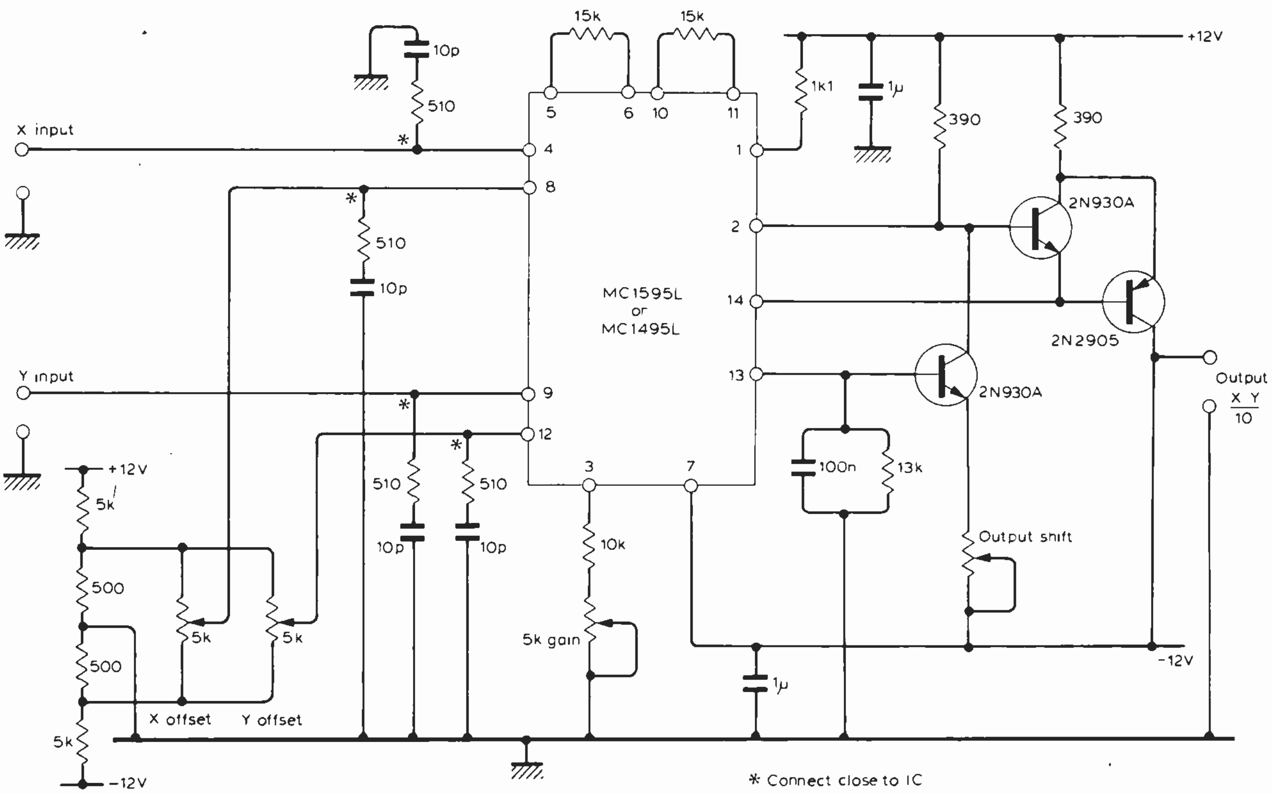
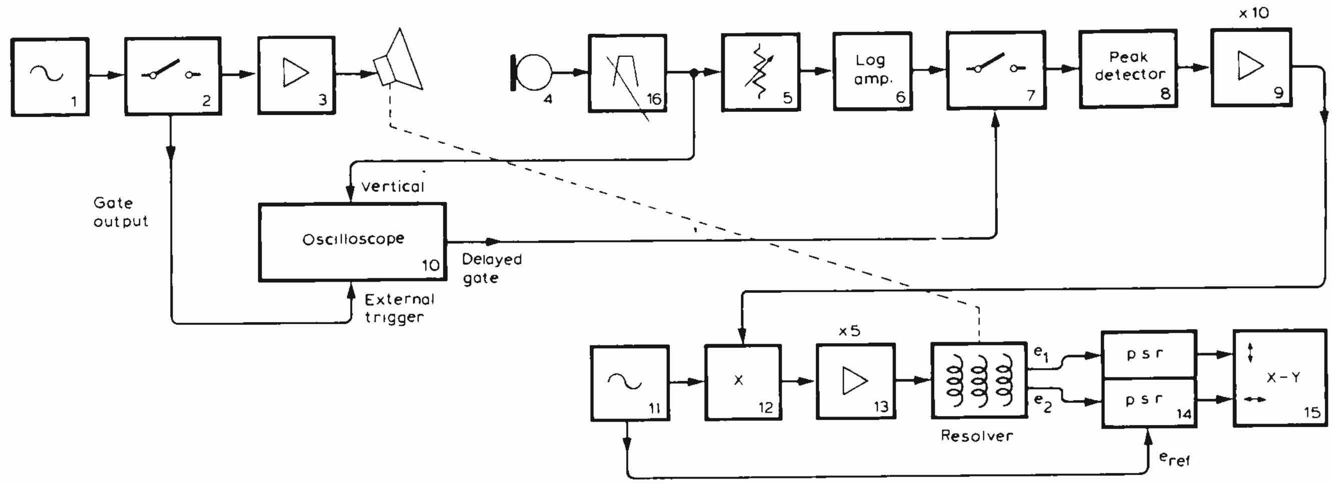


Fig. 7. *Suitable circuit for multiplier of Fig. 5 to control amplitude or resolver input uses Motorola analogue multiplier i.c.*



1. Audio oscillator (e.g. Krohn Hite 5200)
2. Tone burst gate (General Radio 1396)
3. Power amplifier (Dynaco 120)
4. For loudspeaker tests, sound level meter (B&K 2206)
5. Calibrated attenuator (H-P 350D)
6. Logarithmic amplifier (Fig. 4)
7. Sampling gate (Fig. 2)
8. Peak detector (Fig. 3)
9. Amplifier (Fig. 9)
10. Delayed sweep 'scope (Tektronix 453)
11. Audio oscillator (e.g. H-P 200CD)
12. Multiplier (Fig. 7)
13. Amplifier (Fig. 9)
14. Resolver, phase sensitive rectifier (Fig. 6)
15. X-Y recorder (H-P 7035B)
16. Bandpass filter (Krohn Hite 3550)

Fig. 8. *Complete polar response system using x-y recorder with key to equipment used. (Amplifiers 9 and 13 are given in Fig. 9).*

oscilloscope may be pressed into service as an x-y display. The processing chain shown in Fig. 5 coverts the r-θ information into x-y information.

The heart of this system is the resolver unit, which looks like a small servo motor and is commonly available from electronic surplus stores. I used a Kearfott type M-1031-001, but doubtless others would do as well. Internally, the resolver consists of a rotor coil, and two stator coils mounted at 90° to each other. The rotor is fed with an alternating voltage. When the rotor is aligned with a stator coil, the alternating voltage induced in that stator coil is at its maximum; when the rotor is at right angles to a stator coil, the voltage induced in that stator coil is zero. The phase of the stator output voltage reverses as the rotor passes through 90° with respect to it. The result is that the stator voltages are

$$e_1 = e_i \cos\theta$$
$$e_2 = e_i \sin\theta$$

where e_i is the magnitude of the rotor alternating voltage and θ is the resolver shaft angle. The resolver shaft is mechanically connected to the loudspeaker turntable.

The stator voltage must be rectified in such a way that reversal of phase reverses the polarity of the rectifier output voltage. The phase sensitive rectifier which accomplishes this is shown in Fig. 6.

Operational amplifier IC_1 amplifies the reference phase signal from the oscillator of Fig. 5. The output square wave from this amplifier operates the switching transistors, inverted to minimize their saturation voltage. Depending on the relative phase of a stator voltage, the following filter stage will produce positive or negative filtered output.

The final element of Fig. 5 is a multiplier that controls the amplitude of the input voltage to the resolver, thereby controlling the relative magnitudes of e_1 and e_2. A suitable multiplier circuit is shown in Fig. 7. A complete description of the operation and adjustment of this multiplier is given in reference 3.

A block diagram of a working polar response system is shown in Fig. 8 together with a list of the equipment used. A calibrated attenuator (item 5 of Fig. 8) is shown in the signal chain for the purpose of calibrating the system. Two amplifiers are required. The amplifier shown as item 9 boosts the peak detector output to a suitable level to drive the multiplier; the amplifier shown as item 13 provides a low impedance drive to the resolver rotor. These are conventional and are shown in Fig. 9.

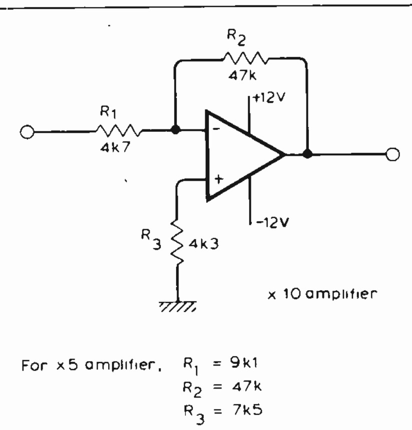


Fig. 9. *Amplifier circuit for items 9 and 13 of Fig. 8. Amplifier 9 has gain of ten times with values shown on circuit, and amplifier 13 has the modified values indicated for a gain of five times.*

The turntable was designed around available bits. The supporting bearing is about 300mm in diameter, originally intended to support a rotating rack of dishes (the so-called Lazy Susan), obtained from a local hardware store. The bearing supports a 60cm square table of 19mm plywood. The drive motor and gear train were salvaged from a chart recorder drive, and rotate the turntable at a rate of about one revolution every three minutes. This rate appears to be a satisfactory compromise between speed and detail. The drive motor is reversible, which is a useful feature.

Although, in total, the system requires a formidable array of equipment, much of it is useable in the lab for a variety of testing purposes. The special purpose equipment involved represents a minuscule investment compared to any anechoic chamber.

Operation

Capetanopoulos has pointed out that the tone burst must satisfy the following constraints:

- The on-time of the burst must be long enough that at least two cycles of the test frequency are passed, so that there is enough energy in the burst at the test frequency.
- The burst must be short enough that the direct burst finishes before the first echoes arrive. This is shown schematically in Fig. 10.

In formula form: $L_R \geqslant L_B + L_D$, where

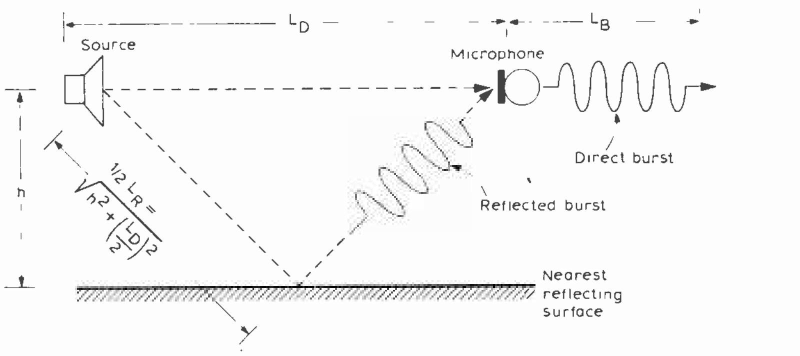


Fig. 10. *Sound burst must be short enough that direct sound finishes before first echo arrives i.e.* $L_R \geq L_B + L_D$. *Minimum spacing for* L_D *is* $2a^2/\lambda$.

L_R is the path length of the reflected sound, L_D the path length of the direct sound, L_B the burst length ($N\lambda$), λ is the wavelength, and N is the number of cycles in the burst. For best separation of direct and reflected sound, the microphone-source spacing L_D should be as small as possible. Minimum spacing is given by: L_D (min) $= 2a^2/\lambda$, where a is the diameter of the source.

● The time between bursts must be sufficient to allow the reflected sound in the room to die away. In this case, the dynamic range of the equipment is 40dB. The reverberation time of a room is defined as the time it takes sound to die away by 60dB, so this length of time — typically 0.75 seconds in a lab setting — should be allowed between bursts.

● A long time between bursts requires a slow decay rate of the peak detector voltage, which forces a slow rate of rotation when a complex polar pattern is to be traced. The decay of the peak voltage between bursts causes a broadening of the trace, but this is not a serious problem.

● The tone burst gating process generates harmonics of the test frequency. This has the effect of preventing a perfect null at points in the polar pattern where one would be observed with a continuous tone under anechoic conditions.

● When large speaker arrays, a loudspeaker column for example, are being tested, care must be taken to ensure that the tone burst is sufficiently long. If it is not, the tone burst from the part nearest the microphone will not overlap the tone burst from a distant part of the array, thereby destroying the directional characteristic of the loudspeaker.

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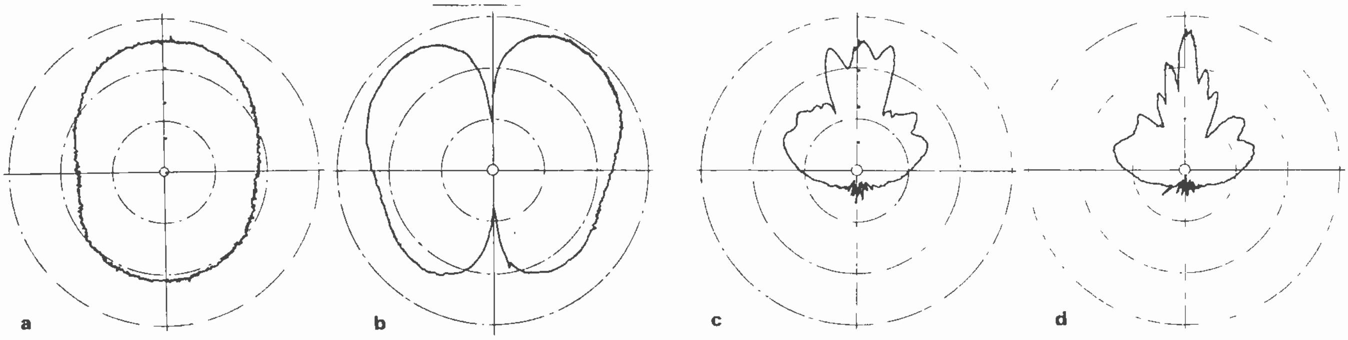
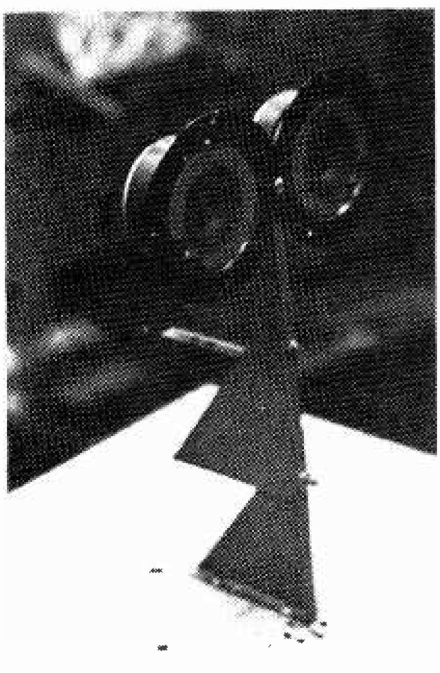
2. Texas Instruments data sheet: Logarithmic Amplifier SM56502N/SN6502N.

3. E. Renschler, Analysis and basic operation of the MC1595, Motorola application note AN489.

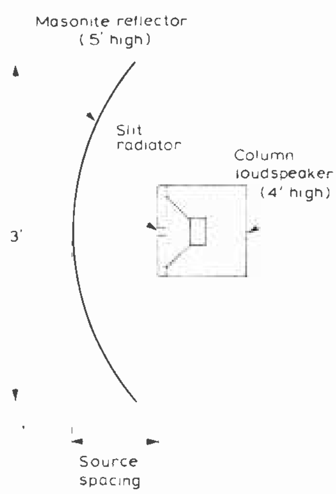
4. L. E. Kinsler and R. E. Frey, Fundamentals of Acoustics, Wiley, 1962.

Typical applications of the technique





● *Polar pattern of the dipole radiator shown left, driven with a test frequency of 1 kHz, drivers in phase (a) and out of phase (b). Dots represents 10dB increments.*



● *Polar pattern of a parabolic loudspeaker with the source at various spacings from the reflector. Directivity was improved by narrowing the column loudspeaker source to a slit of width 25mm. Although the reflector was designed for a focal length of 180mm, trace (c), directivity was best at source spacing of 230mm, trace (d). Test frequency was 4kHz.*

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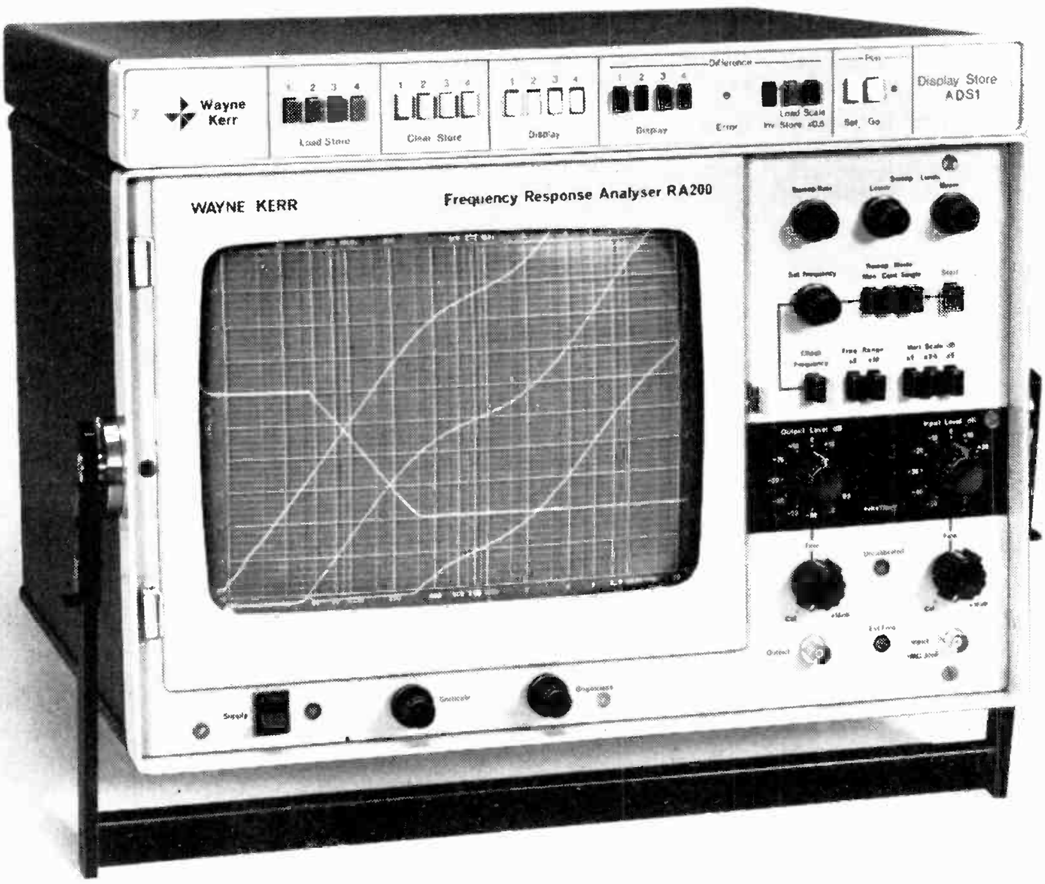

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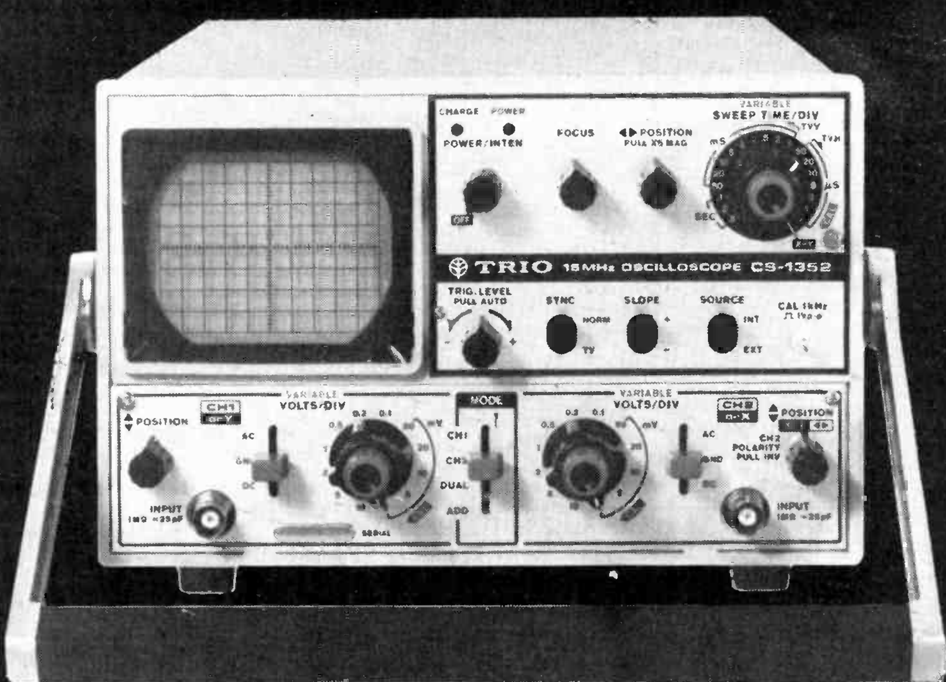

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The paperless revolution — 2

Forces controlling the introduction of electronic information systems

by **A. E. Cawkell,** Institute for Scientific Information

THE TITLE of a recent article (by a member of the Post Office staff) "Uncertainty and Inertia"[33] summarises the situation in which the Post Office finds itself. "The size of the system . . . complexity . . . plant with a life of 40 years . . . 237,000 staff with 11,112 multi-page telecommunication page instructions . . . all militate against rapid changes . . . any change will tend to benefit some at the expense of others." Elsewhere similar points have been put more strongly, with suggestions that over-conservatism about telephone-connected devices and excessive charges compared with the US are a constraint to information flow[34]. However the Post Office may consider, rightly or wrongly, that the funds, investment policy, and resources available to it are insufficient to provide the digital channels and equipment on a scale appropriate to the information age. They may feel that their traffic forecasts do not justify the investment; if they did make that investment the information-deprived might become more deprived. Unfortunately there seems very little possibility, because of the monopolistic UK communications policy, that any other organisation disposed to incur the risk and make the investment for entering the field will be allowed to do so; nor is it likely that the degree of prior consultation and public discussion, appropriate to the importance of this issue, will be allowed to occur. The inevitable conclusion must be that the UK, and probably most of Europe, will only very slowly introduce an appropriate mix of communication channels. The general climate will dampen an already rather low propensity to innovate.

However, the Post Office, given sufficient incentive, can and does innovate. Presumably the development of Viewdata (to be later discussed) is considered to be justifiable socially and financially by reason of the traffic it will generate in the existing network. This praiseworthy enterprise is somewhat tarnished by the cynical change of a monopolistic rule — hitherto rigidly enforced — to permit within-receiver modems, simply because without such a change the system would be less likely to take off. The rule still applies to the community at large.

The current Europe-US scene is particularly interesting; US carriers have provided special services which have generated new traffic by the penetration of low-cost networked digital communication networks set up by commercial organisations like Tymshare and Telenet[35]. One reason for this has been the growth of on-line useage from Europe of large data bases spinning on multi-port time-shared US computers.

Europeans have woken up to the realisation that it would be undesirable, in view of the predicted large increase in the flow of all kinds of information along electrical channels, for this flow to be along foreign controlled channels, however cheap and efficient. At the end of 1975 nine European PTTs agreed to co-operate and implement a network for accessing computers via packet-mode interfaces from various kinds of terminals including those connected to the switched telephone network. One major type of traffic — users to scientific and other information databases on network "host" computers — will be administered by EURONET, organised by the EEC Committee for Information and Documentation of Science and Technology (CDST)[36]. EURONET may be operational in 1978/79.

By contrast, in the United States the FCC attitude of encouraging innovation whilst protecting public service has resulted in intensive activity by small and medium sized companies, and some actual or planned large-scale risk and investment by large companies. This has encouraged the monopolies to become more venturesome, for example AT&T's 96-city Dataphone proposals (1974) which raised another question: was Dataphone created to oust the competition by operating at a loss that AT&T could easily afford? On the other hand some private companies have been taking advantage by "innovations" which are in fact duplications of message services already handled quite well by the monopolies. The FCC's handling of these issues is described in the literature[37].

Communication channels and systems — the next few years

Terrestrial microwave and satellite communication channels are being further developed and new kinds of channels at an early stage of development include waveguide and fibre-optic channels. The table shows some details and capacities of various kinds of communication channels.

In the US, interest is currently centred on the activities of IBM and the specialised common carriers (e.g. MCI, Telenet and at least a dozen others) versus AT&T, and the degree to which the proposed systems would be a complementary whole, improving the flow of information, or a fragmented structure with different organizations offering profitable *creme de la creme* specialized services not necessarily in the overall public interest[38]. Thus the Satellite Business System (owned by IBM, AETNA and COMSAT subsidiaries) will offer a transmission network in the 12-14 GHz band with speeds of up to 6.3Mbit/s available to users. AT&T lines will be unnecessary since communication will be via rooftop aerials[39] with stations rented at $135 a month or less.

A Business Satellite System would further improve information-flow. Companies could fit their various offices with rooftop aerials and their communication costs would drop substantially, governments and PTTs permitting. Unquestionably satellite circuits do reduce costs: US transpacific satellite circuits cost $4000 a month today compared with $15,000 a

Table: capacities of channels (approximate)

Channel	Bit/s	Number of phone circuits	Cost per phone circuit	Number of tv channels
Paired cable	5M	500	$200	1
Co-axial cable	300M	30,000	$30	30
Terrestrial-microwave	10^9	10^5	$15	100
Satellite—(Intelsat 5)	10^9	10^5	$30	100
Waveguide (TE01)	10^9	10^5	$1	100
Fibreoptics	10^{12}	10^8	?	10^5

few years ago. Satellite technology based on space-shuttle launchings will result in further reductions; NASA predictions include personal ground-stations operating at fractions of a milliwatt costing around $10[40]. As yet, international discussions on direct television broadcasting from satellites, planned for the 12GHz band, with all the implications for interference, programme control etc., have hardly started; it seems unlikely that there will be much impact on the man in the street for many years. Meanwhile public service experiments, such as those with ATS-6 for remote communities in Canada and Alaska, and common carrier communications via Comstar will continue.

Fibreoptic and waveguide channels are likely to be used mainly by major carrier to improve their networks — the Post Office is connecting its electronic telephone exchange at Martlesham to the trunk network via a fibre-optic link to Ipswich as a first step[41].

Most broad-impact new developments during the next 5 to 10 years are likely to occur within the existing telephone and television channels. The development of cable television in the United States offers a salutary example as to the constraints of current political and economic issues even when the technology is available and the situation seems ready to take off. Although there are at least eleven million subscribers in the U.S. and the growth rate of c.a.t.v. has been about 16% per annum since 1970, the ebullient future, confidently forecast as "cable in 40-60% of American homes by 1980" has not materialised. This seems to be due to a combination of unsatisfactory FCC regulations, cost of entry, and lack of standardisation[42]. A comprehensive series of NSF-funded studies for c.a.t.v. social services, including interactive systems, did not produce any firm guide-lines because of doubt about content and "critical-mass' audiences, lack of standardisation, and financial doubts [43]. A *Wall Street Journal* headline "talking to the tube" describes a "new interactive system" apparently limited to yes-no responses by viewers[44]; perhaps this item should have been entitled "back to the drawing board."

Paradoxically, a monopolistic structure and a classic combination of circumstances for innovation have given rise to home services with a potentially wide impact in the UK. These circumstances include several or all of the following factors: ● Recent developments in l.s.is. ● Monopolistic control and so quick agreement about standardisation. ● Ease of distribution over existing geographically concentrated networks. ● Relatively low R&D costs and no essentially new technology for transmission. ● Low costs of collecting revenue by suppliers. ● Increased revenue incentive for carriers by increased usage of existing channels. ● Common low cost entertainment/information tv "all purpose" terminals. ● Development of simple retrieval procedures for accessing large files. ● Capacity of, and attraction for a static tv industry for "terminal" manufacture.

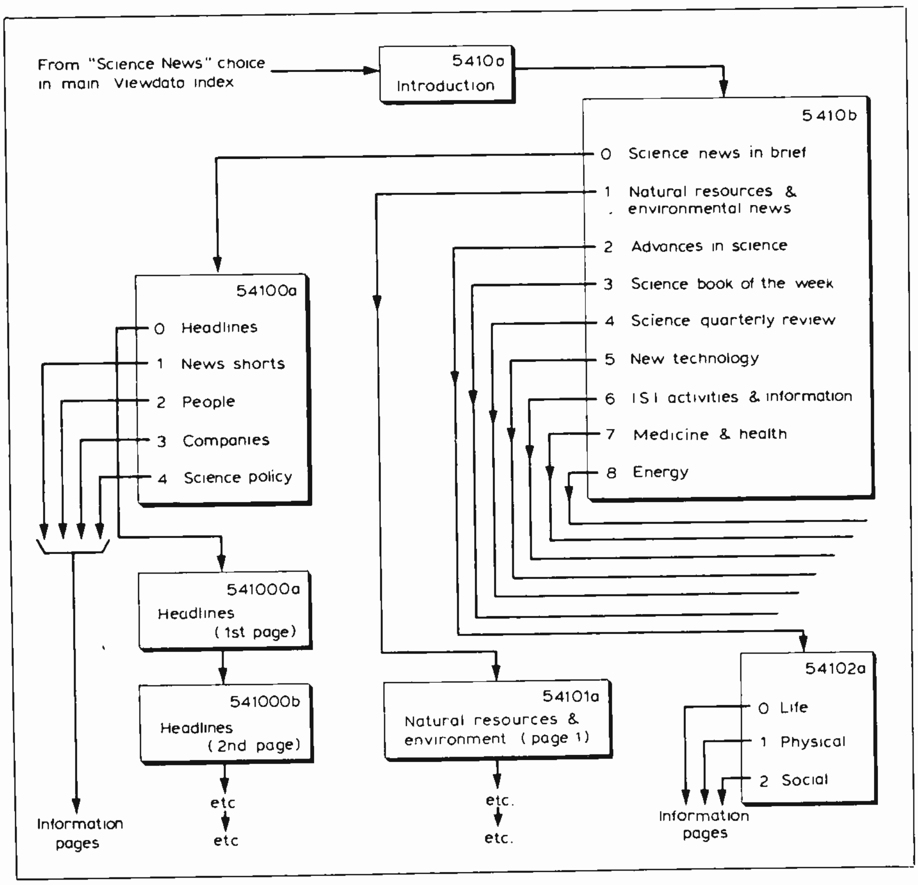
These services are the teletext systems Ceefax (BBC), Oracle (IBA), and the Post Office's Viewdata, now called Prestel[45]. In all of these systems, a "page" of information, filling the screen, consists of up to about 960 characters of text, or graphics. Ceefax and Oracle are receive-only page-capture systems. Data is transmitted in bursts of 7Mbit/s on spare tv lines. A viewer sets a counter on his receiver to capture one out of, say, 100 sequentially transmitted pages; the picture is displayed 12.5 seconds later on average.

In the Viewdata system (see *Wireless World* Feb.-May, 1977 and April-June, 1978) the user dials a computer, in which page data is stored, and "orders" a page by pressing numerical keys. This command data is transmitted from a keypad at 75 bit/s through the switched telephone network. In response, page data is received at 1200 bit/s. The number of pages available is limited mainly by economic considerations and could be many millions. Page information will be fed into a network of local computers by a variety of different organisations, operating independently from the Post Office; because of the nature of the system the information will tend to be less time-dependent and more archival than Ceefax/Oracle. A Viewdata page is selected by viewing ten broad choices, choosing one by depressing a button, choosing one out of ten sub-sets of the first choice then displayed, and so on; the user proceeds from the general to the specific; one out of one million pages could be selected by six successive choices in this manner. This procedure escapes most of the intellectual indexing problems and the need to store inverted files, concerned solely with indexing, which consume as much storage space as the information itself in most computer based systems.

A combined entertainment tv/teletext/Viewdata receiver will contain individual front-end modules, selected by a switch, according to the service desired. The rest of the receiver is common to teletext/Viewdata; the heart of it is a programmed read only memory (r.o.m.) matrix within which characters and shapes (for graphics) are permanently stored. Selected characters are "switched on" by the incoming data and continuously displayed. In Viewdata each page, whether a "routing" page or a final information page, starts to be viewable as soon as a button is depressed. At an incoming data rate of 1200 bit/s a complete picture is formed in a few seconds.

The implementation of national teletext and Viewdata systems* will depend upon the progress of trials of

Fig. 3. *Indexing and page arrangement of Scitel scientific information service for Viewdata provided by the Institute for Scientific Information.*



*In the UK, Viewdata/Prestel starts as a public service early in 1979.

increasing scope and the ability of information suppliers to anticipate demand. The expansion rate will depend primarily upon economic and social factors. The cost of terminals is expected to diminish as l.s.i. modules are manufactured in larger and larger quantities, until a terminal costs perhaps only 10% more than a colour tv set. With Viewdata the public will incur local telephone time costs and information supplier charges depending on the material supplied. Social factors will be discussed later. The indexing and page arrangement of ISI's Viewdata service called SCITEL is shown in Fig. 3.

Near-future activities

Teletext/Viewdata may be the precursor of a wider integration of information processing systems and channels culminating in the "Consumersole" type of facility within the next two or three decades. Various kinds of electronic systems will be introduced sooner in fields where information transfer ranks higher as an occupational necessity and economic pressures are greater. For example efficient information-flow in business, particularly time-dependent information as in stockbroking, is vital, and quite sophisticated networks exist already such as Reuter's Manhattan cable system using video display units (v.d.u.), the Bunker-Ramo business information system and Datastream in England.

When traffic is substantial and private lines can be leased from PTTs on a national or international scale — for example as with the banking (Swift) and air line reservation (Sita) systems — the system operators possess considerable political and technical clout. They probably do not feel unduly frustrated by PTT constraints. However, small users who may be numerous but have to rely on individual connections to a network can be easily monitored and directly billed by PTTs on a per-use basis. For example people who require on-line access from time to time to remote computers — such as those interested in obtaining information from US databases — find that prices and constraints are less satisfactory.

A number of the people who may be expected to become interested in paperless information in the near future will be widely distributed and it seems likely that prices, constraints and inconveniences may slow down their rate of adoption of new technologies.

Education. The possibilities for enhanced teaching via nation-wide channels, low cost terminals, on-line access to information, stand-alone microcomputers, and particularly video disc equipment are well appreciated[46]. Video disc standardisation problems will presumably be resolved once the virtues, economics and production of the various commercial systems have been sorted out.

There are at least two kinds of video disc application. First, visual instructional material may be continuously played into a tv monitor in the manner of a lecture — current discs last for about 60 minutes; secondly, with the Philips/MCA type of machine, operating by laser readout of microscopic impressed pits on the disc surface, the disc is essentially a bit store with an incredibly low storage cost of 0.000012 cents/bit; it has been suggested that the disc might be used as a cheap read-only memory[47]. However, the primary purpose, at present, would be to use the MCA machine's possibilities for digitally-controlled selection of one out of the 54,000 disc tracks. By stepping back the reading head once per revolution, one tv frame may be viewed continuously. The National Library of Medicine in the US is currently considering this system for the storage, delivery and dissemination of audio-visual information.

Another technique which has been tested in prototype form is the VIDAC audi-visual educational distribution system for still pictures with a commentary. In essence the scheme consists of transmitting 1/30th second single still-picture tv frames, using disc storage at a central receiving point for refreshing locally connected tv monitors at the frame repetition rate. The same disc also stores audio information which has been transmitted as a video signal for the remaining 29/30th of a second. A US 4.2MHz tv channel can accommodate an enormous amount of 15kHz audio information once the audio is converted into video, due to a "time compression factor" of 280 times (ignoring the occupancy by sync signals). This information is distributed to local tv monitors as "real time" audio commentary. 900 fifteen-minute programmes may be transmitted from a video tape running for one hour[48].

However, it has to be said that applications of well-established technology are not in widespread use in US education. What's in use now was in use twenty or more years ago. The average teacher does not like "teaching technology"[49].

Teleconferences. If a telecommunications link were to be as satisfactory for the exchange of information as a direct face-to-face meeting between two or more people, then the implications for human behaviour would be profound. According to Short *et al* "The supposed benefits of remote working include improvements in the quality of life through a reduction in time wasted travelling and the greater efficiency in the use of office space and travel facilities"[50]. This would fulfil one of the major conditions necessary for the late Peter Goldmark's "rural society"[51]. On the other hand, is travelling itself a change or a relaxation, and would a video link replace informality with stress? What is the importance of "social presence" at a face-to-face meeting, and what subtle forms of information are lost in any electrical link? Some quite elaborate experiments have been carried out to try and answer these questions including a video conference between a Congressman in Washington and 150 people in his North Carolina district via the CTS satellite[52].

In work done by the Post Office (Confravision), Bell Canada, University of Quebec, and the UK Civil Service, similar conclusions were reached. Comprehensive tv facilities with an expensive wideband channel were much more costly than a narrow band telephone conference but not proportionately more acceptable. The choice of media for certain tasks was less important than the imperative to travel — for instance in order to get to know someone by face-to-face social presence. The opportunities for social etiquette are lost if the meeting is conducted via a communication channel (the "coffee and biscuits" syndrome). However, the difficulty of measuring such intangibles makes conclusions hard to reach; more experiments and further development of lower cost video facilities are needed.

Electronic journals and on-line information. The economic pressures on commercial, learned society, and other publishers of scientific journals, are heavy. Individual subscriptions are rapidly disappearing as journal prices rise; libraries respond to budget cuts by reducing subscriptions. The function of journals, which is to provide rapid information about current research and a record for the archives, has become less satisfactory as the number of journal titles has risen to tens of thousands. In 1975 about 327,000 articles were published in 4175 scientific and technical journals in the US[53], so probably at least one million articles were published throughout the world. 55% of US journals had fewer than 3,000 subscribers; the price of the average journal has increased fourfold between 1960 and 1974.

There have been various responses to this situation; photocomposition is increasingly used as the cost of equipment decreases and sophistication increases. Equipment is becoming available for text preparation with minimum rekeying; text may be prepared on a word-processing machine and the final format stored on floppy disc. The disc can be used to transfer the text to the photocomposer's display and the operator simply enters command codes. The possibilities for using these facilities in mitigation of the above-mentioned journal problems prompted a cost-reducing resource-sharing system called "an editorial processing centre"[54]. An advanced form of this idea is shown in Fig. 4. It can be seen that various paperwork operations are replaced by a movement of manuscripts by digital transmission. Such a facility might be shared for the publication of a number of journals.

After fairly comprehensive investigations the funding organisation (NSF) considered it had done enough to demonstrate feasibility[55]; it remains to be seen whether any publishers will take it up. If readers were to be connected to this network, then we have, in effect, an "electronic journal" (the dotted extensions in Fig. 4). So the question arises when will this happen? According to Senders it is almost imminent[56]. Certainly something like it — an "electronic information exchange" — is under consideration. This exchange would take place using minicomputers with substantial disc storage accessed through 32 Telenet ports at the New Jersey Institute of Technology. Authors in a particular research community would be able to exchange information and "publish" work in electronic form.

A more important question than the one posed above is "when will electronic journals replace existing journals to any significant degree?" According to Garfield, not in the next decade; even then the "electronic journal" will still fulfil the functions that it does today[57]. A reasonable discussion of what may — and may not — happen has been given by Woodward[58]. It seems likely that research communities will use existing networks much more: the ARPA network is already widely used for author information exchange in the US. Existing publishers will, in due course, possess articles in machine-readable form as part of their journal production processes. Access to these electronically, if made available, will erode subscriptions to the printed version.

It is hard to visualise the changeover mechanics of a print-on-paper corpus of readers, to a corpus of terminal viewers. Conventional publishing requires little capital; a replacement electronic journal requires a great deal. In a specific case, an appreciable fraction of readers of a particular journal might also possess terminals connected to some communications network. Collective action by these readers would enable the electronic journal function to ride on existing functions, but in how many cases would this opportunity arise and could be suitably organized? All in all it seems likely that the impact upon conventional journal publication will be gradual unless a government injects very substantial launching capital.

Meanwhile a different kind of activity impinges upon the publication scene. I refer to the on-line secondary information services which are being increasingly used to locate a published item of interest out of the total mass[59]. Organisations like the Institute for Scientific Information, Chemical Abstracts and Biological Abstracts, maintain machine readable indexes which are available from dial-up computer centres such as Lockheed and SDC via international networks like Tymnet and Telnet, and soon via Euronet. This activity impinges upon publication to the extent that centralised photocopying of articles located by these services may be reducing journal subscriptions. If a cheap "relevant article selected from the world's literature" on-demand service exists, it is less necessary to subscribe to and browse through journals in the hope of finding relevant articles. Theoretically, at least, it is absurd to "broadcast" an article in a journal in order to reach a relatively small number of interested persons, and then set up elaborate secondary services to enable those persons to find the article. This brings us back full circle to a notion of a more direct author-reader connection with an "electronic journal" as already discussed.

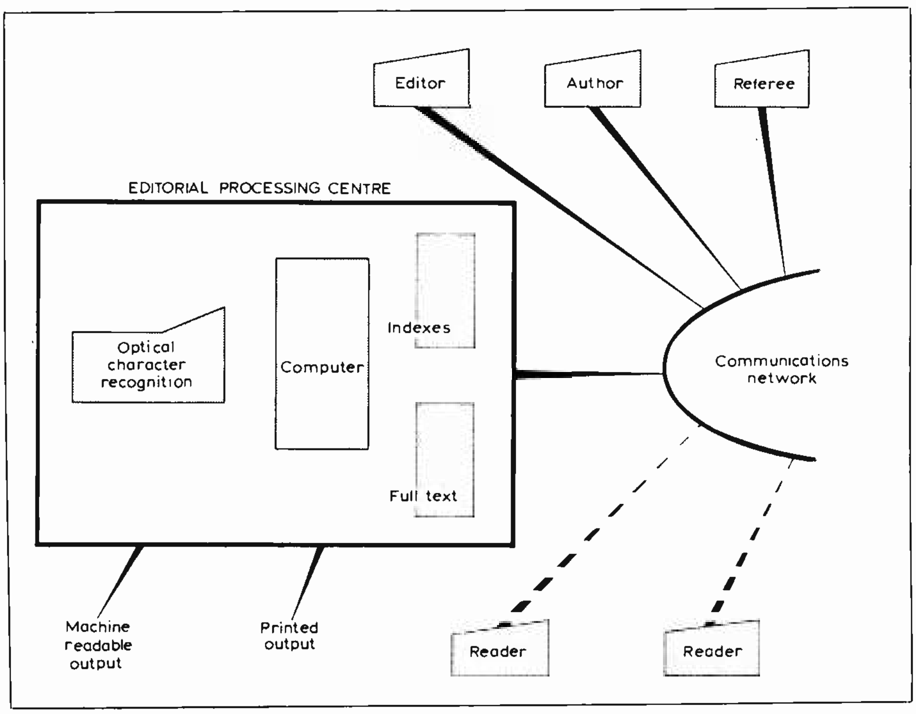


Fig. 4. *Proposed editorial processing centre for an electronic journal. Movement of paper is replaced by digital transmission.*

Electronic funds transfer. Credit transfer between banks is already carried out on a large scale using the Society for World Wide Interbank Financial Telecommunication (SWIFT) network. This private data network interconnects a number of banks in the US, Canada and Europe. Banks were also among the first to use data transmission between offices and branches. A recent development is the transatlantic credit rating system between VISA/BARCLAYCARD using PDP11/45s at Northampton and VISA in San Mateo, California. It takes only a few seconds to put through an enquiry. According to an A.D. Little spokesman there will be a steady move towards a cashless society as magnetic "transaction cards" become widely used for payments via special cash-registers at points of sale. The rate of adoption will depend on the rate of development of the necessary communication networks, but these cards are expected to be widely used in the US by 1985.

Electronic mail. A form of electronic mail is starting up in the UK; it will be possible for Viewdata users to send messages to each other experimentally during the 1978 market trial, and more widely when the national network becomes established. This will of course affect the postal service, but as the Post Office also run Viewdata they are in a position, through pricing policies, to control relative usage; their intentions in this respect are unknown.

In the US "computer mail" over the ARPANET government controlled computer network is well-established[60]; as many people with common interests and the facilities for message exchange are inter-connected via this network, it is hardly surprising that a message exchange system has been established.

Current prices for electronic mail in the US are difficult to establish. Commercial computer mail services are being offered at around $1 for a short message, and this may soon be reduced to 50c[60]. Studies undertaken by the National Research Council ended with the strong recommendation that the US postal service should provide electronic mail services since its basic business is likely to be seriously threatened[61]. Already operating at a loss, the service is steadily losing revenue from the switch by business — an estimated 80% of first-class mail is business related — to telecommunications. It will lose more from the growth of electronic funds transfer. The computer-mail services mentioned above are illegal; to operate computer mail legally onerous FCC common carrier regulations have to be adhered to, so US operators conduct their services under cover. Like other services the reality of channel requirements is one thing and out-dated regulations, drafted for mutually exclusive use, are another.

With the possible exception of business communication, electronic mail seems likely to grow slowly in the UK since appropriate equipment and a channel connection is beyond the means of most people: nearly half of private houses do not have telephones and virtually none a computer terminal. Electronic mail will start to ride upon multi-function systems such as Viewdata and although postal services in the UK and elsewhere have deteriorated and become much more costly they will still represent the most satisfactory method for most people's intermittent communication needs for many years. However, low-price, convenient facsimile systems are a form of electronic mail, and it seems likely that a new generation of fast equipment, capable of transmitting an A4 size page of text in one minute or less, will soon be available. Until now transmission time has been five or more minutes. It remains to be seen whether the new equipment, which incorporates data-reducing coding, will be available at a price which will encourage wide use.

Social forces

Much of the above discussion has been about technology, although it has been hard to treat social issues separately and impossible not to discuss politics. It would be a bold man who would attempt to provide any kind of timetable for the paperless revolution since the expected changes are without precedent and the rate of acceptability is impossible to predict.

Some people think the changes brought about by the increasing use of electronics, computers, microcomputers, etc, in industry, education, the professions and at home, will proceed at a rate which may cause concern but not alarm. Others feel that a revolution without precedent is upon us, demanding immediate attention particularly in its likely effects upon employment.

Those inclined towards a moderate view use data from the past to provide reassurances about the future. They point out that dire predictions about the effects of automation turned out to be unfounded. One notable authority[62] suggests that "... computers are simply one of the many labour saving devices that have been appearing since the beginning of the industrial revolution ... a large body of empirical evidence demonstrates that there is no relation, positive or negative, between the technological sophistication of an economy and the level of employment that it maintains." In another review[63] opinion is more mixed: "the volume of pocket calculators produced has probably more than made up for the number of displaced slide rule manufacturers and their employees"; in another case, the telephone industry, there has been a wholesale changeover from electromechanical to electronic and computer-controlled switched lines between 1962 and 1976, and the number of employees in Western Electric's switching division has not changed much. But in the *operating* telephone companies, less than half the number of people are now needed to administer and maintain the new exchanges; generally "if speculation turns out to be anywhere near the mark ... the impact on employment could dwarf earlier concern about automation." Continuing on an alarmist note, a recent newspaper article, speculating about breakdowns in communication channels, started with the headline "Computerised chaos feared for 2002 A.D."[64].

Intrusion and secrecy have probably received more attention than any other social matter, centred mainly upon the abuse of personal information held in computer storage. In Sweden — with the early Swedish Data Act — privacy protection is ranked higher than social care for children and the aged[65]. Similar concern has been expressed in other countries; in the US, the Privacy Act was passed in 1974. This gives an individual the right to go to any federal agency, check his record, and have it corrected if it is erroneous; furthermore a commission is currently considering extension into the private sector, together with the right to make comprehensive error corrections propagated backwards and forwards to other information which may contain related errors[66]. In the UK secrecy has received the tortoise-like speed of consideration that might be expected. A White Paper was published in 1975 about the subject, and in September 1977 the following comment was made: "we hope to report in the next few months but I cannot say what our recommendations will be"[67]. Another controversial issue is possible European protectionism against US data-processing; Swedish trade unions are alleged to have exerted strong pressure against the export of data for foreign processing.

In addition to the ease of integrating and communicating personal data via large inter-connected computer networks to presumably authorised persons, there is the question of unauthorised reception of data in transmission or called up from computer storage. Many cases of sophisticated in-transit eavesdropping and in-house computer frauds have been reported. One remedy is to scramble data using a code which is secure and convenient to use. Machines for this purpose were devised during the last war but messages using the supposedly secure Type X (US) and Enigma (German) coding machines were successfully decoded. Another well-known method is to use a so-called "one-time pad" which is reasonably secure but inconvenient. A system has recently been introduced in the US by the National Bureau of Standards (NBS) called the Data Encryption Standard (DES); the system and algorithm may be accommodated on chips attached to a computer for encoding and decoding data. Each device has its own 56-bit key. The code is said to be unbreakable but the matter is controversial and surrounded by cloak-and-dagger acitivity[68]. Whether or not the code is unbreakable, the key has to be sent to authorised users to enable them to decode messages. It could be changed as necessary by substituting a new set of randomly chosen digits but earlier recorded messages could be decoded at leisure if the old key became known. Even so some banks believe that this is a considerable advance over other methods and plan to use it.

People have in their minds another future image of computers — that the machines may become too clever by half and take over as masters. There is no doubt that chess-playing machines, progressing towards the grand master level, have caught the imagination of the public; in a recent contest two international masters were unable to beat a machine. Artificial intelligence research and machines capable of executing 100 million instructions per second reinforce a feeling of uneasiness. Real problems would start, according to one researcher, if programmes, already extremely complex, became inscrutable. There may be a real need to guard against this with an "open box" rather than a "black box" approach in the next few years[69].

After unemployment and secrecy, a third, possibly a very insidious effect, might accompany the paperless revolution. Will viewdata-like systems "... buttressed by the superficial impartiality of the computer and dominated by the awesome authority of the box ... distort the process of debate and persuasion that holds a democratic society together?"[70] (as one observer eloquently puts it). If events take a turn in this direction it will be because people are spending more time communicating by electronic media at the office and at home and there is a general drift towards receiving a higher proportion of information in this way. At best people will be at arms length instead of face-to-face. At worst they will become conditioned passive listeners or viewers. This in turn could result in a further reduction in conversation, a tendency to watch potted digests at the expense of more general reading, and a general lessening of social contacts, discussion and controversy.

Associated with this possible trend there could be a reduction in the number of information sources; the number of newspapers is steadily diminishing and it is easy to visualise the influence, by information selection, suppression, or distortion that could be exerted should there ever be only one national newspaper. Pursuing such a trend, if ever information reception by electronic media became overwhelmingly attractive in economic and Zipfian* terms, the power possessed by the providers would be immense.

Next, the question of copyright, designed for print-on-paper, has yet to be resolved. In the United States steps have been taken to alleviate the effects of photocopying by setting-up an agency for royalty collection when a defined quantity is exceeded, and copyright is under consideration in many other countries. Problems raised by property rights in electronically disseminated information have yet to be clarified.

It is impossible to say when or if some of the suggested unpleasant consequences of the paperless revolution which I have discussed will be with us. The technology *per se* is neutral — it's the purpose to which it is put that matters. Governments of whatever complexion will intervene, but the complaint of "too little too late" will be increasingly heard particularly in democracies, because the mechanics are too slow to respond to an ever increasing rate of change.

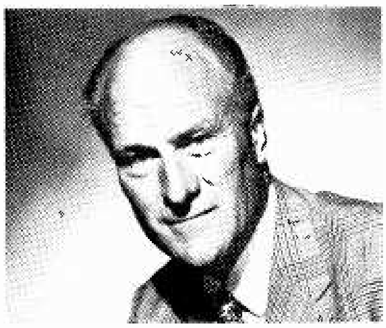
It seems just as likely that "progress" will be achieved by confrontation rather than by smooth transition. If labour-intensive activities are going to be reduced at an unexpectedly rapid rate the only way in which those displaced can be re-employed is by utilisation of the new wealth created by the value added to the new knowledge-intensive products and services. I am not aware of any convincing argument which suggests that sufficient wealth can be produced in this manner.

It is unreasonable to expect that technologists engaged in a technology of increasing complexity will take time off to develop a collective social conscience and use it to influence the course of events. There might be an advance in "socially-clandestine technology" — social consequences, privacy, privacy intrusion, etc., would be played down until eventually the public would find that it had drifted into a highly unpleasant situation brought about by a series of apparently innocuous small steps. There could then be a violent over-reaction in which a whole range of services and activities would be labelled as bad, including those which are in fact beneficial. This situation could arise because of the difficulty of connecting a particular event with a particular social consequence; for example, it is difficult to correlate a percentage increase in unemployment with particular events.

Since hard evidence of forthcoming widespread unemployment or behavioural changes is not available, it is unlikely that governments or other bodies are going to pay any attention to mere prophets of doom. Such people are likely to exaggerate in order to get a hearing and their pleas will be discounted. However, considering the sum total of the issues, it seems to me that when a whole spectrum of events are changing at an ever-increasing rate, some combination of them is likely to add up to Future Shock for a good many people. This shock could be alleviated by the continuous monitoring of events, observation of trends, and accumulation of evidence. If this information was widely publicized as an early warning perhaps planning or action would follow — surely a better way of doing things than by *ad hoc* emergency action.

There ought to be some sociologists who are able to master the technology, and some engineers who are prepared to study the social issues and politics. An articulate group of sociotechnologists, as I will call them, might be able to command as much attention from government and public as does Ralph Nader for other areas of consumption. The formation and funding of a body of this kind is worthy of consideration.

*Zipf's Law concerns the human tendency to select minimum-effort solutions to a problem.



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European Broadcasters determined to hold on to bands I and III

THE European Broadcasting Union will press for sweeping increases in broadcasting frequencies at WARC '79. In some cases, like that of some long wave allocations, they will ask to have exclusive use of frequencies they presently share while in others, such as the frequencies used for outside broadcasting, they want totally new bands allocated.

Their proposals are:

- The whole of the L.F. broadcasting band from 150-285kHz should be allocated exclusively to broadcasting, and extended.
- Medium waveband should be shifted 1.5kHz and, say a majority, extended by 9kHz.
- H.f. allocations (short waves) to be substantially increased, exclusively and world wide, with 26MHz, used for satellite broadcasting.
- V.h.f. band II should be extended exclusively to 108MHz. 500kHZ would be ceded in return!
- EBU should seek an exclusive satellite broadcasting allocation of 9MHz per national programme at 1GHz or thereabouts.
- Band I (47-68MHz) should be retained.
- Band III (174-223MHz) should be retained, made entirely exclusive, and extended by 7MHz!
- Aero radio navigation and fixed services should be excluded from Bands IV and V up to 86zMHz, above which the broadcasting allocation should be retained exclusively for satellite broadcasting.
- Bands above 12GHz should be enlarged and made world wide.

The 40 GHz band, for example, should be extended by 1GHz.

The foreword to the EBU document, published in mid-June, makes clear that "EBU members are recommended to make every effort to attain the common objectives indicated in this document. Given the importance for the future of broadcasting of the WARC 1979 ... the EBU members are requested (if they have not already done so) to approach their corresponding administrations in good time before the WARC 1979, in an attempt to make known the views expressed in the EBU guiding principles given below."

The director of the EBU Technical Centre, R. Gressman, says in a statement issued with the document that its contents have been unanimously approved by the EBU administrative council, which met in Spain at the end of May.

The increases in satellite broadcasting allocations, he explains, are to permit reception in cars and on portable radios. The new 1GHz allocation "is suggested to provide, as requested by the radio programme committee, a minimum of two programmes per country."

The change of the 26MHz band from some terrestrial to satellite broadcasting arises because ionospheric propagation has made it difficult to use on the earth's surface. "Although this does not seem to pose major technical problems, it must be pointed out that the political aspect of such a proposal is rather controversial, and in consequence the views of the members on the advisability of making such a proposal are divided." No such division seems evident elsewhere in the document, particularly on the crucial Bands I and III. "It is emphasised that, contrary to the views expressed by a number of telecommunications administrations, Bands I, III, IV and V ... must be retained exclusively. Frequency sharing with the mobile service, which some telecommunication administrations intend to introduce at least in Bands I and III must be rejected because this would inevitably interfere with broadcast reception, as well as make impossible the further improvement of television coverage in areas still not adequately covered."

Extra frequencies will be needed for all the satellite broadcasting allocations so that provision is made for sufficient up-links to the satellites, eg 800MHz for the 12 GHz band. Large-screen television should be allowed for in the future by extensive provisions in the 40 or 80GHz range.

Although the EBU has little more standing at these conferences than might be accorded its members acting without its auspices – it has been described as a club of European broadcasters – there is little doubt that the unanimity of the EBU membership will go some way to counteracting their individual weakness. Each country at WARC will have only one vote, whether it is the United States or the Gambia, and this procedural arrangement has been criticised by those who feel that the United States or Russia or the UK is entitled to more votes than the Gambia, though a Gambian might be at a loss to understand what logical processes lead to this conclusion. This explains why the EBU countries are concerned to have a unanimous view, to counteract their individual weakness. It also explains the Home Office's determination to compromise the UK view with that of the Europeans, as we showed last month (WW News page 47). Explains but does not excuse.□

British lead in surround sound microphone

THE BBC have now followed the IBA and placed orders for the NRDC sound-field microphone made by Calrec Audio, of Hebden Bridge. And this year's promenade concerts will be recorded using the new microphone, though it is not yet certain that broadcasts will be made with it.

The transducer, acknowledged to be the most advanced of its kind, is a one-point periphonic microphone designed to handle sounds from all directions in a controlled way, and is more accurately coincident than its predecessors. "Its subjective performance goes well beyond anything else commercially available," says Michael Gerzon, co-inventor with Peter Craven and whose mathematical research has enabled the design procedures to be established.

The microphone samples a sound field at carefully chosen points and uses the sampled information to provide the best possible reconstruction of the original. The microphone's directivity is achieved by synthesis using four capsules and frequency-dependent phase-amplitude matrixing — in effect a kind of "spaced-to-coincident" microphone conversion.

Any first-order directional characteristic can be obtained from the B-format outputs. And any number of combination of such microphone characteristics — omnidirectional, cardioid, hypercardioid, figure-of-eight — can be synthesized simultaneously. Using the stereo "pair" output, the angle between the two microphones of the virtual pair can be varied (in addition to the directivity patterns of the individual microphones), and the "pair" can be panned or tilted in any direction electronically. Stereo width and mono compatibility are adjustable without interaction.

Conventional four-microphone "quadraphonic" or quadrifontal outputs can be provided, as well as horizontal ambisonic surround sound and full periphonic outputs. The range of decoder facilities provided by the Ambisonic technology are included, e.g. speaker layout compensation, in addition to test tone circuits.

Development of the sound field microphone, using trial recordings made by Peter Fellgett over three years ago, has resulted in a stability and lack of ambiguity of four-speaker localization "much superior to the best stereo, even for non-central listeners and for sounds at the sides." The degree of coincidence, then up to 7kHz, has been improved since and the latest production microphone is now, in effect, precisely coincident "substantially over the audio range," according to Calrec. The result now sounds very much cleaner and the directivity is sharper, according to Michael Gerzon, "everything is that little bit righter."

The equipment is now starting to sell outside the UK — as a result of exposure at the NAB convention, NBS and CBS have shown interest. And though it is priced at £2,100 (microphone only, £800), the APRS show this month is expected to result in interest from recording studios.

But perhaps the most versatile feature of the microphone and electronics is that the signal processing can be carried out after taping: the desired microphone technique can be chosen later. For the first time full mix-down capability off coincident microphones is possible. "We can now record stereo material that could be used for ambisonic playback in five years or for periphonic playback in ten years," says Michael Gerzon.

Periphonic microphone design is complex, not only because of requirements on the constancy of outputs in terms of phase and amplitude response and polar response, which gives rise to a large number of variables requiring methods of analysis that are new to microphone design, but also because of the need to compute spaced-to-coincident matrixing. Studies by Michael Gerzon, who along with Peter Fellgett and John Wright have NRDC backing for ambisonic technology, made as long as six or seven years ago showed ways of sampling a sphere with minimal loss of information in a spatially analogous way to the familiar sampling theorem of communications theory. Because of the complexity introduced by the sphere it wasn't possible to use standard analytic techniques to prove the new sampling theorem. The proof involves a "considerable measure of mathematical abstraction using the functional-analytic theory of L^2-spaces on measure space" (MG). □

NEW PRODUCTS

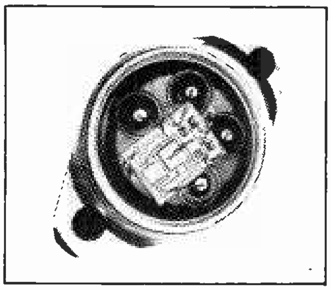
Colour camera

A colour television camera, the FAC71 from Grundig, is now obtainable in the UK. In e.n.g. form, on a studio tripod or adapted for microscopy, the camera is suitable for many uses, delivering a PAL composite video signal to CCIR 625 standards. The standard lens is the Schneider f1.8 motor zoom type of 12.5 to 75 or 10 to 100mm focal length, C-mounted, although a variety of other lenses is available. Light level correction is automatic, using auto-iris control and target voltage variation to cope with a 6000:1 variation; the automatic control can be overridden. A three-position switch affords colour correction for tungsten, daylight and overcast daylight. Two viewfinders are available, both electronic. The e.n.g. configuration calls for a 2.7cm type, used with an eyepiece, while in the studio a 10cm screen is used. Three 2/3in Vidicons are used as standard, giving a full-amplitude signal on a highlight of 1000 Lux and a usable picture on 400 Lux at a resolution of 350 lines per picture width. The supply required is 12V d.c., 65W and a mains unit is available for studio use – a single cable carries power, sync, video, talk-back and recorder control signals. J. O. Grant and Taylor (London) Limited, Arlingham House, South Mimms, Potters Bar, Herts EN6 3PH.
WW 301

Low-cost microcomputer

A single-board microcomputer system, from Rockwell Microelectronic Devices, includes a 20-column printer and a 54-key alphanumeric keyboard and costs less than £250. The system, which is designated as the AIM 65, is intended as an educational aid for first-time users and as a general-purpose microcomputer for engineers. The AIM 65 is available in 1K- and 4K-byte r.a.m. versions and is based around the 6502 c.p.u., which has a 64K address capability with 13 addressing modes. An 8K r.o.m.-resident monitor programme provides all peripheral control and user programming functions, and spare sockets are included to allow the on-board programme memory to be expanded further. The board also has a connector that allows external access to the system bus for memory and input/output expansion. Pelco (Electronics) Limited, Enterprise House, 83/85 Western Road, Hove, Sussex BN3 1JB.
WW 302

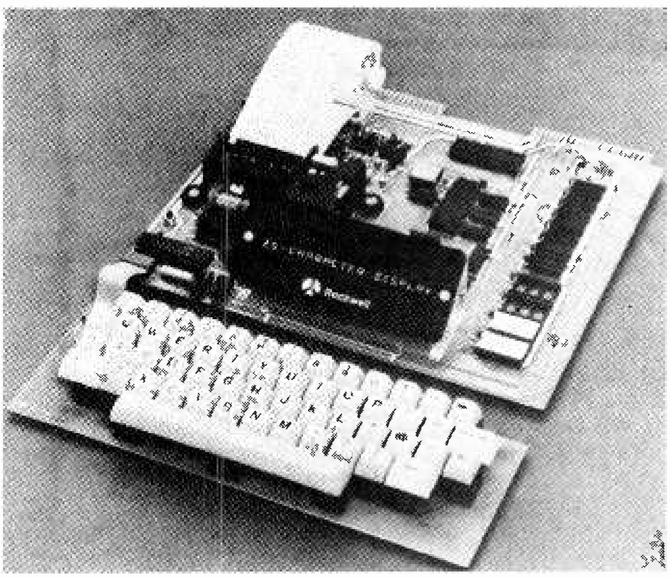
WW 301



WW 303

Hybrid regulator

The SH1705 regulator is a 5V, 5A hybrid device which also contains a 5A bridge rectifier. The circuit, which is housed in a 4-pin T0-3 package, only requires an external transformer and two capacitors to provide a d.c. power supply. The regulator section offers short-circuit protection, thermal shutdown, and internal current limiting. Because the regulator input is available on a separate pin it can be used separately from the rectifier if necessary. The device has a maximum input voltage rating of 23V r.m.s., and a maximum internal power dissipation of 50W with a case temperature of 25°C. Fairchild Camera & Instrument UK Limited, 230 High Street, Potters Bar, Herts EN6 5BU.
WW 303



WW 302

V-f.e.t. transistors

Vertical-geometry field-effect transistors, in a range from Walmore Semiconductors Ltd, can handle continuous-wave output powers up to 100W at frequencies of 175MHz. The devices are claimed to draw negligible d.c. input gate current, making biasing and modulation simpler, and to be much more rugged than comparable bipolar devices. There are three devices in the range, the BF25-35, the BF50-35 and the BF100-35, and these are designed to handle 25, 50 and 100W of c.w. power respectively. They are all suitable for operation at either 80 or 175MHz. Third-order distortion of the v-f.e.ts is similar to that of bipolar products, but their square-law type characteristics give higher-order distortion figures which are 5 to 10dB lower than those obtained with comparable bipolar devices. Noise performance is also improved because the v-f.e.t. is a majority-carrier device. Walmore Semiconductors Limited, 11-15 Betterton Street, Drury Lane, London WC2H 9BS.
WW 304

Crystal oscillator

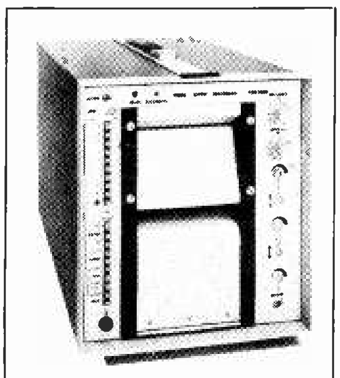
The model CO - 206V crystal oscillator, from Vectron Laboratories, is claimed to have a long-term stability of 1×10^{-10} per day and 3×10^{-8} per year and a short-term stability better than 1×10^{-11} per second. Its stability over the temperature range from 0 to 50°C is better than $\pm5\times10^{-9}$, and a −55 to +71°C temperature range is optional. The noise characteristic of −140dB/Hz, 1kHz from the signal, makes the CO-206V especially suitable as a reference for synthesizers and in applications requiring multiplication to microwave frequencies. The oscillator, which has a voltage control (v.c.x.o.) capability, has an output of 1V r.m.s. into 50Ω at 5MHz, although other frequencies and a logic output are available. Lyons Instruments Limited, Hoddesdon, Herts.
WW 305

P.c.m.-repeater i.c.

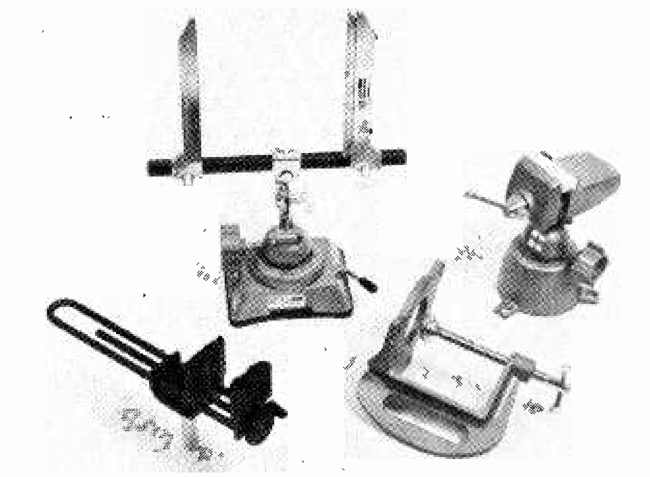
A monolithic repeater circuit. introduced by Exar Integrated Systems Ltd, has been manufactured for pulse-code-modulated telephone systems. The XR-C277 is designed to operate as a regenerative repeater at a data rate of 1.544 Mb/s on T1-type p.c.m. lines. It is contained in a 16-pin ceramic d.i.l. package to provide operation over a temperature range from −40 to +50°C. All the basic functional blocks of a regenerative repeater system are contained within the device, including automatic line build-out and equalization. The device, which is insensitive to reflections caused by cable discontinuities requires only low voltage supplies providing a current of less than 13mA. Memec Limited, Thame Park Industrial Estate, Thame, Oxon OC9 3RS.
WW 306

Hard copy module

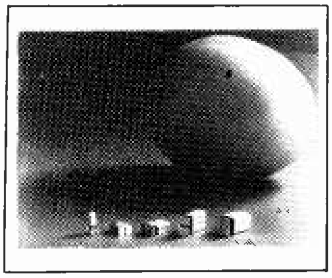
The FOR 1002 produces single frame or 'continuous' video images on low cost, ultra-violet sensitive paper. Up to 14 grey scales may be obtained using suitable paper with chemical development and using photo-developed 'instant' records up to 6 grey scales may be achieved. The video amplifier has a bandwidth from 0 to greater than 4MHz and will enable 200ns pulses to be registered. It is fitted with wideband (0 to 500kHz) X and Y amplifiers which are phase matched to 2.5° at 100kHz. The FOR 1002 may be used as a dual



channel, wideband, strip recorder or as an X-Y plotter. Paper speed may be selected over a range from 1000mm/s to 5mm/s with an error within ±2%. The module is claimed to be suitable for use with sonar equipment for sea bed mapping and with ultrasonic equipment for flaw detection, and cardiac and foetal monitoring. For medical applications, it may be interfaced directly with the Medelac dual channel electromyograph type MS7. Medelac Limited, Manor Way, Old Woking, Surrey GU22 9JU.
WW 307



WW 309



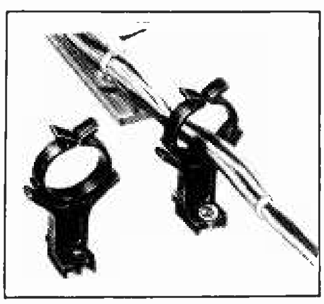
WW 308

Tantalum chip capacitors

Tantalum chip capacitors have presented problems to hybrid circuit manufacturers because of their fragility, bad handling characteristics and the difficulties involved in choosing non-encapsulated and encapsulated components for stock. A range of capacitors, now available from Corning Ltd, is claimed to provide the answers to these problems. To overcome the problem of fragility, the capacitors are metal-cased and have protected cathode surfaces. The anode wires are also solidly entrenched and they have rigid anode terminations and low dissipation factors. The components are of regular size and shape and they may be soldered without risk of delamination. They may also be mounted on all sides, and the polarity is said to be obvious. In addition they are claimed to be vibration and shock proof, moisture resistant, and suitable for all encapsulated or non-encapsulated circuits. The capacitors are available in five different case sizes with tolerances of ±5%, ±10% and ±20% and values ranging from 0.1μF/50V to 47μF/10V. Corning Limited, P.O. Box 37, Pallion Sunderland, Tyne and Wear SR4 6SU.
WW 308

P.c.b. holder and vice set

A set of workbench aids, from Greenwood Electronics, includes a vice with a head that rotates 360 degrees and tilts 180 degrees in the vertical plane. There are three types of bases available; a normal base (97mm high), a low profile base (67mm high) and a vacuum base which secures the vice to any non-porous surface by a powerful suction pad. In addition to the standard vice head, which is 63mm wide and opens to 57mm, there is a low profile head and a wide opening head with a grip range up to 165mm. The wide head has neoprene pads and will hold cylindrical objects. Included in the set is a p.c.b. holder which will take p.c.bs up to 203mm wide. Cross bars up to 762mm, and extra arms, are also available. A bench clamp mounting base in the set allows the vice/holder to be securely clamped to the edge of a work bench or counter. Greenwood Electronics, Portman Road, Reading, Berks RG3 1NE.
WW 309



WW 310

Cable retainer

The BR75-E6-C bundle retainer will accommodate cable bundles up to ¾in in diameter. It is designed to support the bundle above the harness board to enable cable ties to be installed easily. Its spring fingers allow fast routing of wires and easy removal of the completed harness assembly. Installation is simple and positive and requires only two small screws. Two or more retainers may be linked together by their overlapping feet. Panduit Limited. Sittingbourne Industrial Park, Unit 22a, Crown Quay Lane, Sittingbourne, Kent ME10 3JG.
WW 310

Charger for microprocessor p.s.u.

A miniature transformerless battery charger, the BC 150, may be connected to a 210-250V or 105-125V line supply and will provide a completely isolated 3V, 50mA output suitable for maintaining charge on the back up p.s.u. of a microprocessor system. The output terminals are short-circuit protected and are immune to damage from external load removal. The unit, which measures 0.93×0.93×0.50in, is cast in filled diallyl phthalate. The charger is manufactured by Integrated Electronics Co. in the USA, and the price is from £12 in quantity to £21 for prototypes. Sanderling Controls, 26 Hayes Road, Bromley, Kent BR2 9AA.
WW 311

WW 312

Voltage and current sources

Voltage and current sources in the Dial-a-source range, from Delristor Ltd, are claimed to be accurate to within 0.0015%, and to have resolutions to 0.1μV and 'zero' output impedances. The range consists of 14 models so that an optimum unit can be selected for a particular application in terms of voltage and current characteristics, accuracy and operating mode. The standard grade units weigh between 4.5 and 9kg and measure typically 180 × 200 × 260mm. They can be supplied with a British Calibration Certificate, and provision is made on all models for a periodic recalibration against a primary standard. Delristor Limited, 21 Windsor Street, Uxbridge UB8 1AD.
WW 312

SIDEBANDS by Mixer

Blasted with excess of light

As an avid viewer of Star Trek, Dr Who and then Blake's Seven, I am always enormously impressed when someone points a piece of imaginative hardware at a baddy and nonchalantly vapourizes him. It's so much nicer than the noisy, smelly business of shooting off revolvers, with the attendant risk of letting the air out into inter-galactic space. You just press a button and the chap disappears.

I dare say we all have private dreams of making certain people vanish — I know I have — but, after giving the matter some thought, I don't think I'm going to be able to do it by laser, which seems to be the most popular method of blowing people away in starships. It's the power, you see. The lady astronauts never seem to have time to put on all their clothes in the morning and it is fairly clear that they aren't carrying much more than a U2 battery, which would leave most lasers looking a bit wooden. Maybe they're not lasers at all, but small tape machines containing recordings of Ella Fitzgerald.

Be that as it may, the laser has most certainly now reached the stage where it can be applied to a whole heap of problems looking for a solution, to reverse the 1960s *mot*. It may have been one of the first devices to be developed with no clear application ready and waiting for it, and it was several years before industry and the military caught up with it. The time it takes for new kinds of hardware to be developed and adopted gets longer all the time; for instance, teletext and Viewdata have been working for some years now, but they haven't exactly revolutionized our way of life – yet.

On that basis, anyone considering coming out with something spectacular in AD 2001 had better be thinking about starting now, and I would like to place an order for a disintegrator. When I do get one, the first Traffic Warden to put a foot wrong is in for one heck of a surprise.

High Q—low impedance

AFTER EVERY EXHIBITION, the organizers send out to publications such as *Wireless World* a quantity of paper containing remarks solicited from exhibitors on their opinion of the exhibition. Almost invariably, these people enthuse on the number of sales they have made, the interest their wares have provoked and say they'll be back next time. Well, they're hardly likely to say otherwise, or their remarks would be instantly expunged from the record, but one comment that is a constant source of irritation to my non-commercial soul is to do with the "quality" of the visitors.

Future perfect

A young engineer, name of Cholmondeley
turned in his slide-rule, quite glolmondeley.
With each new advance
he'd lost one more chance.
A machine now does Cholmondeley's job, dolmondeley.

What on earth do they mean? Is it something to do with the way they hold their knives and forks, or the authority with which they can say "rindabite" instead of "roundabout"? I hadn't really thought much about it before, but I now realize, with a chill of horror, that all those smooth, immaculate young men on the stands aren't salesmen at all. They're not interested in showing you the new switches, knobs and i.c.s on display. Not a bit of it! What they're doing, in a polite and insidious way, is assessing your quality. One faux pas, such as asking one of them if he's got a light, or requesting directions to the nearest bar, means instant relegation to the masses — the great unwashed, so to speak. On the other hand, if you address the gua . . . salesman, in carefully modulated tones suggestive of the possession of bright blue blood and a thick bank balance, fingers will snap, eyelids will droop and you will be ushered into one of those little closed rooms where the whisky flows like water and the real business is done. You still have to be careful, of course: drop your guard for a second and ask for a half of brown ale and out you go.

I don't know what's going to happen, now I've been able to reveal all this. It could be that we are going to have to re-think our whole approach to this business of exhibitions. Probably the best way to tackle the problem of getting into the sancti is to confuse them. You could turn up on the stand in a top hat, wet suit and clogs and launch into a discussion of anomalous waveguide propagation at sub-zero frequencies and baffle the pin-stripe so effectively that he'd call for help As soon as the faceless ones turn up, you then ask how soon they can supply five million of whatever they're selling and you're in.

I'll put in more thought on this problem and let you know my decision in a future issue. Quality, indeed!

Who dat up dere?

An experiment which stands about as much chance of success as a donkey in the Derby, in which the investigators aren't altogether sure that they would recognize success if it licked their noses, seems like a good way of spending one's time. It beats working down the pit, at least.

In 1976, all those labouring to keep body and soul together will be glad to learn, the CCIR adopted the line of research called SETI which, being interpreted, means Search for Extra-Terrestrial Intelligence. This, of course, implies that we already have terrestrial intelligence—a hypothesis which seems increasingly unlikely. Unfettered by any sense of the ridiculous, many clever scientists and engineers have, however, already been listening for about seventeen years and actually sending signals for over three. There have been one or two transient excitements, which turned out to be natural events, but no-one has yet received the Big Hello.

I'm not going to stick my neck out too far and say that all these people are wasting their time, because with my luck we would immediately be knee-deep in very small green men wanting to be taken to Jim Callaghan. But I cannot, try as I may, see the point of trying to conduct an extremely desultory conversation with someone whose presence or absence has not, so far, made more than a minimal impression on our lives (*pace* von Däniken). At the narrow bandwidth necessary to obtain a passable s:n ratio, the message could take years to complete and several generations to reach a possible receiver. The notion of starting a signal, expecting it to be completed by one's great^{10} grand-children is not an entirely attractive idea—funny stories would tend to lose their point, particularly if one's tenth descendant were to be run over by a bus just as he was within a few decades of the punch-line.

I am well aware of all the "because it is there" class of argument, but a leaning towards the pragmatic leads me to the feeling that resources could, perhaps, be deployed in a rather more immediately productive way.

The ITU, in a recent press handout on this subject, expresses the hope that the discovery of life elsewhere would make us all terrified of instant annihilation and clasp each other to our bosoms in a mutually protective embrace. Well, if that were even remotely probable, I would be all for the project, but a twinge of doubt may, on the basis of the last few thousand years of human history, be understandable.

WW—064 FOR FURTHER DETAILS

The Celestion sound... hand-made to perfection.

Rola Celestion Limited,
Ditton Works, Foxhall Road, Ipswich, Suffolk, England.
Tel: 0473-73131.

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TCT10

Lightweight, portable, Telegdata TCT10 makes light work of on-site circuits and machines.

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Powered from the a.c. mains supply, the TCT10 gives a choice of output levels and test signals in CCITT No 2 and No 5 alphabets including the full 96 character 'fox' message, Q9S and any single character on demand.

Accurate readout (to 1%) is given unambiguously on an LED scale registering up to 40% distortion early/mark bias and late/space bias.

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PLESSEY
CONTROLS

WW—093 FOR FURTHER DETAILS

(R) 600-2-224

NEW PRODUCTS!

NRDC-AMBISONIC UHJ

SURROUND SOUND DECODER

The **first ever** kit specialy produced by Integrex for this British NRDC backed surround sound system which is the result of 7 years' research by the Ambisonic team. W.W. July, Aug., '77.
The unit is designed to decode not only UHJ but virtually all other 'quadrophonic' systems (Not CD4), including the new BBC HJ 10 input selections.
The decoder is linear throughout and does not rely on listener fatiguing logic enhancement techniques. Both 2 or 3 input signals and 4 or 6 output signals are provided in this most versatile unit. Complete with mains power supply, wooden cabinet, panel, knobs, etc.

Complete kit, including licence fee **£45.00** + VAT
or ready built and tested **£61.50** + VAT

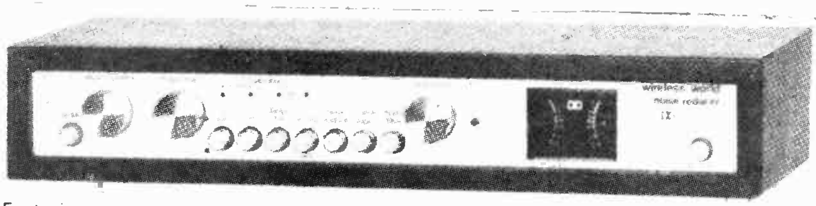
INTRUDER 1 RADAR ALARM

With Home Office Type approval
As in "Wireless World", designed by Mike Hosking. 240V ac mains operated and disguised as a hardbacked book. Detection range up to 30 feet.

Complete exclusive designer approved kit **£46.00** + VAT
or ready built and tested, **£54.00** + VAT

Wireless World Dolby(TM) noise reducer

Trademark of Dolby Laboratories Inc.



Typical performance
Noise reduction better than 9dB weighted.
Clipping level 16.5dB above Dolby level (measured at 1% third harmonic content)

Harmonic distortion 0.1% at Dolby level typically 0.05% over most of band, rising to a maximum of 0.12%

Signal-to-noise ratio: 75dB (20Hz to 20kHz, signal at Dolby level) at Monitor output

Dynamic Range >90db

30mV sensitivity

Featuring:
- switching for both encoding (low-level h.f. compression) and decoding
- a switchable f.m. stereo multiplex and bias filter
- provision for decoding Dolby f.m. radio transmissions (as in USA)
- no equipment needed for alignment
- suitability for both open-reel and cassette tape machines
- check tape switch for encoded monitoring in three-head machines

Complete Kit **PRICE: £39.90** + VAT

Also available ready built and tested .... **Price £54.00** + VAT

Calibration tapes are available for open-reel use and for cassette (specify which) .... **Price £2.20** + VAT *

Single channel plug-in Dolby(TM) PROCESSOR BOARDS (92 x 87mm) with gold plated contacts are available with all components .... **Price £8.20** + VAT

Single channel board with selected fet .... **Price £2.50** + VAT

Gold Plated edge connector .... **Price £1.50** + VAT *

Selected FETs **60p** each + VAT, **100p** + VAT for two, **£1.90** + VAT for four

Please add VAT @ 12½% unless marked thus*, when 8% applies (or current rates)

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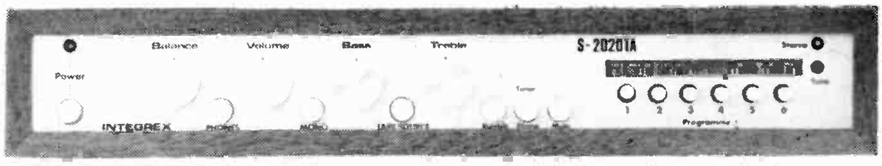
S-2020TA STEREO TUNER/AMPLIFIER KIT

SOLID MAHOGANY CABINET



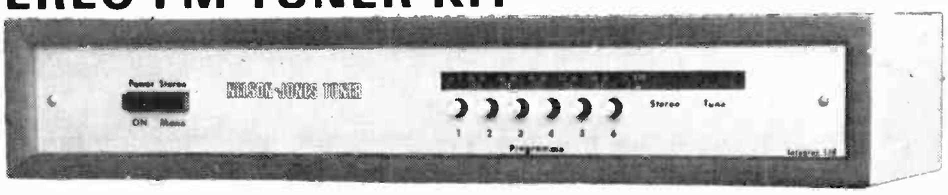
A high-quality push-button FM Varicap Stereo Tuner combined with a 24W r.m.s. per channel Stereo Amplifier.

Brief Spec. Amplifier Low field Toroidal transformer, Mag. input, Tape In/Out facility (for noise reduction unit, etc.), THD less than 0.1% at 20W into 8 ohms. Power on/off FET transient protection. All sockets, fuses, etc., are PC mounted for ease of assembly. Tuner section uses 3302 FET module requiring no RF alignment, ceramic IF, INTERSTATION MUTE, and phase-locked IC stereo decoder. LED tuning and stereo indicators. Tuning range 88–104MHz. 30dB mono S/N @ 1.2μV. THD 0.3%. Pre-decoder 'birdy' filter.

PRICE: £58.95 + VAT

NELSON-JONES STEREO FM TUNER KIT

A very high performance tuner with dual gate MOSFET RF and Mixer front end, triple gang varicap tuning, and dual ceramic filter/dual IC IF amp.



Brief Spec. Tuning range 88–104MHz. 20dB mono quieting @ 0.75μV. Image rejection – 70dB. IF rejection – 85dB. THD typically 0.4%.
IC stabilized PSU and LED tuning indicators. Push-button tuning and AFC unit. Choice of either mono or stereo with a choice of stereo decoders.

Compare this spec. with tuners costing twice the price.

Mono £32.40 + VAT
With ICPL Decoder £36.67 + VAT
With Portus-Haywood Decoder £39.20 + VAT

STEREO MODULE TUNER KIT

A low-cost Stereo Tuner based on the 3302 FET RF module requiring no alignment. The IF comprises a ceramic filter and high-performance IC Variable INTERSTATION MUTE. PLL stereo decoder IC. Pre-decoder 'birdy' filter Push-button tuning

Sens. 30dB S/N mono @ 1.2μV
THD typically 0.3%
Tuning range 88–104MHz
LED sig. strength and stereo indicator

PRICE: Stereo £31.95 + VAT

S-2020A AMPLIFIER KIT

Developed in our laboratories from the highly successful "TEXAN" design. PC mounting potentiometers, switches, sockets and fuses are used for ease of assembly and to minimize wiring

Power 'on/off' FET transient protection.

Typ Spec. 24 + 24W r.m.s. into 8-ohm load at less than 0.1% THD. Mag. PU input S/N 60dB. Radio input S/N 72dB. Headphone output. Tape In/Out facility (for noise reduction unit, etc.). Toroidal mains transformer.

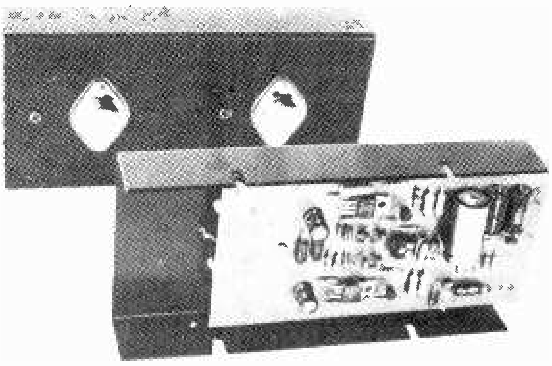
PRICE: £33.95 + VAT

ALL THE ABOVE KITS ARE SUPPLIED COMPLETE WITH ALL METALWORK, SOCKETS, FUSES, NUTS AND BOLTS, KNOBS, FRONT PANELS, SOLID MAHOGANY CABINETS AND COMPREHENSIVE INSTRUCTIONS

BASIC NELSON-JONES TUNER KIT	£14.28 + VAT	**PHASE-LOCKED IC DECODER KIT**	£4.47 + VAT
BASIC MODULE TUNER KIT (stereo)	£16.75 + VAT	**PUSH-BUTTON UNIT**	£5.00 + VAT

PORTUS-HAYWOOD PHASE-LOCKED STEREO DECODER KIT .... £8.00 + VAT

NEW FROM BI-KITS!



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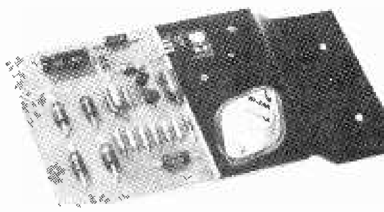
Out Power THD 1%	50 watts min.
Supply voltage Max	70 volts
Operating voltage range	50-70
Load	8-16ohms
Frequency response ± 1 db	25Hz-20KHz
Sensitivity for 50 watts into 8 ohms	500mV
Input Impedance	35K ohms
THD at all power levels up to clipping	.05% max. typically .02%
S/N ratio	100dBs
Max. ambient operational temp.	45 deg C
S/C Complement	13 transistors 3 diodes
Size overall	192 x 89 x 40mm
Weight	240 gms

FOR ONLY £11.95

+8% VAT 25p P&P



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SPM 120/65. One AL250 up to 125w **£5.95** + 12½% VAT. Please add 25p P&P to all orders.

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AL120/45 40-48v ● AL120/55 50-55v ● AL120/65 60-65v ● OUTPUT CURRENT 2 5A ● RIPPLE @ 1A 100mV ● 2A 150mV

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AL80. 35w (RMS) AMPLIFIER **£7.15** + 8% V.A.T. 25p P.&P.
AL250. 125w (RMS) AMPLIFIER **£17.25** + 8% V.A.T. 40p P.&P.
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2N697	0.31	2N3402	0.45	2N4036	0.72	2N5190	0.65	ACY17	1.00	BC171B	0.17
2N698	0.49	2N3414	0.18	2N4058	0.62	2N5210	0.38	ACY22	0.65	BC172C	0.15
2N700	0.28	2N3415	0.18	2N4059	0.17	2N5220	0.15	ACY30	0.60	BC173C	0.17
2N914	0.38	2N3416	0.21	2N4060	0.22	2N5225	0.16	AD150	3.10	BC177	0.22
2N929	0.37	2N3417	0.25	2N4061	0.19	2N5232	0.22	AD161	1.00	BC178B	0.35
2N930	0.37	2N3439	0.85	2N4062	0.20	2N5245	0.37	AD162	1.00	BC179B	0.25
2N1131	0.32	2N3441	0.92	2N4121	0.27	2N5248	0.14	AF106	0.60	BC182A	0.12
2N1303	0.80	2N3442	1.45	2N4122	0.27	2N5293	0.44	AF109	0.82	BC182L	0.15
2N1305	0.80	2N3565	0.25	2N4123	0.19	2N5294	0.44	AF114	0.70	BC183A	0.12
2N1501	0.35	2N3566	0.25	2N4124	0.19	2N5401	0.44	AF115	0.70	BC183LA	0.15
2N1613	0.30	2N3567	0.25	2N4125	0.19	2N5416	1.65	AF118	0.70	BC184	0.12
2N1637	0.72	2N3638	0.17	2N4126	0.19	2N5447	0.16	AF124	0.70	BC184L	0.15
2N1890	0.30	2N3639	0.38	2N4235	1.35	2N5448	0.16	AF139	0.75	BC205	0.17
2N1893	0.30	2N3644	0.40	2N4236	1.65	2N5449	0.20	AF200	1.30	BC212A	0.15
2N1991	1.10	2N3662	0.25	2N4237	1.65	2N5457	0.35	AF201	1.30	BC212LA	0.13
2N2193	0.50	2N3663	0.29	2N4240	1.70	2N5458	0.35	AF239	0.70	BC213B	0.15
2N2194	0.42	2N3702	0.14	2N4250	0.26	2N5555	0.65	AF240	1.25	BC213LA	0.17
2N2217	0.55	2N3703	0.14	2N4266	0.32	2N6109	0.55	AF279	0.88	BC214	0.17
2N2218	0.35	2N3704	0.14	2N4284	0.38	2N6122	0.44	AF280	0.95	BC214L	0.18
2N2219	0.38	2N3705	0.14	2N4286	0.32	2N6123	0.48	ASY28	1.30	BC237B	0.15
2N2221	0.25	2N3706	0.14	2N4287	0.22	2N6124	0.45	ASY55	0.70	BC238B	0.13
2N2222	0.25	2N3707	0.14	2N4288	0.22	2N6125	0.47	BC107	0.15	BC239C	0.17
2N2270	0.49	2N3708	0.12	2N4292	0.27	2N6288	0.50	BC108	0.15	BC256A	0.29
2N2368	0.27	2N3709	0.12	2N4302	0.31	2S702	3.30	BC109	0.16	BC257A	0.18
2N2369	0.27	2N3710	0.12	2N4303	0.33	2S703	3.95	BC113	0.22	BC258B	0.24
2N2483	0.30	2N3711	0.12	2N4342	0.60	40232	0.60	BC114	0.22	BC259B	0.19
2N2613	0.90	2N3712	1.39	2N4401	0.20	40311	0.55	BC115	0.22	BC261A	0.25
2N2646	0.80	2N3714	1.55	2N4402	0.20	40316	0.95	BC116	0.21	BC262B	0.26
2N2848	1.10	2N3716	1.70	2N4403	0.20	40363	1.45	BC118	0.22	BC263B	0.28
2N2904	0.31	2N3794	0.21	2N4822	0.83	40389	0.70	BC135	0.22	BC264B	0.65
2N2905	0.31	2N3819	0.36	2N4870L	0.58	40408	0.82	BC136	0.21	BC307B	0.16
2N2906	0.25	2N3820	0.39	2N4871L	0.51	40440	0.70	BC137	0.22	BC308B	0.16
2N2907	0.25	2N3821	0.95	2N4898	1.55	40512	1.70	BC138	0.44	BC309C	0.16
2N2923	0.17	2N3827	0.27	2N4901	1.65	40594	0.87	BC140	0.30	BC327	0.22
2N2924	0.17	2N3854A	0.30	2N4902	2.20	40595	0.98	BC141	0.32	BC328	0.20
2N2925	0.19	2N3855	0.30	2N4903	2.75	40573	0.80	BC142	0.32	BC337	0.20
2N3011	0.37	2N3856A	0.19	2N4904	1.85	AC126	0.48	BC147	0.13	BC414	0.17
2N3020	0.75	2N3858A	0.20	2N4905	2.40	AC127	0.48	BC148	0.15	BC415	0.16
2N3053	0.25	2N3859A	0.22	2N4920	0.83	AC128	0.48	BC149	0.15	BC416	0.17
2N3054	0.72	2N3860	0.18	2N5086	0.30	AC151	0.43	BC153	0.30	BC547A	0.13
2N3055	0.75	2N3866	1.98	2N5087	0.30	AC152	0.54	BC154	0.30	BC547B	0.13
2N3108	0.75	2N3901	0.30	2N5088	0.30	AC153	0.59	BC157A	0.15	BC548	0.13
2N3133	0.50	2N3904	0.18	2N5089	0.30	AC153K	0.59	BC158B	0.15	BC549B	0.14
2N3242	0.68	2N3905	0.18	2N5129	0.62	AC176	0.54	BC159B	0.17	BC558	0.13
2N3250	0.35	2N3906	0.18	2N5130	0.22	AC176K	0.90	BC160	0.33	BC559	0.15
2N3301	0.45	2N3962	0.95	2N5131	0.22	AC187	0.50	BC167B	0.13	BCY54	2.40
2N3302	0.39	2N4031	0.55	2N5137	0.22	AC187K	0.65	BC168B	0.13	BCY56	0.27
2N3392	0.17	2N4032	0.65	2N5143	0.22	AC188	0.54	BC169B	0.13	BCY70	0.21
2N3394	0.17	2N4033	0.65	2N5180	0.58	AC188K	0.65	BC170B	0.19	BCY71	0.26
2N3397	0.19									BCY72	0.18

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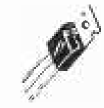

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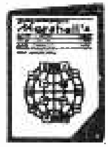

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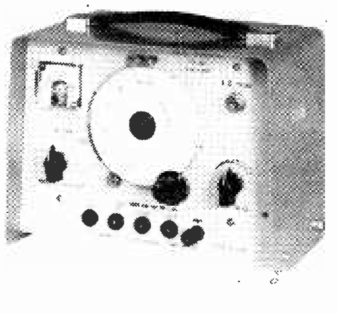

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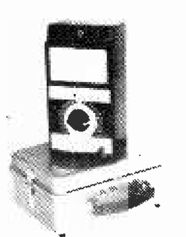

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Sensitivity A.C.	2,000 o.p.v.	2,000 o.p.v.
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6AL5	0.40	12BE6	0.80
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6GK6	0.90	ECC84	0.60
6J4	1.20	ECC85	0.48

ECC88	0.75	EF41	0.75
ECC89	0.80	EF80	0.40
ECC189	0.80	EF85	0.48
ECF80	0.60	EF86	0.60
ECF82	0.55	EF97	0.70
ECF86	0.80	EF98	0.90
ECF200	0.90	EF183	0.70
ECF201	0.90	EF184	0.70
ECF801	0.95	EFL200	1.20
ECF802	0.95	EL36	0.95
ECH42	1.10	EL41	0.80
ECH81	0.55	EL81	0.65
ECH83	0.60	EL82	0.60
ECH84	0.55	EL83	0.60
ECH200	0.80	EL84	0.45
ECL80	0.60	EL86	0.75
ECL81	0.75	EL95	0.70
ECL82	0.60	EL504	0.80
ECL83	1.15	EM80	0.65
ECL84	0.70	EM81	0.60
ECL85	0.65	EM83	0.50
ECL86	0.85	EM84	0.60

All prices are exclusive of VAT (12½%)

EY51	0.60	PL508	1.30
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EZ81	0.50	PY81	0.70
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PC97	0.95	UABC80	0.58
PC900	1.00	UAF41	0.80
PCC84	0.50	UAF42	0.70
PCC85	0.60	UBC41	0.70
PCC89	0.75	UBC81	0.60
PCC189	1.00	UBF80	0.60
PCF80	0.65	UBF89	0.60
PCF82	0.45	UCC84	0.75
PCF84	0.65	UCC85	0.55
PCF86	0.75	UCF80	0.75
PCF201	1.10	UCH81	0.65
PCL81	0.65	UCL81	0.70
PCL82	0.80	UCL82	0.75
PCL84	0.75	UCL83	0.80
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PCL805	0.75	UF80	0.50
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When ordering by post please add (unless otherwise indicated) 30p in £ for packing and postage, plus appropriate rate of VAT

Minimum order charge for approved credit customers is £20 00 Any order below £20.00 (before VAT) should be accompanied by remittance

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Our new 1978 Catalogue is now ready. Please send P O or stamps for 30p for your copy

THE NEWBEAR COMPUTING STORE

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- ★ 110 to 1200 band V24
- ★ 64ch x 16 line, scrolling
- ★ All on 8" x 4" pcb

Needs TV set, UHF modulator and ASCII keyboard

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MC6800P	£9.26	SWATBUG	£16.00
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75154	£2.50		8T26	£1.84
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74LS04	.26	74LS38	.30	74LS125	.50
74LS05	.26	74LS40	.27	74LS126	.50
74LS08	.21	74LS42	.88	74LS132	.85
74LS09	.21	74LS47	.96	74LS136	.38
74LS10	.21	74LS48	.96	74LS138	.65
74LS11	.26	74LS51	.21	74LS139	.65
74LS12	.21	74LS54	.21	74LS151	.96
74LS13	.55	74LS55	.21	74LS153	.58
74LS14	£1.26	74LS73	.34	74LS154	£1.45
74LS15	.21	74LS74	.38	74LS155	£1.05
74LS20	.21	74LS75	.55	74LS156	£1.05
74LS21	.26	74LS76	.34	74LS157	.60
74LS22	.21	74LS78	.34	74LS158	.65
74LS26	.31	74LS83	£1.05	74LS160	£1.22
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74LS28	.40	74LS107	.38		

NEW RANGE OF LOW COST S100 8K RAM BOARDS, PCBs, ETC . . . PLEASE SEND FOR LATEST LIST.

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6	77-68 Mon 1 P C B and components	£50.70
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9	Petitevid V D U Kit	£85.00
10	Kansas City Cassette Interface	£18.95
11	U H F modulator	£4.50

Available direct from us or from your local Bear Bag Stockist (dealer enquiries welcome)

77-68 Corner

(The 6800 Microprocessor that works!)

77-68 Manual (PP50p) £7.50

Veroboard 8 x 8 £4.10

PRINTED CIRCUIT BOARDS

CPU	£10.00
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ROM Monitor	T.B.A.
Veroboard 8 x 8	£4.10
Veroboard backplane 8 × 17	£4.30
Hexadecimal Keyboards	£11.25
FND 500 7 segment display	£1.05
Decoder chip	£2.45
ASCII Keyboard (unencoded)	£27.50
Keyboard assembled and tested	£86.00
Keyboard case	£20.33

Goods are normally shipped within 24 hours, subject to availability. Barclaycard & Access. VAT at 8% for Hardware Components 30p postage and packing unless otherwise stated Cheques to be made out to "The Newbear Computing Store". Send for an up-to-date catalogue to The Newbear Computing Store, 7 Bone Lane, Newbury 0635-49223 Callers are welcome Monday to Saturday 9.00 a.m -5.30 p m , but please ring to let us know when you are calling.

AUDIO KITS OF DISTINCTION FROM POWERTRAN

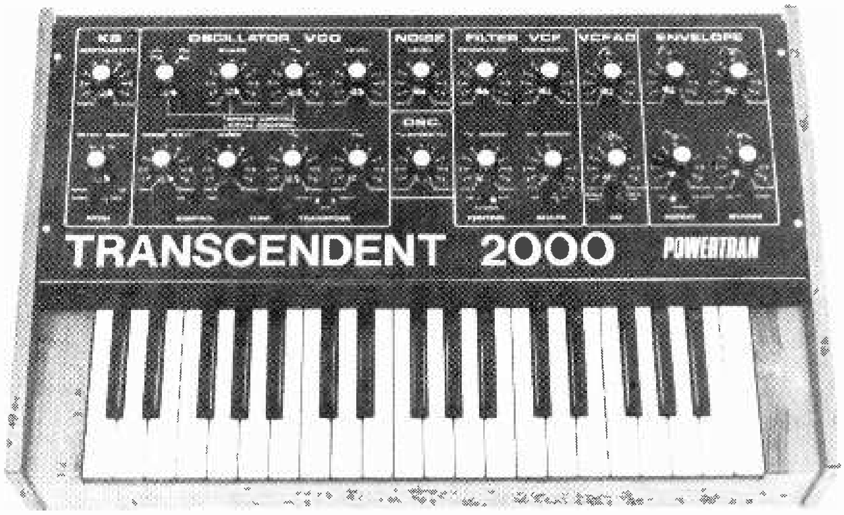
NEW! TRANSCENDENT 2000

SINGLE BOARD SYNTHESIZER

As featured in Electronics Today International (July, August 1978)

Live performance synthesizer designed by consultant Tim Orr (formerly synthesizer designer for EMS Ltd) and featured as a constructional article in Electronics Today International the TRANSCENDENT 2000 is a 3 octave instrument transposable 2 octaves up or down with portamento pitch bending a VCO with shape modulation a versatile VCF with both low and high pass outputs and a separate dynamic sweep control, a noise generator and an ADSR envelope shaper There is also a slow oscillator and a new pitch detector amongst its many features

Kit includes fully finished metalwork solid teak cabinet and really is complete — right down to the last nut and bolt! Virtually everything is on one circuit board and construction is so simple it can be built easily in a few evenings by almost anyone capable of neat soldering! When finished you will possess a synthesizer comparable in performance and quality with ready built units selling for between £500 and £700!



INTRODUCTORY OFFER

£172!

until July 30th 1978

INTERNATIONAL POWERSLAVE 200 + 200 watt AMPLIFIER

As featured in Electronics Today International

400W rms continuous — 800W peak!
0.03% THD at FULL power!
PLUS all the following features too!

* Each channel totally independent with its own stabilised power supply driven by custom designed TOROIDAL transformers!
* Inherent reliability — monster heat sinks for cool running at the hottest venues — electronic open and short circuit protection!
* Ultra low feedback (an incredible low 14dB overall!) super high slewing rate (20V/μs) 200W rms continuous to 4 ohm from EACH channel input sensitivity 0 775V (0dB)
* Professional quality components sturdy 19 rack mounting chassis complete with sleeve and feet for free standing work too
* Easy to build — plenty of working space with ready access to all components minimal wiring extensive instruction suitable for both experienced constructors and newcomers to electronics
* Value for money — quality and performance comparable with ready-built amplifiers costing over £600!

Pack		Price
1.	Fibre glass printed circuit board for power amp	£4.20
2.	Set of capacitors, metal oxide resistors, thermistor, cormet pre-sets for power amp	£6.40
3.	Set of semiconductors for power and with mounting hardware, cooling tabs	£27.60
4.	Pair of monster black drilled heat sinks, transistor mounting bracket	£6.90
5.	Toroidal transformer, Primary 0-117V-234V, Secondaries 42-0-42V, 0-15V, 0-15V, Electrostatic screen	£19.20
6.	Set of all parts for stabilized power supply including fibre glass printed circuit board, mounting bracket, semiconductors, resistors, capacitors, etc	£20.50
7A.	Set of all parts for buffer/overdrive unit including fibre glass printed circuit board, semiconductors, resistors, capacitors, controls — required for PSI 4001 only	£3.80
78.	Set of parts for peak power meter including professional quality meter, fibre glass printed circuit board, components, controls — required for PSI 4002 only	£11.50
8.	Set of all miscellaneous parts including sockets, illum. mains switches, fuse holders, fuses, cut-outs, cable, etc	£12.10
9.	Cabinet, including chassis, anodised silver on black panels, fixing parts, etc. Please state whether Slave or Studio model required	£27.50
10.	Handbook £0.50 or free on request when ordering any of above packs.	

2 each of packs 1-7 (A or 8), 1 each 8, 9 and 10 are required for complete 200 + 200W professional amplifier.

Total cost of individually purchased packs — PS1 4001 £216.80; PS1 4002 £232.20

PSI 4001 SLAVE MODEL

★ ★

SPECIAL PRICES FOR COMPLETE KITS!

PS1 4001—£205.00

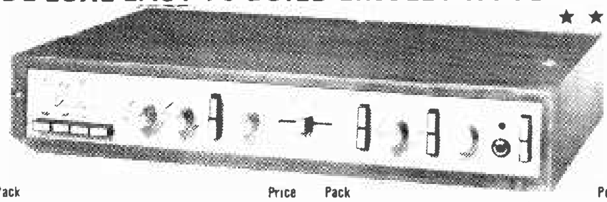
PS1 4002—£220.00

PSI 4002 STUDIO MODEL

★ ★

DE LUXE EASY TO BUILD LINSLEY-HOOD 75W AMPLIFIER

★ ★



AVAILABLE AS SEPARATE PACKS
PRICES IN OUR FREE CATALOGUE

SPECIAL PRICE FOR COMPLETE KIT £99.30

The standard model of our kit for Mr Linsley Hood s 75 watt design has for a long time offered exceptional performance at a very modest cost with high quality high power ready built units of comparable quality generally being over three times the price

Features of the amplifier include very low distortion (less than 0 01 %) 75W rms per channel power output rumble filter variable slope scratch filter variable transition frequency tone controls tape monitoring facilities and individually adjustable inputs This model is based on 5 circuit boards which not having the controls mounted on them can if desired be effectively used separately in high performance audio systems not based on our metalwork

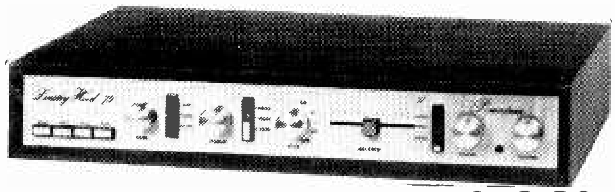
Our new De Luxe model uses 14 boards which interconnect with gold plated contacts and are designed to have the potentiometers and switches mounted upon them This system almost eliminates internal wiring making installation after their assembly delightfully straightforward and as each board can be easily removed in seconds from the chassis checking and maintenance is so simple that even newcomers to electronics will be able to cope competently with the kit Additional features of our new model are inclusion of the latest circuit improvements generously sized heat sinks for heavy duty use even in tropical climates and metal oxide resistors throughout for long term stability and reliability

Pack		Price
1	Fibreglass printed circuit board for power amp	£1 15
2.	Set of resistors, capacitors, pre-sets for power amp	£2.50
3.	Set of semiconductors for power amp	£6.50
4.	Pair of 2 drilled, finned heat sinks	£1.10
5.	Fibreglass printed-circuit board for pre-amp	£1.90
6.	Set of low noise resistors, capacitors, pre-sets for pre-amp	£4.10
7.	Set of low noise, high gain semiconductors for pre-amp	£2.40
8.	Set of potentiometers (including mains switch)	£3.50
9.	Set of 4 push-button switches, rotary mode switch	£5.40
10.	Toroidal transformer complete with magnetic screen/ housing primary, 0 117-234 V: secondaries: 33-0-33 V, 25-0-25 V	£12.95
11	Fibreglass printed-circuit board for power supply	£0.85
12.	Set of resistors, capacitors, secondary fuses, semiconductors for power supply	£5.40
13.	Set of miscellaneous parts including DIN skts., mains input skt., fuse holder, interconnecting cable, control knobs	£6.20
14	Set of metalwork parts including silk screen printed fascia panel and all brackets, fixing parts, etc.	£8.20
15.	Handbook	£0.30
16.	High Quality Teak Veneer cabinet 18.3" x 12.7" x 3.1"	£10.70

2 each of packs 1-7, 1 each of packs 8-16 inclusive are required for complete stereo amplifier. Total cost of individually purchased packs £92.80

PACK PRICES FOR STANDARD KIT

STANDARD LINSLEY-HOOD 75W AMPLIFIER



SPECIAL PRICE FOR COMPLETE KIT £79.80

ASCENSION ISLAND YUGOSLAVIA UNITED STATES OF AMERICA JORDAN GREECE INDIA GUYANA PORTUGAL FALKLAND ISLANDS UNITED ARAB EMIRATES JAMAICA HOLLAND KENYA

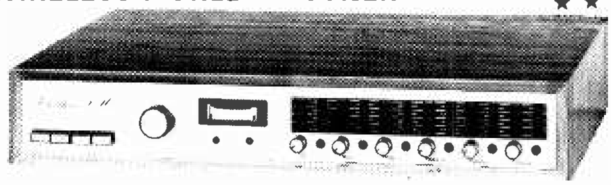
EIRE GRENADA SAUDI ARABIA NEW ZEALAND NORWAY SINGAPORE ICELAND SWEDEN MALAYA INDONESIA BRAZIL SWITZERLAND ZAMBIA GIBRALTAR CHILE SPAIN

Designed in response to demand for a tuner to complement the world-wide acclaimed Linsley-Hood 75W Amplifier, this kit provides the perfect match The Wireless World (Skingley and Thompson) published original circuit has been developed further for inclusion into this outstanding slimline unit and features a pre-aligned front end module, excellent a m rejection and temperature compensated varicap tuning, which may be controlled either continuously or by push-button pre-selection Frequencies are indicated by a frequency meter and sliding LED indicators, attached to each channel selector pre-set The PLL stereo decoder incorporates active filters for "birdy" suppression and power is supplied via a toroidal transformer and integrated regulator For long term stability metal oxide resistors are used throughout

AVAILABLE AS SEPARATE PACKS — PRICES IN OUR FREE CATALOGUE

WIRELESS WORLD FM TUNER

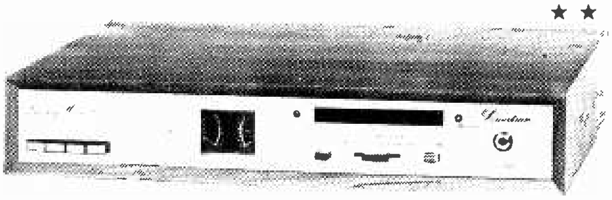
★ ★



SPECIAL PRICE FOR COMPLETE KIT £70.20

LINSLEY-HOOD CASSETTE DECK

★ ★



SPECIAL PRICE FOR COMPLETE KIT £79.60

Pack	Price
1. Stereo PCB (accommodates 2 rep. amps. 2 meter amps. bias/erase osc. relay)	£3.35
2. Stereo set of capacitors, M.O. resistors, potentiometers for above	£7.95
3. Stereo set of semiconductors for above	£8.50
4. Miniature relay with socket	£2.90
5. PCB, all components for solenoid, speed control circuits	£3.80
6. Goldring-Lenco mechanism as specified	£18.50
7. Function switch, knobs	£1.90
8. Dual VU meter with illuminating lamp	£6.95
9. Toroidal transformer with E.S. screen prim. 0-117V, 234V, Sec. 15V	£4.90
10 Set of capacitors, rectifiers, I.C. voltage regulator P.C.B. for power supply (Powertran design)	£2.80
11. Set of miscellaneous parts, including sockets, fuse holder, fuses, interconnecting wire, etc	£3.40
12. Set of metalwork including silk screened fascia panel, internal screen, fixing parts, etc	£7.10
13. Construction notes	£0.25
14. High Quality Teak Veneer cabinet 18.3" x 12.7" x 3.1"	£10.70

One each of packs 1-14 inclusive are required for complete stereo cassette deck. Total cost of individually purchased packs £83.00

Matsushita WY 436 AZ head (optional extra) . £4.50 (free with compete kit)

Published in Wireless World (May, June, August 1976) by Mr Linsley-Hood, this design, although straightforward and relatively low cost, nevertheless provides a very high standard of performance To permit circuit optimization separate record and replay amplifiers are used, the latter using a discrete component front-end designed such that the noise level is below that of the tape background. Pushbutton switches are used to provide a choice of equalization time constants, a choice of bias levels and also an option of using an additional pre-amplifier for microphone use The mechanism used is the Goldring-Lenco CRV, a unit distinguished in its robustness and ease of operation Speed control and automatic cassette ejection are both implemented by electronic circuitry This unit which is powered by a toroidal transformer and uses metal oxide resistors throughout offers an excellent match for the Wireless World Tuner and the Linsley-Hood 75 Watt Amplifier Circuit changes as published in February, 1978, follow-up article are included in the kit AT NO EXTRA COST! A higher performance head (Matsushita WY 436 AZ head as recommended in the follow-up article) is offered as an optional extra but this will be automatically supplied FREE OF CHARGE with all orders for complete kits!

T20+20 AND T30+30 20W, 30W AMPLIFIERS

★ ★

Designed by Texas engineers and described in Practical Wireless the Texan was an immediate success Now developed further in our laboratories to include a Toroidal transformer and additional improvements, the slimline T20+20 delivers 20W rms per channel of true Hi Fi at exceptionally low cost The **easy to build** design is based on a single F/Glass PCB and features all the normal facilities found on quality amplifiers including scratch and rumble filters adaptable input selector and headphones socket In a follow-up article in Practical Wireless further modifications were suggested and these have been incorporated into the T30+30 These include RF interference filters and a tape monitor facility Power output of this model is 30W rms per channel

SPECIAL PRICES FOR COMPLETE KITS

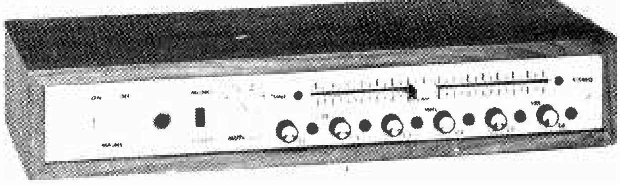
T20+20 KIT PRICE £33.10

T30+30 KIT PRICE £38.40

AVAILABLE AS SEPARATE PACKS — PRICES IN OUR FREE CATALOGUE

WWII TUNER

★ ★



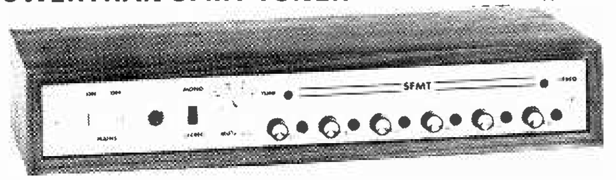
SPECIAL PRICE FOR COMPLETE KIT £47.70

AVAILABLE AS SEPARATE PACKS — PRICES IN OUR FREE CATALOGUE

Following the success of our **Wireless World FM Tuner Kit** this cost reduced model was designed to complement the **T20+20** and **T30+30** amplifiers and the cabinet size, front panel format and electrical characteristics make this tuner compatible with either

POWERTRAN SFMT TUNER

★ ★



PRICE FOR COMPLETE KIT £35.90

AVAILABLE AS COMPLETE KIT ONLY

This is a simple, low cost design which can be constructed easily without special alignment equipment but which still gives a first-class output suitable for feeding any of our very popular amplifiers or any other high quality audio equipment A phase-locked-loop is used for stereo decoding and controls include switchable afc, switchable muting and push-button channel selection (adjustable by controls on the front panel) This unit matches well with the **T20+20** and **T30+30** amplifiers.

Wireless World Designs: Full kits are not available for the projects below but PCBs and component sets are stocked Further details of these and other packs are in our Free Catalogue

30W Bailey Amplifier

BAIL Pk 1	F Glass PCB	£1.00
BAIL Pk 2	Resistors Capacitors	£2.35
BAIL Pk 3	Semiconductors	£4.70

Bailey Burrows Stereo Pre-Amp.

BBPA Pk 1	F/Glass PCB (stereo)	£2.80
BBPA Pk 2	Resistor capacitors (stereo)	£6.70
BBPA Pk 3R	Rotary potentiometers (stereo)	£2.85
BBPA Pk 4R	Rotary switches (stereo)	£3.60

Linsley-Hood Low Distortion Oscillator.

LDO Pk 1	Fibreglass PCB	£1.65
LDO Pk 2	M O Resistors capacitors	£2.60
LDO Pk 3	Semiconductors	£3.90

Regulated Power Supply for Bailey Amplifier

60VS Pk 1	F Glass PCB	£0.85
60VS Pk 2	Resistors Capacitors	£2.20
60VS Pk 3	Semiconductors	£3.10
60VS Pk 6A	Toroidal transformer	£8.80

Stuart Tape Recorder

TRRC Pk 1	Replay Amp F G PCB (stereo)	£1.30
TRRC Pk 1	Record Amp F G PCB (stereo)	£1.70
TROS Pk 1	Bias Erase F G PCB (stereo)	£1.20

E. F. Taylor Pre-Amplifier

EFTP Pk 1	Fibreglass PCB (stereo)	£1.45
EFTP Pk 2	M O Res caps (stereo)	£3.20
EFTP Pk 3	Semiconductors (stereo)	£4.20

NEW! Improved stereo decoder (as described in April 1978 W W) F/Glass PCB, M O Res, Caps, Cermet pre-sets, IC, IC socket, **£6.30**

SQ QUADRAPHONIC DECODERS

These state-of-the-art circuits described by CBS are offered as kits of superior quality with close tolerance capacitors metal oxide resistors and Fibreglass PCBs designed for edge connector insertion Further information on these kits is given in our FREE CATALOGUE

M1 Basic matrix decoder	£5.90
L1 Full logic decoder	£17.20
L2A Full logic decoder with variable blend	£22.60
L3A As L2A but with high performance discrete component front end	£30.10
(or with carbon film resistors)	£25.90
SQM1-30 Decoder complete with 30W rear channel amplifiers Complete kit matches T30+30 amplifier	£40.75

EXPORT A SPECIALITY!

Our Export Department can readily despatch orders of any size to any country in the world Some of the countries to which we sent kits last year are shown in this advertisement To assist in estimating postal costs our catalogue gives the weights of all packs and kits This will be sent free on request by airmail together with our "Export Postal Guide" which gives current postage prices There is no minimum order charge Prices same as for U K customers but no Value Added Tax charged Postage charged at actual cost plus 50p documentaton and handling Please send payment with order by Bank Draft, Postal Order International Money Order or cheque drawn on an account in the U K Alternatively for orders over £500 we will accept Irrevocable Letter of Credit payable at sight in London

Value Added Tax not included in prices
UK Carriage FREE

SERVICING FACILITIES: Available for all ★★ complete kits

PRICE STABILITY: Order with confidence! Irrespective of any price changes we will honour all prices in this advertisement until August 31st 1978 if this month's advertisement is mentioned with your order Errors and VAT rate changes excluded

U.K. ORDERS: Subject to 12½% * surcharge for VAT (i e add ⅛ to the price) No charge is made for carriage *or current rate if charged

SECURICOR DELIVERY: For this optional service (U K mainland only) add £2 50 (VAT inclusive) per kit

SALES COUNTER: If you prefer to collect your kit from the factory, call at Sales Counter (at rear of factory) Open 9 a m -4 30 p m Monday-Thursday

QUALITY: All components are brand new first grade full specification guaranteed devices All resistors (except where stated as metal oxide) are low noise carbon film types All printed circuit boards are fibreglass, drilled roller tinned and supplied with circuit diagrams and construction layouts

FOR FURTHER INFORMATION PLEASE WRITE OR TELEPHONE FOR OUR FREE CATALOGUE

DEPT. WW7

POWERTRAN ELECTRONICS

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ANDOVER HANTS SP10 3NN (0264) 64455

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VALVES

Minimum Order £1.00

A1065	1.25
AR8	0.60
ARP3	0.60
ATP4	0.50
B12H	3.00
DAF96	0.60
DET22	19.50
DF96	0.60
DK96	0.80
DL92	0.50
DY86/87	0.55
DY802	0.55
E55L	7.50
E88CC/01	1.30
E180CC	1.30
EC180E	6.00
E182CC	3.50
EA76	2.00
EABC80	0.50
EB91	0.40
EBC33	0.50
EBF80	0.50
EBF83	0.50
EBF89	0.50
EC52	0.40
ECC81	0.55
ECC82	0.50
ECC83	1.15
ECC84	0.45
ECC85	0.50
ECC86	1.25
ECC88	0.60
ECC189	0.80
ECF80	0.50
ECF82	0.45
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ECH34	0.95
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EL86	0.70
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PCF86	0.65
PCF200	0.90
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PCF801	0.55
PCF802	0.65
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PCF806	0.85
PCF808	1.00
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PL83	0.50
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6BR7	2.30
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6SG7	0.75
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6SJ7GT	0.50
6SK7	0.60
6SL7GT	0.75
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6SQ7	0.75
6V6GT	0.75
6X4	0.60
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9D2	0.60
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11E2	11.00
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12AT7	0.55
12AU7	0.50
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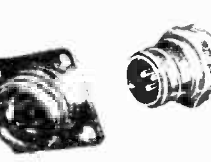

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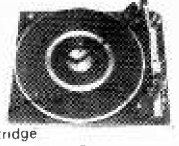

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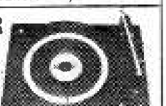

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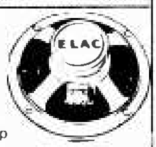

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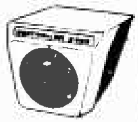

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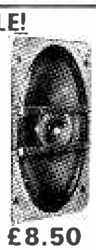

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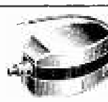

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HEATED TRANS 6.3V ½ amp	£1.00
Ditto 3 amp	£1.75

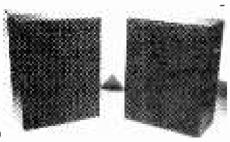
GENERAL PURPOSE LOW VOLTAGE. Tapped outputs

2 amp 3 4 5 6 8 9 10 12 15 18 25 and 30V	£5.30
1 amp 6 8 10 12 16 18 20 24 30 36 40 48 60	£5.30
2 amp 6 8 10 12 16 18 20 24 30 36 40 48 60	£8.50
3 amp 6 8 10 12 16 18 20 24 30 36 40 48 60	£11.00
5 amp 6 8 10 12 16 18 20 24 30 36 40 48 60	£14.50

12V 100mA	£1.00	20V 40V 60V 1 amp	£3.50
12V 750mA	£1.30	12V 300mA	£1.00
20V 3 amp	£2.45	10V 30V 40V 2 amp	£2.75
30V 5 amp and 17V-0-17V 2 amp	£3.45	40V 2 amp	£2.95
		20V 1 amp	£2.20
0 5 8 10 16V ½ amp	£1.95	20V-0-20V 1 amp	£2.95
9V 3 amp	£2.75	30V-0-30v 2 amp	£7.00
24V 3 amp + 48V ½ amp	£3.50	2 of 18V 6 amp	£9.00
30V 2 amp	£3.00	12-0-12V 2 amp	£2.95
30V 1½ amp	£2.75	9V ¼ amp	£1.30

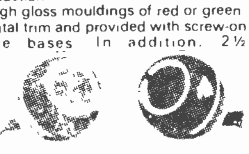
AUTO TRANSFORMERS 115V to 230V or 230V to 115V 150W **£5.00**
250W **£6.00.** 400W **£7.00** 500W **£8.00**
FULL WAVE BRIDGE CHARGER RECTIFIERS
6 or 12V outputs 2 amp **75p.** 4 amp **£1.25**
CHARGER TRANSFORMERS 1½ amp **£3.50**
4 amp **£6.80**
12V 1½ amp Half Wave Selenium Rectifier **25p**

BOOKSHELF SPEAKERS



Teak or White. 13 × 10 × 6in approx. 50 to 14,000 cps. 10 watts rms. 4 ohms.
£16 pair Post £1.30

EXTENSION SPEAKERS £3.95 ea.
These little marvels of modern sound reproduction are ideally suited for today's domestic audio set-up. Two of these smart spheres, each with 5 watt deep throated ceramic magnets, will produce superb stereo reproduction.
The globe shaped cases in high gloss mouldings of red or green are finished with chrome frontal trim and provided with screw-on rubber inset protective bases. In addition, 2½ metres of twin lead already fitted with phono plug is supplied.
Full Range Frequency Response. Impedance 8 ohms. Power Peak 5 watts.



LOW VOLTAGE ELECTROLYTICS
1, 2, 4, 5, 8, 16, 25, 30, 50, 100, 200mF 15V **10p.**
500mF 12V **15p;** 25V **20p;** 50V **30p;**
1000mF 12V **17p;** 25V **35p;** 50V **47p;** 100V **70p.**
2000mF 6V **25p;** 25V **42p;** 420mF/500V **£1.30.**
2500mF 50V **62p;** 3000mF 25V **47p;** 50V **65p.**
3900mF 100V **£1.60.** 4700mF 63V **£1.20.** 2700mF/76V **£1.**
5000mF 6V **25p;** 12V **42p;** 35V **85p.** 5600mF/76V **£1.75**
MANY OTHER ELECTROLYTICS IN STOCK
SHORT WAVE 100pF air spaced gangable tuner, **95p.**
TRIMMERS 10pF 30pF, 50pF, **5p.** 100pF, 150pF, **15p.**
CERAMIC, 1pF to 0.01mF, **5p.** Silver Mica 2 to 5000pF **5p.**
PAPER 350V-0.1 **7p;** 0.5 **13p;** 1mF 150V **20p;** 2mF 150V **20p;** 500V-0.001 to 0.05 **12p;** 0.1 **15p;** 0.25 **25p;** 0.47 **35p.**
MICRO SWITCH SINGLE POLE CHANGEOVER 20p.
SUB-MIN MICRO SWITCH, 25p. Single pole change over.
TWIN GANG, 385 + 385pF **50p;** 500pF standard **75p.**
365 + 365 + 25 + 25pF. Slow motion drive **65p.**
120pF **TWIN GANG, 50p;** 365pF **TWIN GANG, 50p.**
NEON PANEL INDICATORS 250V. Amber or red **30p.**
RESISTORS. 10Ω to 10M ¼W ½W 1W, 20% **2p;** 2W **10p.**
HIGH STABILITY. ½W 2% 10 ohms to 1 meg. **12p.**
Ditto 5%. Preferred values 10 ohms to 10 meg. **5p.**

ELECTRO MAGNETIC PENDULUM MECHANISM
1.5V d.c. operation over 300 hours continuous on SP2 battery, fully adjustable swing and speed. Ideal displays, teaching electro magnetism or for metronome, strobe, etc. **95p** Post 30p

BAKER MAJOR 12" £16.88
Post £1.00

30-14,500 c/s, 12in double cone woofer and tweeter cone together with a BAKER ceramic magnet assembly having a flux density of 14,000 gauss and a total flux of 145,000 Maxwells. Bass resonance 40 c/s. Rated 25W. NOTE: 4 or 8 or 16 ohms must be stated.

Module kit 30-17,000 c/s with tweeter crossover, baffle and instructions. **£20.52** Post £1.60 each
Please state 4 or 8 or 16 ohms

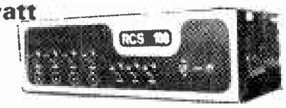
BAKER "BIG-SOUND" SPEAKERS. Post £1.00 each

'Group 25'	'Group 35'	'Group 50/15'
12in 30W **£12.96**	12in 40W **£15.12**	15in 75W **£28.08**
4 or 8 or 16 ohm	4 or 8 or 16 ohm	8 or 16 ohm

BAKER LOUDSPEAKER, 12 INCH, 60 WATT.
GROUP 50/12, 4 OR 8 OR 16 OHM HIGH POWER. FULL RANGE PROFESSIONAL QUALITY. RESPONSE 30-16,000 CPS. MASSIVE CERAMIC MAGNET. WITH ALUMINIUM PRESENCE CENTRE DOME. **£22.68** Post £1.60

TEAK VENEERED HI-FI SPEAKERS AND CABINETS
For 12in or 10in speaker 20x13x12in **£14.50** Post £2
For 13x8in or 8in speaker **£8.50** Post £1
For 6½in speaker and tweeter 12x8x6in **£5.95** Post 75p
Many other cabinets in stock. Phone your requirements.
SPEAKER COVERING MATERIALS. Samples Large S.A.E.
LOUDSPEAKER CABINET WADDING 18in wide **20p** ft

R.C.S. 100 watt VALVE AMPLIFIER CHASSIS

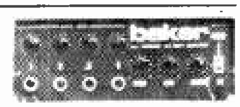


Four inputs. Four way mixing master volume, treble and bass controls. Suits all speakers. This professional quality amplifier chassis is suitable for all groups, disco, P.A., where high quality power is required. 5 speaker outputs. A/C mains operated. Slave output socket. Produced by demand for a quality valve amplifier. 100V line output to order. Send for leaflet.
Suitable carrying cab **£16.50**. Price **£94** carr. £2.50

Horn tweeters 2-16kc/s 10W 8 ohm or 16 ohm **£3.60.**
Audax Tweeters 3-18kc/s 50W 8 ohm **£7.50.**
CROSSOVERS. TWO-WAY 3000 c/s 3 or 8 or 15 ohm **£1.90.** 3-way 950 cps/3000 cps. **£2.20.**
LOUDSPEAKERS P.M. 3 OHM 7x4in **£1.50;** 6½in **£1.80;** 8x5in **£1.90;** 8in **£1.95.**
SPECIAL OFFER: 80 ohm 2¼in, 2¾in 35 ohm, 3in 25 ohm 2½in 3in, 5x3in 7x4in, 8 ohm 2½in, 3in, 3½in, 5in, 15 ohm 3½in dia 6x4in, 7x4in, 5x3in, 3 ohm, 2½in 2⅝in, 3½in, 5in dia **£1.50 each.**
PHILIPS LOUDSPEAKER, 8in, 4 ohms, 4 watts, **£1.95**
RICHARD ALLAN TWIN CONE LOUDSPEAKERS
8in diameter 4W **£2.50.** 10in diameter 5W **£2.95;** 12in diameter 6W **£3.50.** 3/8/15 ohms, please state.
MOTOROLA PIEZO ELECTRIC HORN TWEETER. £7.95
Handles up to 100 watts. No crossover required.

Black Plastic Construction Box with brushed aluminium facia. Sturdy job. Size 6¼ x 4¾ x 2in **£1.50**

BAKER 150 WATT PROFESSIONAL MIXER AMPLIFIER



All purpose transistorised. Ideal for Groups, Disco and P.A. 4 inputs speech and music. 4 way mixing. Output 4-8/16 ohms a.c. Mains. Separate treble and bass controls. Master volume control. Guaranteed. Details S.A.E. **£79** £1.50 carr.

100 WATT DISCO AMPLIFIER
volume, treble, bass controls 500 M.V. or 1 volt input. Four loudspeaker outputs 4 to 16 ohm. All transistor. **£59**

GOODMANS COMPACT 12-INCH BASS WOOFER

Standard 12in diameter fixing with cut sides 10⅜ square. 14,000 Gauss magnet. 30 watts R.M.S. 4 ohm imp. Bass resonance = 30 c.p.s. Frequency response 30-8000 c.p.s. **£10.95 each** Post £1

ALUMINIUM HEAT SINKS. FINNED TYPE.
Sizes 6½" × 4½" × 2¼" **95p.** 6½" × 2" × 2¼" **65p.**
BALANCED TWIN RIBBON FEEDER 300 ohms. 5p yd.
JACK SOCKET Std. open-circuit 20p, closed circuit 25p;
Chrome Lead-Socket 45p. Mono or Stereo.
Phono Plugs 8p. Phono Socket 8p.
JACK PLUGS Std. Chrome 30p; Plastic 25p; 3.5mm 15p.
STEREO JACK PLUG 30p. SOCKET 25p.
DIN SOCKETS Chassis 3-pin 10p. 5-pin 10p.
DIN SOCKETS FREE 3-pin 25p; 5-pin 25p. DIN PLUGS 3-pin 25p; 5-pin 25p. VALVE HOLDERS, 10p; CANS 10p.
TV CONVERGENCE POTS 15p each
Values = 5, 7, 10, 20, 50, 100, 200, 250, 470, 2000 ohms

MONO PRE-AMPLIFIER. Mains operated solid state pre-amplifier unit designed to complement amplifiers without low level phono and tape input stages. This free-standing cabinet incorporates circuitry for automatic R.I.A.A. equalisation on magnetic phono input and N.A.B. equalisation for tape heads. Power ON/OFF PHONO/TAPE switches and pilot lamp are on the front panel; phono socket input and output are rear located.

£4.50 each or £8 pair. Post 50p

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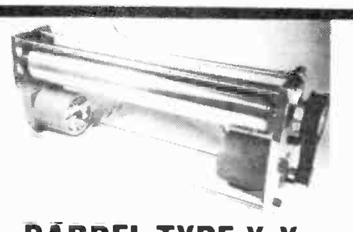
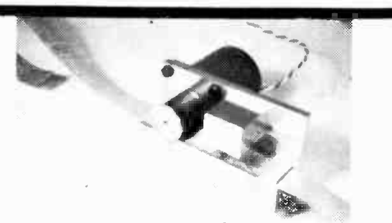


BARREL TYPE X-Y PLOTTER ASSEMBLY

X-Y PLOTTER ASSEMBLY



PAPER TAPE READER ASSEMBLY

BARREL TYPE X-Y PLOTTER ASSEMBLY
120V Stepping Motor. Provision for Pen (Pen not supplied). AS PICTURE **£55** ea. With alternative motor for non-reversible requirements recorder/printer applications etc **£48 ea.** With Pen and Paper guides **£78.** With Pen, Sprocket and Paper guides **£88.** other voltage options available. P&P all units £2.50.

X-Y PLOTTER ASSEMBLY
Consisting of frame with X & Y assemblies (No pen but provision) Bed size 12 × 9. Motor options 120V only **£43.45 ea.** 120V (Can be changed to 12/24V), data supplies **£51.15 ea.** 12/24V **£70.40 ea.** P&P all versions £2.50.

PAPER TAPE READER ASSEMBLY
Rigid alloy frame. 8 hole. High quality stepping motor. Directly driven from 120V reads 30 char. per sec. Reversible. Can be DC Stepped faster or slower. Steel paper guides. Without Opto-sensor **£27.50** ea. With Optics **£45** ea. P&P £2.

STEPPING MOTORS ONLY
Motors as used in plotters etc. All motors 200 steps per revolution. 20 oz. inch torque. 120V 1000-0-1000 ohm. Can be changed with care to 12/24V. Data supplied **£8** ea. P&P £1. Supplied for 12/24V operation **£13** ea. P&P £1. Just think about the uses!

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Brand New Boxed — Carriage all tubes **£3.25.** Telequipment S52, **£10** ea; D51, **£15** ea; S42, **£10** ea. D53A, **£20** ea. D52, **£15** ea; S31, **£10** ea. Bradley 200, **£85** ea. Advance OS3000, **£85** ea. GEC types 924F, **£25** ea; 924E, **£17.50** ea; 1496B, **£75** ea. Brimar D13-51GH, **£65** ea; D10-210GH/32, **£40** ea; D13-46GM, **£35** ea.
NOT BOXED — NEW — WARRANTED. Telefunken D14-131 replacement for Solartron CD1740, Cossor CDU150, S.E. Labs SM112 and GEC/MOV 1474 at **£55** ea.

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HANDSETS only 706 style **£1.75** each. Older style **£1.** P&P 75p.
TELEPHONE EXCHANGES. Eg 15-way automatic exchange only from **£95.**

POWERFUL MINIATURE GERMAN 12V REVERSIBLE MOTOR. No load current 70MA, excessive load 400MA. Size 1½x13/16" dia. Shaft 5/16 x approx 1/16" dia. **50p** each. P&P 40p.

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Guaranteed all full spec devices. Manufacturers' Markings.
At **5p** each
BC147, 2N3707, BC172B, BC251B, BC348B, BC171A/B, BC413, D10, BAX13, 1N937, BA102BE, BZX83, TIS61, 2N5040.
At **10p** each
1N4733A, SN7451N, BYX10-15KV 0.36A, BYZ10 **15p** ea. TIP34A — **50p** ea. BD538 — **40p** ea. Heavy Duty Bridge Rectifier — **20p** ea. CA3123E — **£1** ea. BDY55 — **£1** ea. 2N3055 — **40p** ea. TIP31B **12p** ea.
TBA560CO **£2** ea. 1N4436T-TO3 Flat mount 10A 200piv **£1** ea. 2N5879 with 2N5881 Motorola 150W Comp. pair **£2.**
BD535, BD53B Comp. pair — **75p.**
Linear Amp 709 — **25p** ea.
P&P Extra on all items.
FINNED HEAT SINK — single TO3 — size 4¾in x 3in x 1¼in **50p** ea. P&P 75p.
Texas Bridge Rectifier 5SB05-50V 5A **60p** ea. P&P 20p.
MOTOROLA POWER TRANSISTORS type W0993/441. TO3 Min voltage 500. **20p** ea. P&P 15p.

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Double Beam DC-6 MHZ £120

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POTTER & BRUMFIELD 18-48V DC Relay. 3 pole c/o. Heavy Duty. Plug-in type with base **50p** ea. P&P 25p.
MINIATURE KEYBOARD. Push contacts marked 0-9 and A-F and 3 user definable keys. **£1.75** ea. P&P 35p.
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ROTRON CENTAUR FANS Size 4.5 × 4.5 × 1.5. 115V 5 blade **£4** ea. P&P 75p.
Min. PLUG-IN type RELAYS. Plastic covers. 2-pole c/o 24V **25p** ea. P&P 15p.
CROUZET/MURTEN SCHWEIZ MOTORS. 110V 50HZ 4 rpm. Gear box can be removed. **75p** ea. P&P 75p.
FRAMCO MOTORS. 115V 50HZ Input single phase. 1/12th HP. 1450 rpm. on silent mount. New condition **£2.75** ea. P&P £1.75.
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BROOKE CROMPTON & PARKINSON extractor fan assembly 240V operation **£2.75** ea. Carr £3.25.
MAGNETIC DEVICES. Plug-in RELAYS 240V AC. 3-pole c/o. Heavy duty 10 amp. Complete with base. Ex brand new equipment. NOT USED. 3 on sub-assembly **£2.50** P&P £1 or **£1.25** ea. P&P 45p.
SMALL MAINS TRANSFORMER 240V Pri. 12V 100MA sec. 60×40×42mm. **50p** ea. P&P 75p.
G.I. BRIDGE RECTIFIER type W01 (ideal for above) **17p** ea.
FAIRCHILD FND10 7 segment display 0.15 Red. Common cathode **65p** ea. P&P 15p.
MULLARD TUNER MODULES — with data.
LP1171 combined AM/FM IF strip 10.7MHZ **£3.50** ea. P&P 50p.
LP1179 FM front end with AM tuning and 87.4MHZ to 104.5MHZ tuning. 10.7MHZ IF **£3.50** ea. P&P 50p.
The Pair £5.75 P&P 75p.
POWER UNIT MODULE containing 2 small, 3 med & 1 large ferrite cores. 3-TO3 power transistors, caps, resistors, high powered diodes, 9 transistors, 3 min fuse holders, etc. **£1.50** ea. P&P £1.25.
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TEKTRONIX OSCILLOSCOPES
541A with G Plug-in **£160. 545** with CA Plug-in **£200. 547** Main Frame **581A.** Main Frame **535** with 82 Plug-in **£425. 661** with 4S1 **£350.**

Stocks of better oscilloscopes always changing. Enquiries please. Plug-in units not sold separately.

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GENERAL RADIO. Osc. Unit 1209B, 250-920Megs **£50.**

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GENERAL INSTRUMENTS TRANSFER FUNCTION & IMMITANCE BRIDGE Type 1607A. In transit case. Complete **£525.**
RACAL UNIVERSAL COUNTER TIMER UNIT 100MHZ Ex-Ministry **£50** each.
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HEWLETT PACKARD microwave freqenncy convertor Type 2590B **£175.**
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MARCONI Signal Generator TF867 15kc-30MHZ **£55.**
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AVO TRANSISTOR & DIODE TESTER CT537. £50 each.
AUTO TRANSFORMERS. 240V input. 110V output. 1.25KVA **£18** each. Carr £2.75.

TELETYPE ASR28 with built-in tape reproducer and print on tape facility **£450.**

FEED BACK LTD. Wave Form Gen. Sin/Trap/Saw Sq.+DC offset **£80.**
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TELETYPE ASR33 with **20ma loop.** Good condition. **Special low price £395** ea.

½" MAG TAPE
Approx. 2,000 ft. **NOW 25p** each. P&P £1. Or 5 for **£1,** carr. £2.75.

FOR THE VDU BUILDER tube M28-13GH 23 x 17cm at **£12**. Base connections supplied.
Heads for **PERTEC 6000/7000** — enquiries.

PLESSEY VDU. No keyboard — weird electronics **£60** ea.
TELETYPE KSR33 from **£275** each.
Limited quantity of 35RO — 20ma loop — can be changed to ASC11 code (3 hours' simple work and £10 parts) **OUR PRICE EXCLUDING PARTS REQUIRED £70** ea.

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Polished Wooden Cases to take normal 'QWERTY' KEYBOARDS, or can be carefully cut to take any size. **3** each. P&P £1.50.

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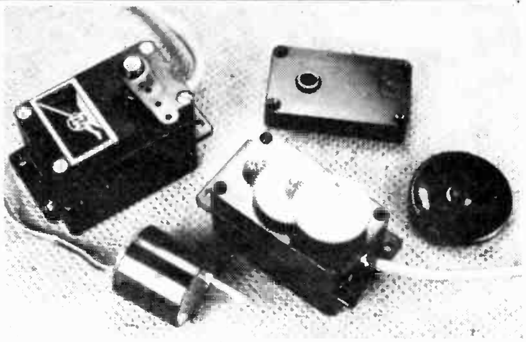

Multiplex Systems Off-the-shelf delivery of 2-30 channel multiplex systems for transmission of binary or analogue information through radio, cable, sound or light transmission systems. Low cost, proven performance, high reliability. Each system can be tailored to suit your particular application without significant extra costs.

Complete Systems We produce all the necessary items for complete remote control or indication systems — and can quickly (and at surprisingly low cost) combine our standard items into a complete, tailor-made system — and have wide experience of such work for very varied applications (including control of development models for some of the biggest names in the UK and for signal transmission to submersible vehicles, closed circuit TV cameras, airships, etc., etc. We would be happy to discuss your requirements (preferably by telephone in the first instance).

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10KHZ READOUT

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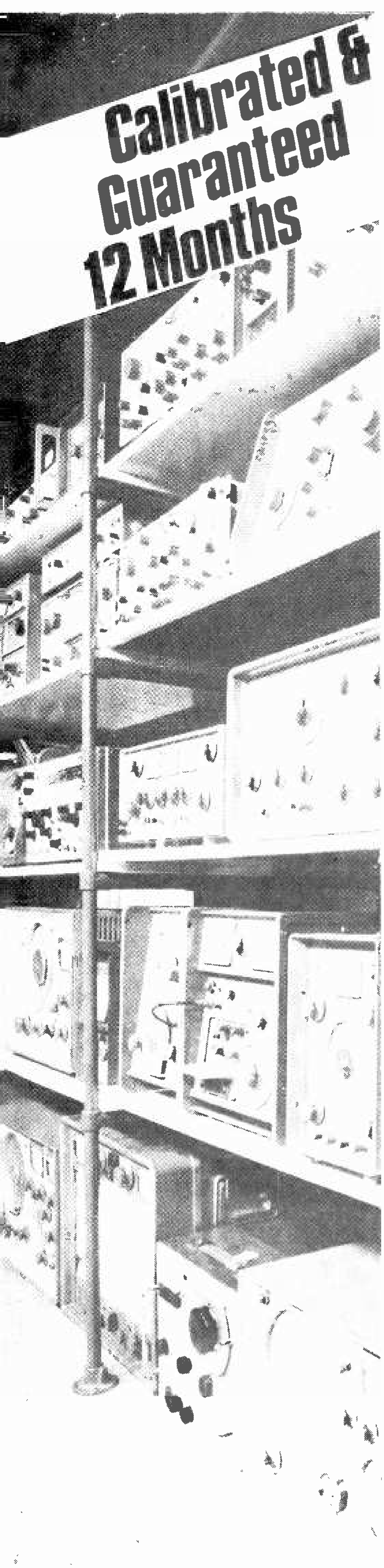

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Dual Trace Moduler Oscilloscope D83/V4/S2A. DC 50 MHz 5m V 20V DIV Delayed Sweep Excellent condition £610.00

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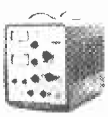

U.H.F. Signal Generator 612A. 450-1200MHz in 1 band Output Voltage 0 1µV to 0 5V Output impedance 50Ω A M 0-90% Ext A M Facility Pulse mod facility Various modern versions from £900.00-£1250.00
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50MHz Pulse Generator PM5712
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Low Frequency Generator PM5105. 10Hz-100kHz sine & Square wave £156.00
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H.F. Communications Receiver RA117E. 1-30MHz Full specification on request £350.00
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MARCONI INSTRUMENTS

F.M./A.M. Signal Generator TF995B/2. Frequency Range 200kHz to 220MHz in five bands Output 0 1µV-200mv Output Impedance 75Ω Modulation (F M.). Normal deviation continuously variable in two ranges ± 25kHz and ± 75KHz on all bands. Greater deviation is available on most bands. Modulating Frequency Internal FM 1kHz, External FM 50Hz to 15kHz Modulation (A M) Internal AM 1kHz 0-50% External AM 50Hz to 10kHz, 0-50% £675.00

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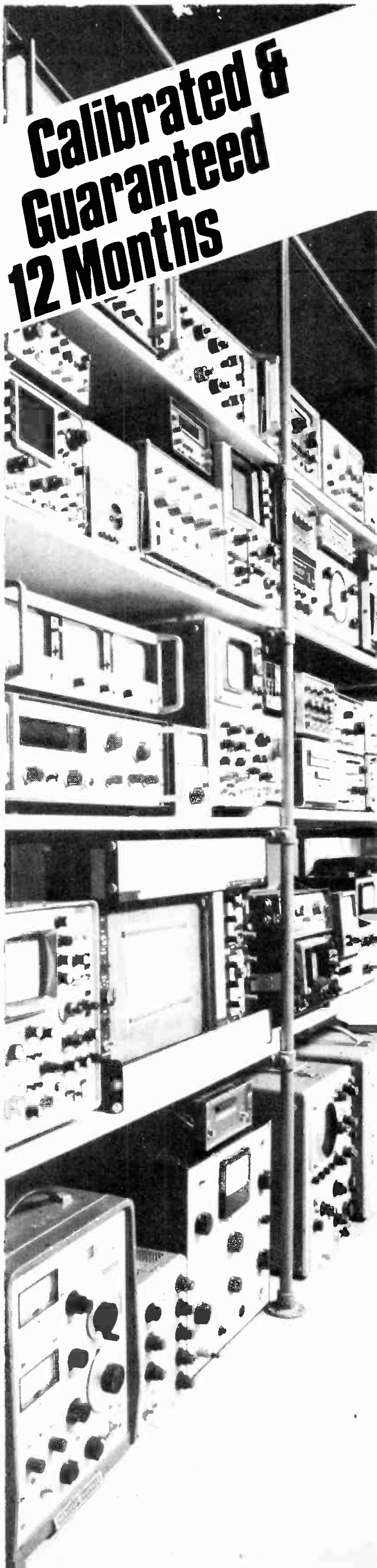

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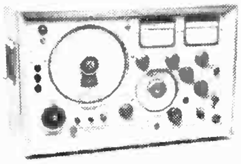
U.H.F. Signal Generator TF1060. Frequency range 450-1250MHz (1 band). Output 0.15μV to 445mV. Output Impedance 50Ω. Int. sine A.M. 1kHz. Ext. pulse mod. **£400.00**

A.M. Signal Generator TF144H/4. A later version of TF144H with similar spec. **£375.00-£600.00**

A.M. Signal Generator TF144H/4S. Electrical specification, as TF144H/4 **£375.00-£700.00**



A.M. Signal Generator TF801D/1. Frequency Range 10MHz to 470MHz in five bands. Output Attenuator 0.1μV to 1V. Output Impedance 50Ω (Type N connector). Modulation Internal AM 1kHz, 0 to 90% External AM 30Hz to 20kHz, 0 to 90% **£400.00-£750.00**

Carrier Deviation Meter TF791D. Carrier Freq range 4 to 1024MHz. Deviation range up to ±125kHz. Modulating Frequency range Up to 35kHz. Late models **£295.00**

20MHz Sweep Generator TF1099. Video sweep output. Lower limit 100kHz fixed. Upper limit continuously variable up to 20MHz. 0.3 to 3V p-p. Z=75Ω. Input & Output detector probes. Markers at 1MHz intervals **£295.00**

A.M. Signal Generator TF801D/8S. Same spec. as TF801D/1S + freq. counter o/p facility **£695.00**

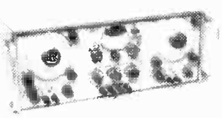
F.M./A.M. Signal Generator TF995A/2M. 1.5 to 220MHz. 2μV to 200mV int. & Ext. A.M. Int. F.M. at 1kHz deviation 0-75kHz **£375.00-£475.00**

Sensitive Valve Voltmeter TF2600. 12 ranges 1mV-300V f.s.d. 1% accuracy up to 500kHz. Usable up to 10MHz **£175.00**

R.F. Electronic Voltmeter TF2604. 7 ranges 300mV-300V f.s.d. from 20Hz-1500MHz. 8 ranges 300mV-1kV DC. 7 ranges. Resistance 500Ω to 500MΩ **£225.00**

R-C Oscillator TF1101. Frequency Range 20Hz to 200kHz in four bands. Output Attenuator 1mV to 20V. Maximum Output 20V across external 600Ω load. Output impedance 600Ω **£120.00**

Phase A.M. Signal Generator TF2003. 0.4-12MHz **£150.00**



Two-Tone Signal Source TF2005R. Frequency Range 20Hz-20kHz in six bands (each oscillation can be adjusted and used independently). Harmonic Distortion Less than 0.05% between 63Hz and 6kHz when using unbalanced output. Intermodulation Below 80 dB with respect to the wanted signal. Amplitude Reference Level Up to +10dBm from each oscillator. Output Attenuator 111dB in 0.1dB steps **£415.00**

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Wide Range R.C. Oscillator TF1370A. 10Hz to 10MHz sine wave, 10Hz to 100kHz square wave. Output up to 31.6V **£275.00**

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5 watt Dummy Load TM5582 for use with TF2604 **£25.00**

A.F. Oscillator TF2100. 20kc/s to 20Kc/s. Extremely low distortion. Output Impedance 600Ω unbalanced **£150.00**

M.F. Oscillator TF2101. 30c/s to 550kc/s. Stable frequency. Low distortion. Output Impedance 600Ω unbalanced **£115.00**

F.M./A.M. Modulation meter TF2300S. Incorporating Oscillator TM8045/1 3.5 to 1000MHz. Full specification on request **£825.00**

M.F. Transmission Measuring Set TF2333. Frequency range 30Hz to 550kHz. The TF2333 is a transmission measuring set of the conventional type that normally forms part of the essential test gear for audio and baseband equipment of multi-channel telecommunications systems. Signal Source, oscillator-frequency range 30Hz to 550kHz in five ranges. Attenuator, Range 70dB in 10dB and 1dB steps **£600.00**

F.M. Signal Generator TF1066B/6. 10-470MHz R.F. output 0.2μV-200mV e.m.f. Output Impedance 50Ω. Modulation Internal AM 1kHz & 5kHz 0-40%. External AM 30Hz to 15kHz 0-40%. Internal FM 1kHz & 5kHz deviation 0 to 100kHz or up to 400KHz according to carrier freq. range. External FM 30Hz to 100kHz deviation same as int. Crystal Calibrator facility **£685.00**

Variable Attenuator TF338C. 0-105dB Freqs. up to 100KHz. 600Ω impedance **£90.00**

M.F. Attenuator TF2162. DC-1MHz 0-111dB in steps of 0.1dB **£120.00**
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100-Watt R.F. Power Meter: TF1020A Series. Frequency range D.C. to 250 MHz. Two power ranges 50 and 100W full scale. Output Impedance 75Ω **£105.00**

In Situ Universal Bridge TF2701. Measures capacitance, capacitance with R in parallel. Resistance & Inductance. Int. source 80Hz & 1KHz **£395.00**

R.F. Power Meter TF1020A/4M1. 75 ohms. 1-50 watts & 2-100 watts. DC-250MHz **£120.00**

R.F. Power Meter TF1020A/5M1. 50 ohms. 1-50 watts. 2-100 watts. DC-250MHz **£135.00**

Output Test Set TF1065A. AF Power 10uW to 3W (5 ranges). Freq. Range 250Hz-10KHz. RF Power 1-25W. FM & AM measurements. DC current & voltage measurements. Full spec. on request **£225.00**

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770U VHF Receiver. 180-390 MHz in 6 ranges. AM/FM demod. Muting. AVC. Noise limiting. IF gain. S meter **£265.00**

730/1A Communications Receiver. 480kHz-30 MHz in 5 ranges. BFO, noise limiting. AF filter. AVC. rf gain. S meter **£240.00**

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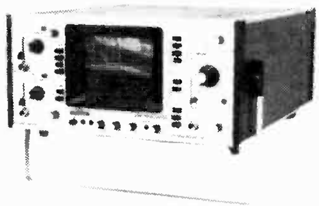

A100 Modular Oscilloscope c/w A101 and A112 modules. Dual trace. DC-30MHz. 5mV-20V/div sensitivity. Time base range 0.1μS-0.5 S/div. with x 5 mag. Full delayed sweep **£380.00**

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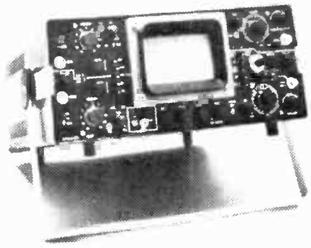

Portable Solid State 'Scope 7500. DC-40MHz. 10mV/div sensitivity ×10 gain extends sensitivity to 1mV/div (3Hz-5MHz). Mixed & calibrated sweep delay. Dual trace. AC & DC coupled Z mod. BRAND NEW **£495.00**

Dual Trace Portable Oscilloscope Type D7210. DC-15MHz. 10mV-5V/DIV. Delayed Sweep. Immaculate **£350.00**

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7401	0.12	7496	0.60	74191	0.99	74LS114	0.36	4008	0.92	4086	0.76
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7403	0.12	74100	0.94	74193	1.05	74LS124	2.45	4010	0.48	4093	0.65
7404	0.13	74104	0.40	74194	0.90	74LS125	0.44	4011	0.15	4094	1.80
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7407	0.28	74109	0.45	74197	0.90	74LS136	0.40	4014	0.80	4097	3.50
7408	0.14	74110	0.46	74198	1.48	74LS138	0.53	4015	0.77	4098	1.12
7409	0.14	74111	0.70	74199	1.48	74LS139	0.53	4016	0.42	4099	1.90
7410	0.13	74116	1.60	74221	1.50	74LS151	1.05	4017	0.77	4404	1.00
7411	0.18	74118	0.82	74273	2.15	74LS153	0.50	4018	0.87	4412	0.30
7412	0.21	74119	1.30	74279	1.25	74LS154	1.20	4019	0.42	4428	0.80
7413	0.25	74120	0.82	74283	1.70	74LS155	0.86	4020	0.92	4445	1.50
7414	0.54	74121	0.25	74284	6.85	74LS156	0.86	4021	0.82	4449	0.30
7416	0.27	74122	0.40	74293	1.35	74LS157	0.47	4022	0.82	4501	0.17
7417	0.27	74123	0.53	74298	1.92	74LS158	0.53	4023	0.15	4502	0.88
7420	0.13	74125	0.44	74390	1.92	74LS160	1.22	4024	0.66	4507	0.50
7421	0.28	74126	0.45	74393	2.12	74LS161	0.69	4025	0.15	4508	2.25
7422	0.17	74128	0.62	74LS00	0.19	74LS162	1.22	4026	1.28	4510	1.05
7423	0.25	74132	0.68	74LS01	0.19	74LS163	0.69	4027	0.50	4511	0.98
7425	0.20	74135	0.68	74LS02	0.19	74LS164	1.20	4028	0.67	4512	0.92
7426	0.25	74136	0.75	74LS03	0.19	74LS168	2.00	4029	0.86	4514	2.85
7427	0.25	74137	0.94	74LS04	0.20	74LS169	2.00	4030	0.48	4515	2.80
7428	0.34	74141	0.58	74LS05	0.20	74LS170	1.76	4031	2.34	4516	1.02
7430	0.13	74142	2.00	74LS08	0.19	74LS173	1.05	4033	1.25	4518	0.99
7432	0.24	74143	2.00	74LS09	0.19	74LS174	1.12	4034	2.00	4519	0.50
7433	0.32	74144	2.00	74LS10	0.19	74LS175	1.05	4035	1.00	4520	1.05
7437	0.24	74145	0.64	74LS11	0.19	74LS189	2.85	4036	2.40	4521	2.00
7438	0.24	74147	1.30	74LS12	0.19	74LS190	0.81	4037	0.99	4522	1.35
7440	0.13	74148	1.18	74LS13	0.46	74LS191	0.81	4038	1.00	4527	1.60
7441	0.52	74150	0.99	74LS14	1.10	74LS192	1.80	4039	2.80	4528	0.92
7442	0.55	74151	0.60	74LS15	0.19	74LS193	1.80	4040	0.88	4529	1.10
7443	0.90	74153	0.60	74LS20	0.19	74LS195	1.12	4041	0.77	4536	3.56
7444	0.90	74154	1.05	74LS21	0.19	74LS196	1.20	4042	0.72	4553	4.20
7445	0.70	74155	0.63	74LS22	0.19	74LS197	1.20	4043	0.82	4555	0.85
7446	0.70	74156	0.63	74LS26	0.24	74LS221	1.12	4044	0.82	4556	0.85
7447A	0.64	74157	0.63	74LS27	0.40	74LS247	0.97	4045	1.40	4558	1.25
7448	0.60	74159	1.70	74LS30	0.19	74LS248	0.97	4046	1.32	4566	1.40
7450	0.13	74160	0.80	74LS32	0.25	74LS249	0.97	4047	0.96	4583	0.75
7451	0.13	74161	0.80	74LS37	0.27	74LS251	1.00	4048	0.60	4585	1.03
7453	0.13	74162	0.80	74LS38	0.27	74LS253	1.05	4049	0.42		
7454	0.13	74163	0.80	74LS40	0.19	74LS257	1.05	4050	0.42		
7460	0.13	74164	0.89	74LS42	0.53	74LS258	1.05	4051	0.84		
7470	0.28	74165	0.89	74LS47	0.97	74LS266	0.39	4052	0.84		
7472	0.22	75166	0.99	74LS48	0.97	74LS273	2.50	4053	0.84		
7473	0.26	74167	2.70	74LS49	0.97	74LS279	0.50	4054	1.10		
7474	0.26	74170	1.68	74LS51	0.19	74LS283	1.00	4055	1.00		
7475	0.30	74172	4.00	74LS54	0.19	74LS289	2.85	4060	0.98		
7476	0.26	74173	1.18	74LS55	0.20	74LS293	0.90	4066	0.48		
7480	0.45	74174	0.89	74LS73	0.30	74LS298	1.60	4067	3.50		
7481	0.90	74175	0.68	74LS74	0.34	74LS352	0.92	4068	0.24		
7482	0.80	74176	0.88	74LS75	0.45	74LS353	1.05	4069	0.17		
7483	0.72	74177	0.88	74LS76	0.32	74LS365	0.50	4070	0.17		
7484	0.90	74178	1.20	74LS78	0.32	74LS366	0.50	4071	0.17		
7485	0.88	74179	1.10	74LS83	0.78	74LS367	0.50	4072	0.17		
7486	0.26	74180	0.90	74LS85	0.90	74LS368	0.50	4073	0.17		
7489	2.00	74181	1.92	74LS86	0.35	74LS386	0.37	4075	0.17		
7490	0.35	74182	0.75	74LS93	0.95	74LS670	2.00	4076	1.05		
7491	0.65	74184	1.20	74LS95	1.10	4000	0.14	4077	0.46		
7492	0.44	74185A	1.20	74LS107	0.36	4001	0.15	4078	0.22		
7493	0.40	74186	7.20	74LS109	0.36	4002	0.16	4081	0.17		
7494	0.80	74188	2.70	74LS112	0.38	4006	0.92	4082	0.20		

WW—087 FOR FURTHER DETAILS

STEREO DISC AMPLIFIER 2

FOR BROADCASTING, DISC MONITORING AND TRANSFER WITH THE HIGHEST QUALITY. Stereo Disc Amplifier 2 is a self-contained mains powered unit which accepts cartridge inputs and produces balanced line level outputs. Permanent rumble filtering and switched scratch filtering are included.
1 KHz @ 6mV set for 0dBV 7 output, loaded 600 ohms.

Total Harmonic Distortion
Output + 10dBV 7 30 Hz — 20KHz below noise
Output + 20dBV 7 1KHz—88dB 0.004% 30Hz-20KHz—82dB 0.008%

Static Intermodulation Distortion 50Hz + 7KHz 4 1
Output + 10dBV 7 —90dB 0.003% limit of measuremen

Dynamic Intermodulation Distortion 3 18KHz square wave (single pole —3dB @ 100KHz) + 15KHz sine wave 4 1 Relative to 15KHz component
Pre-emphasised input 1V pk-pk —70dB 0.03% limit of measurement

Cartridge impedance interaction on frequency response.
High inductance cartridge 1H Less than 0.2dB

Clipping Point Complementary to RIAA Curve. 1KHz clips at + 24dBV 7 output
30Hz-20KHz Within 1dB
Clipping determined by onset of peaky distortion products or THD exceeding —80dB

Differential Phase Shift between left and right channels
50Hz-20KHz Within 0.5
Worst error at LF and HF filter turnovers Within 5

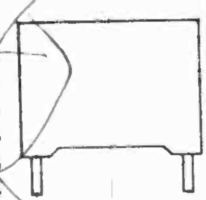
Crosstalk 1KHz — 76dB 30Hz-20KHz. — 60dB

SURREY ELECTRONICS
The Forge, Lucks Green, Cranleigh, Surrey GU6 7BG (STD 04866) 5997

NEW

NOISE SUPPRESSION CAPACITORS 250v AC

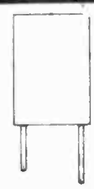
0.015	.13
0.022	.13
0.033	.14
0.047	.15
0.068	.16
0.1	.18
0.15	.24
0.22	.32



.015 —1 PCM 15mm
.15 .22 22.5mm

POLYPROPYLENE RADIAL LOAD

Cylindrical Plastic Case. PCM 5mm. PCM 2½%. Tolerance — 100pf; 220pf; 330pf; 470pf 630V 680pf; 1000pf; 1500pf; 2200pf; 3300pf; 4700pf; 160V. Size 7x12.5mm. Price .08 ea.



TANTALUM BEAD

47	35V	.10	22	10V	.15
1	35V	.10	22	16V	.16
2.2	16V	.10	47	16V	.18
2.2	35V	.10	220	3V	.18
3.3	16V	.10	100	6V	.18
4.7	10V	.10	100	10V	.32
10	16V	.11			
10	35V	.15			
15	25V	.15			

C.W.O. V.A.T. included
P. & P. 20p — Overseas extra

GREENWAY ELECTRONIC COMPONENTS (EAST GRINSTEAD) LTD.
62 Maypole Road, Ashurst Wood, East Grinstead, Sx. RH19 3RB.
Tel. 034-282 3712

Semiconductor Supplies (CROYDON) LIMITED

SUMMER 1978 CATALOGUE

Orchard Works, Church Lane, Wallington, Surrey. SM6 7NF
Telephone: 01-647 1006 (5 LINES) TELEX 946650

WW—096 FOR FURTHER DETAILS

Appointments

Advertisements accepted up to 12 noon Tuesday, August 1, for the September issue, subject to space being available.

DISPLAYED APPOINTMENTS VACANT: £7.50 per single col. centimetre (min. 3cm)
LINE advertisements (run on): £1.10 per line, minimum three lines.
BOX NUMBERS: 50p extra. (Replies should be addressed to the Box Number in the advertisement, c/o Wireless World, Dorset House, Stamford Street, London SE1 9LU.)
PHONE: Barry Leary on 01-261 8508
Classified Advertisement Rates are currently zero rated for the purpose of V.A.T.

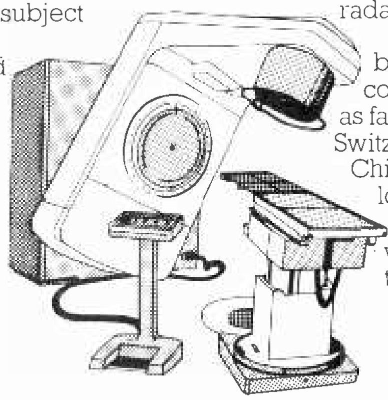
Installation Engineers around the World.

M.E.L. a Division of Philips Electronic and Associated Industries is committed to the Development, Manufacture and Marketing of advanced Linear Accelerators. They are installed in major hospitals throughout the world. These machines play an important role in the treatment of Cancer, a subject which demands sustained developments, sophisticated equipment and highly professional Engineers.

If you are a self-reliant, mature and adaptable Engineer prepared to spend periods of six to sixteen weeks away from base, join our team and share the challenge and rewards of worldwide installation work.

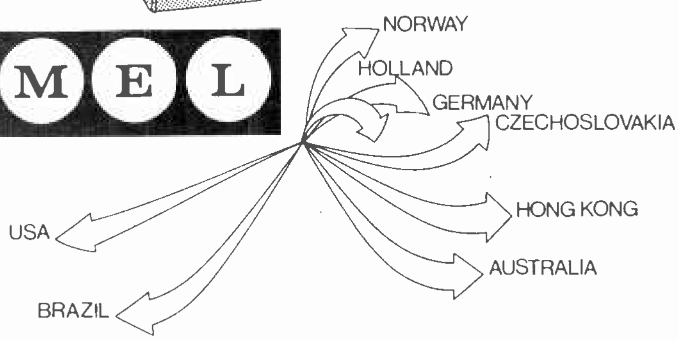
Male or female, you will need to be qualified to HNC level with a good knowledge of semi-conductor and digital circuitry and ideally with experience of modern high power radar and computer systems.

Based in Crawley, Sussex midway between London and Brighton you could become involved in projects as far afield as the USA, Austria, Switzerland, Yugoslavia, Holland, China, Brazil and Norway. So if you are looking for the opportunity to carry out worthwhile medical installation work on a worldwide basis, get in touch – NOW.



Contact Alistair Budd,
Personnel Officer,
M.E.L., Manor Royal, Crawley, Sussex.
Telephone: Crawley 28787.

M E L



8314

TELEVISION ENGINEER

A vacancy occurs with an old establishment Retailer.

The [illegible] requires someone with a wide range of experience in Television and Audio equipment, a clean driving licence is essential. Large flat available for suitable applicant

HYDES OF CHERTSEY LTD.
56/60 Guildford Street, Chertsey
Telephone: Chertsey 63243

(8225)

SALOP AREA HEALTH AUTHORITY

ELECTRONICS ENGINEER GRADE III

required for the Area Works Department based initially at Copthorne Hospital attached to the Intensive Therapy Unit

Qualification: **H.N.C./O.N.C. ELECTRONICS**
Responsible to: **Area Engineer**
Salary Scale: **£3,744-£4788 per annum**

Experience required

Candidates must possess a wide experience of electronic equipment, together with appreciation of the safety aspects of such equipment.
The position offers the opportunity to be involved in a very rewarding aspect of electro-medical engineering and he/she will be under the control of the respective clinician within the above department for all clinical responsibilities appertaining to his/her duties.

For job description and application form write to Area Engineer, Area Works Department, Copthorne Hospital South, Shrewsbury, Salop. Tel. 52244 Ext. 3273. Closing date 8th August, 1978

(8362)

FRANK CODY ELECTRONICS LTD.

require

AN ELECTRONICS ENGINEER

with some experience of V.H.F. and U.H.F. R/Ts for interesting work on our range of marine and land mobile communications and navigation equipment

Frank Cody Electronics Ltd.
40 Sunbury Cross Centre
Sunbury-on-Thames
Middlesex TW16 7AZ
Tel: Sunbury-on-Thames 88705

(8326)

Aircraft Equipment Department

Electronics Research and Development with Ferranti

Section Leader

Static Invertors

The Aircraft Equipment Department at Bracknell now require an experienced Electronic Engineer to lead a team responsible for static power conversion activities. This is an activity in which the Company has achieved a leading position and we consider that the post can only be filled by a professionally qualified engineer with drive and ability who has had several years experience in the design and development of static invertors, power supplies and allied equipment. An attractive salary will be paid and relocation expenses and housing assistance may be available if required.

The laboratories are located in a pleasant manor house on the outskirts of Bracknell.

Applications should be made in the first instance to Mrs. J. Hunt, Ferranti Limited, Lily Hill House, Bracknell, Berkshire RG12 2SJ. Telephone Bracknell 24001. Please quote reference number A209/ WW

FERRANTI

Selling technology

(8374)

THE OPEN UNIVERSITY

FACULTY OF TECHNOLOGY

RESEARCH TECHNICIAN

(Electronics and Telecommunications)

A technician is required to join the Electronics Discipline. His or her main duties will be to contribute to the Discipline's research programme in telecommunications, digital processing, instrumentation and control. This will involve the construction and testing of experimental and prototype electronic equipment, the maintenance and updating of documentation and drawings and the general maintenance of the technical facilities in the electronics research laboratory.

The required qualification is ONC in electronics, T5, or equivalent, with, preferably, two years' experience of laboratory or prototype development work.

The person appointed will be expected to live within 20 miles of the University. We do offer assistance with removal expenses to make this possible. There is a wide variety of corporation and private housing, and we have an Accommodation Officer to advise and help new appointees.

The appointment is at Technical Grade 3, for which the salary scale is £2,688 - £3,060 per annum. We offer generous holidays and excellent social and sporting facilities.

Application forms and further particulars are available, by postcard request please, from The Recruitment Office, (MH3427/1), The Open University, P.O. Box 75, Walton Hall, Milton Keynes MK7 6AL, or by telephone from Milton Keynes 63405 or Milton Keynes 63868 (24 hour answering service). Closing date for applications 4th August 1978.

(8381)

APPOINTMENTS IN ELECTRONICS

Take your pick of the permanent posts in:

MISSILES — MEDICAL
COMPUTERS — COMMS
MICROWAVE — MARINE
HARDWARE — SOFTWARE

For expert advice and immediate action on career improvement, 'phone, or write to, Mike Gernat BSc

Technomark

Engineering and Technical Recruitment

11 Westbourne Grove
London W2. 01-229 9239

THE ROYAL NATIONAL THROAT, NOSE AND EAR HOSPITAL
Gray's Inn Road, London WC1X 8DA

MEDICAL PHYSICS TECHNICIAN IV

Applications are invited for this post in the Audiological Physics Department to join the team of Physicists and Technicians developing and maintaining audiological equipment of all kinds. Candidates should have O.N.C., H.N.C., H.N.D., or an equivalent qualification in electronics with relevant experience. An interest in Electro-Acoustics should be an advantage. Salary scale £3069-£4134 pa plus London Allowance of £354 pa.

Application forms and details from Miss P. Colyer Audiology Division, R.N.T.N.E. Hospital, 330 Gray's Inn Road, London WC1X 8DA. 01-837 8855 ext 133

8332

SPEECH FOR THE TOTALLY DEAF

A post is available for a Ph.D. level ELECTRONICS ENGINEER/PHYSICIST to work on the practical development of a bio-compatible electro-cochlear stimulator. An ability in the use of bio-compatible materials and an interest in hearing would be an advantage. A knowledge of speech processign and micro-computer techniques is desirable.

The work is complementary to an MRC supported research investigation into the feasibility of providing a degree of useful hearing for speech by extra-cochlear electrical stimulation. It has proved possible in this way to give hearing for certain speech patterns to some persons who are otherwise irremediably deaf. Collaboration with the present team members would be necessary at Cambridge, Guy's Hospital and University College London. Salary support for a period of three years is available from the Royal National Institute for the Deaf – Range II £5.669 to £6.077. Application for background information should be made either to Professor A. J. Fourcin, Dept. of Phonetics and Linguistics, University College, London, 4 Stephenson Way, London NW1; to Mr. E. E. Douek, Guy's Hospital, London, SE1, or to Dr. B. C. Moore, Dept. of Psychology, Downing Street, Cambridge.

8324

UNIVERSITY OF EDINBURGH
DEPT. OF CHEMISTRY

ELECTRONICS TECHNICIAN

A challenging position for the successful applicant, who must take charge of a well equipped electronics workshop and three qualified technicians. The department has a wide range of sophisticated instrumentation and the applicant should have a broad spectrum of electronics experience and will be expected to advise staff on design and data collection problems. HNC or equivalent qualifications desired. Salary on the scale £3,654-£4,365 p.a.

Application forms are available from the Personnel Office, University of Edinburgh, 63 South Bridge, Edinburgh EH1 1LS. Telephone 031-667 1011, ext. 4510-3. Ref. A278

(8344)

MEDICAL RESEARCH COUNCIL
NATIONAL INSTITUTE FOR MEDICAL RESEARCH

A vacancy exists in a multidisciplinary team for a

PHYSICIST or ENGINEER

to work on optical devices for investigating human hearing, in a challenging project involving coherent optics and state of the art electronics. The appointment will be for up to three years and will be in the present salary scale £4387-£6850 (under review) according to age and qualification, plus £450 p.a. London Allowance; superannuation provision.

There is also a permanent Research Officer post in the Engineering Department for general electronic projects, experience in optics would be an advantage. Salary range £3615-£5260, according to age and qualifications.

Applications, giving details of qualifications, experience and the names of two professional referees, should be sent to the Director, National Institute for Medical Research, Mill Hill, London NW7 1AA. Closing date 28th July, 1978.

(8361)

Electronics Engineers on the move

INVEST 5 MINUTES IN YOUR FUTURE

DESIGN, TEST, Q.A; FIELD SERVICE, MANAGEMENT, ETC.

Take advantage of the best opportunities being offered in the Electronics Industry from amongst over 3000 U.K. Companies with whom we deal. We are seeking all categories of Electronics Engineers for equipment ranging from computers to communications.

By returning the application form below, your job requirements will be matched against our clients' numerous vacancies, many of which are not advertised. Your application will be treated in strict confidence and no approaches will be made to existing employers or to any other companies you care to specify. Please remember, our service is completely FREE to applicants.

So don't delay - act now to give yourself the best chance of finding the perfect job.

If you wish to discuss any aspect of the Electronics job market, you are welcome to phone anytime. Please ask for Brian Cornwell.

Capital Appointments Ltd. 29/30, Windmill St. London, W.1. ☎ 01-637 5551

PLEASE WRITE IN BLACK INK. (OR BLUE).

NAME: A.H. Esquire. ADDRESS: 80, BR, B B302DX -

Tel: (Home): 01 558089 72 (Office): U of B. Elect. Eng. Dept: 5th floor (Home base) or 409 (Research Lab)

Date of Birth: 31/1/58 Place of Birth: W-O-T, Surrey - Nationality now: British If not British, is a Work Permit req'd? ?

Marital Status: Unemployed Car Driver: If you buy me one Car Owner: If you pay for one -

Type of Position required: Upside down (HA HA) - (Company director if poss) Approx. Salary level: 10^71

Please indicate areas in which you are prepared to work:

Cent. London		S. Coast		E. Midlands	
S.E. London		West Country		W. Midlands	
S.W. London	✓	N.E. Engld.		E. Anglia	
N.E. London		N.W. Engld.		Wales	
N.W. London		Scotland	✓	Overseas	S of F.
Home Counties: N.W. Surrey/Berks		N.E.	S.W.	S.E.	

Are you a houseowner? NO Are you willing to relocate? ???

Are you prepared to travel - In U.K? Overseas? ✓ S of France

State of health: Poor at present (COLD), usually v. good -

Notice Period required: 10^9

Availability for Interview: Friday Mornings, before 11.

EDUCATION: NOT proper.

Secondary School Qualifications: 4 A-levels, lots of O-levels.

College or University Qualns: 2/3 degree (Hons).

Any Professional Membership: —

INDUSTRIAL EXPERIENCE:

Period of Employment	Company & Location	Products	Job Title	Responsibilities	Reason for leaving	Final Salary
1. Current or last employment From: To:	Sperry's Bracknell	Message Switch	Engineer	Very few - included getting signatures for approval of Drawings -	Had to go back to Brum	£52-80 p.w.
2. Previous employment From: To:	Self-employed	TV (half-time)	Repair	TO customer.	lost interest, insufficient income.	~£20 pw!
3. Previous employment From: To:	—	—	—	—	—	—

ELECTRONICS PROFILE: Indicate extent of experience- A-Extensive; B-Moderate; C-Limited; If Nil experience, leave blank.

X	Telephone Eqpt.		Data Commns.	C	Radio/Hi-Fi/T.V.		Broadcast Eqpt.
C	Digital/Logic		Analogue Eqpt.	X	Software/Programming		Minis/Microprocessors
X	Computers/Periphs.		Test Gear/ ATE.		Process Control		Power Supplies
	UHF/VHF. Comms.	X	Microwave		Radar/Navaids		Medical Electronics
	Signalling Systems		Security Eqpt.		Avionics	R	Simulators
	Weapons		Scientific Eqpt.		Data Recorders		Photocopiers
	Phototypesetting		Servo-mechs.		Components-Active		Components-Passive
	Production Eng.		Electrical Eng.	A	Telling off store-keeper.	A	making Tea.

Others - Please state.

Please indicate any Companies you do not wish us to contact.

Well, I nicked a few 'scopes from GEC, so don't contact anyone in the GEC group, OK?

If you wish to detail further aspects of your experience or job requirements, please enclose on a separate sheet. WW31

Radio Officers

When the ship comes home, why not settle down?

We're the Post Office Maritime Service and we have everything in a job that you'd want: the kind of work you're trained to do, good pay, job security and all the comforts of home where they really count – at home!

Vacancies exist at several coast stations for qualified Radio Officers to carry out a variety of duties that range from Morse and teleprinter operating to traffic circulation and radio telephone operating. And for those with ambition, the prospects of promotion to senior management are excellent.

You must have a United Kingdom Maritime Radio Communication Operator's General Certificate or First Class Certificate of proficiency in Radio-telegraphy or an equivalent certificate issued by a Commonwealth Administration or the Irish Republic. And, ideally, you should have some sea-going experience.

At 25 or over, salary starts around £4093, rising after three years to about £5093. (Starting salary for those between 19-24 varies between £3222-£3732.) Overtime is additional, and there is a good pension scheme, sick-pay benefits and at least 4 weeks' holiday a year.

For further information, please telephone Andree Trionfi on Freefone 2281 or write to her at the following address:
ETE Maritime Radio Services Division (WW/C/8)
ETE17.1.1.2, Room 643, Union House,
St. Martins-le-Grand, London EC1A 1AR.

Post Office Telecommunications

(7141)

RADIO TECHNICIANS

Government Communications Headquarters has vacancies for Radio Technicians. Applicants should be 19 or over.

STANDARDS required call for a sound knowledge of the principles of electricity and radio, together with appropriate experience of using and maintaining radio and electronic test gear.

DUTIES cover highly skilled telecommunications/electronic work, including the construction, installation, maintenance and testing of radio and radar telecommunications equipment and advanced computer and analytic machinery.

QUALIFICATIONS: Candidates must hold either the City and Guilds Telecommunications Part 1 (Intermediate) Certificate or equivalent HM Forces qualification.

SALARY (inc. supps.) from £2,673 at 19 to £3,379 at 25 (highest pay on entry) rising to £3,883 with opportunity for advancement to higher grades up to £4,297 with a few posts carrying still higher salaries.

Opportunities for service overseas.

Further particulars and application forms available from:

GCHQ

Recruitment Officer (Ref. WW/18)
GCHQ, Oakley
Priors Road, Cheltenham, GL52 5AJ
Cheltenham (0242) 21491 ext 2270

(8035)

Marine Radio Service Engineers

Tilbury and Milford Haven

International Marine Radio Co. – a subsidiary of Standard Telephones and Cables Ltd – is engaged in the manufacture of high quality marine communication equipment. Due to our continuing expansion plans we have vacancies for Marine Radio Service Engineers in our Tilbury Depot. As part of this expansion programme it is also our intention to open a Depot in the Milford Haven area.

The work will be concerned with installation and service of communication equipment on board commercial vessels of all types.

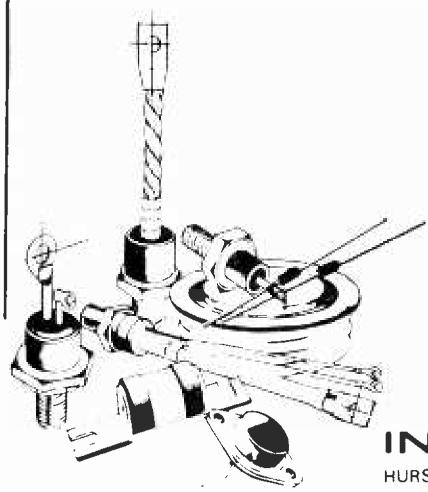
Ideal candidates, male or female, will have had at least three years sea experience as a Radio/Electronics Officer. A company vehicle is provided for business and personal use.

For further details on both these positions please contact: Jonathan Smith, International Marine Radio Co. Ltd., Peall Road, Croydon, CR9 3AX. Telephone 01-684 9771.

ITT Marine

(8323)

Internal Sales Engineers (Semiconductors)



These positions involve dealing with customers' application problems relating to our devices, and providing a technical back to our field sales force.

An ONC is a minimum requirement and HNC/Degree would widen the future horizon. Ideally applicants will be in their twenties or early thirties with previous relevant experience.

Attractive salary and excellent prospects of promotion into all aspects of sales and marketing here and in our European headquarters. For further details telephone: Mike Walker, OEM Sales Manager, or Alf Tucker, Personnel Manager.

(8377)

INTERNATIONAL RECTIFIER IOR

HURST GREEN · OXTED SURREY RH8 9BB TEL. OXTED 3215/4231 TELEX RECTUK OXTED 95219

SALES ENGINEER

(Male/Female)

MIDLANDS/NORTH OF ENGLAND

Our Clients, whose Head Office is based in the South of England, are a young marketing division of an American Company engaged in the professional Audio Field. They require to expand their sales team and seek a representative to sell in the Music and P.A. industry as well as Studio and Television. The area to be covered being the Midlands to the North of England.

Our Clients handle a range of professional sound products from America, already widely accepted in the appropriate fields.

Qualifications required are H.N.C. minimum, preferably in Audio. However, experience in selling Audio Products and proven sales ability will be considered.

Salary package of up to £5,000 per annum together with a Cortina Estate car will be offered to the successful applicant. If you wish to join a Go Ahead Company, then write, stating age, qualifications and experience to.

BEDFORD BUREAU
4/5 North Street, Quadrant, Brighton BN1 3FA

(8325)

Advanced realist wanted for electromedical product development

We are looking for a person who possesses two main qualities the ability to generate ideas and the experience to oversee their development into commercially realistic prototypes. It follows that a sound knowledge of the latest electronic techniques is an essential requirement.

The right person will be invited to head our development team and play a major part in the realisation of our next generation of electromedical products. We are a leading British manufacturer of Physiotherapy equipment involving pulse stimulator, ultrasound, short wave and microwave techniques. We now wish to develop new products, as well as updating aspects of existing equipment.

If you feel that you are such a person, we should like to hear from you. Please enclose full details of your career and qualifications, and it would also be helpful if you included a few words indicating your own involvement with our particular section of the industry.

If you are the right person, you will find that we are offering a very attractive salary with a full range of benefits, plus a very agreeable working environment in south Oxfordshire.

Please address your application to **Box No. WW8337.**

(8337)

A challenging career in the Medical Field

International X-Ray Company, a leader in its field, has several interesting positions for

X-RAY ENGINEERS

These vacancies occur in the North West and Southern England

Very generous salaries will be paid to the successful applicants.

A Company Car will also be provided.

There are excellent promotion prospects for the right persons.

Those applying should be suitably qualified electronically and preferably have some experience in the X-Ray Field.

Please apply in writing to.

C. G. R. Medical Ltd.

Astronaut House, Feltham, Middlesex

Giving full details of education and career to date

(8331)

UNIVERSITY OF SALFORD

PSYCHOLOGY TECHNICIAN

Required to assist with research work and under-graduate practical classes in the Department of Sociology and Political Studies. Duties will include maintenance, modification and construction of equipment and after appropriate training, assistance with psychological testing.

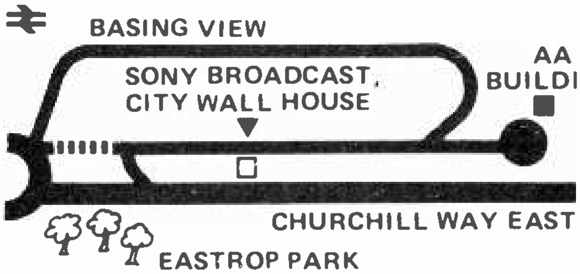
Salary Grade 5 £3186 to £3720.

Further details and application forms available from The Registrar, University of Salford, Salford M5 4WT, to whom completed applications should be returned by 28th July, 1978, quoting reference SOC/77/WW.

Sony Broadcast establish New European Headquarters in Basingstoke.

In February, the setting up of a new SONY BROADCAST Technology Centre in the UK and the search for suitable premises in the Basingstoke, Reading or Camberley areas, was announced.

We have now found what we were looking for at City Wall House, Basing View, Basingstoke – a fine new building in the business area with a commanding view over the town and the park. Our warehousing, production, test and despatch facilities are under construction just a mile or so away. In addition, we are, of course, retaining our distributor facilities at Vianen in Holland.



Our earlier advertisements brought such a terrific response that we have now filled all but one of our immediate engineering vacancies but we do still have a vacancy for an **ASSISTANT MANAGER (SPECIAL PROJECTS) at a starting salary of £7,000 p.a.** The man or woman we are looking for will not necessarily hold a degree although a full and detailed knowledge of television principles and practice is essential. Rather we are looking for someone who is essentially practical with at least two years experience of all aspects of studio or outside broadcast unit planning and design. Not a detailed expert but someone equally at home with lightning conductors and drains facilities diagrams, cable schedules and standby electric generators. Ideally, someone in their mid to late twenties anxious to develop their potential in a thrusting new company. Applicants giving full details of qualifications and experience, please contact Mr Ken Barrett Technical Director

SONY BROADCAST also have the following vacancies in the Marketing Services Department of their Marketing Division based in Basingstoke Hants

SALES PROMOTION MANAGER

Starting salary £8 500 plus car

ASSISTANT SALES PROMOTION MANAGER

Starting salary £7 000

EXECUTIVE SECRETARY (Multilingual)

Starting salary £3 200 to £4 000 depending on qualifications and experience

COPY TYPIST/CLERK

Starting salary £2 500 £3 000 depending on age competence and experience

Basically we are now ready to set up an efficient and effective Sales Unit which will prepare attractive Proposals for our customers both in the UK and overseas. We are aiming at a same day service in response to telephone telex or Ansafone enquiries 48 hours in response to written enquiries or invitations to tender for standard products

Ideally our **SALES PROMOTION MANAGER** will be a multilingual man or woman able to translate from German French Italian and Spanish into English and to converse briefly in these languages with up to-date experience of UK commercial practice in the broadcasting business together with an engineering background a pleasant manner and a proven ability to sell. Clearly we are not going to find all these attributes in one person – if we do we will gladly pay both salaries together – and hence the post of ASSISTANT MANAGER to complement the first. We must have at least one different language in each person at least one must have relevant commercial experience at least one must know enough about broadcast engineering to be able to respond fully to enquiries about specifications and facilities. Both should have a pleasant manner. Some travel will be necessary mainly in the UK

Applications please, giving full details of qualifications and experience to Stuart Sansom, OBE Marketing Director

"What we are offering is unique – and the needs of broadcasters are tremendous."

– Masahiko Morizono Managing Director Sony Corporation

SONY Broadcast

Sony Broadcast City Wall House Basing View
Basingstoke Hants
Tel 0256 55011 Telex 858424

(8340)

Appointments

ELECTRONICS TECHNICIANS

When you see a good job advertised what do you look for next?

Obviously, before you contemplate a change of job and possibly area you must weigh-up your present job prospects, pay and surroundings and measure them against those that have attracted you.
Really that's all we want you to do NOW–we are confident that the combination of Marconi Instruments and its locations in St. Albans and Luton will persuade you to give very serious consideration to the appointments we have vacant.

Job Satisfaction

If you would like working for a successful Company you'll like us–66% of our products ranging from microwave test equipment to automated test systems are exported. Unlike any other in the business we achieved the 'double' in 1977 with the Queen's Award for both Exports and Technological Achievement–just two reasons why our people have every reason to be proud of their Company and its expertise.

Housing

The Hertfordshire/Bedfordshire area is probably one of the most picturesque of the counties surrounding London and contains some very reasonably priced housing both of the modern and rural varieties. The average family house is priced in the region of £16,000 to £22,000.

Schooling

The family man will be particularly impressed with the local schools both Junior and Senior–modern, spacious buildings are the order of the day and individual successes are very encouraging.

Sports and Social Activities

For the energetic our own sports and social club is very active, particularly with the recent addition of a squash court. Golf courses, cricket and football clubs abound and for the less energetic many social activities are available.

Local Amenities

If you still have time on your hands you will enjoy a visit to the theatre in either St. Albans, Luton or Watford. The local Rep. is very well supported.

All in all we can offer you a really worthwhile job, attractive pay, relocation and equally important, excellent local surroundings. Why not ring John Prodger, Personnel Officer, he lives locally and can give you first hand information about the jobs and surrounding districts.

MARCONI INSTRUMENTS LIMITED
Longacres, Hatfield Road, St. Albans, Herts.
Tel: St. Albans 59292 or after 6pm and weekends St. Albans 30602

(8384)

mi A GEC MARCONI ELECTRONICS COMPANY

alacra

require

FIELD ENGINEERS

With electronics/electro-mechanical experience to service high quality computer forms handling equipment involving discrete and integrated circuitry both digital and analogue. Qualifications desirable e.g. C&G Radio & T.V. but less important than good practical ability. Training will be given. Package includes company car, expenses and pension scheme. Preferred location Greater London but other areas in UK will be given consideration.

Ring Graham Crabtree on 01 965 9311 or write with full details to Service Manager, Alacra Ltd., Iveagh Avenue, North Circular Road, London NW10 7UJ.

CHELSEA COLLEGE
University of London

ELECTRONICS TECHNICIAN

Grade 3 required for Electronics Workshop. Interesting prototype construction and servicing work mainly for Departments of Electronics and Physics. Relevant experience essential and a suitable qualification in Electronics desirable. Day release can be arranged for approved courses.

Salary £3,153-£3,525 p.a. inclusive. Application forms and further information from Mr M. E. Cane (3EW), Chelsea College, Department of Electronics, Pulton Place, London SW6 5PR.

(8397)

UNIVERSITY OF LIVERPOOL
Department of Electrical Engineering

TECHNICIAN

Electronics Service Technician to service wide range of equipment.

Applicants should possess C & G in Radio and Television servicing or Electronics servicing or must have equivalent training and experience. Salary within a range up to £3,402 p.a. according to qualifications and experience. Application forms may be obtained from the Registrar, The University, P.O. Box 147, Liverpool L69 3BX. Quote Ref RV/841.

(8382)

MICROPROCESSOR CONSULTANCY

Hardware · Software · Systems · Intel · Motorola · Intersil · DEC · Consultancy · Training · Turnkey Systems

MICRO LOGIC CONSULTANTS
Horsham (0403) 730464
24-Hour Answering Service

8327

Test Gear

The following vacancies have occurred at the Springfield Road Works of EMI Ltd., a medium sized, self-contained unit concerned mainly with large quantity production of precision electro-mechanical devices.

Laboratory Technician

To assist Engineers with testing and development of electronic circuits and test equipment and to produce breadboards and prototype test equipment. Qualification C & G or O.N.C. (Electronics) and/or relevant experience in electronic prototype work.

Test Gear Maintenance Engineer

With sound experience of radio and T.V. servicing and some further knowledge of maintenance of electronic instrumentation. Qualification of C & G, R & TV servicing or equivalent is desirable.

EMI

For further details contact
Miss Pedley, Personnel Officer
EMI Ltd.
Springfield Road Works, Hayes
Middlesex. Tel. 01-573 2701

(8329)

Research Technician

A technician is required to join a team working on circuit techniques for very high speed digital transmission systems for telecommunications applications. The work will include electrical design, layout and testing of high frequency thin film hybrid and monolithic integrated circuits as well as more conventional practical electronic work. Some experience of the special considerations that apply to very high speed silicon bipolar circuits would be an important advantage and the preferred qualifications are up to H.N.C. or equivalent.

Please ask for a Personal History Form quoting reference No. 115 from Mr M. L. Malpass, Personnel Manager, Philips Research Laboratories, Cross Oak Lane, Salfords, Nr. Redhill, Surrey. Tel 02934 5544.

(8391)

PHILIPS Research Laboratories **PHILIPS**

SCOTTISH HOME AND HEALTH DEPARTMENT

WIRELESS TECHNICIANS

Applications are invited for two posts of Wireless Technician in the Scottish Home and Health Department.

Location: One post is in Inverness. The other is not yet known but could be at Edinburgh, East Kilbride or Montreathmont.
Qualifications: Candidates must hold an Ordinary National Certificate in Electronics or electrical Engineering **or** a City and Guilds of London Institute Certificate in an appropriate subject **or** a qualification of a higher or equivalent standard.
Experience: 3 years' appropriate experience.
Starting Salary: £2,627 (age 17) to £3,700 (age 25 or over) scale maximum £4,252.

Applicants should have sound theoretical and practical knowledge of Radio Engineering and Radio Communications equipment in HF, VHF and UHF bands. The work involves installation and maintenance of equipment located at considerable distance from headquarters. A clean current driving licence and ability to drive private and commercial vehicles are essential.

Appointment is unestablished initially but there is prospect of an established (i.e. permanent) appointment after 1 year's satisfactory service.

Application forms and further information are obtainable from Scottish Office Personnel Division, Room 110, 16 Waterloo Place, Edinburgh EH1 3DN (quote ref. PM(PTS) 2/5/78) (031-557 2090, Ext. 227).

Closing date for receipt of completed application form is 9th August 1978.

(8316)

FACULTY OF ART & DESIGN — GREENGATE HOUSE

Studio Engineer

required to plan anf manage audio and colour-capable TV studios. The post involves working with academic staff and technicians, and also entails a large amount of contact with students. The applicant should possess a graduate or full professional qualification and have at lease two years' experience in broadcast or closed circuit colour TV, studio engineering and management.

Inclusive salary ranges from £5,044 to £5,350 depending upon age, qualifications and experience.

Application forms and further details can be obtained from the Personnel Office, North East London Polytechnic, 109 The Grove, Stratford, E.15. Telephone 01-555 0811, ext. 32. Please quote reference number A535/78.

Closing date 15th August, 1978.

NELP North East London Polytechnic

(8351)

It makes more sense to deal with the Organ-Grinder

The way we see it, when you're looking for a new job there's only one person you should have to talk to and that's a potential employer.
We can arrange it.
Once we receive the coupon below . . . we'll send you a confidential application form.
Think of it as an interview – fill in all relevant details about your achievements, ambitions and the companies you don't want to join.
Leave the rest to us.
We'll compare this information to the needs of our clients – some 3000 major companies from industry and commerce. Each time the two match up, you'll be shortlisted for a key job . . . one which may never have been advertised. Our clients will then contact you direct.
We can help save your time, your energy, your money and you could find a better job sooner than you think.
Lansdowne Appointments Register, Design House, The Mall, London W5 5LS. Tel: 01-579 2282 (24 hour answering service).

Lansdowne

For those too busy doing a good job to find a better one.

Our clients are keen to meet men and women, Electrical Electronic/Sales/Engineers, aged 20 to 40 years, with potential earnings of between **£4000 and £7000 p.a.**

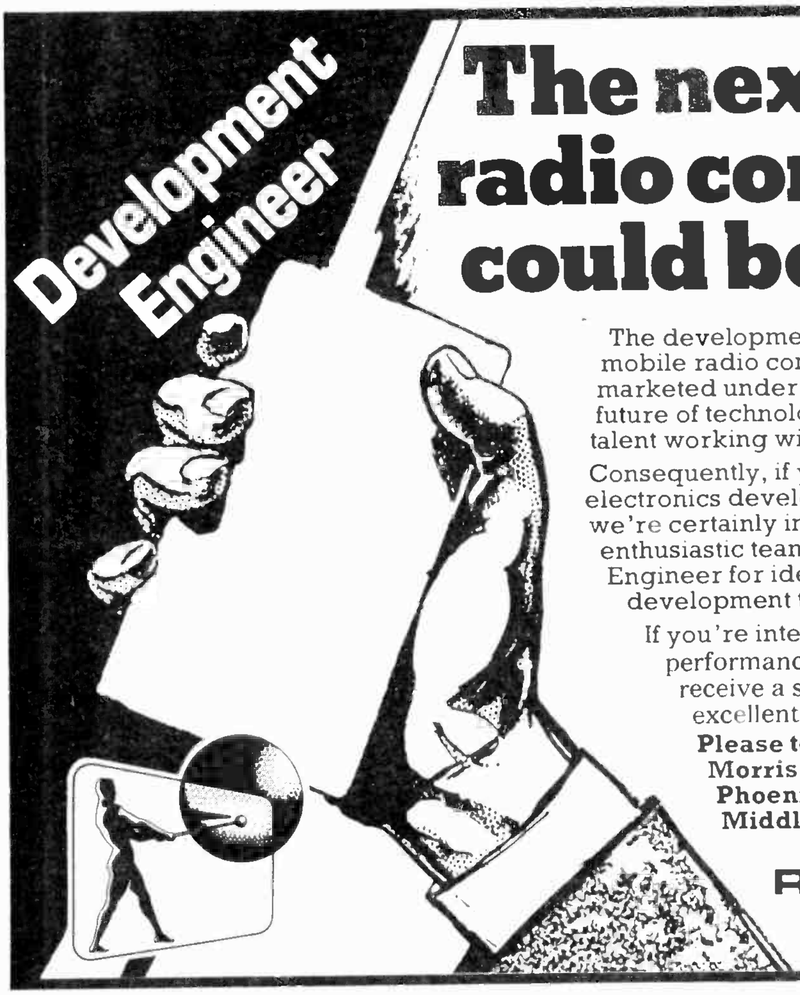
Name: ____________________

Address: ____________________

____________________ WW17/7

Lansdowne Appointments Register, Design House, The Mall, London W5 5LS. Tel: 01-579 2282 (24 hour answering service)

(8383)



The next generation of radio communications could be in your hands

The development and production of some of the most sophisticated mobile radio communications today takes place in Brentford and is marketed under the name of Rank Telecommunications. However, the future of technology in this field rests in the hands of the engineering talent working with us today. Particularly Development Engineers.

Consequently, if you're qualified to at least HNC with electronics development experience, not necessarily in UHF/VHF, we're certainly interested in meeting you. Working alongside an enthusiastic team, you'll be responsible to the Chief Development Engineer for identifying and following through full-scale product development to prototype.

If you're interested in getting into the development of high performance, high reliability communications systems, you'll receive a salary negotiable to £5500 together with an excellent benefits package.

Please telephone or write with full career details to Bryan Morris, Personnel Manager, Rank Pullin Controls, Phoenix Works, Great West Road, Brentford, Middlesex. Telephone: 01-560 1212.

RANK PULLIN CONTROLS

(8396)

Communicate with Racal

Radio Communications Systems Planning Engineers

Racal Communications Systems Limited pleasantly situated in Bracknell, Berkshire, is a member of the highly successful Racal Electronics Group and a world leader in H.F./S.S.B. telecommunications techniques.

Racal design a wide range of systems from small networks to major radio communications projects, which include Point-to-Point, Ground-to-Air and Shore Ship complexes. With the continued growth in demand for Racal communications systems there has resulted a need for Engineers, at all levels, to undertake the planning of radio systems in many parts of the world.

The Engineers selected will be capable of accepting responsibility for the systems from inception to final implementation, and have experience, both operationally and technically, in H.F. radio systems and associated ancillary equipment. They will be required to liaise on a technical basis with customers, at all levels, throughout the world, and this will necessitate overseas travel of limited duration from time to time.

For these positions Racal offers competitive salaries, over 4 weeks annual holiday, and a first class pension and free life assurance scheme.

If you are interested in, and wish to be considered for these positions, please write stating age, experience and present salary, for an application form to:

The Personnel Manager,
RACAL COMMUNICATIONS SYSTEMS LTD.,
Western Road,
Bracknell, Berks.

RACAL

ELECTRICAL/ ELECTRONIC ENGINEERS

Design unique computer/ communication systems

This is an opportunity to design, plan and manage the implementation of a wide range of interesting and unique computer/communication systems. The computer systems range from the use of microprocessors for specific applications, through mini computers to large main frame systems employing the whole range of peripheral devices. The communication systems range from line communications through the full spectrum of radio communications including satellite communications.

Although the job has a high managerial content in that you direct a team, you lead from the front. The work involves the interpretation and definition of internal customer requirements, and the preparation of project studies, designs and plans which provide technical solutions and define and cost all resource requirements to implement the solution.

There are opportunities to travel within the UK and also for short periods overseas.

Candidates must have passed, or been exempted from, examinations qualifying them for corporate membership of IEE or IERE, and have an aggregate of at least five years' recognised study, professional training and experience. Project management experience in the computer/communication field an advantage.

Starting salary between £4325 and £5735, depending on qualifications and experience. Promotion prospects. Non-contributory pension scheme.

For further details and an application form (to be returned by 11th August, 1978) write to Civil Service Commission, Alencon Link, Basingstoke, Hants. RG21 1JB, or telephone Basingstoke (0256) 68551 (answering service operates outside normal office hours). Please quote T(26) 85/1.

(8356)

GCHQ Cheltenham

Charles Barker
Confidential Reply Service

Please send full career details and list separately companies to which we should not forward your reply. Write the reference number on the envelope and post to our London office, 30 Farringdon Street, London EC4A 4EA

R+D Group Leaders

Marine Radar & Satellite Communications

Our client is engaged in an expansion programme and now seeks experienced Group Leaders to set up and manage new development teams in two key areas: Marine Radar and Satellite Communications.

These positions are likely to be of interest to candidates currently earning around £5,500.

Ref 1491

(8353)

UNIVERSITY OF LEEDS

Two Electronics Technicians, Grade 3, required in the Department of Physiology. The persons appointed would be required, under the supervision of the Electronics Engineer, to assist in the construction and maintenance of electronic equipment associated with research and teaching of biological studies. Must be capable of working from circuit diagrams and sketches.

Applicants should hold O.N.C. or equivalent qualifications and have had at least 3 years relevant experience. Salary is in the range of £2,688-£3,060, according to qualificatons and experience. Applications stating age, qualifications and full experience, together with the names and addresses of two referees should be addressed to Mr. E. French, Departmental Superintendent, Department of Physiology, Medical Multipurpose Building, Mount Preston Street, Leeds LS2 9NQ.

(8330)

WINCHESTER AND CENTRAL HAMPSHIRE HEALTH DISTRICT

ROYAL HAMPSHIRE COUNTY HOSPITAL

MEDICAL PHYSICS TECHNICIAN GRADE III

under the control of the District Engineer in the District Electronics Department based at this hospital.

The successful applicant will be required to work on, repair and maintain electro-medical and electronic equipment used by all departments within the Hospitals attached to the Winchester and Central Hampshire Health District.

Salary Scale £3,744 p.a. to £4,788 p.a. Applicants not previously employed by the Health Service will start at the minimum of the scale.

Minimum technical qualification O.N.C. or equivalent.

Closing Date: July 31st, 1978.

Application forms obtainable from the District Personnel Department, Royal Hampshire County Hospital, Romsey Road, WINCHESTER. Tel. Winchester 63535, Ext. 350/352.

(8359)

SENIOR DEVELOPMENT ENGINEER

ANALYST PROGRAMMER—MICROPROCESSORS

TEST ENGINEERS

S.E. LONDON/KENT

Electrosonic Ltd. is a leading company in the expanding fields of lighting control equipment and audio visual systems.

The company is based at Woolwich and is within easy reach of rural Kent.

SENIOR DEVELOPMENT ENGINEER

A professional development engineer is sought having wide all-round experience of electronic control circuit design together with audio design experience.

The applicant should have a commercial approach to development and be able to carry a project from initial design and breadboarding to final production including development or programming of associated test equipment and full documentation.

ANALYST PROGRAMMER

We seek creative people who have good computer experience and preferably have a strong computer element in their educational background.

The work involves Intel hardware using both high and low level language and an opportunity to design and implement multiprocessor systems.

Salaries for the above posts negotiable and are not expected to be a limiting factor.

TEST ENGINEERS

Experienced electronic engineers are required initially for testing and fault finding of unit and systems electronic equipment employing some of the latest digital, analogue and audio circuitry.

Applicants should have considerable experience in the testing and fault finding of modern electronic equipment. Academic training to HNC level or equivalent is desirable.

The positions offer opportunities for transfer to technical support positions in the company's software or hardware design teams and project engineering section after two years in the test department.

Starting salary £3,500 - £4,000.

The company offers an attractive working environment and excellent conditions of employment.

Apply: Mr. R. D. Naisbitt, Engineering Director

ELECTROSONIC

815 Woolwich Road, Charlton SE7. Telephone: 01-855 1101

(8375)

TEST TECHNICIANS

We have opportunities in West London for Technicians, male or female, to do interesting work testing small batches of electronic equipment for use in broadcasting.

Technicians with at least one year's experience of electronic work and qualified to Final C & G or ONC standard will start at a salary of between £3230 and £3490 on a scale which rises to £3880.

Senior Technicians with at least two years experience and a qualification to HNC or FTC standard start at a salary between £3535 and £3835 on a scale which rises to £4800.

Less experienced Technicians are given facilities to continue their training and study to HNC or FTC level, but may start at a lower salary.

Apply in writing to: **Mr. P. W. Green, BBC, Equipment Department, Power Road, Chiswick, London W4,** or telephone 01-994 8541 Ext. 232 for an application form.

BBC

(8378)

FOREIGN AND COMMONWEALTH OFFICE COMMUNICATIONS DIVISION

has vacancies for

RADIO TECHNICIANS

to carry out shift duties concerned with MW and HF broadcasting systems involving frequency changing, fault finding and routine maintenance, keeping logs, and recordings.

Applicants should have minimum qualifications of City and Guilds Intermediate Certificate in Telecommunications or its equivalent.

The successful candidates will serve initially at Crowborough, but may be required to serve elsewhere in the UK or overseas should the necessity arise.

Salary is according to age, e.g. £3,176 per annum at age 21, £3,435 at age 23, £3,700 at age 25 or over on entry rising by annual increments to a maximum of £4,252 per annum.

The appointments attracts 4 weeks ' paid holiday and prospects of pensionable employment.

Recruitment Section
Foreign and Commonwealth Office
Hanslope Park, Hanslope, Milton Keynes MK19 7BH

(8320)

Service and Test Engineers

As aircraft and electronics equipments become more sophisticated and our servicing programme expands, the need for experienced Service and Test Engineers increases.

At Stanmore, we are involved in the provision of spares and the repair, maintenance and overhaul of a variety of British and American airborne electronic equipment.

We need Engineers who can successfully maintain the high standards and efficiency required both in the aircraft and the workshop.

It's skilled work, calling for sound practical experience of radio and electronics theory, ranging from audio to microwave and including the use of advanced test equipment for fault diagnosis. Training in this field will be given to suitable, less experienced engineers.

The Company offers excellent salaries and benefits together with first-class working conditions in well-equipped workshops. This Unit is conveniently situated in pleasant surroundings within easy reach of the A1 and M1.

MARCONI AVIONICS
A GEC-Marconi Electronics Company

If the job sounds interesting and you'd like to put us to the test, write with details of experience to:
Mrs. E. Wagg
Marconi Avionics Ltd.
22-26 Dalston Gardens, Stanmore, Middlesex
HA7 1BZ.
Tel: 01-204 3322

CITY OF LONDON POLYTECHNIC
LIBRARY & LEARNING RESOURCES SERVICE

TECHNICIAN GRADE 5

We are looking for a versatile person to join a small team involved in the running of **Media Services** throughout the Polytechnic.

The successful applicant will be mainly concerned with the servicing of audio visual and television equipment, but he/she will also be required to operate a whole range of television and audio equipment, and become involved in media productions.

A keen interest in the audio visual field is essential, together with a sound practical knowledge of TV electronics.

Salary — (Grade 5) £3.675-£4.212 including London Weighting, starting point dependent upon qualifications and experience.

Further details and application forms may be obtained from the Assistant Secretary, City of London Polytechnic, 117-119 Houndsditch, London EC3A 7BU.

The closing date for completed applications will be 15th August, 1978. (8372)

LUXMAN DISTRIBUTORS

Require an additional

HI-FI ENGINEER

Must be experienced and capable of servicing high quality equipment. Good prospects.

Apply: **Sales Manager,**
HOWLAND-WEST LTD.
3/5 Eden Grove
London N7 8EQ
Tel: 01-609 0293

(8389)

SERVICE ENGINEER, freelance, able to rewire and quality control pick-up arms. Box No. WW 8339.

SOUND SYNTHESISER manufacturer offers a unique opportunity for a young, enthusiastic assembly and test engineer. Qualifications secondary to ability, training given. Part-time. 01-769 0880. (8370

THAMES TELEVISION TECHNICAL TRAINING SCHEME

Thames Television will again be running their Training Course for the following:-

Sound Operators, Television Technicians, Television Engineers, Film Trainees.

Candidates should preferably be between the ages of 20 to 25, possess an academic qualification in their specialist subjects, i.e., City and Guilds, HNC or a University Degree, or to have a number of years' experience in television or associated industry. The training course will be up to a year and will cover the theoretical and practical aspects of television.

Those wishing to apply should send details of their previous experience and qualifications to The Training Organiser, Thames Television Limited, Teddington Lock, Teddington, Middlesex.

THAMES

(8328)

REDIFFUSION INDUSTRIAL SERVICES LIMITED

A vacancy has arisen for a

SUPERVISOR

who under the direction of the Production Manager will be responsible for the control and direction of a team of workshop technicians and assemblers. Several years' practical experience in this type of work, involving closed circuit television, public address and small batch production techniques are required together with an aptitude in controlling and delegating work to staff. An attractive salary is offered and fringe benefits include a self-contributory pension and insurance scheme, subsidised canteen and discounts on a wide range of goods including television rental.

We also require

WORKSHOP TECHNICIANS

and applications are invited from personnel with experience in prototype wiring. The maximum basic weekly wage rises to £71.72 and in addition there are excellent opportunities for overtime work. Applications in the first instance should be addressed to.

J. T. Paul
Production Manager
Rediffusion Industrial Services Limited
Rediffusion House
214 Red Lion Road
Surbiton
Surrey KT6 7RP
Telephone No.: 01-397 5133

(8358)

ELECTRONIC DEVELOPMENT/ TEST ENGINEER

We are expanding our activities into new specialist areas and require an experienced engineer for TTL, CMOS and linear circuitry. Interesting opportunities in pleasant surroundings. Starting salary up to £4,000 p.a. depending on experience.

Apply in writing to **Professor E. T. Hall, Littlemore Scientific Engineering Co., Railway Lane, Littlemore, Oxford.**

8335

UNIVERSITY OF LONDON
INSTITUTE OF NEUROLOGY
DEPARTMENT OF NEUROLOGICAL SURGERY

ELECTRONICS TECHNICIAN GRADE 4

required starting in July to work under minimum of supervision with clinical and research staff. Work will involve patient monitoring, construction and maintenance of transducers, and of digital and analogue equipment. It will involve both clinical and laboratory setting and there will be opportunity for developing or improving equipment.

He will be based in the Department's research laboratory at Queen Square but will also work in the National Hospitals, Queen Square and Maida Vale. Initial salary will be on the scale £3,420-£3,865.

Applications in writing to the **Secretary, Institute of Neurology, Queen Square, London WC1.**

8342

THE ROYAL FREE HOSPITAL

MEDICAL PHYSICS TECHNICIAN III (Electronics)

Salary on scale £3,776-£4,708 p.a., dependent on qualifications and experience.
There is a vacancy in the Electronics workshop of this new major Teaching Hospital. Applicants should hold the City and Guilds Full Technological Certificate or an equivalent qualification and have experience in analogue and digital circuit.
Application form (to be returned by 18th August 1978) and Job Description from the Personnel Department, The Royal Free Hospital, 21 Pond Street, Hampstead, London NW3 2PN. Tel. 01-794 0431. Please quote ref. 0759.
Camden and Islington Area Health Authority (T)

8334

Electronic Component and Standards Engineers

As one of Europe's largest and most experienced real-time computer development companies, GEC Computers can provide an exceptionally attractive career opportunity for Electronics Engineers within the Components and Techniques Section of the Engineering Group at Borehamwood. The work entails selection, evaluation, specification and generation of application rules for a wide variety of passive and active components, including microprocessors, associated with advanced digital computing projects in both the military and commercial fields.

Applicants, male or female, should possess a degree in Electronics Engineering or other suitable disciplines and, preferably, should have experience in a similar environment. However, consideration will be given to capable and experienced engineers interested in specialising in this area.

Every encouragement will be given to successful candidates to keep in touch with advances in computing and component technology and application.

A competitive salary will be offered together with an attractive range of fringe benefits including assistance with relocation where appropriate.

Write with personal and career details to: Mrs. E. Harrington, Personnel Department, GEC Computers Limited, Elstree Way, Borehamwood, Herts or telephone 01-953 2030 ext 3697.

GEC Computers Limited

GEC

(8390)

Theatre Projectionist

International Advertising Agency

We need a projectionist who will play a major role in all aspects of film projection together with responsibilities for co-ordination of film library, audio video equipment and involvement in agency presentations.

Ideally, you should be 25-35 with 2/3 years' experience in a similar environment. Salary will be negotiable plus profit sharing bonus and other excellent benefits.

Please phone or write to:
**Chris Starling, Personnel Department,
Foote, Cone & Belding Ltd.,
82 Baker Street, London W1M 1DL.
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FCB

(8379)

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We manufacture a wide range of professional broadcast equipment, and you will be working on the design and development of audio products and related systems for Television and Radio Studios and Outside Broadcast Vehicles.

Other responsibilities include the design of audio circuitry for such projects as programme audio, communications and digital applications.

This job would suit someone with a good background in audio product design and development, educated to degree level or equivalent, who wishes to move into a senior, supervisory role.

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For an application form contact
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Pye TVT Limited, Coldhams Lane, Cambridge CB1 3JU
Telephone: Cambridge 45115 (8386)

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(ii) Switching

To train local staff in the practical maintenance of Strowger public and private branch exchanges, Test Desk operation and subscribers' lino fault control.
Candidates must have ten years' experience with a telecommunication operating or manufacturing organisation working on Strowger equipment, five years of which must have been in a supervisory capacity. A knowledge of reed relay exchanges is desirable.

(iii) Telecommunications Traffic

To train local staff in traffic duties with the object of creating a complete traffic forecasting and sales and service section, within the Department and in both telex and telephone operating duties.
Candidates must have ten years experience in a telecommunication operating organisation with a minimum of seven years' experience in a post equivalent to Traffic Superintendent. A sound knowledge of telephone exchanges and sales and service operations is required. Knowledge of International telephone and telex services would also be an advantage.
Tax free salary for all posts is up to the equivalent of £8,800 per annum including a special allowance. Both salary and allowance attracts a 25% tax-free gratuity. Benefits include free passages, generous paid leave, children's holiday visit passages and education allowances, outfit allowance and subsidised housing. For full details and application form ring Glenys Smith, 01-222 7730 x 3231, or write quoting MR2T/603/WD.

Crown Agents

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(8373)

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(8315)

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Tel: Brighton 507131.**

PCR

(8322)

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Candidates, male or female, should be qualified to degree level and should have experience of logic design and programming. A knowledge of FORTRAN would also be an asset.

A competitive salary will be offered depending on qualifications and experience, and there is an attractive range of benefits.

Write with personal and career details to Mrs. E. Harrington, Personnel Department, GEC Computers Limited, Elstree Way, Borehamwood, Herts or telephone 01-953 2030 ext 3697.

GEC Computers Limited GEC

(8387)

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(8345)

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(8393)

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8333

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(8313)

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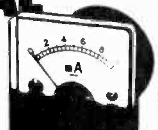

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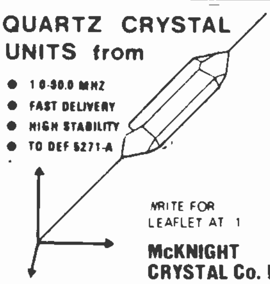

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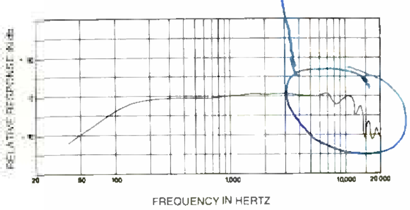
SM59

Mellow, smooth, silent...

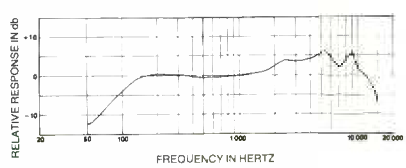
The SM59 is a relatively new, dynamic cardioid microphone. Yet it is already widely accepted for critical studio productions. In fact, you'll see it most often where accurate, natural sound quality is a major consideration. This revolutionary cardioid microphone has an exceptionally flat frequency response and neutral sound that reproduces exactly what it hears. It's designed to give good bass response when miking at a distance. Remarkably rugged—it's built to shrug off rough handling. And, it is superb in rejecting mechanical stand noise such as floor and desk vibrations because of a unique, patented built-in shock mount. It also features a special hum-bucking coil for superior noise reduction!



SM58

Crisp, bright "abuse proof"

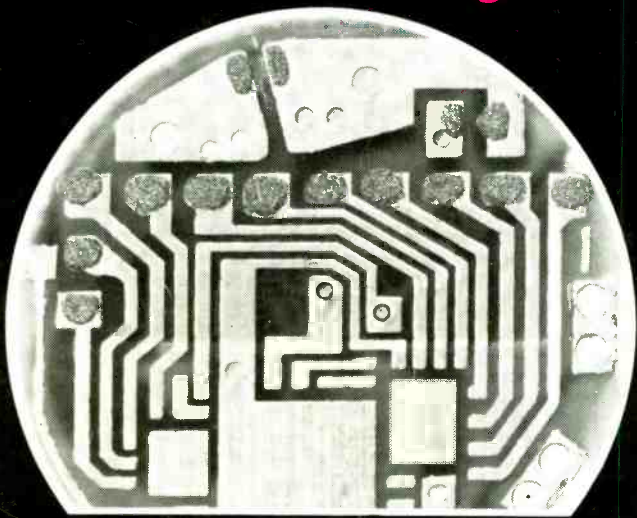
Probably the most widely used on-stage, hand-held cardioid dynamic microphone. The SM58 dynamic microphone is preferred for its punch in live vocal applications...especially where close-up miking is important. It is THE world-standard professional stage microphone with the distinctive Shure upper mid-range presence peak for an intelligible, lively sound. World-renowned for its ability to withstand the kind of abuse that would destroy many other microphones. Designed to minimize the boominess you'd expect from close miking. Rugged, efficient spherical windscreen eliminates pops. The first choice among rock, pop, R & B, country, gospel and jazz vocalists.

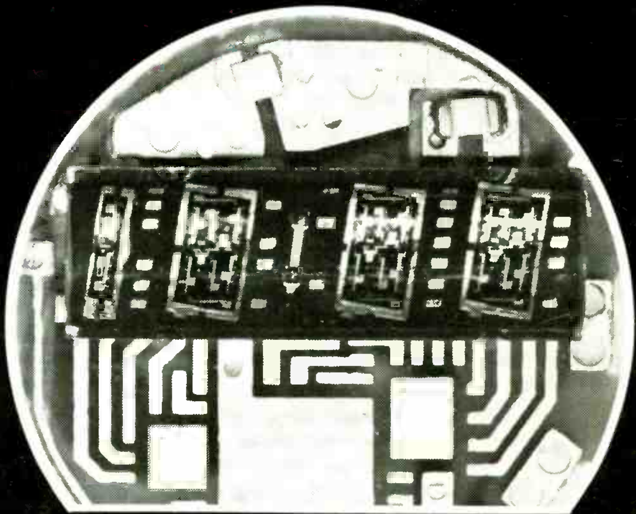


professional microphones...by SHURE®

Shure Electronics Limited, Eccleston Road, Maidstone ME 15 6AU—Telephone: Maidstone (0622) 59881

To see how Multicore Oxide-Free Solder Creams offer you higher profits – just watch





Applications don't come much more critical than digital watch manufacture.
Here, discrete deposits of Multicore Oxide-Free Solder Cream are screened onto the PCB. A precision job, with no risk of operator error or fatigue. And, a convenient temporary adhesive for the positioning of components.

Solder-flow is accomplished by simply passing the units over a hot plate.
Fast. No oxide to contend with. No dirty residues.
This manufacturer says Multicore Oxide-Free Solder Cream has *reduced reject rate substantially* and offers superior soldering quality.

ordinary solder creams cannot match this profitable performance. Here's why...

...because ordinary solder creams or pastes contain rosin-based flux mixed with solder powder produced by atomisation. This means that every particle of the powder is covered with a layer of oxide – slowing down the soldering process, leaving a dirty flux residue and causing solder globules to stick to the flux and possibly fall loose into the equipment after shock or vibration. But, Multicore have developed a very special method of producing solder powders that are virtually oxide-free.

These can be used in cream form – comprising an homogeneous stable mixture of pre-alloyed powder and flux, designed specifically for hybrid microcircuits, PCB's and critical component joints.

When heated, Multicore Oxide-Free Solder Creams melt and flow as quickly and cleanly as rosin-cored solder wire, leaving a pale clear flux residue without solder globules.

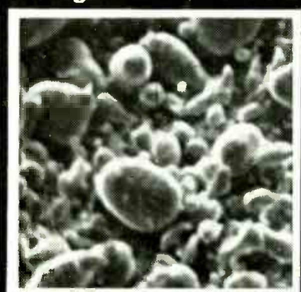
The in-built quality of Multicore Oxide-Free Solder Creams make them the ideal specification for almost any application calling for low cost yet high reliability.

They are available in a wide range of combinations of solder alloys, fluxes, particle sizes, flux contents and viscosities – often replacing solder preforms.

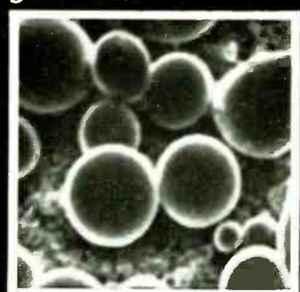
However, if you have an application that specifically requires preforms, remember that Multicore supply a wide variety of those as well.

Multicore Solders Ltd are Ministry of Defence Registered Contractors and on Qualified Products List QQ–S–571E of U.S. Defense Supply Agency for solder creams and preforms.

Compare these electron-microscope enlargements at x 240 magnification:



'Ordinary' cream solder powder, revealing poor particle shape and dross.



Solder powder from Multicore Oxide-Free Solder Cream displays clean, uniform particles.

Multicore

For full information on Oxide-Free Solder Creams or any other Multicore products, please write on your company's letterhead direct to:

Multicore Solders Limited,
Maylands Avenue, Hemel Hempstead, Herts. HP2 7EP.
Telephone: Hemel Hempstead 3636. Telex: 82363.