Signal divider for satellite TV receivers
Computer-controlled slide fader
Uniphase loudspeaker system

UK £1.50
IR £2.20
(incl. VAT)
**BBC Micro Computer System**

**UPGRADE KITS:**

- Tech EPROMs/RAMS
- 40T SS DD £10.00 (d)
- 40T DS DD £12.50 (d)

**DIT ACCESSORIES:**

- 40 Disc Lockable Box £8.50 (c)
- 30 Disc Storage Box £5.00 (c)

**UTILITY ROMS:**

- DISK GATE for FX/FX compatible £3.10 (d)
- DISK GATE for FX/M Acorn £3.00 (d)

**COMMUNICATIONS ROMs:**

- TERMINAL £25.00 (d)
- MODEMASTER II £25.00 (d)
- COMMANDER II £25.00 (d)

**PROFESSIONAL SOFTWARE:**

- Wordstar Made Easy £7.95 (d)
- Wordstar Handbook £11.95 (d)
- Viewstar £10.95 (d)

**INTERFACE PARTS:**

- Acorn 132 Parallel Lead £6.50 (d)
- Acorn 132 Serial Lead £6.00 (d)
- IBM 132 Parallel Lead £12.00 (d)

**PROJ:**

- Programmers Guide to BBC £15.00 (d)
- Programmer's Reference £15.00 (d)
- Turbo (5.25"), £25.00 (d)
- Turbo (3.5"), £35.00 (d)

**CARD INTERFACE:**

- Acorn 132 Parallel Lead £6.50 (d)
- Acorn 132 Serial Lead £6.00 (d)
- IBM 132 Parallel Lead £12.00 (d)

**ACCESSORIES:**

- EX 1000 £295 (a)
- LX800 £329 (a)
- EPSON 8143 £30 (a)
- EPSON 8148 £50 (a)

**MONITORS:**

- 510 150 MHz Freq Meter £25.00 (d)
- VIA 6522 Book £10.00 (d)
- Math Prog vt BBC Basic £9.95 (d)

**PRINTERs:**

- EPSON FX80 £189.00 (d)
- FX1000 £200.00 (d)
- Star 9610 (Parallel) £179.00 (d)

**BOOKS:**

- The Programmer's Reference £13.75 (d)
- The Programmer's Reference £15.00 (d)
- The Programmer's Reference £15.00 (d)

**PROJECTs:**

- E-86: £86.00 (d)
- Electromagnetic KIt £86.00 (d)
- Universal Terminal (6520) £75.00 (d)

**ALL PRICES EXCLUDE VAT, please add carriage 50p unless indicated as follows:**

- £4.50 (d)
- £5.00 (d)
- £5.00 (d)

**NEW PRODUCTS**

- Acorn 132 Parallel Lead £6.50 (d)
- Acorn 132 Serial Lead £6.00 (d)
- IBM 132 Parallel Lead £12.00 (d)

**SEND FOR DETAILED LEAFLET:**

- A powerful editor with many features. Send for detailed leaflet.

**PROFILES:**

- Junior Computer Kit £86.00 (d)
- Housekeeper Kit £86.00 (d)
- Electromagnetic KIt £86.00 (d)

**TECHNOLINE VIEWDATA SYSTEM**

- Tel: 01-450-7506
- Using 'standard type protocols, for more information available 24 hours, 7 days a week.

**PLEASE ADD CARRIAGE AS PER CODE & 5% VAT**

- Orders from Government Depts. & Colleges etc. welcome.
- Telephone: 01-723-0233

**IMPORTANT NOTICE:**

- Prices subject to change without notice.
13 Editorial

Components
14 Sensors & actuators
20 The reason for miniature transducers by Mike Coope
22 Infra-red detector for alarm systems

Computers
24 PROJECT: A 256-colour adapter for the EGA by Peter Balch
28 Towards the Supernode computer by Dr Chris Jesshope

General Interest
30 PROJECT: Computer-controlled slide fader (1)

Audio & Hi-fi
36 PROJECT: Uniphase loudspeaker system
40 The value of silence by Dr Dylan Jones and Dr Chris Miles

Radio & Television
43 PROJECT: Signal divider for satellite TV receivers by R. van Terborgh
46 PROJECT: Low-noise preamplifier for FM receivers
49 Radio & TV news
52 PROJECT: Slave indication unit for intelligent time standard

Design Abstracts
60 Electronic compass

Test & Measurement
62 Dual trace oscilloscopes: a review — Part 4 by Julian Nolan
68 A word in the hand makes the measurement firm by David Simpson

Information
19 Events; 21-27-49-66 News; 57 New literature; 58 People; 59-73 New products; 70 Readers services; 72 Terms of business

Guide lines
76 Buyers guide 77 Switchboard 78 Classified ads 78 Index of advertisers

In next month's issue:
The main theme will be Electrophonics and a number of articles will deal with this popular subject, among them:
- Guitar fuzz unit
- Computer-controlled music generator
- MIDI code generator
Further:
- Active loudspeaker system
- Digital optical transmitter
- Radio communications of the future

see pages 74 and 75 for our special offer of three Crotech oscilloscopes

Front cover
In line with our theme of the month, our front cover this month shows a selection of thermocouple temperature sensors.
Sensors and medicine

Mention the United Kingdom Atomic Energy Authority's laboratory at Harwell to most people and they immediately think of nuclear engineering and power stations. It would, no doubt, surprise them to hear that nuclear engineering is now but a relatively small part of the UKAEA's activities. During the past decade, the laboratory has, in fact, become a research institute for the whole of British industry, and is now one of the largest contract research organizations in Europe.

One of the research programmes is devoted to discovering new devices and materials for use in biosensors. These combine micro-electronics and biochemisty to give novel types of detector. The surface of such a sensor has to react with a specific substance to give a change that can be detected and converted into an electrical signal.

One promising method is to mimic the human body's information transmission system, that is, to make an artificial nerve. The success of such a device hinges on substances called ion gates. Normally, cells are surrounded by insulating membranes that exclude all unwanted molecules. Ion gates can upset this by opening up channels in the membrane through which ions can pass. This is the crucial information transduction event. Not only does the opening of a channel produce an electrical current (moving ions), but amplification as well. One gate can let millions of ions through at a time.

The most exciting artificial nerve sensor consists of an artificial membrane only two molecules thick (3 to 5 nm). These form self-assembly, highly ordered systems that are very good electrical insulators. Specific detector molecules, such as antibiotics, are incorporated into the membrane, and when the substances to be detected are bound to these, it is observed as a change in the gating characteristics.

One of the first uses of the Harwell device may be to detect human pregnancy hormones; it will be possible to tell whether a woman is pregnant much sooner than at present.

There is even greater potential for the device in other fields. As the original idea for the sensor came from mimicking the human nerve, it seems a simple progression to create an artificial brain cell. Neuro-physiologists now believe that learning and memory occur when the ionic transmission characteristics of the membrane separating brain cells is semi-permanently altered. Chemicals released by the body are responsible for this change, which occurs over a period of time.

This is similar to the way the new biosensor works and the way in which future parallel computers may operate. If the devices are to work as memory or switching elements, the binding of a messenger molecule to a receptor molecule in the cell membrane must be made more reversible. This is made possible by the use of artificial proteins.

The possible extension of the technology to computer and logic circuits lies outside the scope of the biosensor project, but Harwell is using its expertise in computing to improve the current parallel computer processing algorithms and is evaluating new applications in control and instrumentation.
Radiant, mechanical, thermal, magnetic, and chemical effects in our environment are nowadays normally detected and measured by electronic means. The conversion of these (analogue) effects into (digital) electrical signals is invariably effected by sensors. These transducers have become so important that without them life on earth would almost literally come to a standstill.

Sensors come in a wide variety; it is estimated that there are close to 20,000 different types produced by thousands of manufacturers all over the world. The most important types are used in the detection or measurement of temperature, pressure, gases, radiation, humidity, magnetism, acceleration, direction, angle, flow, level, presence, position, displacement, and many more. The operation of most sensors depends on optics (lasers, optical fibre, infra-red emitters and detectors), semiconductivity (photo transistors, photo diodes), thermoelectricity (thermocouples), or piezoelectricity. The demands made on most sensors are high: they must be sensitive, corrosion-resistant, inexpensive, precise, stable, easily integrated into a microelectronic circuit, and preferably have a linear input/output characteristic.

**Optic sensors**

Fibre optic sensors can be regarded as comprising three parts: the optical transmitter, the optical modulator, and the optical receiver. Each of the three parts has one major "active" component. The transmitter has an emitter (such as the LED or a laser); the modulator has the stimulus sensor mechanism (such as a diaphragm or a specific optical property material); and the receiver has a photodetector. The emitters employed in fibre optic sensors can be classified as broadband (incandescent), narrowband (LED), coherent (lasers), or blackbody radiators (emitting from inside or outside the fibre). The choice of which one to select depends solely upon the modulator mechanism being employed. For instance, fluoroptic thermometers use temperature dependent fluorescence of materials at the end of a fibre optic probe. Many sensors for high temperature measurements rely upon blackbody radiation for ranges from 300 to 2000 degrees Celsius. However, the vast majority of applications use their own external light sources in the form of an LED or a laser, primarily because of the specific need to accurately control the emitter wavelengths, power outputs, and modulation frequencies.

Fibre optic sensors have been helped significantly by developments in LEDs, super luminescent diodes (SLDs), and lasers used in the fibre optic communications and optical disc industry. Semiconductor LEDs can emit from either their surfaces or their edges, depending on their design. Surface emitting LEDs (SLEDs) have a wide solid angle on the output beam, and the beam intensity is Lambertian. Edge emitting LEDs (ELEDs), on the other hand, have a waveguide mechanism inherent in their structure (as do lasers) and thus have a narrower Gaussian intensity beam.

TABLE 1.
Comparison of Surface LEDs (SLEDs), Edge LEDs (ELEDs), SLDs, and Lasers

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>SLED</th>
<th>ELED</th>
<th>SLD</th>
<th>Laser</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spectral width (nm)</td>
<td>80-100</td>
<td>75-80</td>
<td>10-20</td>
<td>0.6-2.5</td>
</tr>
<tr>
<td>Typical optical power output (mW) at 100 mA (except lasers)</td>
<td>0.5-0.75</td>
<td>0.4-0.5</td>
<td>0.6-0.8</td>
<td>5-10</td>
</tr>
<tr>
<td>Coupling efficiency of optical power into fibres</td>
<td>Mediocre, needs lensing</td>
<td>Small</td>
<td>Sensitive</td>
<td>Best</td>
</tr>
<tr>
<td>Response time (ns)</td>
<td>10-50</td>
<td>5-15</td>
<td>5-15</td>
<td>1-2.5</td>
</tr>
<tr>
<td>Stability to ambient temperature</td>
<td>Least changed</td>
<td>Sensitive</td>
<td>Least sensitive</td>
<td>100</td>
</tr>
<tr>
<td>Lifetime expectancy in years</td>
<td>1000</td>
<td>1000</td>
<td>1000</td>
<td>100</td>
</tr>
<tr>
<td>Package options</td>
<td>Lenses: Yes</td>
<td>No</td>
<td>No</td>
<td>Special cases</td>
</tr>
<tr>
<td></td>
<td>Fibre connectors: Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Fibre pigtail: Yes*</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Thermoelectric coolers &amp; stabilization modules: No</td>
<td>Seldom needed</td>
<td>Special cases</td>
<td>For all critical applications</td>
</tr>
</tbody>
</table>

An actuator is a device that converts an electrical signal into another form of energy, normally mechanical. It is thus a special type of transducer. Typical examples are loudspeakers, electronic switches, and many measuring instruments.
The amount of power an emitter needs to generate for a fibre optic sensor application is a function of several design factors. The power from an emitter must first be transferred into an optical fibre. In many cases, it must be tailored appropriately (e.g., through a polarizer, as in the case of a fibre gyroscope) prior to such introduction.

LEDs, SDLs, and lasers are not only made of the same semiconductor materials but also have the same basic device structure. In principle, these semiconductor devices have a p-n junction, which upon being forward biased leads to a recombinant of holes and electrons with the simultaneous emission of photon energy. The wavelength of this emitted light is in turn governed by the composition of the semiconductor material. Thus, the amount of aluminium determines the center wavelength of the emitted light.

LEDs, SDLs, and lasers are in an ascending order of sophistication (see Table 1). An SDL can be regarded as an emitter that is half-way between an LED and a laser. An LED produces spontaneous emission in its “active” region and thus has a wide spectrum about a central wavelength. A laser has a built-in mechanism in its structure so that light produced in its active region is made to oscillate between its specially designed front and back facets, thus leading to a primary wavelength or mode of operation.

An important application of the optic sensor is in robotics, since it makes possible artificial vision, without which robots cannot reach their full potential. Another application of the optic sensor is in seam tracking and process control in arc welding. The sensor is inherently insensitive to the arc light.

An interesting application is the oxygen sensor that measures oxygen saturation in the human blood so as to control the rate of a pacemaker. The sensor is integrated in the stimulation carcase and located in the right ventricle of the heart. A new line of intelligent sensors promises to rid cars, buildings, aircraft, and factories of most of the increasingly complex wiring. One of these sensors uses a multiplexable optical encoder chip produced for Honeywell by its Optoelectronic Division in Richardson, Texas. This chip combines sensors and analogue and digital circuits on a single wafer. The on-chip sensors can determine direction or rotation, rotational velocity, and angular position.

A new technique to measure physical correlations in multi-use fluid transportation systems has been developed by the Berg Akademie Freiberg in Federal Germany. In this, fibre optic probes are used to accurately measure particle concentration, fluctuation, speed, size, and cross-sectional distribution — all critical in process control and regulation.

Among the measurement said to be possible with the system are impurities in water, organic or inorganic liquids, gas bubbles in liquids, crystals in saturated solutions, and flocculants in pipes and other apparatus.

Japan's Sofia University has developed an optic sensor that controls on-off switching for use in optical computers. The optical switch needs no electric circuits, since the optical signals are controlled by light beams. Remote control and information exchange are possible. The development is expected to accelerate the development of optical information processing technology, which forms the basis of optical computers and optical communications.

**Semiconductor sensors**

Semiconductor sensors have two important advantages over other types: they are invariably produced from silicon, which is a plentiful and well-researched material, and they can easily be integrated with amplifier and logic circuits onto a single wafer.

These sensors are normally encountered in the form of photo transistors or photo diodes. A photo transistor is a detector that consists of a bipolar junction transistor operated below the break-down voltage. The p-i-n and Schottky photodiodes are versions of the depletion-layer type. Avalanche photodiodes are reverse-biased p-n junction diodes that are operated at voltages above the breakdown voltage.

Sensors for the detection of gases are normally manufactured from other semiconductors materials such as tin oxide, zinc oxide, titanium oxide, and others.

**Piezoelectric sensors**

When certain materials are subjected to mechanical stress, an electrical polarization is set up in the crystal and the faces of the crystal become electrically charged. The polarity of the charges reverses if the compression is changed to tension. Conversely, an electric field applied across the material causes it to contract or expand according to the sign of the electric field.

Piezoelectric sensors are important since they couple electrical and mechanical energy and, therefore, are used as gramophone pick-ups, loudspeakers, microphones, to name but a few.

**Practical applications**

**Temperature sensors.** As already mentioned, many temperature sensors are based on the Seebeck effect that occurs in a thermocouple. They are normally produced in the shape of a probe: a wide variety of such probes is shown in Fig. 1.

A photo diode produces a current when it is illuminated. There are two main classes of photo diode: depletion-layer and avalanche. Depletion-layer diodes consist commonly of a reverse-biased p-n junction operated below the breakdown voltage. The p-i-n and Schottky photodiodes are versions of the depletion layer type. Avalanche photodiodes are reverse-biased p-n junction diodes that are operated at voltages above the breakdown voltage.

Sensors for the detection of gases are normally manufactured from other semiconductors materials such as tin oxide, zinc oxide, titanium oxide, and others.

**Thermocouple sensors**

Thermocouple sensors depend on the phenomenon that when two dissimilar metals are joined at each end and the two resulting junctions are maintained at different temperatures a voltage is developed between them. Copper-constantan or iron-constantan thermocouples can be used up to 500 °C. Temperatures up to about 1500 °C may be measured with the aid of a platinum/platinum-rhodium alloy thermocouple, and even higher temperatures may be measured with an iridium/iridium-rhodium alloy thermocouple.

**Fig. 1. A selection of thermocouple temperature probes. (Photograph courtesy Omega International Inc.)**

Another well-known type of temperature sensor is the thermistor. This is basically a resistor, made from semiconductor material, that has a negative temperature coefficient. This means that when the ambient temperature rises, the element becomes more conductive (its resistance decreases) and the consequent change in voltage across it is a measure of the temperature rise. It should be noted that there are also thermistors with a positive temperature coefficient, whose resistance, therefore, increases when the temperature rises.

Temperature may also be measured by...
measuring infra-red (heat) radiation, for which an infra-red sensor as shown in Fig. 2 is used. This technique, called thermal imaging or thermography, is based on the property that each object radiates heat. The technique, for which a camera with a suitable lens system may be used, does not require any external source of illumination. It is used, for instance, in production tests to determine whether any component heats up too quickly (and is, therefore, almost certainly faulty). It is also used in medicine for diagnostic purposes to determine whether any areas of the body have an unusual temperature distribution.

Pressure/force sensors. Although there are various methods of measuring pressure and force, the most common one makes use of the piezoelectric effect as discussed earlier in this article. The most widely used material for the manufacture of pressure/force sensors is quartz. This material has some important advantages over others: (1) it is strong; (2) it is cheap; (3) it is a good electrical insulator so that the electric charge caused by the pressure collapses only slowly.

![Fig. 2. Typical infra-red sensor.](image1)

The parts making up a typical piezoelectric sensor are shown in Fig. 3. It consists of a wafer of silicon only 1 mm in diameter, onto which a tiny piezoelectric crystal and four resistive tracks have been etched with the aid of ion implantation. When pressure distorts the crystal, the resistance value of one or more of the legs of the resistance bridge changes. This type of sensor is versatile: it can be used for measuring absolute or relative pressure, overpressure, and pressure difference. It is suitable for pressures up to 40 MPa.

This type of sensor is, of course, widely used in all sorts of weighing machine. Other areas of use are hydraulics, water works, refineries, filter plants, pressure chambers, and loudspeakers.

Pressure sensors are also used in accelerometers, but there they operate somewhat differently. Such a sensor for measuring mechanical vibrations or impact contains a freely moving seismic mass and a piezoelectric element (normally quartz)—see Fig. 6. When the seismic mass is accelerated in the dire-

![Fig. 3. Constituent parts of a piezo-electric pressure sensor. (Photograph courtesy Telefunken AG).](image2)

![Fig. 4. Construction of a typical piezo-electric pressure sensor. (Courtesy Siemens AG).](image3)

![Fig. 5. A selection of typical pressure sensors. (Photograph courtesy Bruel + Kjaer).](image4)

![Fig. 6. Construction of accelerometer sensor. M=seismic mass; P=piezo-electric element; B=underside; R=initial tension. (Courtesy Bruel + Kjaer).](image5)

Humidity sensors. Humidity sensors are used almost exclusively in hygrometers, i.e., instruments for measuring the humidity of air. In the past, these sensors used a human hair, or a strand of silk, but nowadays they use a capacitor, a dew point mirror, or optical means.

The dew point mirror sensor depends on the effect that when a smooth surface is cooled it mist up. The moment this misting up starts is determined optically. Since it is accurately known at which pressure and temperature gases condense, this technique yields very accurate results.

Another type of dew point sensor consists of a very small wafer of resistive material which has been coated with a hygroscopic chemical. The wafer is fitted with two electrical terminals. When mist forms on the coating the resistance of the wafer increases. This type of sensor is quite vulnerable, but because of its very small dimensions, it is used in Sony's 8 mm Camcorder.

Optical humidity sensors make use of the property that gas molecules absorb energy at certain frequencies: water vapour does so in the infra-red region. It is thus possible with the aid of an infra-red sensor to determine how much energy is absorbed. The higher the humidity, the more energy is absorbed. This technique has the disadvantage that the infra-red sensor soits up easily and then becomes unusable.

Nowadays, the most important and best-value-for-money type of humidity sensor

...
is based on a capacitor. This is, of course, a special capacitor which as a dielectric that is sensitive to humidity. In the Valvo sensor—see Fig. 10—the dielectric is in the form of a foil that has been coated at both sides with gold, which forms the electrodes. Humidity changes the dielectric constant of the foil and thus the capacitance of the capacitor. Since this capacitor forms one of the legs of a capacitive bridge, the change in capacitance can be readily converted into an electrical voltage.

Gas sensors. As stated before, gas sensors are normally based on a variety of semiconductor materials. Such materials have the property that their resistance decreases when certain gases are present in the surrounding air. This effect is caused by adsorption of gas molecules on the surface of the semiconductor material. The consequent layer of gas molecules influences the conductivity, and thus the resistance of the element. These sensors are very sensitive: concentrations of only 1 ppm of the relevant gas in air are readily detected.

A variant of this type of sensor is Telefunken's ISFET—see Fig. 12. Basically, this is a modified MOSFET in which the usual metal gate has been replaced by a layer that reacts to the ions of certain gases. ISFETs are unbreakable, small, have a low-impedance output, have a large linear range of operation, are temperature compensated, and provide an output signal that is suitable for driving a microprocessor. Many gas sensors still depend (and will continue to do so) on a chemical reaction to generate an electrical voltage, current, or resistance change. Yet other sensors use the heat generated by the combustion reaction when a gas hits the surface of the sensor. This heat is applied to a platinum wire whose resistance then changes.

There are also optical gas sensors and these are used particularly for the detection of fire or smoke. They normally use a photo diode or photo transistor to monitor the light absorption behaviour of the surrounding air. When smoke darkens the air, the photo transistor switches off and this operates an appropriate actuator.

Light sensors. Probably the best known type of sensor is the light sensor. This can be based on a photo diode, photo transistor (see Fig. 13), p-i-n diode, photo varistor, or solar cell. All of these are made from the same material, silicon, and function in similar fashion at wavelengths from about 400 nm to around 1000 nm. Photons enter the silicon and cause a number of electrons to jump to a different energy level. This in turn causes a photo current which can be used to operate an actuator.

For wavelengths below 400 nm (ultraviolet light), photomultipliers are used. These are normally constructed as a valve and have the usual advantages of electron tubes: good bandwidth, low noise factor, high amplification. Primary electrons, emitted from the
Biological sensors. During the past few years, a new type of sensor has entered the fields of biology and medicine. These so-called biosensors consist of biological molecules, such as enzymes and antibodies. When such sensors react to other substances, a small electric signal is generated that can be detected with the aid of a suitable electrode (probe).

Remote sensing. Another interesting new field where sensors are indispensable is that of remote sensing. This exciting new technique has been made possible by the routine availability of satellite information for the entire surface of the earth. Remote sensors on board satellites provide digital data in seven wavebands of visible light, reflected infra-red radiation, and thermal infra-red radiation. Different surfaces reflect different amounts of radiation, which is why they appear in different colours and light intensities to us. In the same way that we distinguish objects by their appearance (but in a more sophisticated manner), these remotely sensed images can be used to identify the land-cover types which exist in an area. Since they record in the infra-red region, many things we cannot normally see are shown. Crop condition and the thermal properties of buildings or water can be 'seen' and displayed, for instance.

Remote sensing enables scientists to study the earth's surface on a scale which was until recently only dreamed of. For a very small part of the time it would take to survey a large area by conventional methods, digital information can now be used to identify and measure the extent of crop types, major land uses, soils, properties of water bodies, geological structures, and vegetation conditions. In sparsely populated areas, the existence of certain surface features is being established for the first time, and over all areas of the world, what were previously partial surveys can now be completed. A great attraction of remote sensing is the relatively low cost of large-scale surveys. For instance, images with ground resolution down to 10 m and covering 50 km x 50 km can be obtained for less than £1,000.

A final thought. Although the science and technology of sensors and actuators has made vast strides in the past few decades, the most complex, reliable, and versatile sensor system remains man. Coupled with his intelligent data processing unit which almost certainly will not be emulated during the life of anyone alive today, he forms a formidable system of intelligence. A pity we do not always appreciate it.

We acknowledge with thanks the cooperation and help received from the following organizations in the preparation of this article: British Aerospace; Bruel + Kjaer; Drägerwerk AG; Entran Ltd; Hawker-Siddeley; IGI Consulting Inc.; Omega International Corporation; Plessey Semiconductor; Salford University; Sensorsystem Wiedemann; Siemens AG; STC Mercator; Telefunken; Valvo Philips.

Anglo-Japanese agreement
A formal trade agreement was signed recently between Fujisoku Electric of Japan and Arrow Hart (Europe) Ltd, the Plymouth-based manufacturer of special-purpose electrical components. Under the agreement, Fujisoku, a leading Japanese switch manufacturer, will purchase rocker switches from Arrow Hart and sell them on their home markets.
EVENTS • EVENTS • EVENTS • EVENTS • EVENTS

IEE meetings this month
1 Recent developments in digital NDT equipment design.
2 Home automation.
8 Control problems of spacecraft — past, present, and future.
8-10 Digital communications*
11 Mobile radio networks.
16 Advances in sensors in biotechnology.
21-24 Video, audio, and data recording.
28 Expert systems in process control.
Full details from The Institution of Electrical Engineers
Savoy Place • LONDON WC2R OBL • Telephone 01-240 1871, except:
* Secretariat IZS 88 • Hasler AG • TDS1 • Belpstrasse 23 • CH-3000 Bern 14 • Switzerland.

Electro-optics and Laser Show
At the national exhibition Centre, Birmingham from 22 to 24 March. Further details from Cahners Exhibitions Ltd • Chatsworth House • 59 London Road • TWICKENHAM TW1 3SZ • Telephone 01-891 5051.

Further details from BEAMA • 8 Leicester Street • LONDON WC2H 7BN • Telephone 01-437 0678.

ICS courses this month
Fibre optic communications 8-11 Paris and 15-18 London Integrated voice/data communications and ISDN 15-18 Paris. Details from ICS Publishing Company Ltd • Telephone 0800 282 353 (UK only) or +44 372 379211 (outside UK);
France: Integrated Computer Systems • Telephone (1) 48 39 88 00.

Frost & Sullivan events this month (all in London)
7-9 Artificial Intelligence
14-16 Voice Processing
21-23 An Introduction to Data Communications
Frost & Sullivan Ltd • Sullivan House • 4 Grosvenor Gardens • LONDON SW1W 0DH • Telephone 01-730 3438.

European & National Standards
The third of a series of seminars organized by BEAMA on the theme European and National Developments in Quality and Standards - Opportunity or Threat? will be held at the Selfridge Hotel, Orchard Street, LONDON Wi on 22 March. It will be addressed by the Minister of Trade and Industry, the Rt Hon Kenneth Clarke, QC, MP.

TO BE PUBLISHED THIS SPRING
Two new books from ELEKTOR ELECTRONICS

DATA SHEET BOOK 2
ISBN 0 905705 27 0
Price £8.25
This book contains data on ICs as well as on discrete transistors and diodes. Moreover, it gives an introduction to fast (HCMOS) devices and a review of symbolic logic as proposed in BS3939:Section 21.

MICROPROCESSOR DATA BOOK
ISBN 0 905705 28 9
Price £8.95
This reference book gives a general description, hardware block schematic, software structure, DC characteristics, and instruction set for over 70 microprocessors.

RDP Transducer Indicators

turn any transducer into a measuring system
- Direct digital readout in engineering units
- Analogue and BCD outputs
- High and low-level trips
- Bench or panel mounting
- Many options

RDP Electronics Ltd.
GROVE STREET, HEATH TOWN, WOLVERHAMPTON
UNITED KINGDOM. Tel: (0902) 57512.
Telex: 335430 RDP-G.
THE REASONS FOR MINIATURE TRANSDUCERS

by Mike Coope*

A statement made by a senior engineer in the aircraft industry recently summed up some of the reasons why many industries have turned towards the use of miniature transducers. "Years ago our aircraft engine control electronics were the size of a small suitcase but today the total package size has been dramatically reduced. This obviously means that when we are testing these components, particularly for important vibration tests, that the additional weight that we add by employing transducers on to the unit can, if the size, and hence weight, are not minimal, completely change the test performance. We must therefore look for transducers, in this particular case accelerometers, with the smallest possible mass."

The simple but important rule that applies here is that $F = m \times a$. Hence the additional force that is applied to the item under vibration test is dependent on the mass and the distribution of mass in the overall dimensions of the transducer. For instance, suppose that a conventional sized accelerometer is used for the vibration test. If it weighs 100 grams and is being used for 100 g acceleration, by calculation in the $F = m \times a$, a further 10 kg is added to the weight of the component under test. This will considerably distort the results of the vibration tests.

Entrap designs and manufactures piezoresistive semiconductor strain gage accelerometers which have the capability of measuring both steady-state dc and high response dynamic vibration inputs. The EGA range offers models with measuring ranges from 0-5 g up to 0-5000 g within a housing as small as 0.140 x 0.140 x 0.270 in. (3.4 mm x 3.5 mm x 6.75 mm) and weighing as little as 0.5 grams. The EGA Series has the desirable feature of fluid damping to protect against resonant excitation. The EGAX model has the additional feature of internal overrange stops which give the accelerometer the capability of accepting an overload of ±10,000 g in either the normal sensitive acceleration measuring axis, or in all directions. This feature is available even on the lowest measuring range of ±5 g. Not only will this overrange feature make the accelerometer suitable for many impact and guidance applications, but it will also protect a valuable measuring transducer from day-to-day mishandling on the work-

shop floor where accidents will unfortunately happen.

These particular features of low mass and high overrange of the EGAX accelerometers have proved beneficial to a particular area of research in the medical field. Various departments of Medical Establishments have the need to study the features of muscular tremours and diseases such as Parkinson's disease. With patient involvement, the need is for an unobtrusive and small vibration measuring device to monitor the movements of the patient's limbs that has the capability of withstanding several thousand 'g' should the accelerometer be inadvertently dropped to the floor. This specification exactly fits the Entran EGAX Series of accelerometer, which has been used for many years by several Medical Establishments. Entran designs and manufactures a variety of semiconductor strain gauges, of which the smallest is active over 0.020 in. (0.50 mm) length by 0.006 in. (0.150 mm) width. The distinct advantage of these resistive sensing elements is (a) their micro-miniature size and (b) their extremely high gauge factors. The term gauge factor (GF) is a measure of the incremental change in the resistance of the strain gauge for a given incremental change in the active length of the gauge, i.e. $GF = \Delta R / \Delta L$.

Hence, gauge factor is a measure of the sensitivity or output performance of the strain gauge. To give a comparison, standard foil strain gauges typically have a gauge factor of 2.0, whereas that for a semiconductor strain gauge can be typically 150. This means that when semiconductor types are used, we can expect improvements of outputs in the region of approximately 75 times. Entran takes full advantage of these properties of their strain gauges in their extensive range of miniature transducers.

In the accelerometer (Fig. 1) strain gauges are bonded in pairs to the top and bottom surfaces of a single degree of freedom cantilever beam. A mass is attached to the end of this beam and the resulting deflection of the beam when experiencing a 'g' force results in a linear signal output when the strain gauges are wired into a Wheatstone bridge and an excitation voltage is applied (Fig. 2).

The advantages of strain gauge properties are also used in miniature pressure transducers (Fig. 3) where the parameter is sensed by monitoring the deflection of a metal diaphragm. To achieve the highest possible dynamic response, the diaphragm must be small and its designed full scale deflection minimal. With their inherent high sensitivity and ultra-miniature size, semiconductor strain gauges can be used on a stiff, low deflection diaphragm to achieve this criterion. A further advantage of the miniature diaphragm is its low deflection, resulting in low stress levels within the diaphragm material, and hence almost infinite fatigue life. Thus Entran pressure transducers offer measurement of both static and high frequency dynamic inputs.

The smallness of pressure has an important bearing on their performance. Size can also be important on the overall effects of the test. For instance, in the testing of the aerodynamics of scale models of new military and civil aircraft, automobiles, aircraft components such...
as helicopter blades, missiles, and generally all transport where the efficiency of movement is important, the transducer must be as unobtrusive as possible so as not to alter the original shape of the test piece. Entran have ultra-miniature transducers of low profile designs (EPL) with a thickness of 0.040 in. (1.02 mm), which are used in a recessed mounting to give original aerodynamic flow lines of the test model. Alternatively, all Entran EPI pressure transducers are available with diameters from 0.800 in. (2.03 mm) down to 0.050 in. (1.27 mm) and are used in many wind tunnel tests because they can be easily accommodated within the rivet head of an aircraft structure without affecting the structure and pattern of the normal air flow.

Entran's specialization is in the design and manufacture of miniature transducers for the measurement of acceleration, pressure, load and strain, but many other models have been developed with the requirements of Entran's customers in mind. Although standard models exist, it is accepted that many transducer requirements fall outside the normal specification and, for these situations, Entran has special engineering facilities to provide the low-cost OEM style transducer or the ultra-sophisticated, latest-technology, quality-assured transducer.

Within this framework of adaptation to market requirements, Entran offer a range of accelerometers and pressure transducers which are the outcome of long experience of transducer design. The new range of devices offers robust styling, both internally and externally, as well as the optional addition of internal miniature electronic circuits to give (a) amplified output up to 10 V FS; (b) supply regulation; (c) custom filtering. This short article emphasizes a few of the aspects that miniature transducers can play in the latest fields of industrial, research, medical, aerospace, chemical, automotive and many other industries. Further information on ENTRAN sensors may be obtained from ENTRAN Ltd.

COMPONENT NEWS

Thirty million TDA460Os

Seven years ago, Siemens found a way of integrating the control circuit for switch-mode power supplies used in TV sets on a single 7 mm² chip. Since then, sales figures have reached 30 million for the bipolar TDA4600 and 10 million for the TDA4601 version (with extended voltage range: 80-270 V).

Its ability to produce the required voltages at varying input voltages and loads in an economical way has made the TDA4600/4601 the unrivalled top product on the market, favoured by more than 200 customers throughout the world. An enhanced version, the TDA4605, using "SiPmos" transistors has now reached the production stage. As early as 1972, engineers at the Applications Research Laboratories of Siemens had conceived the idea of using a flyback converter as a power supply for TV sets. Until then, the standard practice had been to provide a rigid, and cost-intensive, coupling with the line frequency circuit. The introduction of the flyback converter drastically reduced the circuitry and components. The integration of the entire control circuit on the TDA4600 further simplified the power supply section in the TV set. The improved reliability of power supplies equipped with the TDA4600 is reflected in the significant reduction in TV set failures over the past several years.

Roxburgh Electronics become Alps distributor

Following an agreement with Armon Electronics LTD—official UK agents for Alps Electrical Company, Japan's largest independent components manufacturer-Roxburgh Electronics have been appointed nationwide distributors for the comprehensive range of Alps products.

Further information from Roxburgh Electronics Ltd. 22 Winchelsea Road RYE East Sussex TN31 7EI. Telephone (0797) 223777.

Liquid level sensors

Gentech International have extended their proven range of versatile liquid level sensors with a new externally fitted version which is simply and economically mounted using a compression grommet.

Prototyping kit for membrane keyboards

New from Highland Electronics is the DMC DT series of 'do-it-yourself' prototype keypad kits which contain all the parts necessary to build a customised membrane switch/keyboard panel.

Available in 4, 12, 16, 40, 80 and 102 QWERTY key configurations, the kit includes the basic switch unit, graphics overlay, colour pad, connector, bezel, and face plate. Options include dry transfer lettering to add numbers, letters, of function keys, depending on the user's applications. The DT series of kits is offered in a choice of key colour and lettering styles. Switch technology used in the keyboards combines low cost with high reliability and tactile feedback is provided by a stainless steel dome under each key position. Seven types of standard switch layouts can be cut into different configurations without disabling the remaining keys.

The switches have been successfully tried and tested to over three million operations at 24 VDC/5 mA.

The DMC DT prototyping membrane keypad kit is available ex-stock from Highland Electronics Ltd. Albert Drive BURGESS HILL RH15 9TN. Telephone: (0444) 45021.

* Mike Coope is Technical Sales Director of Entran Ltd.
INFRA-RED DETECTOR FOR ALARM SYSTEMS

As a follow-up to the design abstract on the Type PID-11 published last year (1), this article describes a versatile infra-red sensor which will find many applications in security and alarm systems.

The Type PID-11 infra-red sensor from Siemens introduced in reference (1) is a versatile component that lends itself to building a simple, yet effective and sensitive, transducer that detects heat emanating from mammals. To be able to understand the basic operation of the circuit shown in Fig. 1, it is recommended to read the sections Application tips and Some suggested circuits in reference (1).

The infra-red sensor, IC2, is powered by a regulated 5 V supply. The reference voltage available on pin 4 (2.2 V) is applied to opamp A1 for comparison with the voltage at pin 3. The voltage on pin 2 of the comparator is held slightly below the reference with the aid of potential divider R1-R2. In the non-activated state of the circuit, the output of A1 is, therefore, high. When the sensor detects infra-red radiation, however, the comparator supplies a short, low, pulse. Opamp A2 functions as a monostable multivibrator (MMV) and a buffer whose gain depends on the ambient light intensity measured by phototransistor T1. The trigger threshold of A1 can be adjusted with preset P1. The preset in network Cs-R5-P2 at pin 6 of A2 enables adjusting the mono time of the MMV, i.e., the hold time of the circuit. Incident daylight on phototransistor T1 effectively raises the trigger threshold for the MMV, and hence ensures automatic disabling of the alarm by reducing its sensitivity. Pins 5 and 6 of the monostable are logic high in the non-activated state of the alarm. When the PID-11 senses the infra-red component in heat emanating from a mammal, the voltage on pins 5 and 7 of A2 drops abruptly to practically nought. The voltage on C1 is no longer maintained by D1, and the capacitor discharges. At the end of the discharge period, the monostable reverts to its initial state. Opamp A2 supplies a digital (TTL compatible) switch pulse at output DIG. The function of relay driver T3 and alarm indicator D1 is self-evident. The maximum on-time of the relay that can be set with P2 is about 1 minute after detection of any single alarm pulse from the detector.

Construction, adjustment and applications

The printed circuit board shown in Fig. 2 holds all the components in the circuit diagram, and so enables ready construction of the compact detector unit. The completed board is shown in Fig. 3.

Fig. 1 Circuit diagram of the PID-11 based infra-red detector for alarm systems.
Note that the top of the phototransistor, \( T_1 \), and that of the alarm indicator, \( D_3 \), is level with the top of the PID-11. Relay driver \( T_2 \) and regulator \( I C_3 \) do not need heat-sinks. The completed board can be fitted in a water-resistant, strong ABS enclosure, with suitable grommets, strain reliefs and sockets for the connection of the wires for the relay, the mains, and the digital output, if used.

When the circuit is used as an automatic porch light controller, it is recommended to fit it in a sheltered position over the front door, paying due attention to safe and sound insulation. In many cases, it may be safer (and cheaper) to use a separate 8 V AC adaptor plugged into a mains outlet in the home, rather than the PCB mounted mains transformer, \( T_n \). The adjustment of the circuit, i.e., the sensitivity and the relay on-time, is governed by the application in question. Initially, it is recommended to test the completed circuit by adjusting \( P_i \) such that the circuit is just off in the absence of an infra-red source. For this adjustment, it is necessary to temporarily cover the phototransistor against incident light. The value of tantalum capacitor \( C_s \) may be increased when the maximum relay on-time of 30 to 60 seconds is too short for the given application. It should be noted that the PID-11 signals detection of an infra-red source by an output pulse of about 1.5 s rather than by a continuous logic level. The pulse, which can be measured on the output of \( A_1 \) and \( A_2 \), is positive or negative, indicating a cold-to-warm or a warm-to-cold transition, respectively.

When fitting the IR detection unit, it is important to ensure that it can not detect heat from external sources (sunlight, heating systems, etc.). Also note that the sensitivity of the IR detector depends on the ambient temperature. Strong magnetic fields may cause interference in the sensor and hence spurious operation of the alarm. Finally, be sure to avoid overloading the relay contacts by switching too heavy loads.

Reference:


Siemens distributor in the UK is ElectroValue Limited 28 St Judes Road Englefield Green Egham Surrey TW20 0HB. Telephone: (0784) 33603. Telex: 264475.

Northern branch: 860 Burnage Lane Manchester M19 1MA. Telephone: (061 432) 4945.

Fig. 2 Track layout and component mounting plan of the PCB for building the IR detector.

<table>
<thead>
<tr>
<th>Parts list</th>
<th>Semiconductors:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistors (±5%):</td>
<td>( R_1 = 20k )</td>
</tr>
<tr>
<td>( R_2 = 33k )</td>
<td>( D_1 = 80V400 ) or ( 400V1000 )</td>
</tr>
<tr>
<td>( R_3 = 10k )</td>
<td>( D_2 = N4148 )</td>
</tr>
<tr>
<td>( R_4 = 100k )</td>
<td>( D_3 = \text{red LED} )</td>
</tr>
<tr>
<td>( R_5 = 1M )</td>
<td>( D_4 = N4001 )</td>
</tr>
<tr>
<td>( R_6 = 680R )</td>
<td>( T_1 = BPI03-3 )</td>
</tr>
<tr>
<td>( R_7 = 390R )</td>
<td>( T_2 = BD140 )</td>
</tr>
<tr>
<td>( R_8 = 1M0 )</td>
<td>( I C_1 = TL272 ) or ( TL272 )</td>
</tr>
<tr>
<td>( 131; 132 = 470 ) or ( 500k ) preset for horizontal mounting</td>
<td>( I C_2 = \text{PID-11} ) (Siemens)</td>
</tr>
<tr>
<td>( C_1 = 470u ) or ( 500k ) preset for vertical mounting</td>
<td>( I C_3 = 7805 )</td>
</tr>
</tbody>
</table>

Capacitors:

| \( C_1 = 470u \) or 25 V | Miscellaneous: |
| \( C_2 = 10p \) or 16 V | \( F_1 = 50 \) mA delayed action fuse with PCB mount holder. |
| \( R_1 = 220 \) | \( T_1 = \text{PCB mount transformer}; 8V \); 150mA. |
| \( R_2 = 10 \) | \( R_1 = \text{PCB mount SPDT relay}; 5V \); e.g. Siemens V23127-B001-A101. |
| \( R_3 = 15 \) | 2-way PCB mount screw terminal. |
| \( C_3 = 15p \) or 1V beaded tantalum | 3-way PCB mount screw terminal. |

Fig. 3 The completed circuit board ready for fitting in the ABS enclosure.
The 256-colour board described in this article is offered as a design idea to advanced users of the IBM-PC XT equipped with an EGA. The extension board plugs into the EGA feature connector. It produces analogue RGB signals, and TTL-level Hsync and Vsync. Many popular colour monitors accept either TTL signals from the EGA, or RGB signals from the 256-colour board, and can, therefore, be used both for the normal EGA modes and the new 256-colour modes.

By default, the colour extension board is inactive, and the EGA works as normal: installing the board does not, therefore, affect the execution of existing programs.

EGA modes
A complete description of all the display modes offered by the EGA is, unfortunately, beyond the scope of this article. In mode 14, the card produces 640 by 200 pixels, each of which can be assigned 1 of 16 colours. In mode 16, it produces 640 by 350 16-colour pixels. The 256-colour board combines pairs of these to give 320×200 or 320×350 pixels, each of which can be assigned 1 of 256 colours. This is similar to the performance of the VGA card used in the new PS/2 range of IBM PCs. In 256-colour mode, a VGA can display only 320×200 pixels.

In modes 14 and 16, the EGA outputs each pixel as four TTL signals called R, G, B and I. The 256-colour board combines pairs of pixels to give single 8-bit pixels. These eight TTL signals are converted to red, green and blue analogue signals by three D-A (digital to analogue) converters.

Feature connector
The EGA card contains a 32-pin socket called the Feature connector. This allows access to several signals on the EGA card. The proposed image extension uses 11 of these signals—see the pin assignment in Fig. 1.

- GND and +5 V provide power to the 256-colour board.
- R, G, B and I are the EGA pixel colour signals. R, G and B are the primary red, green and blue signals, while I is used for either the secondary green, or the intensity signal.
- 14 MHz is a clock running at one cycle per EGA pixel. The EGA pixel colour signals change on the falling edge of each clock cycle.
- ATRS/L is the attribute shift load signal. This is a short, active low pulse that indicates the loading of each byte into the EGA's pixel shift registers.
- HIN and VIN are the active high horizontal and vertical synchronization signals (note: signals going into the 256-colour board are labelled 'IN').
- INTERNAL enables and disables the 256-colour board. The signal is high when the EGA has disabled its internal video drivers.

![Fig. 1. The Feature connector on the IBM Enhanced Graphics Adapter (EGA).](reference)

Circuit description
The circuit diagram of the 256-colour board is shown in Fig. 2. The RGBI bits of the odd-numbered pixels of the EGA are latched into IC1. When the RGBI bits of the even pixels arrive, they are latched into IC3 along with the odd-numbered pixel bits now stored in IC1. This means that 8 bits of pixel information appear at the outputs of IC3 for every two cycles of the 14 MHz clock. Clocking of IC1 and IC3 takes place on the rising and falling edges of a 7 MHz signal, obtained by IC4 dividing the 14 MHz signal by 2.

It is important that IC1 stores the odd-numbered pixels, and IC3 the even-numbered ones, not vice versa. IC1 is cleared by the low level on ATRS/L every 8 pixels to maintain the correct phase relationship.

Timing
The timing of the clock signals applied to IC1 and IC3 is critical. The clock pulses must arrive when the RGBI signals are stable. Delaying and inverting the 14 MHz signal in a 7404 gate ensures the right timing and polarity. Similarly, the CLEAR signal for IC1 is obtained by delaying the ATRS/L signal in two 7404 gates. Do not use a 74LS04 in this application: its propagation delay is too short. The way in which the correct delays are obtained may be frowned upon for good reasons, but it is the only reasonable way of getting the timing right, given the signals available on the EGA's feature connector. The timing diagram of the circuit is given in Fig. 3.

D-A converters
An 8-bit pixel appears at the outputs of IC3 every 143 ns. These digital signals must be converted to analogue RGB levels that drive the monitor. The most advanced way of obtaining analogue RGB signals would be to use a chip that combines the functions of colour palette and multiple D-A converter. There are several such chips available, for instance the Type TMS34070 from Texas Instruments (reference 9), or the Type IMSG170 from Inmos, which can display any 256 out of 262,144 colours at a clock rate of up to 50 MHz. A palette chip would require an interface to the PC bus, address decoding circuitry, and
A colour monitor typically requires horizontal and vertical synchronization signals. The horizontal sync tells the monitor when to end each horizontal scan line, and when to start the next. Similarly, the vertical sync signal indicates the end of the vertical scan of the screen, and the start of the next. Some monitors require the horizontal and vertical sync to be combined to give composite sync.

The horizontal sync signal produced by the EGA is an active high TTL pulse. The polarity of the vertical sync signal is not fixed, however, and depends on the monitor and video mode used. In the 16-colour 640×200 mode, the vertical sync is an active high TTL pulse, while in the 640×350 mode it is active low.

The Taxan Type KS12R monitor can work in three modes. In mode 1 (IBM-PC mode), it displays 16 colours using active high TTL horizontal and vertical sync signals. It can also be switched to mode 2 (Apple-II mode), which displays analogue signals and uses active low TTL horizontal and vertical syncs. There is a separate connector on the monitor for each of these modes. The two sets of sync signals may not be applied simultaneously.

The HIN and VIN signals from the EGA are inverted by N1-N2, and buffered by ICI. When ICI is disabled, the Hsync and Vsync outputs are switched to high impedance, and no longer drive the monitor. When ICI is enabled, the EGA sets its own horizontal and vertical retrace output signals to high impedance. The control of ICI is reverted to below.

Be sure to check the specification of the monitor used in respect of the polarity of the sync signals. If it needs positive going synchs in both modes, the inverters on the HIN and VIN lines must be removed. Alternatively, set the sync signal polarity to the correct setting.
polarieties under software control by writing to the Miscellaneous Output Register of the EGA.

Enabling the board
The 256-colour board can be switched on and off under software control. Bit 4 of the EGA’s Miscellaneous Output Register controls the video and sync drivers of the EGA. A logic 1 disables the output drivers on the EGA, and causes INTERNAL on the Feature connector to go logic high. On the 256-colour board, this high level is inverted by $N_3$ and used for enabling the sync and pixel outputs on latches IC1 and IC2. By default, INTERNAL is logic low, so that the 256-colour board is inactive at power-on, and the EGA works as normal.

Construction and setting up
The construction of the colour extension card will present no difficulties to anyone who has completed any previous hardware project. The physical layout of the board is not critical.

The prototype was constructed on Veroboard, and plugs into the Feature connector of the EGA as a daughter-board. Figure 4 shows a suggested arrangement. The board is supported by an indirect connector which plugs into the Feature connector, and by a bracket bolted to the EGA 9-pin D-type video connector.

The outputs from the 256-colour board should be taken to a separate connector. It is suggested to use a 15-pin D-type so as not to confuse it with any of the other sockets on the rear panel of the computer. Remove the cover for the slot next to the EGA to give access to the 256-colour board.

The even-numbered presets are adjusted so that each colour is just off when the pixels are all zero. Then adjust the odd-numbered presets so that the screen is a bright white when the pixels are all set to 255 (FFh).

Software
A complete description of the EGA hardware and software is available from IBM. The comprehensive document is called Update Number 1 for the IBM Technical Reference Options and Adapters. The IBM reference part number is 6138280.

To get started with the colour extension board, use the BIOS calls to control the EGA, and write to the Miscellaneous Output Register. Setting bit 4 in this register disables the video and sync drivers on the EGA and enables the drivers on the 256-colour board.

Table 1 shows a Turbo Pascal procedure which puts the EGA into 640x200 16-colour mode, and enables the colour extension. The procedure uses BIOS interrupt $S10$, function $S00$, to set the display to video mode 14. It then writes $S33$ to the EGA Miscellaneous Output Register. For mode 14, the BIOS normally sets this register to $S23$, but bit 4 must also be activated here to enable the 256-colour board (for video mode 16, the BIOS normally sets the Miscellaneous Output Register to $SA7$).

Table 2 shows a Turbo Pascal procedure which draws a single pixel in one of 256 colours. It uses integer variables r, g and b to calculate the value of the two "pixel" bytes to be written, then calls BIOS interrupt $S10$, function $S0C$, to write the lower and upper halves of the 256-colour value to the even and odd-numbered pixels of the EGA. Using the BIOS to set the display mode always disables the colour extension board, making it easy to return to the standard 16-colour graphics.

It should be noted that the BIOS is extremely slow to write pixels. Eventually, users of the colour extension board will want to write software that gives direct access to the EGA hardware. For this,
the above mentioned IBM manual on the EGA is indispensable.

Reference:

---

New computer system for Metropolitan Police

Systems Designers Scientific has been selected by the Metropolitan to act as prime contractor in a £17 million project to provide the Met's computerized Crime Report Information System—CRIS. The new system will replace the Met's current paper-based crime report system with a force-wide integrated computer network. The present crime report system has become unwieldy and costly in valuable police manpower. CRIS will cut down time spent by officers supervising paperwork, allow complex searches through databases, and provide each division with instant access to crime reports from throughout the Metropolitan Police area. CRIS will be available to around 30,000 police officers and civil staff, 24 hours a day, seven days a week, for the immediate creation, updating, and interrogation of crime reports. Police personnel will be able to access instantly crime reports from the past two years and obtain, within four hours, crime reports from the previous four years held in archives. Nearly 2,000 computer workstations will be placed in all Metropolitan Police Divisions, Sub-Divisions, Areas, Enquiry Centres, and in various HQ branches to access databases held on a network of 233 EC MicroVAX computers at the divisions and a central VAX cluster based around eight VAX8700 mainframe machines.

Further information from Systems Designers • Centrum House • 101-103 Fleet Road • Fleet • Hampshire GU13 8PD.

High-performance portable

AMT's portable IBM compatible, the PC SPORT PLUS, has a conventional memory of 256 K that can be increased to 640 K, while a further 512 K memory can be added on a separate memory bank. The computer runs at 8 MHz. The keyboard provides a standard layout and in addition separate cursor keys (assisting numeric inputs to spreadsheets), ten function keys, and a reset button. A 360 K disk drive is built into the right-hand side of the machine and an external drive can be connected at the rear. Communications are available with two serial RS232 ports, 25-pin and 9-pin respectively. This facility allows the use of various modems without a converter lead. The display card is CGA (640 x 200), while an EGA card will be available soon as an optional extra. The PC SPORT PLUS is priced at £499 plus VAT. With DOS 3.2, 640 K RAM, and a monochrome monitor added, the price goes up to £703 plus VAT. Further details from Applied Micosystems Technology Ltd • 249-251 Cricklewood Broadway • LONDON NW2 6NX.
Esprit is a research programme supported by the Commission of the European Communities. It is currently funding a collaborative project to develop and exploit a low cost, high performance supercomputer, in which Southampton University is playing a major role.

Unlike conventional supercomputers, such as the Cray 1 and Cray 2, which tend to use expensive ultra-fast circuits, the prototype being designed at Southampton University makes use of the latest microprocessor technology. The Supernode supercomputer is based on the revolutionary transputer, which is a modern microprocessor designed by INMOS as a component of parallel processing systems.

Parallel processing uses many processors to obtain increased system performance. For example, the Supernode supercomputer may eventually contain several thousand transputers, all of which could be brought to bear on a single applications problem. The research programme, as well as developing several prototype supercomputers, will investigate programming and applications techniques for this novel computer architecture.

The exploitation of such large scale parallelism is by no means well established and the United Kingdom, like the rest of Europe, has an active research programme to ensure its information technology industry remains competitive during this period of major change. In fact Southampton University was initially funded by Britain's Alvey programme to investigate the feasibility of using the transputer as a basis for a supercomputer. Other partners in the Esprit collaboration also had prior funding for transputer research.

Prototype production
The collaborators in this project come from Britain and France, and include universities, small and large companies, and a government research establishment. The role of prime contractor with overall project management is filled by the Royal Signals and Radar Establishment (RSRE). The remainder of the plan is divided into work packages which involve the close cooperation of small groups of collaborators.

The prototype designing is being led by Southampton with collaboration from the RSRE and the two industrial partners, Thorn EMI and Telmat of France. These two will manufacture seven small and four large machines for the work, with commercial exploitation to follow. Provision for real time input and output to the supercomputer is being developed by collaboration between RSRE and Thorn EMI.

The major component of the Supernode supercomputer—also known as the Reconfigurable Transputer Processor—is the newly announced T800 transputer, which was developed within a work package under this collaboration by INMOS.

IMAG at Grenoble University, in France, is working on the system software for the Supernode machine in collaboration with Southampton. They are also studying the implementation of high level languages such as Prolog on this novel architecture.

The remaining collaborators are working on applications of the supercomputer, including image and signal processing, image generation by ray tracing, computer aided design (CAD) for very large scale integration (VLSI), computer aided manufacture (CAM), and applications in science and engineering.

Transputer development
The T800 transputer is the major component in the Supernode. It is a derivative of the T414 transputer announced by INMOS some two years ago. The major difference between these two chips is that the T800 contains an additional processing unit for handling floating point numbers. Floating point or real numbers may have fractional parts and have a very wide range of values; most microprocessors handle only integers (whole numbers), with operations for real numbers being provided by software, or alternatively by an additional special chip.
Southampton University identified the limitation of software floating point at an early stage in its feasibility study, based on its applications in science and engineering. This was basically a speed limitation, for it should be noted that all supercomputers provide support for rapid floating point computation and, inevitably, a software implementation will not provide a comparable performance.

The T800 chip is about 1 cm² and contains about 250,000 transistors. Unlike more conventional microprocessors, it can be used entirely on its own as it contains a simple but efficient 32-bit integer processor, the floating point processor which handles numbers stored using up to 64 bits of information, some very fast random access memory (it can store 4096 characters), and four high speed input and output channels.

It is the latter communication channels that provide the key to the transputer's success in parallel processing component. In any parallel processing system, the processors must be able to communicate with each other, to share data and to synchronise their activity. The communication channels on the transputer provide both of these facilities. A single channel can transmit about two million characters per second in each direction over the three-wire circuit used to connect transputers together. The four links provide the ability for any transputer to talk to four others directly. This means that transputers could be connected in a regular two-dimensional lattice. The limitations of such networks are that communications between transputers that are not neighbours will have to be provided by software, with intermediate transputers acting as sorting offices which forward data in conveniently sized packets to a transputer they can talk to but which is closer to the data's destination. Being provided by software, this mechanism is considerably slower than a direct connection.

**Powerful workstation**

The problems faced in designing the supercomputer all relate to communication, for this is the key to all successful parallel processor designs. Transputers can only have direct connections to four other devices although the sorting office analogy could provide a solution to the difficulty of providing other channels. The problem is that the more transputers are included in the system the slower communication between distant transputers becomes. In programming the supercomputer, what is ideally required is the ability to realize the direct connections between transputers specified by the program.

One of the key features of the Supernode supercomputer is the ability to realize this aim. This is provided by switching circuits on the links. Each transputer has its links connected into a switch through which they may be connected to any other transputer in the system. To provide an alternative analogy, this is similar to telephones when each user (transputer) is connected to an exchange from which he can make a call for a given duration to any other user connected to the exchange.

In practice, it is expected that the computer will be used with all of the connections established at a given time, providing a pattern of communication or network that reflects the flow of data in the applications program. One of the disadvantages of using these switching circuits is the cost of the switch, which grows as the square of the number of inputs to the exchange. This cost function is avoided to some extent by designing the computer in modules, each with their own local exchange and of course with lines to other main exchanges. A unit of about 30 transputers can be constructed economically in this way.

This supercomputer, the Supernode, can stand alone as a powerful workstation, or can itself be used as the basis of a super-supernode. One transputer acts as a supervisor, setting the switches on request. It talks to all other transputers within the node by means of a control bus which is used to synchronise many transputers to a common event, so that the switches may be reset.

**The prospects**

A single Supernode can contain 32 worker transputers, each containing storage for 256,000 characters, a controller, a memory server with storage for 16 million characters, and a disk server with capacity limited only by disk drive technology. Such a node could perform up to 50 million floating point operations per second, the rate usually obtained from machines such as the Cray 1, a multi-million pound supercomputer dating from 1976.

A Supernode supercomputer could be manufactured for ten or perhaps hundreds of thousands of pounds, and a collection of 32 supernodes in a single supercomputer could produce a proportionally higher performance, in excess of 1000 million floating point operations per second. This is in the same league as today's supercomputers which sell for about £12.5 million. The Supernode supercomputer could be marketed for a fraction of this cost.

**References:**

1. Southampton University, Department of Electronics and Computer Science, Southampton, United Kingdom, S09 5NH.
2. INMOS Ltd, 1000 Aztec West, Almondsbury, Bristol, United Kingdom, BS12 4SQ.
3. Royal Signals and Radar Establishment, St Andrews Road, Malvern, Hereford and Worcester, United Kingdom, WR14 3PS.
4. Thorn EMI Research Laboratory Ltd, Dawley Road, Hayes, Middlesex, United Kingdom, UB3 1HH.

**Computer News**

Dataquest expects PC sales to exceed $200 billion

The personal computer market will total more than $200 billion over the next five years, according to Dataquest. That is almost double the industry's $111 billion income from its inception in 1975 to the end of 1986. The expected increase will be fuelled by two major factors: replacement of older units and a growing number of new computer users.

Further information from

Cochrane Communications Ltd • CCL House • 59 Fleet Street • LONDON EC4Y 1JU.

**Microbeeb on target**

Microbeeb, the function-packed BBC BASIC control computer from Cambridge Microprocessor Systems, is finding its way into more and more applications where the user requires computational power with a complete range of 1/O functions. These may include full colour graphics, digital and analogue 1/O, stepper motor control, multiple serial channels, and many others - all fully programmable in BBC Basic and CMS Multipasic, the multi-tasking version of BBC Basic.

Further information from

Cambridge Microprocessor Systems Ltd • Brookfield Business Centre • Twytheny Road • Cottenham • CAMBRIDGE CB4 4PS.

**Cheaper transputer systems**

The cost of the Kuma K-Max Transputer Development System for the Atria ST Series has been reduced from £995 to £695, excl. VAT. The standard K-Max is supplied with an Inmos T414, 256 K RAM, and an Assembler. It can be upgraded by adding a further T414 and 256 K RAM and is supported by two Oscam products from Kuma: Oceham-ST (£49.09 incl. VAT) and Cascade-XP (£199.50 incl. VAT).

Further information from

KUMA Computers Ltd • 12 Horsehoe Park • PANGBOURNE RGB 7JW.
COMPUTER-CONTROLLED SLIDE FADER (1)

Revenge yourself on giggling friends and relatives joined to watch and criticize your clumsy slide presentation.

This project gives the creativity you put in your colour slides an extra dimension in the true sense of the word. A chance for all mindful photographers and slide makers to stun their audience with a dazzling show of fading and dissolving images, sudden or gradual colour changes, the repeating of "theme" slides, and many more special effects, achieved by intelligent control of four slide projectors.

The main difficulty in making a slide presentation is to capture the attention of the audience. Television, the motion picture, and modern advertisement techniques prove beyond doubt that the degree of attention depends strongly on the rate at which the human mind appears to perceive changing images. While appreciating the difference in character and objective between a well-prepared slide presentation and, say, a video clip, the former is often needlessly static. It is, of course, true that this is often useful for educational purposes, where it is required that an image be shown as long as necessary to allow for explanatory comments, but the show soon becomes dreary when pictures are abruptly changed with the operator occasionally forced to go through all the previous ones before he can pick out the slide that requires repeating for additional comment.

The computer controlled slide fader de-

Fig. 1. Functional blocks in the computer-controlled slide fader system.
The effects that can be obtained with it are in the hands of the operator: in its basic version, the fader enables computer control of the lamp intensity in 64 steps, and the reverse/forward motion of the slide carrier in any one of up to four slide projectors—see Fig. 1. The hardware required for this is relatively simple, and can be extended or simplified to personal needs. The whole slide show can be designed, directed and prepared by programming a computer in BASIC. Each slide projector requires its own 8-bit output port. Not many computers have 4 such outlets, however, and require equipping with extension circuits published, or to be published, in Elektor Electronics:

- **MSX systems:**
  - 6502, 6800 and Z80 based systems:
  - IBM PC XT and compatibles: to be described in a forthcoming issue of *Elektor Electronics*. Controls 4 projectors.
  - Centronics port: to be described in a forthcoming issue of *Elektor Electronics*. Controls up to 4 projectors.

Digital to analogue converter (DAC) ICs accept the 6-bit binary information from the computer, and translates this into a corresponding direct voltage between 0 and +2.5 V on the output, pin 4. The maximum value is derived from a reference voltage source set up around +5 V and 4 series-connected silicon diodes. Each DAC, all 6 inputs DB6...DB0 incl., on the DAC are pulled low, so that the converted analogue output voltage is 0 V. The maximum value of the output voltage, +2.5 V, is available when all DAC inputs are programmed logic high, i.e., when the computer sends F0H, F8H, or BFH to the DAC. All 6 inputs DB6...DB0 to the DAC are pulled low, so that the converted analogue output voltage is 0 V.

### Circuit description of the lamp dimmer

Slide images can be faded in and out, just like sound, if the intensity of the projector lamp can be controlled in small steps. Figure 2 shows the circuit diagram of 1 of 4 identical dimmers. At the heart of the circuit is the Type TCA280A dimmer chip, whose basic operation is discussed in reference (1). The intensity of the lamp driven by the triac is an inverse, but non-linear, function of the direct control voltage applied to pin 8 of the chip. The minimum value of the input voltage, +2.5 V, gives maximum intensity, while the lamp is quenched at +5 V. The dimmer is powered from the available 24 VAC connections on the lamp transformer in the projector. The triac is fitted as an external component to avoid high currents being carried on the PCB. The TCA280A advertises an inverse, but non-linear, function of the intensity of the lamp driven by the triac. The amplification of the opamp is, therefore, -1. With preset Pi set to the centre of its travel, the voltage at the non-inverting (+) input is -2.5 V. This is the lowest output voltage of the opamp, resulting in minimum illumination of the lamp. The use of the inverting and span shifting opamp facilitates the programming on the computer, since the lowest and highest values sent to the DAC correspond to minimum and maximum illumination of the projector lamp. A preset is used rather than a fixed potential divider to enable optimum matching of the dimmer to the lamp in the associated projector.

Bits 6 and 7 in the byte sent to each channel arrange the forward or reverse motion of the slide carrier via relays Rei and Res. The contacts of these form an SPDT switch connected to pins 3 and 5 on the relevant 5-way DIN socket at the output of the controller board. The intensity control signals for the 4 dimmer boards, and the system ground, are also carried via the DIN sockets.

The pin-out on Ks is in accordance with that on the previously mentioned 32-bit I/O and timer cartridge, so that this connects directly to the 4-way slide controller board. For non-MSX computers, the connection of the slide controller is, unfortunately, a matter of finding the right bits and connections at both ends of the cable.

The 5 V supply for the circuitry on the controller board is obtained from the computer via pins 21 and 22 on Ks.

![Fig. 2. Circuit diagram of the TCA280 based lamp dimmer.](image-url)
Fig. 3. Circuit diagram of the 4-way computer interface.
Parts list

MAIN BOARD (CIRCUIT DIAGRAM: Fig. 3).

Resistors (±5%):
- $R_1, R_2, R_3, R_4, R_5, R_6, R_7 = 120K$
- $R_8, R_9, R_{10}, R_{11}, R_{12}, R_{13}, R_{14} = 6K$
- $R_{15} = 2.7K$
- $P_1 - P_4$ incl. = 250K or 220K preset H

Capacitors:
- $C_1, C_2, C_3$ incl. = 1nF
- $C_4, C_5, C_6 = 100pF, 16V$

Semiconductors:
- $D_1, D_2, D_3, D_4, D_5 = 1N4148$
- $T_1, T_2$ incl. = BC547B
- $I C_1, I C_2, I C_3, I C_7 = ZN436E$ (Ferranti)
- $I C_2, I C_4, I C_6 = CA3130$

Miscellaneous:
- $K_1 - K_4$ incl. = 5-way angled DIN socket (180°) for PCB mounting.
- $K_5$ = 50-way angled header; 2 rows of 25 pins, for PCB edge mounting.
- $R_{15}$ incl. = SPST relay for PCB mounting, e.g. Siemens V23101-A0003-B101.
- PCB Type 87259 (see Readers Services page).

DIMMER PCBs (CIRCUIT DIAGRAM: Fig. 2).

Resistors (±5%):
- $R_1 = 470R; 0.5 W$
- $R_2, R_7 = 100K$
- $R_3 = 22K$
- $R_4 = 330K$
- $R_5 = 150K$
- $R_6 = 270K$
- $R_8 = 22K$
- $R_9 = 150R$

Capacitors:
- $C_1 = 470pF, 16V$
- $C_2 = 1p2$ (see text)
- $C_3 = 1nS$

Semiconductors:
- $D_1 = 1N4001$
- $I C_1 = T C 220A$
- $T r i = T C 236$ or $T C 246$ (see text)

Fig. 4. This PCB is used for building the interface and 4 dimmers.
Construcation: 5 boards in 1

The ready-made printed circuit board of Fig. 4 is cut in 5 pieces to obtain 1 interface board, and 4 dimmer boards. Commence the construction by populating the dimmer boards according to the component overlay and the parts list. Mount a 1μF and a 220nF capacitor in parallel if the 1.2μF type in position C1 is difficult to obtain. Electrolytic capacitors Ci and triac Tri are fitted as external components. This enables the triac to be cooled effectively, while avoiding tracks carrying lamp currents of several amperes. The dimmer board and the triac should be mounted in a suitable location inside the slide projector. A metal surface near the fan is, of course, ideal for mounting the triac because it forms a heat-sink (do not forget to insulate the triac with a mica washer). Figures 5 and 6 illustrate the mounting of the triac and the dimmer board in a slide projector Type Diamator 1500 AF.

In some cases, the existing DIN socket on the slide projector may have to be rewired in accordance with the pin-out on the socket fitted on the controller board. If this is impossible, or less desirable, it is a relatively simple matter to mount an additional DIN socket for ready connection to the interface. Whatever solution is adopted, be sure to know exactly how the slide carrier control system is actuated externally. In case of doubt, it is recommended to consult the user manual supplied with the projector. Universal 5-way DIN cords as used for audio equipment are perfectly adequate for connecting the slide controller to the projectors.

The completion of the 4-way controller board is straightforward. Note the use of PCB mounted DIN sockets, which make for a compact board, obviating the need for extensive wiring. The unit can be fitted in a suitable ABS enclosure, observing that the intensity span presets, P0...P0 incl., are easily accessible for adjustment purposes. Figure 7 shows a suggestion for the front panel lay-out.

Over to you: software

In principle, all effects in a slide presentation are based on 3 operations, namely visual mixing of slides, arranging the order of the slides, and lamp intensity control. As already stated, the number of possible effects depends solely on the creativity put into the computer program. It is, for example, possible to revert to an early slide in the show by reverse shifting of the slide carrier in projector number 3, whose lamp is turned off, while projectors numbers 1, 2 and 4 are used for the current images. This calls for a software slide counter on each channel to keep track of the slide numbers, and hence the forward/reverse mo-

<table>
<thead>
<tr>
<th>10 SSCREEN: CLS</th>
<th>TEST PROGRAM FOR SLIDE FADER</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 DEFINT A-Z</td>
<td></td>
</tr>
<tr>
<td>30 DIM A(15),B(15),C(15),D(15)</td>
<td>ADDRESS INITIALIZATION</td>
</tr>
<tr>
<td>40 FOR I=0 TO 3</td>
<td></td>
</tr>
<tr>
<td>50 A=I+16</td>
<td></td>
</tr>
<tr>
<td>60 D(I+1)+A=I+16</td>
<td></td>
</tr>
<tr>
<td>70 C(I+1)+A=I+16</td>
<td></td>
</tr>
<tr>
<td>80 NEXT</td>
<td></td>
</tr>
<tr>
<td>90 ON STOP GOSUB 590: STOP ON</td>
<td></td>
</tr>
<tr>
<td>100 FOR X=0 TO 15:</td>
<td>START CONDITIONS</td>
</tr>
<tr>
<td>110 OUT C(X),255: OUT C(X),8: OUT C(X),7: OUT C(X),3</td>
<td></td>
</tr>
<tr>
<td>120 OUT D(X),8</td>
<td></td>
</tr>
<tr>
<td>130 I(X)=0</td>
<td></td>
</tr>
<tr>
<td>140 NEXT</td>
<td></td>
</tr>
<tr>
<td>150 P=0: X=1</td>
<td></td>
</tr>
<tr>
<td>160 ON KEY GOSUB 268,340,370,410,450,490,520,550</td>
<td></td>
</tr>
<tr>
<td>170 FOR I=1 TO 10</td>
<td></td>
</tr>
<tr>
<td>180 KEY (I) ON</td>
<td></td>
</tr>
<tr>
<td>190 NEXT</td>
<td></td>
</tr>
<tr>
<td>200 KEY1,&quot;OFF&quot;: KEY2,&quot;ON&quot;: KEY3,&quot;+&quot;: KEY4,&quot;-&quot;: KEY5,&quot;-&quot;</td>
<td></td>
</tr>
<tr>
<td>210 KEY6,&quot;PREVIOUS&quot;:KEY7,&quot;NEXT&quot;:KEY8,&quot;STEP-&quot;:KEY9,&quot;STEP+&quot;:KEY10,&quot;RESET&quot;</td>
<td></td>
</tr>
<tr>
<td>220 KEY ON</td>
<td></td>
</tr>
<tr>
<td>230 LOCATE 10,6: PRINT&quot;PROJECTOR:&quot;;P+1;&quot;: LOCATE 10,8: PRINT&quot;LEVEL:&quot;;I(P);&quot;</td>
<td></td>
</tr>
<tr>
<td>240 LOCATE 10,18: PRINT&quot;STEP SIZE:&quot;;X;&quot;: LOCATE 10,12: PRINT&quot;CHANGE:&quot;;X;&quot;</td>
<td></td>
</tr>
<tr>
<td>250 GOTO 220</td>
<td></td>
</tr>
<tr>
<td>260 ' '</td>
<td>KEY 1 INTENSITY -</td>
</tr>
<tr>
<td>270 I(P)=I(P)-X: IF I(P)=0 THEN I(P)=0</td>
<td></td>
</tr>
<tr>
<td>280 OUT D(P),I(P): X$=&quot;-&quot;</td>
<td></td>
</tr>
<tr>
<td>290 RETURN</td>
<td></td>
</tr>
<tr>
<td>300 ' '</td>
<td>KEY 2 INTENSITY +</td>
</tr>
<tr>
<td>310 I(P)=I(P)+X: IF I(P)=63 THEN I(P)=63</td>
<td></td>
</tr>
<tr>
<td>320 OUT D(P),I(P): X$=&quot;-&quot;</td>
<td></td>
</tr>
<tr>
<td>330 RETURN</td>
<td></td>
</tr>
<tr>
<td>340 ' '</td>
<td>KEY 3 CHANGE REVERSE</td>
</tr>
<tr>
<td>350 OUT D(P),64: X$=&quot;-&quot;: I(P)=0</td>
<td></td>
</tr>
<tr>
<td>360 RETURN</td>
<td></td>
</tr>
<tr>
<td>370 ' '</td>
<td>KEY 4 CHANGE FORWARD</td>
</tr>
<tr>
<td>380 OUT D(P),128: X$=&quot;-&quot;: I(P)=0</td>
<td></td>
</tr>
<tr>
<td>390 RETURN</td>
<td></td>
</tr>
<tr>
<td>400 ' '</td>
<td>KEY 5 CHANGE OFF</td>
</tr>
<tr>
<td>410 OUT D(P),0: X$=&quot;-&quot;: I(P)=0</td>
<td></td>
</tr>
<tr>
<td>420 RETURN</td>
<td></td>
</tr>
<tr>
<td>430 ' '</td>
<td>KEY 6 PREVIOUS PROJECTOR</td>
</tr>
<tr>
<td>440 P=P-1: IF P=0 THEN P=15</td>
<td></td>
</tr>
<tr>
<td>450 RETURN</td>
<td></td>
</tr>
<tr>
<td>460 ' '</td>
<td>KEY 7 NEXT PROJECTOR</td>
</tr>
<tr>
<td>470 P=P+1: IF P=15 THEN P=0</td>
<td></td>
</tr>
<tr>
<td>480 RETURN</td>
<td></td>
</tr>
<tr>
<td>490 ' '</td>
<td>KEY 8 REDUCE STEP SIZE</td>
</tr>
<tr>
<td>500 X=X-1: IF X=1 THEN X=1</td>
<td></td>
</tr>
<tr>
<td>510 RETURN</td>
<td></td>
</tr>
<tr>
<td>520 ' '</td>
<td>KEY 9 INCREASE STEP SIZE</td>
</tr>
<tr>
<td>530 X=X+1: IF X=63 THEN X=63</td>
<td></td>
</tr>
<tr>
<td>540 RETURN</td>
<td></td>
</tr>
<tr>
<td>550 ' '</td>
<td>KEY 10 RESET</td>
</tr>
<tr>
<td>560 P=0: X=X: X$=&quot;-&quot;</td>
<td></td>
</tr>
<tr>
<td>570 FOR I=0 TO 15: OUT D(I),0: I(I)=0: NEXT</td>
<td></td>
</tr>
<tr>
<td>580 RETURN</td>
<td></td>
</tr>
<tr>
<td>590 ' '</td>
<td>STOP ROUTINE</td>
</tr>
<tr>
<td>600 FOR I=0 TO 15: OUT D(I),0: NEXT</td>
<td></td>
</tr>
<tr>
<td>610 DEUSR=USER: A=USR(0)</td>
<td></td>
</tr>
<tr>
<td>620 CLS: END</td>
<td></td>
</tr>
</tbody>
</table>

Table 1. MSX BASIC test program for the slide fader.
tion of the carrier. A library of routines can be written for fade-in and fade-out effects timed by the CTC (counter/timer controller) on the MSX I/O & timer board.

Programmers should have little difficulty spotting and adapting the slide controller routines in the test program of Table 1. This program runs on MSX computers fitted with at least one I/O & timer cartridge, Part 2 of this article will detail the use of 4 cartridges, so that the same program tests and controls a maximum of 16 projector channels.

Non-MSX users will find lines 260 up to and including 580 useful for analysing the ways in which the test program controls the interface. The instructions in lines 220, 230, 240 and 250 are executed in a loop. The ON KEY GOSUB statement does not form part of this because the function keys on an MSX computer can be programmed to call the relevant subroutine after generating an interrupt (see line 160).

Fig. 6. An ideal location for the hot triac. Some filing is required to fit the heat-sink between the sides of the fan enclosure.

Key the program into the computer, and familiarize yourself with the functions assigned to the function keys. Select a projector, and quench the lamp by holding down the INTENSITY - key. Then adjust the relevant preset on the controller board such that the lamp just about lights. This setting guarantees fast response to software-controlled intensity variations while lengthening the useful life of the lamp.

Some projectors have single-key slide carrier control. This can be simulated by the interface board if the software ensures the correct duration of the forward and reverse pulses. Although it would be possible to omit 1 relay on the board, this is not recommended because it makes the controller less versatile. A better solution in this case is the connection of pins 2 and 3 on the socket internal to the projector in question.

Fig. 7. Suggested front panel lay-out.

The subject of software for the slide fader will be reverted to in part 2 of this article. We will then discuss an advanced effects program for no fewer than 16 projectors.

References:


(2) Articles on MSX extensions in Elektor Electronics:

- I/O bus, digitizer and 8-bit I/O bus: January 1986, p. 66 ff.
- Cartridge board. February 1986, p. 32 ff.;
- Add-on bus board. March 1986, p. 55 ff.;

Please refer to Past Articles on the Readers Services page in this issue.
UNIPHASE LOUDSPEAKER SYSTEM

A loudspeaker system that is based on Audax drive units and uses a 12 dB Linkwitz filter. The closed box design enables the drive units to be located in a straight acoustical line.

The use of a Linkwitz filter (Ref. 1) in a loudspeaker system makes sense only if the drive units are positioned in straight acoustical line.

The three-way system presents nothing new, but the drive units have some special characteristics as will be seen later. Total costs for two loudspeakers (drive units, wood, filter components, etc.) is of the order of £250. Listening tests in which the uniphase system was compared with commercially available products show that the quality is roughly the same as that of a commercial system costing twice as much.

The most noteworthy aspect of the box is the staggered front, which is essential to get the drive units in a straight acoustical line. This means that the drive units are positioned in a manner which ensures that the acoustical output of each of the three drivers reaches the listener at exactly the same time.

It might be thought that to achieve this it is sufficient to measure the depth of each cone to be able to calculate by how much each drivers must be displaced with reference to one another. It's a good start, but unfortunately not sufficient. This is because the phase behaviour of each drive unit is far from ideal—see Fig. 1 for a typical phase characteristic of a bass driver in a closed box. Although W. Marshall Leach published a very interesting article on the phase behaviour of drive units in the Journal of the AES as long ago as 1980, it appears that in the practical systems of most manufacturers no notice has been taken of the findings of Mr. Leach.

In an ideal loudspeaker system d/dω must be a constant to obtain optimum pulse behaviour. With reference to the curve of Fig. 1, it is seen that this is virtually impossible to attain. Any box that contains more than one drive unit and a cross-over filter will have a phase behaviour that causes impulse distortion. Even in a wideband system without filter, it is very difficult to attain optimum impulse behaviour.

Is phase shift audible?

During the past few years, there have been a number of investigations into the question whether phase errors are audible or not. These investigations have failed to agree. It is probable that the sensitivity to phase errors varies from one person to another. And what about the test methods? Our own experience shows that serious phase deviations can definitely be detected in the reproduced sound. Particularly the pronounced phase jumps around the cross-over point of the filter seem to be the culprits. These jumps also cause the loudspeakers to produce a different sound pattern at different positions around the room. This is because the acoustic radiation pattern around the cross-over points shows large variations along its axis.

We have the impression—shared with a number of researchers—that most listeners are not so much sensitive to absolute phase deviations, but rather to sudden phase differences.

A matter of less than an inch

Above resonance, the loudspeaker behaves capacitively at first and then, at higher frequencies, inductively. This behaviour is caused by the voice coil.
The phase behaviour of each driver can be measured with a good standard microphone. On the basis of the results, the drivers are then displaced with reference to one another until their phase characteristics meet smoothly at the cross-over points. This cannot be achieved with 100% accuracy, but the resulting over curve approaches the theoretical one very closely. Fig. 2 shows the overall phase behaviour of the uniphase system after these corrections had been introduced. In practice, the drive units were positioned such that the points of origin of their cones lay in a straight line. This implies that only the specified Audax drivers should be used, since otherwise the distances between the drivers would be incorrect. In other words, if drivers other than the Audax units are used, the phase behaviour must be measured again, and the design of the enclosure adapted accordingly.

Three-way: an acceptable compromise
A loudspeaker system in which account is paid to the phase behaviour and the separation of the drive units cannot very well be realized with fewer than three drivers. Also, the cross-over points should be chosen at other than the standard frequencies. In the present system, they lie at 370 Hz and 3,200 Hz. The latter frequency was chosen deliberately because a middle frequency driver, even if it is small, gives more and more problems with its phase behaviour above that frequency. Moreover, a 25 mm tweeter performs very well at that frequency, particularly if it is remembered that the cross-over points here lie at −6 dB. It should be noted that the distances between the drive units were determined for these frequencies; other values must, therefore, not be used.

The drive units
The bass unit is a 24 cm type on a cast aluminium chassis. The magnet, although of reasonable size, is not particularly large. Since the enclosure is a closed box (which has better impulse behaviour than a bass reflex), the magnet should not be too large to avoid the frequency response characteristic falling off too early.

The middle frequency driver is a splendid unit. To all outward appearances, it looks like a conventional model, but its magnet is the same size as that of the bass unit, and its cone is made of TPX. An aluminium cone in the centre ensures a better spread of the high tones. Its cost is similar to that of the bass unit. It should, however, be borne in mind that this unit takes care of the most important part of the audio range. In our prototype, it performed beautifully.

The tweeter is a modernized version of a well-established unit, which has formed part of Audax’s range for many years. It is, without doubt, still one of the best tweeters available. This version has ferronfluid cooling and damping of the voice coil. It reproduces the very high frequencies with just a little better definition than the original model.

The filter
The present system uses a 12 dB Linkwitz filter—see Fig. 4, which is one of the best passive filters. Next month we intend to publish an active version of the loudspeaker system that will make use of the active network published last year (Ref. 2). However, for those who are not

Components list
Resistors:
- (all 5 W)
- \( R_1 = R_2 = 10 \Omega \)
- \( R_3 = 83 \Omega \)
- \( R_4 = 40 \Omega \)
- \( R_5 = 53 \Omega \)

Capacitors:
- \( C_1 = C_2 = 33 \mu F \) 50 V bipolar
- \( C_3 = 15 \mu F \) 50 V bipolar
- \( C_4 = 15 \mu F \) MKT or MKC
- \( C_5 = 5 \mu F \) 450 V or 110 V MKT or MKC
- \( C_6 = 10 \mu F \) 50 V bipolar
- \( C_7 = 2 R 3 \) (Ref. 2)

Inductors:
- \( L_1 = 6 \mu H \) (wind on 20 mm pot core from 0.9 mm dia. enamelled copper wire)
- \( L_2 = 0.5 \mu H \) (air-cored 10 mm dia.; wind from 1 mm dia. enamelled copper wire)
- \( L_3 = 2 \mu H \) (wind as \( L_1 \))
- \( L_4 = 0.5 \mu H \) (wind as \( L_1 \))

Miscellaneous:
- Bass drive unit: Audax Type MHD24P37RSM
- Middle frequency driver: Audax Type TX11 x 25RSN
- Tweeter: Audax Type DTW100T25FFF
- Synthetic cotton wool wadding (see text)
- Universal filter PCB Visaton Type UP70/3
- Fixing bolts, nuts, and crinkle washers for drive units
- Loudspeaker terminals (4)

The loudspeakers and filter PCB for this project are available from CSI Electronics (see page 78).

The filter
The present system uses a 12 dB Linkwitz filter—see Fig. 4, which is one of the best passive filters. Next month we intend to publish an active version of the loudspeaker system that will make use of the active network published last year (Ref. 2). However, for those who are not
prepared to spend the extra money for an active system with six output amplifiers, the passive system is an excellent choice that offers very good sound quality. The design of the filter follows the earlier article (Ref. 1) fairly faithfully. The increasing impedance presented by the bass unit at higher frequencies is compensated by \( R_1 \) and \( C_2 \). A similar network is provided for the middle frequency drive unit, otherwise the filter would not behave as predicted by theory. Furthermore, the middle frequency driver and the tweeter have been given a small attenuation network to match them more closely to the woofer. The resistances in parallel with the drive units effectively flatten the resonance peak of the impedance characteristic of the middle and high frequency drivers, since these peaks are close to the respective cross-over points.

Readers who check the values of the network components will find that those of \( C_3 \) and \( L_3 \) do not correspond with the theoretical values. The cause for this discrepancy is that the impedance of the middle frequency unit rises sharply in the vicinity of the cross-over point, in spite of the 8.2 ohm shunt resistor: consequently, during the design it was found that the practical values deviate sharply from the computed ones.

**The enclosure**

The enclosure is an upright, narrow box of such a height that the middle and high frequency drivers are roughly at ear height. The narrow front keeps the number of reflections to a minimum. As already mentioned, the front surface is staggered to make it possible for the drive units to be placed at the correct distances from one another. Otherwise, the construction is fairly con-
The volume of the woofer compartment is about 60 l, which is sufficient to obtain a Q<sub>tc</sub> of 0.7. The -3 dB point of the combination lies at around 45 Hz. The section for the middle frequency unit has a volume of some 15 l. Again, that is necessary to obtain a Q<sub>tc</sub> for this section of 0.7. Furthermore, it ensures good impulse behaviour over the middle frequency range.

The box is made of MDF (medium density fibre board), a material that resembles chipboard but has a much greater density. If this material cannot be obtained, chipboard of the best quality may be used.

**Construction**

The filter is constructed on Visaton's Type UP70/3 universal filter PCB as shown in Fig. 5. Some additional holes will have to be drilled in this board. Inductors L<sub>1</sub> and L<sub>3</sub> should be made with a pot core, otherwise they become too large for PCB mounting. All other inductors are air-cored. Capacitors C<sub>1</sub>, C<sub>2</sub>, C<sub>3</sub>, and C<sub>6</sub> are bipolar electrolytic types; all other capacitors are MKT (metallized polytheneplastic) types (MKC—metallized polycarbonate types are suitable alternatives). The construction plan for the box is shown in Fig. 6. The panels are interconnected with the aid of suitable dowels and wood glue: bear in mind that the finished box must be airtight. Apart from the panel separating the woofer from the other speakers and the panel halfway up the bass unit compartment, no struts are required.

The drive units are mounted with the aid of nuts, bolts, and crinkle washers. Subsequently, the cables between the drivers and the filter are put in. Take care that the hole in the slanting separating panel through which the cables from the middle and high frequency units to the filter are fed is made airtight after fitting the cables.

The rear of the box is provided with a good quality terminal board. The filter is mounted on the inside rear panel of the woofer compartment: take care that all cables are connected correctly!

Next, the box is filled with wadding, for instance, synthetic cotton wool which is sold in bags. About 1 bag is needed for the top compartment and 3 bags for the woofer section.

When all that is done, the box is closed, again using good quantities of wood glue to ensure an airtight closure. Finally, the enclosure is finished to individual taste (cloth, veneer, varnish, etc.).

**Finally**

The enclosures may be positioned against a wall, but preferable not in a corner.

**References:**

1. Linkwitz filters; Elektor Electronics April 1987 p. 36.
2. Active phase-linear cross-over network; Elektor Electronics September 1987, p. 61.
3. Designing a closed loudspeaker box; Elektor Electronics February 1986, p. 68.
5. Loudspeaker efficiency; Elektor Electronics June 1986, p. 52.
Most people would agree that their concentration on reading and attempts to memorise information are made more difficult when someone nearby is speaking. One reason stems from the part that hearing has played as a warning system in the course of human evolution. Recent laboratory studies have produced data showing the disruptive effect that speech can have in open-plan offices, control towers and even on the flight decks of aircraft, causing serious losses of efficiency. Research is also helping psychologists to chart the flow of information in the brain.

"Under all speech that is good for anything there lies a silence that is better. Silence is deep as Eternity; speech is as shallow as Time."


Silence is a precious commodity, the more so when we are trying to think clearly or read. Religious orders insist on it for periods of devotion and contemplation. Librarians demand it, too, but are often frustrated by people who insist on whispering.

At our place of work we may find that our ability to understand the written word, or the clarity of our thought processes, is muddied by ringing telephones and the babble of voices in the background. Of all the sounds that impinge upon us, the human voice is especially intrusive; from what is known of the psychology of hearing there are good reasons to suppose that speech is treated in a slightly different way to other sounds.

Abundant anecdotal evidence suggests that the human voice, even when whispered, makes reading difficult; this is true even when the person tries to ignore the sound, so it is clear that speech can intrude without invitation upon our consciousness. Although interference between the written and spoken word is obvious and natural to the layman, it poses a range of significant questions for the psychologist interested in how the brain processes information. First, we must ask why it is that information delivered to two separate sensory organs, the eye and the ear, somehow get mixed in the brain. For interference to occur, the streams of information coming from the two sense organs must share some common pathway in the brain. Part of the psychologist’s interest is in locating the precise point at which the interference takes place. Second, what are those features of speech which make it so difficult to ignore, and why are our strenuous attempts to suppress it usually of no avail?

Disrupting memory

From a series of experiments in various laboratories, a fairly clear picture is beginning to emerge of the way in which...
relevant speech interferes with reading. Studies have proved fruitful for the academic psychologist interested in the workings of the brain and for all those interested in the abatement of noise. Two distinct strands of research on irrelevant speech are discernible: the first examines an effect, now well established in the literature, of irrelevant speech on short-term memory; the second focuses on the more recently discovered effects on the reading process.

Typically, short-term memory is tested by asking a person to recall a list of items such as letters, short words or digits. Each list comprises up to nine items, presented visually at a rate of about one per second. At the end of the list, or soon thereafter, the person is asked to write down the items in the order in which they were presented. The presence of irrelevant speech during the presentation of the items appears to reduce the number recalled by about 20 per cent. By any standards this is a significant degree of impairment. The failure to remember is roughly the same over the whole list; it is apparent only when ordered recall is required, but not when the items can be recalled in any order.

Over the last ten years several features of this disruption have become more clearly understood. First, the loss of efficiency does not depend upon the meaning of the interfering speech; the degree of impairment is similar if the speech is in a language that the person does not understand. Furthermore, reversed speech produced by running a tape backwards through a tape recorder is as disruptive as proper speech. Second, it has been shown that while the intelligibility of speech does not matter, sounds that are not speech do not interfere. For example, white noise (which is a random mix of hissing sounds like those heard from a radio or television set that is not tuned to a transmitting station), is not disruptive. Perhaps this is because white noise and speech are composed of different kinds of acoustic signals. But there is at least one exception to this general finding, which arises from a study we made of the disruptive effect of singing. We have shown that the effect of sung words is similar to that of spoken words. But if the tune is hummed rather than sung the effect is less marked, which suggests that the sound has to be word-like rather than more broadly speech-like. Finally, the intensity of the speech is unimportant: speech as loud as a shout or as low as a whisper disrupts memory to the same degree.

### Phonological form

What does this pattern of results tell us about the processes responsible? The findings indicate that the brain mechanism discriminates on the basis of how closely the incoming signal approximates to speech. The more similar the sound and speech are to one another, the greater the disruption. However, this mechanism fails to discriminate on the basis of meaning, for the disruption occurs whether the passage heard is meaningful or not. More recent experiments have shown that it is the similarity between the irrelevant speech and the sound of the material being remembered that is crucial. Words which are read are converted into a code which has a sound-like basis, as if the person was producing 'inner speech'. For example, if the list of words has the sounds of *run, new, tree, sore, four*, then the disruption will be severe.

This points to the possibility that the two streams of information, one originally visual and the other auditory, are converging at a point where they are both held in a so-called phonological form.

**The need for this conversion process becomes evident if we reflect for a moment on the way that we read. One way of understanding reading is to think of it as a conversion process from letters and words into sounds, into what we have already referred to as inner speech. When learning to read, the child has to appreciate the appropriate set of rules for converting shapes on the page into this inner speech. Some of the sounds associated with words, and therefore inner speech, may already be known to the child through hearing the language. So hearing and reading share a common level of analysis within the brain. In adult life, whenever we are confronted with the particularly difficult task of remembering a list of words or letters in the correct order, we make this type of analysis. Intrusion of a similar signal via the ear will lead to confusion; the more similar the codes used in the two streams are, the greater is the confusion when they are stored in memory.**

### Susceptibility of reading

Another line of our work has focused on the effects that irrelevant speech has on reading. At the outset we suspected that the effects of speech on reading would be different from those on memory. To investigate this possibility we used the technique of playing speech of different sorts while the person was proof-reading a text for spelling and grammatical errors. Typically, a volunteer would spend 15 minutes or so looking for errors which we had deliberately and carefully introduced into the text. We measured how many of these errors they could detect under various conditions of ambient sound.

There are three main features to the outcome of these experiments. First, meaning of the speech in this instance is important. This has been shown by manipulating the speech in a variety of ways. For example, reversed speech produces a roughly similar effect to silence. We were able to confirm this by demonstrating that people bilingual in Welsh and English were disrupted by irrelevant speech in either Welsh or English when they read English text. But the reading of those English speaking readers unable to understand Welsh was
not disrupted by irrelevant Welsh. Secondly, intensity of speech is not important; just as in the results to do with memory, a whisper has as much effect as a shout. Third, the effect does not depend on other physical features of the speech, such as the number of voices, or whether its source is stationary or moving. The main point seems to be that meaning is important.

Discrete effects

The conclusions from these findings are that it is the meaning of the speech that affects proof-reading. In contrast, short-term memory is affected by speech like properties of the acoustic signal. So there seem to be two discrete effects, one on reading and the other on memory.

We were able to check this by developing a variant of the proof-reading task. We used a computer-based system, in which two forms of the task were developed. In one, a single line of text was displayed. The reader could examine each line and use an electronic pointer to mark errors. When each new line was written-on the screen the old line was erased, preventing the reader from looking back. The other form displayed the two lines preceding and the two lines following the line under correction. The reader was free to check backwards and forwards. The two versions were used to determine whether reading was being disrupted through reliance of reading on memory. Presenting the reader five lines of text necessarily reduces the immediate burden on working memory; the reader may check whether the grammar is correct by glancing back or forward to the entire sentence under scrutiny. In contrast, by providing one line of text only, the reader is forced to remember parts of the sentence while examining it for errors.

If reading is disrupted through the effect that speech has on memory, it would be thought that the effect would be more pronounced where the burden on memory is greater. The results of our experiments show just the opposite. The five-line version proved to be more susceptible to disruption. We think that the fluency of reading is important: the more fluent the reading, as with five lines of text, the more likely it is to be disrupted by speech.

Evolution

We are now left with the question of precisely why speech-like sound intrudes into our thoughts. Part of the answer comes from an understanding of the role that hearing has played in human evolution. It has the characteristics of an early warning system and has been described as the sentinel of the senses. It can receive information through the auditory channel in darkness; it can provide one line of text for free to check backwards and forwards. The other form displayed the two lines preceding the screen the old line was erased, preventing the reader from looking back. The other form displayed the two lines following the line under correction. The reader was free to check backwards and forwards. The two versions were used to determine whether reading was being disrupted through reliance of reading on memory.

Offering the reader five lines of text necessarily reduces the immediate burden on working memory; the reader may check whether the grammar is correct by glancing back or forward to the entire sentence under scrutiny. In contrast, by providing one line of text only, the reader is forced to remember parts of the sentence while examining it for errors.

If reading is disrupted through the effect that speech has on memory, it would be thought that the effect would be more pronounced where the burden on memory is greater. The results of our experiments show just the opposite. The five-line version proved to be more susceptible to disruption. We think that the fluency of reading is important: the more fluent the reading, as with five lines of text, the more likely it is to be disrupted by speech.

Wake a sleeping person and, unlike the eyes, the ears are omnidirectional. The way we use our eyes is far more purposeful and directed: the ear, in comparison, is a passive and automatic recipient of information. We know, too, that nerves from the ears connect with those parts of the brain to do with alertness. Signals passed on by the ear are far more likely to be significant to a person's survival. All of these features suggest a system tuned to act as a vigilant guardian but one through which, nevertheless, a great deal of intelligent information is transmitted. So speech may take advantage of the ear's guardianship of our consciousness because it can gain privileged access to our thoughts.

The next stages of our research will focus on what it is in the nature of the speech signal that determines the degree of disruption. To begin with, this will mean looking at two features of the speech signal, both of which have the potential to interfere. The first is the possibility that speech has a certain combination of sounds, spaced at particular intervals, that characterise speech only. It is likely that the nervous system is tuned to receive such features while rejecting others. The second is that the so-called prosodic features, those increases and decreases in intensity of speech that give it a rhythm of its own, might be responsible. These changes of intensity, which are peculiar to speech, might also be subject to tuning by the nervous system.

Practical outcome

What are the practical implications of our findings? Wherever people are engaged in activities like those we have already described, it seems likely that they run the risk of being distracted by irrelevant speech. Workers in open-plan offices, where there is little or no acoustic isolation, are likely to have their efficiency impaired. Activities such as reading, composing text and performing mental arithmetic are all likely to suffer to some extent.

Most recommendations for the office environment take scant regard of what has already been found out by psychologists. It is usually assumed that the degree of interference by speech is similar to that induced by white noise. That is, it is taken for granted that the interference can be predicted by knowing the ratio of the intensities of signal and noise. But we know that the effect of speech does not depend on its intensity and is therefore largely independent of its distinguishability from background noise. This probably explains the discrepancy that has often been found between objective acoustic measurements in offices and complaints by the people working there.

Control rooms

In any complex system where an operator is exposed to material which has to be read and interpreted, the intrusive effects of speech may be at work. More important is that in control rooms, where streams of speech and text are mixed haphazardly, there is a chance that irrelevant speech will impair the memory of instrument readings and sequences of events. In air traffic control towers and in the control rooms of power stations the intake of visual information is at risk. In these settings, only some of the speech heard will be relevant to the task at hand, so there is good reason to recommend that some kind of control be exercised over incoming spoken messages. In person-to-person communication it could be done by channelling speech via microphones and headphones, so that there is some degree of control over reception.

In control systems using advanced technology, machine-generated speech will be used more and more to pass messages from the machine to the user. Interference from such sources can be kept down by queuing messages within a computer system so that the operator can listen to them at a convenient time when the workload is low enough.

Most profound

It is during the development of reading skills that the effect of irrelevant speech may have its most profound effects. In primary schools the trend has been toward classrooms of the open-plan type. Though data are not yet available, there is every possibility that in such settings fluent reading is being disrupted and the faltering steps of learners are being impaired.

Of all our experimental findings, the single most important is that the disrupting effect of speech is independent of intensity. This means that the traditional idea of abating it ought to be supplanted by eliminating it. Reducing the level of noise by modest degrees is relatively cheap, getting rid of ambient noise altogether is an extremely difficult and expensive enterprise. Yet there may be settings such as those awaiting the flight deck of an aircraft in any complex system where the potential costs of disrupting work might be so high that such a course should be seriously considered.

"And silence, like a poultice, comes To heal the blows of sound." The Music Grinders, by Oliver Wendell Holmes.
As stated in the introductory article on MMICs (reference 19), these new devices are eminently suited to building high performance wideband amplifiers with only a handful of components. In the present application, a single MMIC is used for amplifying the IF output signal of a commercially available low noise block down converter (LNB or LNC). The standardized IF bandwidth of LNBs is 950—1750 MHz, but it should be noted that these are not absolute band edges. Most LNBs have a relatively high conversion gain (55 dB typ.), but this is often found to decrease with frequency. Similarly, the attenuation of the downlead coax cable increases with frequency, so that the highest down-converted transponder signals are almost invariably of lower absolute amplitude than those further down in the IF band, while C/N figures are still roughly the same because reduced gain results in less noise (compare the S-meter reading of Super Channel to that of, say, Teleclub Switzerland).

The foregoing observations have consequences for the design of a cable amplifier/signal divider for use in satellite TV receiving systems:

1. The amplifier should have a relatively high drive margin to prevent it being "blocked" by the high output levels supplied by the LNB.
2. The frequency response of the amplifier should be as flat as possible across the entire IF band.

Both requirements are met by the proposed amplifier/splitter based on the Type MSA0404 MMIC, which ensures an output power of +12 dBm at 1 dB compression, and a third-order intercept point of +26 dBm (0 dBm=1 mW in 50 Ω).

The 2-way signal divider described here provides a modest, but often welcome, insertion gain of about 4 dB on both outputs, and allows relatively inexpensive coax cable to be used for connecting the indoor units. Still, do not be tempted into using, say, 30 m RG-58, or ubiquitous "TV coax": the massive attenuation such a cable introduces is impossible to overcome by the best cable amplifier or IDU input stage. Stick to good quality COAX12, COAX6, or H43 cable (all 75 Ω), terminated in BNC, N or F connectors. Green or yellow coax cable occasionally seen in TV and radio distribution networks is also suitable, while C/N figures are still roughly the same because reduced gain results in less noise (compare the S-meter reading of Super Channel to that of, say, Teleclub Switzerland).

The circuit diagram of Fig. 1 shows the single-chip amplifier and 2-way signal divider. The LNB is connected to BNC, N or F socket K1; the 2 indoor units (IDUs) to K2 and K3. Amplifier IC1 is a Type MSA0404, whose technical characteristics can be found in Fig. 5 in 19. Gain of the MMIC is 8 dB; input and output impedance are 50 Ω. The mismatch between the 75 Ω cable and the 50 Ω input of the amplifier (K2: MMIC), is of no practical consequence (reference 19).

The amplified wideband signal is applied to a resistive splitter, R2-R3, for feeding to the indoor units. Given the amplification of the MMIC, and the losses in the splitter, the net gain on each channel is still about 4 dB (do not forget that the MMIC has a 50 Ω output, and that K2 and K3 are terminated in 75 Ω). More gain is not desirable here because it would lead to overdriving of the input stage in the IDU.

Output K2 on the amplifier/splitter accepts the LNB supply voltage carried on the downlead coax cable to the IDU. This supply voltage is also used for powering the MMIC via R1-L1, and appears on K1 after passing through chokes L1 and L5. Indoor unit 1 (IDU 1) connected to K2 powers the LNB and the signal divider. The supply voltage on the coax cable should not disappear when IDU 1 is switched off, because this would make make reception on IDU 2 impossible. The Elektor Electronics indoor unit (reference 10) causes no problems in this respect: the LNB supply voltage is present on the RF input as long as the unit is connected to the mains, i.e., irrespective of the position of the on/off switch.

Capacitors C3, C5, C6 and C7 ensure adequate supply decoupling, while C1, C4 and C8 are DC blocking capacitors with a low reactance and stray inductance at the frequencies involved.

Series resistor R1 should be dimensioned in accordance with the LNB operating voltage supplied by the IDU on the downlead coax cable. The MMIC draws about 50 mA at the recommended supply voltage of 3.5 V, so that

\[
R1 = \frac{\text{Vsupply} - 5.5}{0.05} \text{ [Ω]}
\]

The value of 220 Ω shown in the circuit diagram ensures safe operation of the
Fig. 1. Circuit diagram of the wideband amplifier and splitter for satellite TV receivers.

amplifier when connected to the Elektor Electronics IDU (V_LNB = 15 V).
Warning: some indoor units supply an LNB voltage as high as 18 V or even 24 V. Always measure V_LNB on the centre tip of the RF input connector of your IDU with the LNB connected to the downlead coax cable. Then calculate R1 as shown above.
The dimensioning of R1 is not critical: calculate the theoretical resistance, select the next higher value from the E12 series, measure the voltage on the RF OUT/BIAS terminal of the MMIC, and decrease the resistor value if required, until the operating voltage is between +5 V and +6 V. Be sure to use an ordinary 1/2 W carbon film resistor; its inductance is essential in this application.

Construction
Prepare the small Eddystone enclosure shown in the photographs prior to starting any soldering work. Study the locations of K1, K2 and K3 on the PCB before drilling the holes for these flange-type BNC sockets, which are fitted onto the lid as shown in Fig. 3. You may have required, until the operating voltage is between +5 V and +6 V. Be sure to use an ordinary 1/2 W carbon film resistor; its inductance is essential in this application.

Construction
Prepare the small Eddystone enclosure shown in the photographs prior to starting any soldering work. Study the locations of K1, K2 and K3 on the PCB before drilling the holes for these flange-type BNC sockets, which are fitted onto the lid as shown in Fig. 3. You may have

Fig. 2. The small, double sided, printed circuit board for the signal divider is available ready-made through Elektor Electronics' Readers Services.

Parts list
Note: SMD = surface mount device.
Resistors (± 5%):
R1 = 220Ω; 0.5 W carbon film (see text).
R2, R3 = 22Ω SMD
IC1 = MSA0404 (Avantek; distributors are listed in reference [1]).

Capacitors:
C1, C4, C5 = 68p SMD
C2, C3, C6 = 1n0 SMD
C7 = 10p, 25 V tantalum bead
Semiconductor:
L1: L2: L3 = home made — see text.
Inductors:
K1: K2: K3 = BNC socket (flange type).
Miscellaneous:
PCB Type 880067 (see Readers Services page).
Diecast enclosure (Eddystone; dimensions approx. 112 x 64 x 30 mm).

Fig. 3. Side view of a prototype of the signal divider, showing the PCB and the RF connectors secured onto the lid of a diecast enclosure.
to provide new mounting holes on the PCB if you intend to use Type N or F sockets instead of BNC. Mount a suitable clamp to the box to enable attaching this near, or onto, the dish aerial stand. If this is the most favourable location for the splitter considering the lengths of the downlead cables. Provide lettering on the lid to rule out any likelihood of erroneous connections.

Now proceed with the completion of the printed circuit board shown in Fig. 2. Less experienced constructors should note that all parts, with the exception of the 3 sockets, are fitted direct onto the track side of the board. The leads of C, R, and the 3 inductors should be kept as short as possible.

The MMIC is seated in a 0.4 mm hole, and its 4 leads are soldered straight onto the relevant copper areas. All capacitors, with the exception of tantalum bead type C, are surface mount devices, secured in place by fast soldering with a low-power iron. The same goes for divider resistors R and R.

The 3 home-made inductors in the amplifier are identical. The winding data are as follows:

\[
L_1, L_2, L_3 = 12 \text{ turns } 0.5 \text{ mm (SWG25) enamelled copper wire; close-wound; internal diameter: } 2.5 \text{ mm.}
\]

Use a sharp knife to remove the protective PTFE collar around the centre pin where this protrudes from the BNC socket. The 3 sockets are held against the outside of the lid, and the PCB is pushed onto the centre pins that protrude at the inside. Press the PCB firmly against the lid, and push the twelve M2.6 screws through the holes in the PCB. Carefully tighten the screws, and solder the centre pins of the RF sockets onto the copper islands at the track side of the board.

Finally, be sure to terminate output IDU 2 in 75 \( \Omega \) at all times. In most cases, the attenuation of the downlead cable is high enough to ensure proper termination of the amplifier if IDU 2 is disconnected in the home. If, for some reason, the downlead cable to IDU 2 is temporarily disconnected from the amplifier output, this must be terminated in a 75 \( \Omega \) dummy load (a 75 \( \Omega \) resistor fitted in the RF plug). In general, the signal divider should be fitted as close as possible to the LNB.RGK.

References:

(1) MMICs revolutionize wideband RF amplifier design. Elektor Electronics, January 1988, p. 38 ff.


(3) Indoor unit for satellite TV reception, parts 1, 2 and 3. Elektor Electronics, October 1986, November 1986, January 1987.

RF module for IDU. Elektor Electronics July/August 1987, Supplement p. 10.

---

**ELECTRONICS NEWS**  
**ELECTRONICS NEWS**

**VideoDisc market in Europe**

A report from Frost & Sullivan, The VideoDisc Market in Europe (#E870) does not deal with the consumer market, which failed to materialize in the early 1980s—in fact, one of the blazing mistakes made by videodisc makers then was to chase the general public. Videodiscs aimed at the film-viewing public experience virtually non-existent take-up because of the rapid penetration of videocassette recorders (VCRs).

Instead, the study sees the emerging videodisc arena as one primarily aimed at the professional audio-visual market for industrial, institutional, and commercial organizations. The most favoured and developed applications are for training and point-of-sale advertising and information. The study predicts that growth rates will average close to 25% a year through 1991, with more than 5350 million worth of machines installed in Europe by then.

Frost & Sullivan Ltd • Sullivan House • 4 Grosvenor Gardens • LONDON SW1W 0DH • Telephone 01-730 3438.
LOW-NOISE PREAMPLIFIER FOR FM RECEIVERS

First in a short series of articles on simple to build RF preamplifiers is a tuneable aerial booster for the FM band.

The RF preamplifier described here is intended for fitting as close as possible to the FM band aerial. It is a tuneable, rather than a wideband, amplifier, which is fed and tuned via the downlead coax cable. The amplification and the noise figure of the FM aerial booster are 25 dB and about 1 dB, respectively. All preamplifiers described in this series are powered and tuned by a common supply/tuning unit installed at an appropriate location in the home.

Circuit description

The circuit diagram of Fig. 1 shows that the preamplifier is a conventional design based on a VHF MOSFET tetrode Type BF981. The preamplifier input can be connected to unbalanced (60...75 Ω) as well as balanced (240...300 Ω) aerials or feeder systems. The balanced input allows the preamplifier to be connected direct to the dipole element. In this case, the preamplifier can take the place of the balun removed from the ABS, water-resistant, enclosure that houses the dipole terminals. This solution ensures the lowest possible input loss, and obviates the need for a separate preamplifier enclosure on the mast.

The balanced or unbalanced aerial signal is applied to winding a of tuneable inductor L1. Varactors D1-D2 form the adjustable capacity across winding b, so that the tuning range of L1 is about 86...109 MHz. Gate 2 of DG MOSFET T1 is held at about +4 V by potential divider R3-R5. The bias voltage is effectively decoupled by surface mount capacitor C1. Blocking capacitor C3 takes the amplified RF signal from a half-impedance tap on drain inductor L2. The MOSFET is fed with a constant operating voltage of 12 V, supplied by regulator IC1. The direct voltage on the downlead coax can be varied between 15 V and about 26 V by means of the supply/tuning unit near the receiver. Zener diode D3 in the preamplifier ensures that the tuning voltage for varactors D1-D2 is the voltage on the downlead coax minus 12 V. Example: if the downlead coax carries +18 V, the tuning voltage at junction D1-D2 is +6 V with respect to ground. The lowest downlead voltage is about 15 V to ensure the minimum voltage drop across regulator IC1. Choke L3 forms a high impedance for the amplified RF signals superimposed on the tuning/supply voltage.

Construction

Commence the construction of the preamplifier with winding the inductors. Input inductor L1 is wound on the former in the Type 10V1 inductor assembly from Neosid—see Fig. 2. First, close-wind L1 as 11 turns, 0.6 mm enamelled copper wire. Study the component overlay on the PCB (see Fig. 3) to find the 2 pins on the base that connect to L1b. Close-wind L1b as 4 turns, 0.6 mm enamelled copper wire onto L1b, starting at the base of the plastic former. The tap is made after 2 windings. Stretch the turns, and carefully scratch off a small area of the enamel coating approximately half-way the inductor. Solder a short wire to this point, and point it down towards the base. Press the inductor together again. Connect the end wires and the tap wire to the base pins, and verify continuity and orientation of the completed inductor. Drain inductor L2 is wound as 4 turns 0.3 mm enamelled copper wire through a small ferrite bead. The centre tap is made after two turns by twisting...
3 cm or so of the wire before making the third and fourth turn. The twisted wire is then cut to length, the enamel coating is scratched off, and the connection is carefully pre-tinned. Choke L3 is the simplest to make: it is wound as 6 turns Ø0.2 mm enamelled copper wire through a small ferrite bead. The three home-made inductors in the preamplifier are shown in the photograph of Fig. 4.

The PCB for this project is a double-sided, but not through-plated, pre-tinned type. The four resistors are mounted upright. Ascertain the pinning of MOSFET T1 before fitting it on the printed circuit board: depending on the make of the device, it may be necessary to mount it with the type indication facing the PCB. The ground terminal of R2, R4, IC1, C3, C4, C5, the source terminal of T1, the anode of D1, input pin 2, the 2 solder tabs on the shielding can of L1, and the output ground terminal, are soldered at both sides of the PCB. The only component at the track side of the board is SMD capacitor C1. This is soldered direct across the GATE 2 and SOURCE connections of the MOSFET. Fit a 15 mm high brass or tin metal screen with a small clearance for the MOSFET as shown on the component overlay.

### Supply/tuning unit

The circuit diagram of the simple, regulated and adjustable, power supply for the downlead-powered preamplifiers is shown in Fig. 6. The output voltage of integrated regulator IC1 is adjusted between 15 V and 26 V with tuning control Pi. The tuning and supply voltage for each preamplifier is applied to the centre core of the respective downlead coax cable by a choke-resistor combination. The tuning/supply unit is built on the double-sided, pre-tinned printed circuit board shown in Fig. 7. Construction should not present problems: grounded component leads or terminals are soldered at both sides of the PCB. Fit IC1 with a TO220-style heat-sink, but make sure that this is insulated from the ground area.

The winding data for the 3 chokes on the board are as follows:

\[ L_1, L_2, L_3 = 6 \text{ turns } 0.2 \text{ mm enamelled copper wire through a small ferrite bead (length: approx. 3 mm).} \]

The tuning control, Pi, is conveniently fitted onto the 3 soldering pins to go round a 3-wire connection. The assembled board, the 24 VAC power transformer, mains switch and fuse are housed in a small enclosure with a sloping front panel. Omit D1...D4 incl., and C1-C3, when a 24 VDC source, such as a
mains adapter, is already available—connect this to the points marked + and 0. The tuning control can be fitted with a vernier and a scale for the frequency range of each preamplifier.

**Testing**

Connect the AC input of the completed tuning/supply unit to the secondary of the 24 VAC mains transformer, apply power, and verify the presence of the adjustable direct voltage on the three DC/RF terminals. Check whether P1 sets the voltage between +15 V and +26 V.
Tune the FM receiver to a relatively weak transmission at about 108 MHz, and make a note of the signal strength. Connect the input of the completed preamplifier to the aerial, not a cable network outlet. The preamplifier output is connected to the appropriate soldering terminal on the tuning/supply board via a short length of coax cable. Similarly, connect the unbalanced (75 Ω) output of the FM receiver to the RF (RX) output on the tuning/supply board. Set Pi to +26 V on the cable to the preamplifier. Verify the presence there of +12 V on Cs, and +14 V on Cs. Use a plastic trim tool to adjust the screw core in Li for optimum reception. Vary the supply voltage between 22 V and 26 V to check that this tunes the preamplifier.

Set the supply to +15 V, and tune the receiver to a signal at the lower band edge, i.e., approximately 88 MHz. Check that Li is still adjusted for optimum reception by carefully adjusting the core. Tune to a number of stations at regular frequency intervals in the FM band, optimize reception by adjusting Pi in the tuning/supply unit, and make notes of the downlead voltage. If necessary, redo the adjustment of Li to ensure that the span of the tuning voltage covers the entire FM band. For optimum tracking of the resonance frequency with the tuning voltage applied to the varactors, the core in Li should be turned to about halfway the aerial winding. This completes the initial adjustment of the FM band preamplifier, which is ready for fitting into a waterproof enclosure.

The next installment in this series will deal with preamplifiers for the shortwave, VHF and UHF TV bands.

**RADIO & TV NEWS**

**Distance learning**

Professor Bill Spence, head of Ulster University's Communications Department, recently demonstrated how new technology is presenting opportunities for distance learning and teleconferencing by giving an hour-long lecture to the International Technology Conference in Perth, Western Australia, from his office in Northern Ireland. Professor Spence has been sponsored by the British Council to carry out research into distance learning. This has resulted in visits to Laval University, Quebec, and Rutgers University, New Jersey. Rutgers has a similar problem to Ulster University in that it consists of four campuses, each about 96 km apart, and is trying to improve communications with the latest technological aids, such as advanced telephone conferencing, closed circuit television, electronic mail, and document publishing.

As a result of Professor Spence's visit, the communications department at Ulster University now has access to the North American computer network known as Binet through arrangements made by the Office of Television and Radio at Rutgers University as a contribution towards the further collaboration of both universities in the field of distance learning.

**Land mobile services through INMARSAT**

At last October's INMARSAT Assembly in London, the INMARSAT Council were requested to examine the commercial, technical, and operational feasibility of providing land mobile satellite services. The organization is already introducing telephone, telex, facsimile, and data services for aircraft operations and passengers later this year.

As part of the feasibility study, a specially equipped van is touring Europe to demonstrate to truck and bus manufacturers, and the media, the reliability and potential of land mobile satellite services to a moving vehicle. The equipment on the van consists of a small, roof-mounted, omni-directional antenna, a car-radio sized receiver, and a printer. The van's route is taking it through southern England, Federal Germany, Belgium, the Netherlands, and Switzerland.

**In-orbit delivery of British satellite**

The European Telecommunications Satellite Organization, EUTELSAT, has taken formal delivery in orbit of EUTELSAT I F-4 after a series of rigorous acceptance tests. EUTELSAT I F-4, originally called ECS-4, was built by a European consortium led by British Aerospace. It was launched by Ariane rocket last September from Kourou in French Guiana and has now been placed in its final geostationary orbital position at 10° East.

The spacecraft will complement EUTELSAT I F-1 (ECS-1) and EUTELSAT I F-2 (ECS-2), also manufactured by British Aerospace as prime contractor, which provide a range of telecommunications services to Europe, including telephone, business services, and TV distribution.

EUTELSAT I F-4 is the 11th communications satellite to be launched in the series of 18 which have been developed from the Orbital Test Satellite. It will operate at 14/11 GHz and 14/12 GHz, and its transponders will be used mainly for TV distribution.

Produced to a demanding Interspace of France requirement for vibration testing of a space satellite, the Environmental Engineering Department of British Aerospace Army Weapons Division have designed a dual head vibration fixture to a Ling Dynamic Systems specification.

With a diameter of 2.1m the satellite vibration test fixture couples a three tonne specimen to two electromagnetic vibrators. A maximum weight, minimum static stiffness and a minimum lowest resonant frequency were specified for the fixture. The major problem was to devise a fixture that would transmit the motion of the vibrators to the test piece faithfully, without distorting the motion as a result of the fixture’s own physical characteristics.
Multi-standard MAC decoder announced

Nordic VLSI of Norway, in co-operation with the Norwegian Telecommunications Administration, have succeeded in producing the first working C/D/D2 MAC (multi-MAC) compatible chip for reception of TV services via satellite. The first prototypes of the VLSI chip were combined with MAC satellite receiving equipment produced by Tandberg Telecom. The prototype chip, which had 230,000 transistors on board, worked first time without any need for redesign or modification. Following this success, Nordic teamed up with Plessey Semiconductors and Philips to develop a complete Multi-MAC transcoder concept with provisions for decrypting and conditional access decoding. In this joint venture, Plessey Semiconductors will manufacture three of the full-custom VLSI CMOS ASICs at the heart of the decoder and also supply a Teletext full-custom VLSI CMOS ASIC. To complete the decoder, Philips will develop the operating software (including decryption) and supply ICs from their extensive bipolar and MOS ranges to perform the analogue signal processing, computer control and data conversion functions.

This unique cooperation has led to the availability of the first-ever chip-set for constructing an advanced multi-standard MAC decoder which can enormously increase the market applicability of TV sets through its most innovative feature — multi-standard operation that meets all the requirements of today’s European satellite TV market.

Unique features of a decoder built with the chip-set:
- Implements the full CMAC/DMAC/D2MAC packet standard
- Can handle the standard MAC format for picture plus up to eight mono or four stereo sound channels
- Is compatible with any TV set architecture
- A conditional access control feature allows deserializing and decryption of sound and vision signals (Pay TV) and of Teletext. This feature can handle several broadcasts simultaneously and meets the requirements of the new Part 6 of the EBU specification. Entitlements can be addressed over-air, via a smart-card or via a keyboard
- Single- and double-cut conditional access deserializing of the vision signal as specified by the EBU
- Very flexible packet multiplexing allows full-field sound/data transfer of up to 50 high quality sound channels at a rate of nearly 20 Mbit/s
- All packet addresses in the selected data bursts are Golay decoded
- The configuration data can be changed without disrupting the service
- Can handle Teletext in accordance with the EBU specification during the frame interval or in the packet multiplex
- A second vision signal aspect ratio and decompression ratio will allow future high-definition TV (aspect ratio 16:9) to be accommodated whilst retaining compatibility with present standards (aspect 4:3)
- Linear or compassed sound signals can be decoded
- Processing of 1st and 2nd level error protection of the sound signal, including error concealment
- Digital mixing allows simultaneous processing of stereo sound and commentary channels
- Sound quality comparable with compact disc
- The decoder is software controlled.

Main functions of the multi-standard MAC decoder

The main part of the decoder comprises four full-custom VLSI CMOS ASICs from Plessey Semiconductors; MAC control circuit MV1720, MAC video circuit MV1710, MAC sound circuit MV1730 and MAC Teletext circuit MV1740. These are complemented by several Philips ICs; a MAC Analogue (MACAN) circuit TDA8734 which performs analogue signal processing and includes functions such as data slicing, clock recovery and video clamping, a microcomputer comprising a microprocessor (e.g. the 16-bit 68070) plus RAM and ROM, and a conditional access control module incorporating a PC880C51 8-bit microcontroller. Standard Philips ICs are also used for D to A and A to D conversion of the video signal (3 x TDA8702 and TDA8703 or Plessey SP94308 respectively), D to A conversion of the stereo sound signal (dual DAC TDA1541A), and for filtering the sound signal (SA97220).

The conditional access control module handles both over-air and/or local addressing for decryption. It can either be detachable or be implemented as a permanent part of the TV set. In either case, it’s connected to the microcomputer via the EBU interface.

The user interface, in its minimum form, consists of pushbuttons and LEDs. A more advanced version would incorporate a keyboard for controlling menus and service identification data displayed on the screen of the TV set.

Nordic VLSI, together with Tandberg Telecom and Elektrisk Bureau, has also formed the Crypto-MAC consortium, which will produce encoders and complete receivers using Nordic VLSI chips. The consortium has already signed several contracts for delivery of such equipment.

Philips expect to commence production of the multi-MAC decoder in June of this year.
CCIR is 60 years old

Sixty years ago, the ITU Plenipotentiaries of 80 states meeting in Washington D.C. (USA) from 4 October to 25 November 1927, turned a page of the Union's history by creating the International Radio Consultative Committee (CCIR).

Taking advantage of the presence of several CCIR delegates gathered in Geneva for interim study groups meetings, the CCIR held a celebration today to commemorate the event. In the years following the setting up of the Union, international agreements in the field of radiocommunications could be made by international conferences without much difficulty. However, as a result of the rapid development of the techniques used and their increasing complexity, it became clear in the 1920s that preliminary studies and coordination of the work undertaken in each Member country in telecommunications research and development would be required by international conferences to enable them to reach agreements within reasonable periods of time.

It is against this background that the decision was made to establish in 1927 a permanent body within the ITU Secretariat to deal with these questions. The role of the CCIR today is to study and issue Recommendations on technical and operating questions relating to radiocommunications. The First Plenary Assembly — the policy-making body made of representatives of Member administrations — was held in The Hague in 1929 and the first post-war Assembly, which reconvened the work of the CCIR, was held in Stockholm in 1948. Over 300 Recommendations adopted throughout its 60 years of history are still in force to date.

CCIR's Recommendations cover nearly every domain of the use of radio technology, including radio relay systems in telecommunications networks, satellite systems for communications, radio and television broadcasting, and mobile services such as maritime, aeronautical and land vehicle mobile communications. Some basic aspects of radiocommunication are also studied, as radio waves propagation and technical means that would lead to a better and more economical use of the frequency spectrum.

The CCIR is headed by a Director elected at Plenipotentiary conferences and is assisted by a specialized secretariat. The present Director of the CCIR is Mr. Richard Kirby from the United States.

The International Telecommunication Union (ITU) was founded in 1865 and as such is the oldest specialized agency of the United Nations. It now has a membership of 163 countries. It is the international organization responsible for the planning of telecommunications worldwide, for the establishment of equipment operating standards, for the coordination of data required for the planning and operation of telecommunications services and, within the United Nations system, for the development of telecommunications.

Cultural television channel expands in Europe

Britain's Satellite Television Arts Channel, which broadcasts cultural programmes to cable homes in western Europe, has added West Germany and Austria to its 'footprint' as from 1 January this year. From that date, it will also be available in many more households in Belgium, Denmark, the Republic of Ireland, Luxembourg, Finland, Norway, the Netherlands, Sweden, and Switzerland, as well as in Britain.

The expansion follows the conclusion of an agreement between the two-year old channel and SkyChannel, which pioneered satellite transmissions of family entertainment within Europe and provides for Arts Channel programmes to be transmitted via Sky's Eutelsat F1 satellite transponder. The three hours of cultural programmes are scheduled for transmission at 2330 UTC, although trailer highlights will be shown during the day so that viewers who do not want to stay up can set their video recorders.

Arts Channel makes about one fifth of its own programmes and 95% of the total output is of European origin. The range includes ball, opera, drama, music, and visual arts. The channel is currently filming a major four-part documentary, William and Mary, marking the 300th anniversary later this year of the accession to the British throne of Dutch Prince William of Orange and his English wife Princess Mary. This Anglo-Dutch programme will describe the architecture, painting, and music of the period.

Buzzbox attracts the deaf

The problem of how to attract the attention of a deaf child has been solved by a UK engineering product designer. He has produced a vibrating bracelet that is worn by the child and radio controlled by the parent.

Mr Paul Fearis developed the Buzzbox during his final year at South Bank Polytechnic, London, in response to a problem raised by the UK Royal National Institute for the Deaf. It consists of two units — a transmitter worn by the parent, and a receiver worn by the child, both running off rechargeable batteries. The vibrating bracelet is connected to the receiver by a wire. Both units are about the size and weight of a small calculator, are moulded in plastic and water resistant. "I used the sort of rugged radio-control apparatus used in aeroplanes," explained Mr Fearis, "so it should survive being dropped."

The transmitter sends a signal within the standard Citizen's Band frequency but this does not create any interference with CB radio, since the Buzzbox signal is digitally encoded. The vibration is then received and decoded by the child's receiver, triggering the vibrator in the bracelet. The system will work up to a distance of 1.6 km in an open area, or 0.4 km in a heavily built-up area.

The parent can send a signal on two different channels, each of which will light up a different light-emitting diode (LED) on the child's receiver, one red and the other green. The parent and child agree as to the meaning of the two different signals. The LED and vibrator will automatically switch off after 16 seconds if a child does not switch them on first. The 16 second period can be changed by changing the resistance and capacitance of the trigger circuit.

The vibrator itself consists of a small DC motor driving an off-centre weight, so that the weight of the motor controls the frequency of vibration felt by the child. (200 Hz is thought to be the frequency to which humans are most touch-sensible.)

Blind people could also use the system, says Mr Fearis, if the red/green LEDs were replaced by two different types of vibratory signal. The child could receive a pulsed vibration, for instance, by sending a square-wave radio signal.

The Buzzbox is to be manufactured by Mentmore Industries, workshop for the disabled in Hackney, London, and will retail for about £47.
The serial data output of the Intelligent Time Standard described last month is geared to driving a number of auxiliary time and date indication units installed at some distance from the master clock.

Applications of the indication unit described here can be found in and around the home, in studios, offices, laboratories, schools, workshops, or any other building in which accurate, central, timekeeping is a must.

The slave indication unit described here is an optional extension to the Intelligent Time Standard (DCF77 clock) described in [1]. The unit has large time and date displays with automatic brightness regulation, and is connected to the Time Standard via a 2-wire cable.

Circuit description

At the heart of the present circuit is a pre-programmed microcontroller Type 8748H from Intel. The "invisible" program that controls the operation of the indication unit has been designed and loaded into the EPROM on board the 8748H by Elektor Electronics. The internal machine code enables the microcontroller to combine the functions of:
1. serial data receiver;
2. ASCII to 7-segment decoder;
3. intelligent display multiplexer and refresh timer.

Hence, software is used in this application to make for a remarkably low chip count in a circuit whose operation is, none the less, relatively complex. With reference to the circuit diagram of Fig. 1, serial data at TTL level transmitted by the Intelligent Time Standard enters the circuit of the slave indication unit via buffer/inverter T1, which drives the INT (interrupt) input of the microcontroller, IC1. Figure 2 shows the circuit diagram of the display unit, which consists of two multiplexed rows of 7-segment LED displays, and 7 discrete LEDs. Port P1 of the 8748H controls the segments of the upper 6 displays (time), and the 7 LEDs (day of the week), while port P2 controls the lower 8 displays (date). IC2 and IC3 contain power buffers inserted between the port outputs of the microcontroller and the cathodes of the display segments and the discrete LEDs. The display unit is multiplexed by databits DB0... DB7 and darlington transistors T2... T9 incl.

The brightness of the displays is controlled automatically as a function of ambient light intensity. This function is realized by phototransistor Tm in conjunction with voltage regulator IC3 (reference [2]). The common-anode voltage for the displays, UA, is directly related to the ambient light intensity measured by Tm. The minimum brightness of the displays can be set to individual requirements by increasing the value of R1 to 220 Ω, and reducing R4 to 560 Ω.

The regulated 5 V power supply for the slave indication unit is of conventional design, and merits no further comment. The alternating input voltage (9...10 VAC) is obtained from a mains adapter, or a suitable power transformer.

Construction: two boards

The slave indication unit is built on two equally sized printed circuit boards that can be fitted in a sandwich construction.
March 1988

EE

to allow the use of a relatively flat enclosure (see the introductory photograph). For ease of wiring and access, the boards are mounted with facing track sides. It is also possible to use the control board for driving other display units, such as the Jumbo Displays (reference 19), provided the necessary alterations are made to this circuit.

If the sandwich construction is used, the boards are best interconnected with short lengths of strong, solid wire. For other mounting arrangements, it is recommended to use a 5 cm long connection made in flatcable.

The component mounting plan for the control board is shown in Fig. 4. There are 6 fixed, and 2 variable, wire links, whose function is shown in the circuit diagram. Fit links A—C (century: 19xx) and E—F (no zero suppression).

All segment control outputs are made in soldering terminals. Common-anode driver transistors T2...T9 incl. are fitted in a neat row on the PCB, and can do without a heat-sink. Be sure to check the mounting position of these transistors against the pin-out shown in the circuit diagram, Fig. 1. Voltage regulators IC2 and IC3 need heat-sinks of the style and size indicated on the component overlay. It is not necessary to insulate the metal tabs of the regulator chips from the heat-sinks. These can be bolted direct onto the PCB, provided that they are—and remain—well insulated from one another, as well as from any other part on the board (remember that the heat-sink for IC2 is connected to ground, and that for IC3 to junction R41—R43).

The phototransistor, T1, is fitted in a position that allows the detection of ambient light only, i.e., the device must not "see" the light emitted by the LED displays. Preset P1 makes it possible to set the display brightness to personal preference, and as required for the ambient light condition.

The display board is simple to build. Commence the construction with fitting the 8 wire links on it. LEDs Ds...Dn may be omitted, or fitted purely for

Fig. 1. Circuit diagram of the remote indication unit for the Elektor Electronics Intelligent Time Standard.

Fig. 2. Circuit diagram of the display unit.

Fig. 3. Eight miniature resistors may be used instead of a 9-pin SIL resistor network.
decorative purposes. The contrast, and hence the legibility, of the read-out can be enhanced by means of a red, semi-transparent, display bezel.

Check the operation of the on-board power supply before fitting the ICs in their sockets. Set Pi to the centre of its travel. Verify the presence of +5 V on pins 26 and 40 of the socket for the microcontroller, ICi. Evidently, the circuit works only when the microcontroller Type 8748H contains the correct control program. Ready-programmed 8748Hs for this project are available from Elektor Electronics or its agents under order number ESS 559.

Fit the ICs, and test the completed circuit by applying power. In the absence of time and date information from the Intelligent Time Standard, the displays should read 00 00 00 (time) and 01 01 1900 (date). If this checks out, the boards are ready for fitting into a suitable enclosure.

Fig. 4. The printed circuit board for the control board in the slave indication unit.

| Parts list |
|------------------|------------------|------------------|
| **CONTROL BOARD, CIRCUIT DIAGRAM: FIG. 1.** | **Capacitors:** | **Semiconductors:** |
| Resistors (±5%): | C1 = 3n3 | Di = 1N4148 |
| R1 = 10K | C2; C10 = 1μF; 10 V | Dz . . . Ds incl. = 1N4001 |
| R2 = 4K7 | C3; C4 = 33p | Ti = BC547 |
| R3 = 5K6 | C5 = 2200μF; 25 V | Tz . . . Ts incl. = BD675 |
| R4 . . . R11 incl. = 2K2 | C6 = 220μF | Tio = BC516 |
| R12 . . . R15 incl. = 3K3 8-way SIL resistor network | C7; C9; C11 = 100n | **Miscellaneous:** |
| R26 . . . R35 incl. = 27R | C8 = 10μ; 10 V | X1 = 10 MHz quartz crystal (enclosure: HC25U) |
| R10 = 1K0 | | Heat-sink for IC2 |
| R40 = 100K | | Heat-sink for IC3 |
| R41 = 680K | | PCB Type 87104-1 (see Readers Services page) |
| R42 = 220K | | |
It is recommended to drill a number of ventilation holes in the top and bottom panel of the enclosure, to keep the temperature of the voltage regulators on the heat-sinks within reasonable limits. The mains transformer plus fuse is preferably fitted in a separate box. Figure 7 shows a suggestion for making an attractive looking front panel for the slave indication unit.

Parts list
DISPLAY UNIT. CIRCUIT DIAGRAM: FIG. 2
Resistors (± 5%):
R1 ... R4 incl. = 33R
Semiconductors:
D1 ... D14 incl. = LED, Ø 3 mm, red
LD1 ... LD14 incl. = 7750 or 7751 (common anode LED display)
Miscellaneous:
PCB Type 87104-2 (see Readers Service page).

Connection to the Time Standard
Diodes D3 and D4, if present, are removed from the PCB in the Intelligent

Fig. 5. The printed circuit board for the display unit.
Time signals

It is possible to drive the slave indication unit from clock systems other than the Intelligent Time Standard, but only if the format of the serial time and date information is brought in accordance with that discussed in (1).

The numerical data structure shown in the example of Fig. 6 is selected when input on the Time Standard is activated, and configuration diode D3 has been fitted. It should be noted that the slave indication unit recognizes ASCII input data only. Data is organized as two hexadecimal figures, with two spaces (20h) to separate complete numbers. ASCII character 30h (0) is treated as 20h (space) by the slave indication unit, while the Intelligent Time Standard can be set up to replace leading zeroes by spaces. The data blocks are displayed strictly in the order in which they are received. The carriage return and line feed sequence (CR-LF; 0Dh-0Ah) is used for marking the end of the complete data block, and for resetting the internal pointers to prepare for reception of the next data string.

With reference to Fig. 6, the LEDs and displays are controlled by the following data blocks:

Block 1: LED D1...D7, day of the week;
Block 2: LD1-LD6, day of the month (1-31);
Block 3: LD7-LD9, month (1-12);
Block 4: LD10-LD11, year (00-99);
Block 5: LD12-LD13, hours (0-23);
Block 6: LD14-LD15, minutes (0-59);
Block 7: LD16-LD17, seconds (0-59).

The order in which the data blocks are sent, and their assignment to the displays, is fixed, since the slave indication unit cannot change the format of the received data.

The data speed on the serial link between the time standard and the remote indication unit is 4,800 bits/s. The structure of the serial data is:

8 databits, no parity, 1 stop bit.

Software

Although the operation of the software loaded in the microcontroller is, normally, invisible to the user, it is none the less useful to read the following description of its main functions.

Broadly speaking, the control program...
in the microcontroller 8748H is geared to perform two functions:
1. conversion to parallel of the serial data stream received from the Intelligent Time Standard;
2. driving, multiplexing and refreshing the display unit.

The microcontroller used here does not have an ACIA function (Asynchronous Communications Interface Adapter), so that serial-to-parallel conversion (sliding in) of received data can only be effected with the aid of timing routines in an interrupt structure. The start bit in each new data word causes the first interrupt, which is received while the main program works on multiplexing and refreshing the read-out. Display refresh is automatically corrected as a function of interrupt handling time. Thanks to this part of the control software, the read-out is stable and equally bright under all conditions, while correct processing of input data is ensured at the same time. The display routine in the control program is interrupted for 54 μs at 208 μs intervals (208 μs is the bit period for 4800 baud). There are 10 interrupts per received byte.
The displays are multiplexed in pairs (LD-LD, LD-LD) at a frequency of about 125 Hz, and an on-time of about 1 ms. In the absence of the automatic refresh correction, reception of 10 consecutive data points would cause an unacceptable delay of 540 μs, and hence would give rise to annoying display flicker. Day of the week indicators D1...D7 incl. are controlled together with LD, and only 1 of the 7 LEDs can light at a time.
The automatic leading zero suppression for the tens indication of the day, month and hour read-out can be disabled by fitting jumper E-F instead of D-E.

This option has been included in the design to allow the indication unit to be used in applications other than clock systems (studio timers, score-displays, etc). With jumper E-F fitted, leading zeroes are displayed, irrespective of whether these are caused by input character 20H (space) or 30H (0).
The software in the slave indication recognizes and processes the SYNC/NO SYNC code transmitted by the Intelligent Time Standard after the two seconds bytes and subsequent spaces in the time string (Mode: EXTRA INFO ON, SYNC = 42H; NO SYNC = 45H, see Fig. 6 in (ii)). This code may be used for controlling a LED that indicates whether or not the time standard is synchronized to DCF77. Such an indicator has not been provided on the slave indication unit, but is readily added by fitting the anode of a LED to CA8, and the cathode to line b2.

References:
(2) Jumbo displays. Elektor Electronics July/August 1985, p. 7-8 ff.

Note:
The control program in the 8748H (ESS 559) is not public domain software: the copyright rests with Elektor Electronics. Source listings and/or hex dumps of the program are, therefore, not available.

---

**Fig. 7. Suggested front panel layout.**

---

**NEW LITERATURE**

**Practical Digital Electronics Handbook**
by Mike Tooley
ISBN 1-870775-00-7
197 pages — 215 x 136 mm
Price £6.95 (soft cover)

As the title of the book suggests, the emphasis of the work is on the practical aspects of electronic circuits. Consequently, there is hardly any theory to be found in its pages. Quite correctly, Mr. Tooley is saying that the designer of electronic circuits need not know the internal function of ICs, for instance.

In a similar manner, logic networks are approached from a practical angle — no Boolean algebra here.

The treatment of microprocessors deals to some extent with the internal architecture, but with these devices that is virtually unavoidable.

The book further deals with semiconductor memories, I/O devices, the RS-232C interface, the IEEE-488 general purpose instrument bus, and the IEEE-1000 microprocessor bus.

A very useful part of the book is an appendix dealing with the necessary tools and test equipment required for fault-finding, complete with details of a number of test gear projects.

 Altogether a very useful book for anyone involved in the design, manufacture, or servicing of digital circuits.

**Oscilloscopes**

**Revised second edition**

by Ian Hickman
133 pages — 215 x 135 mm
Price £5.95 (soft cover)

The second edition of this popular book was reviewed in the July 1986 issue of *Elektor Electronics*. This revised edition has been updated and enlarged to cover new instruments that have been introduced since then. Among the new instruments are the Tektronix 2225 and the 1100 Series, the Beckman 9020, the Meguro M10-1255, the Philips MO3050, the Crotech 3133, the Nicolet 4094, the Gould 4072, and the Hewlett-Packard HP54110D.

The book remains well illustrated with diagrams and photographs and will continue to appeal to everyone who wants to know about oscilloscopes, from the student to the graduate, from the hobbyist to the technician.

William Heinemann Ltd
10 Upper Grosvenor Street
LONDON W1X 9PA
Audio Amplifier Fault-finding Chart
by Chas. E. Miller
Price 95 p

This chart has been designed to help the reader approach fault rectification and repair of audio amplifiers in a systematic and logical way. The author has developed the chart by drawing on many years' experience in repairing audio and hi-fi systems. Used correctly, the chart should enable the user to trace many common faults reasonably quickly.

All the user has to do is to select one of the faults shown at the top of the chart, and follow the arrows while carrying out the suggested checks in sequence until the fault is cleared.

Measuring 640×450 mm, the chart should prove of interest to anyone involved in the repair or servicing of audio circuits.

Bernard Babani (publishing) Ltd
The Grampians
Shepherds Bush Road
LONDON W6 7NF

DATABOOKS
Soft Magnetic Ferrites is a bi-lingual (Serbo-Croat and English) book that should be of interest to anyone involved in the design of inductors. The 186-page publication is available from ISKRA Ltd.

Databooks
Soft Magnetic Ferrites is a bi-lingual (Serbo-Croat and English) book that should be of interest to anyone involved in the design of inductors. The 186-page publication is available from ISKRA Ltd.

The Hawker Siddeley Group has made the following appointments. Mr. R.P. HAMPSON becomes chairman of Brush Electrical Machines Ltd.; Mr. B.G. SHOOSSMITH becomes chairman and managing director of Crompton Parkinson Ltd.; Mr. W.M.M. PETRIE becomes managing director of Brush Electrical Machines Ltd.

Printronix have appointed Roy Venables (above) UK Sales Manager in succession to Martin Phillips, who now manages the company's sales in Scandinavia and the Benelux.

Mr. David DEY has joined the UK Communications Division of British Telecom as Deputy Managing Director. Mr. DeY was until recently Managing Director of Plessey Telecommunications.

Mr. Ron Bull, BSc, CEng, (above) the immediate past president of The Machine Tool Trades Association, is the newly elected President of CECIMO, the European Committee for co-operation of the Machine Tool Industries.

Marconi Radar Systems of Chelmsford has appointed John Winstanley director, airspace business, with particular responsibility for all the activities of the company's airspace control division. At the same time, the company has appointed Steve Menzies financial director.

The ASIC Data Book should be of interest to anyone involved with Application Specific ICs. It is available from MITEC UK • Easthampstead Road • BRACKNELL RG12 1NF • Telephone (0344) 53974.

CATALOGUES
The 1988 Babani Books list is available free of charge. Just send a 220×110 mm stamped, addressed envelope to Bernard Babani (publishing) Ltd • The Grampians • Shepherds Bush Road • LONDON W6 7NF.

Mr. Ron Bull, BSc, CEng, (above) the immediate past president of The Machine Tool Trades Association, is the newly elected President of CECIMO, the European Committee for co-operation of the Machine Tool Industries.

Printronix have appointed Roy Venables (above) UK Sales Manager in succession to Martin Phillips, who now manages the company's sales in Scandinavia and the Benelux.

Mr. David DEY has joined the UK Communications Division of British Telecom as Deputy Managing Director. Mr. DeY was until recently Managing Director of Plessey Telecommunications.

Mr. Ron Bull, BSc, CEng, (above) the immediate past president of The Machine Tool Trades Association, is the newly elected President of CECIMO, the European Committee for co-operation of the Machine Tool Industries.

Marconi Radar Systems of Chelmsford has appointed John Winstanley director, airspace business, with particular responsibility for all the activities of the company's airspace control division. At the same time, the company has appointed Steve Menzies financial director.

The ASIC Data Book should be of interest to anyone involved with Application Specific ICs. It is available from MITEC UK • Easthampstead Road • BRACKNELL RG12 1NF • Telephone (0344) 53974.

CATALOGUES
The 1988 Babani Books list is available free of charge. Just send a 220×110 mm stamped, addressed envelope to Bernard Babani (publishing) Ltd • The Grampians • Shepherds Bush Road • LONDON W6 7NF.
Accelerometers for severe environments
BRUEL & KJAER (UK) LTD. have recently released two new accelerometers for use in severe environments. They are Types 8315 and 8317 and both are constructed on the now well-known Delta Shear principle. The 8315 is suitable for use at 250 °C, has a frequency range from 0.1 to 8100 Hz and weighs 102 grams.

The 8317 is certified as intrinsically safe for explosive areas (Class EE1X IIC T6/T5/T4), has been in line drive amplifier, a frequency range from 0.2 to 7500 Hz and weighs 112 grams. Both can be supplied with integral cable if required.

New dual-element pyro infrared detectors
Quantelec has announced a new range of pyro infrared detectors which are specially designed for applications such as burglar alarm systems, positioning units, automatic light switches and door openers. Manufactured by Sentel in West Germany, the new detectors feature a dual element design with parallel opposed elements which produces a high level of common mode rejection. This makes the devices ideal for the above applications.

The detectors use Lithium-Tantalate as the IR-sensing material so that the responsivity of the device is independent of the temperature within its operating temperature range of -40 to +70 °C. The standard window material is silicon, coated for an optical bandwidth of 7 to 14 µm. A range of different filters is also available including silicon with wide-band AR-coating, quartz, Infrarod 2, Calcium Fluoride and narrow band windows. Frequency response of the detectors is flat from 0.3 to 0.5 Hz, and -6 dB/octave beyond 1 Hz. The frequency range is from 0.2 to 7500 Hz and weighs 112 grams. They are Types 8315 and 8317 and both have a frequency range from 0.1 to 8100 Hz and weigh 102 grams. Both can be supplied with integral cable if required.

New low-cost card turns a PC into a fax machine
PC users can now use their micros to send and receive fax messages — thanks to a new, low-cost card available ex stock from Dram Electronics. The IC-01B fax card costs £54.60 and slots into the back of any IBM PC or clone. It enables the PC to send text to any Group II or Group III fax machine over telephone lines under CCITT V29 and V27 standards.

The card meets T4 and T30 compatibility. Data rates are as follows; V29: 9600/7200/4800 bps; V27: 4800/2400 bps; V21: channel 2 at 300 bps. Data format is synchronous. Power consumption is 3.6 W. Built-in software converts data from ASCII to fax format for transmission. The card generates tones up to 4800 Hz and detects tones of 462 Hz, 1100 Hz and 2100 Hz. Dailing is by tone, pulse or voice frequency energy detect.

New range of enclosures in stock at ESS
Available off the shelf from ESS is a wide range of West Hyde enclosures. Included in the stock at ESS is the popular range of Bopla enclosures. In the range is the modular electrical/electronics enclosure system Combicard.

Wide range of enclosures in stock at ESS
Available off the shelf from ESS is a wide range of West Hyde enclosures. Included in the stock at ESS is the popular range of Bopla enclosures. In the range is the modular electrical/electronics enclosure system Combicard.

Kemo has developed a new range of high-performance filter modules which are available with a wide selection of characteristics and different configurations. The standard 1100 Series modules are supplied in a compact, common-pinout 2-inch square package, but filter assemblies are also available in the form of IBM PC or compatible cards, VME boards or 32-channel rack/bench mounting carrier systems.

The filtering functions available in the 1100 Series cover elliptic, Bessel and Butterworth types, with an emphasis on the preparation of signals for digital signal processing. Both seventh and ninth-order elliptic functions are included, with a wide choice of shape factors. The frequency range of the filter cutoff frequency is from 10 Hz to 250 kHz, and all filters in the range share a basic common specification with only small changes between different response and frequency options. Hence designers can specify many different filters in a complex system without compatibility problems.

Other features of the Kemo 1100 Series include a deep attenuation floor down to -90 dB, low noise and distortion with a wide dynamic range, and close phase match within batch deliveries.

Kemo Limited • 9-12 Goodwood Parade • Elmers End • BECKENHAM BR3 3QZ. Telephone: (01 658) 3838.

High-performance filter modules
Kemo has developed a new range of high-performance filter modules which are available with a wide selection of characteristics and different configurations.

The standard 1100 Series modules are supplied in a compact, common-pinout 2-inch square package, but filter assemblies are also available in the form of IBM PC or compatible cards, VME boards or 32-channel rack/bench mounting carrier systems.

The filtering functions available in the 1100 Series cover elliptic, Bessel and Butterworth types, with an emphasis on the preparation of signals for digital signal processing. Both seventh and ninth-order elliptic functions are included, with a wide choice of shape factors. The frequency range of the filter cutoff frequency is from 10 Hz to 250 kHz, and all filters in the range share a basic common specification with only small changes between different response and frequency options. Hence designers can specify many different filters in a complex system without compatibility problems.

Other features of the Kemo 1100 Series include a deep attenuation floor down to -90 dB, low noise and distortion with a wide dynamic range, and close phase match within batch deliveries.

Kemo Limited • 9-12 Goodwood Parade • Elmers End • BECKENHAM BR3 3QZ. Telephone: (01 658) 3838.
DESIGN ABSTRACTS

The contents of this column are based on information obtained from manufacturers in the electronics industry, or their representatives, and do not imply practical experience by Elektor Electronics or its consultants.

ELECTRONIC COMPASS

Two magneto-resistive sensors and a relatively simple measuring and control circuit form the basis for the design of an all-electronic direction finder.

Magneto-resistive sensors: a brief recap

The basic structure of the four magneto-resistive elements in the Wheatstone bridge Type KMZ10A is shown in Fig. 1. The sensor elements are essentially meander-shaped, permalloy, tracks with gold stripes. This structure is referred to as a barber's pole for obvious reasons. Inside the plastic encapsulation of the Type KMZ10A magneto-resistive sensor from Valvo (Philips/Mullard) is a silicon substrate that carries four of such elements connected as the arms of a Wheatstone bridge.

The KMZ10A makes use of the Gauss-effect, i.e., the property of current-carrying material to change its resistivity in the presence of an external magnetic field. This change is brought about by rotation of the magnetization relative to the current direction. The degree of bridge imbalance is used for indicating the magnetic field strength, or, more precisely, the variation in magnetic field in the plane of the permalloy carriers relative to the direction of current.

Designing an electronic compass

The earth's magnetic field is relatively weak, so that the final accuracy of an electronic compass based on magneto-resistive sensors is limited mainly by drift incurred in the sensor, and offset voltages in the instrumentation amplifier. Offset voltages and signals caused by magnetic fields can, however, be discriminated by making use of a property typical of the Barber's pole structure, namely that the two directions of magnetization result in two directions of maximum sensitivity. This phenomenon can be exploited in a practical circuit that arranges for the sensor to be fed with a series of positive and negative magnetic pulses in the x direction.

For the KMZ10A, the continuously reversing field applied should have a strength of 3 kA/m. This value is ensured by an inductor winding secured direct onto the sensor enclosure, or by fitting the sensor inside a small coil former.

Figure 3b shows that the offset voltage remains constant during the periodic magnetization by the positive and negative pulses. It is seen that the signals of interest are rectangular pulses, which are relatively simple to separate from the offset voltage. This obviates the need for an auxiliary field, which would degrade sensitivity. The full sensitivity of about 14 (mV/V)(kA/m) stated for the Type KMZ10A is, therefore, available, while measurements of field strengths, $H_s$, of up to 0.25 kA/m can be carried out without running into sensor instability. The proposed principle of alternating fields for each plane of maximum sensitivity is well suited to direction measurements in the earth's magnetic field. The construction of an electronic compass for navigation in or on vessels and vehicles can be based on two magneto-resistive sensors positioned at right angles, and fitted in the form of an inductor that supplies the reversing field. Temperature compensation for the sensor is not required in most cases, because the relative, rather than absol-
Fig. 3. An external inductor supplies a pulsating and reversing auxiliary magnetic field to the four sensors in the Wheatstone bridge (a). Elimination of the offset current (b) and pulse diagram (c).

Fig. 4. Two magnetic field sensors Type KMZ10A positioned at right angles, and fitted in a coil former Type 4322 021 30270 (normally part of pot core set P18/11). The inductor is wound as 100 turns Ø0.35 mm enamelled copper wire (SWG29). R=0.8 Ω; L=87 µH; H's=8.3 (kA/m)/A.

Fig. 5. Suggested circuit of the sensor head and instrumentation circuitry that can form the basis for designing an electronic compass.

Source: Valvo, Technische Informationen 861105.

Kikusui COS-5042TM

Kikusui are a well-established company producing a range of test equipment that includes signal generators, power supplies, FFT analysers, and a variety of oscilloscopes. Their COS-5000TM range of oscilloscopes extends from a 'basic' 20 MHz model, the COS-5020TM, to the 100 MHz COS-5100TM. The COS-5042TM, the top model in Kikusui's 40 MHz range, costs £715, excluding VAT. The cheapest single timebase 40 MHz scope from Kikusui comes in at £565, excluding VAT. Accessories available include viewing hoods, trolleys, protective front covers, and a suitable camera mount. The two probes supplied with the 5042 are very similar to those provided with other Japanese scopes. The 5042's small dimensions (288 mm (W) x 150 mm (H) x 370 mm (D)) make its use in conjunction with other instruments in a confined space particularly easy. It is a pity, though, that the 5042 is not provided with a swivel stand, something that with an instrument in this class is normally taken for granted. The one-position stand fitted may be useful if the instrument is to be stacked. The 5042 weighs 7.5 kg.

The 5042 is supplied with a standard IEC style terminated mains lead and can operate from line voltages ranging from 100 to 240 VAC. Facilities provided on the instrument include a trigger holdoff and 3 input channels, the third channel being usable as a trigger view or marker channel. As usual, both the Z-modulation and CH1 output sockets (BNC) are mounted on the rear panel along with, surprisingly, the CH3 position control.

The two main input channels, CH1 and CH2, both have input sensitivities which range from 5 mV/div to 5 V/div, extendable by a x5 switch to 1 mV/div. A variable control extends the maximum attenuation to approximately 10 V/div. No uncalibrated indicators are provided for the Y-amps which could initially lead to user reading errors, but these should be kept to a minimum thanks to the very clear markings of the variable controls. Input capacitance is reasonable, and certainly acceptable, at 25 pF, although input capacitances of 20 pF are becoming increasingly popular on scopes at and above this bandwidth. The bandwidth of both amplifiers is good, extending up to approximately 45 MHz (−3 dB) in the 5 mV/div to 5 V/div ranges and an excellent 23 MHz (−3 dB) when the x5 magnifier is brought into operation. The x5 magnifier permits operation in the 2-4-10 sequence against the more usual 1-2-5 sequence, as well as permitting a maximum sensitivity of 1 mV/div. In the x5 mode, the maximum error is increased from 3% to 5%, in common with most other scopes of this class. As is increasingly the case for scopes of this complexity, only one channel is invertible (CH2) so that in some situations swapping of probes may be necessary. A minimal amount of drift is exhibited by both amplifiers at switch on, enabling accurate measurements to be carried out during the warm-up period, without having to resort to adjustments of the Y trace positions after a short period of time.

The third channel is of the same bandwidth as channels 1 & 2, but its ranges are restricted to 0.1 V/div and 0.5 V/div. These are, however, useful in that by the addition of a x10 probe they can be used for digital measurements, or as a marker channel. In addition, the channel can also be coupled internally, facilitating its use as a trigger view channel capable of displacing the triggering waveform of either CH1 or CH2. All three channels are accurately matched so probes should be fully interchangeable between them without any compensation adjustments. A 1 kHz 0.5 p-p probe compensation waveform is provided. The wide variety of operating modes provided include the display of CH1, CH2 or CH3 singly or in any combination. Only CH1 and CH2, however, can be added. When in add mode, both the input waveforms can be seen, as well as the resultant which I found to be genuinely useful. The price paid for this versatility is in the ease of operation. Push buttons are used in place of the more usual slider type switches for most of the triggering and mode selection functions. The trigger functions of the 5042 are fairly comprehensive and include auto peak-to-peak triggering, trigger holdoff and an alternate mode. The auto triggering facility worked well in most cases, although it did suffer from a distinct lack of sensitivity over the whole bandwidth. Typical sensitivity was two divisions, which in dual, or triple trace applications can prove to be inadequate. In this case, it is necessary to switch into manual trigger control where the sensitivity is typically 1.2-1.5 div at 40 MHz, or about 1/5 div at 10 MHz. The trigger holdoff was successful in stably displaying a wide range of waveforms and in some ways made up for the lack of sensitivity. External sensitivity is good at 40 mV (10 MHz) or 150 mV (40 MHz) and its usefulness is extended by a +5 control, allowing triggering of, for example, only the wanted signal if a large amount of noise is present. The effective 'lock on' time of the auto trigger circuit was good with the minimum of delay present in most cases. Triggering sources include the useful alternate triggering facility, as well as line, and, of course, CH1, CH2 or CH3 (Ext). Automatic switching between frame and line synchronization is provided in the TV mode which is surprisingly useful, enabling generally faster and more efficient operation when the scope is operated in this mode. Because of its nature, it did not appear to affect the scope's versatility in any way. An effective HF reject facility is provided, although a corresponding LF facility is not. Triggering facilities for the second (B) timebase, are rather limited.
Although perfectly adequate for most purposes, the main drawback is that the maximum deflection speed is limited and timebase is the same, 50 ms/div. An uncalibrated sweep control is provided for the A and B timebases. The display is not as clear as it could be, especially in some cases where the signal is not visible. However, the sensitivity to the grid and the screen is very good, providing a wide variety of environments. In contrast, the COS5040'TM offers a very good overall performance combined with good construction, but in some cases it has one or two minor drawbacks, such as its lack of triggering sensitivity and B timebase facilities, but overall these do

**Table 14**

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>Unsuitable</th>
<th>Unsatisfactory</th>
<th>Fair</th>
<th>Average</th>
<th>Good</th>
<th>Very Good</th>
<th>Excellent</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEL'D SWEEP PERFORMANCE</td>
<td><strong>X</strong></td>
<td><strong>X</strong></td>
<td><strong>X</strong></td>
<td><strong>X</strong></td>
<td><strong>X</strong></td>
<td><strong>X</strong></td>
<td><strong>X</strong></td>
</tr>
<tr>
<td>CRT BRIGHTNESS</td>
<td><strong>X</strong></td>
<td><strong>X</strong></td>
<td><strong>X</strong></td>
<td><strong>X</strong></td>
<td><strong>X</strong></td>
<td><strong>X</strong></td>
<td><strong>X</strong></td>
</tr>
<tr>
<td>EXTERNAL CONSTRUCTION</td>
<td><strong>X</strong></td>
<td><strong>X</strong></td>
<td><strong>X</strong></td>
<td><strong>X</strong></td>
<td><strong>X</strong></td>
<td><strong>X</strong></td>
<td><strong>X</strong></td>
</tr>
<tr>
<td>OVERALL SPECIFICATION</td>
<td><strong>X</strong></td>
<td><strong>X</strong></td>
<td><strong>X</strong></td>
<td><strong>X</strong></td>
<td><strong>X</strong></td>
<td><strong>X</strong></td>
<td><strong>X</strong></td>
</tr>
<tr>
<td>MANUAL</td>
<td><strong>X</strong></td>
<td><strong>X</strong></td>
<td><strong>X</strong></td>
<td><strong>X</strong></td>
<td><strong>X</strong></td>
<td><strong>X</strong></td>
<td><strong>X</strong></td>
</tr>
</tbody>
</table>

**ELECTRICAL CHARACTERISTICS**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input coupling</td>
<td>CH1, CH2, CH3: AC, DC or Gnd.</td>
</tr>
<tr>
<td>Input impedance</td>
<td>CH1, CH2, CH3: 1 MΩ or 25 pF.</td>
</tr>
<tr>
<td>Frequency response</td>
<td>CH1, CH2, CH3: 1 Hz to 20 MHz.</td>
</tr>
<tr>
<td>Maximum input</td>
<td>CH1, CH2, CH3: 100 V (DC + AC peak).</td>
</tr>
<tr>
<td>Linearity</td>
<td>CH1, CH2, CH3: ± 1% for CH1, ± 2% for CH2, ± 3% for CH3.</td>
</tr>
<tr>
<td>Frequency response</td>
<td>CH1, CH2, CH3: 0.1 Hz to 20 MHz.</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>CH1, CH2, CH3: 0.5 V/div or 0.1 V/div ± 3%.</td>
</tr>
<tr>
<td>Signal Delay time</td>
<td>CH1, CH2, CH3: approx. 20 ns on CRT screen.</td>
</tr>
<tr>
<td>Voltage 300 (DC + peak AC)</td>
<td>CH1, CH2, CH3: 1.5 kV, domed -mesh type.</td>
</tr>
<tr>
<td>Input capacitance</td>
<td>CH1, CH2, CH3: 80 mm x 100 mm; accelerating voltage 12 kV.</td>
</tr>
<tr>
<td>Input impedance</td>
<td>CH1, CH2, CH3: 1 MΩ/25 pF.</td>
</tr>
<tr>
<td>Input coupling</td>
<td>CH1, CH2, CH3: AC, DC, or Gnd.</td>
</tr>
<tr>
<td>Frequency response</td>
<td>CH1, CH2, CH3: 1 Hz to 20 MHz.</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>CH1, CH2, CH3: 0.5 V/div or 0.1 V/div ± 3%.</td>
</tr>
<tr>
<td>Signal Delay time</td>
<td>CH1, CH2, CH3: approx. 20 ns on CRT screen.</td>
</tr>
<tr>
<td>Voltage 300 (DC + peak AC)</td>
<td>CH1, CH2, CH3: 1.5 kV, domed -mesh type.</td>
</tr>
<tr>
<td>Input capacitance</td>
<td>CH1, CH2, CH3: 80 mm x 100 mm; accelerating voltage 12 kV.</td>
</tr>
<tr>
<td>Input impedance</td>
<td>CH1, CH2, CH3: 1 MΩ/25 pF.</td>
</tr>
<tr>
<td>Input coupling</td>
<td>CH1, CH2, CH3: AC, DC, or Gnd.</td>
</tr>
<tr>
<td>Frequency response</td>
<td>CH1, CH2, CH3: 1 Hz to 20 MHz.</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>CH1, CH2, CH3: 0.5 V/div or 0.1 V/div ± 3%.</td>
</tr>
<tr>
<td>Signal Delay time</td>
<td>CH1, CH2, CH3: approx. 20 ns on CRT screen.</td>
</tr>
<tr>
<td>Voltage 300 (DC + peak AC)</td>
<td>CH1, CH2, CH3: 1.5 kV, domed -mesh type.</td>
</tr>
<tr>
<td>Input capacitance</td>
<td>CH1, CH2, CH3: 80 mm x 100 mm; accelerating voltage 12 kV.</td>
</tr>
<tr>
<td>Input impedance</td>
<td>CH1, CH2, CH3: 1 MΩ/25 pF.</td>
</tr>
<tr>
<td>Input coupling</td>
<td>CH1, CH2, CH3: AC, DC, or Gnd.</td>
</tr>
<tr>
<td>Frequency response</td>
<td>CH1, CH2, CH3: 1 Hz to 20 MHz.</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>CH1, CH2, CH3: 0.5 V/div or 0.1 V/div ± 3%.</td>
</tr>
<tr>
<td>Signal Delay time</td>
<td>CH1, CH2, CH3: approx. 20 ns on CRT screen.</td>
</tr>
<tr>
<td>Voltage 300 (DC + peak AC)</td>
<td>CH1, CH2, CH3: 1.5 kV, domed -mesh type.</td>
</tr>
<tr>
<td>Input capacitance</td>
<td>CH1, CH2, CH3: 80 mm x 100 mm; accelerating voltage 12 kV.</td>
</tr>
<tr>
<td>Input impedance</td>
<td>CH1, CH2, CH3: 1 MΩ/25 pF.</td>
</tr>
<tr>
<td>Input coupling</td>
<td>CH1, CH2, CH3: AC, DC, or Gnd.</td>
</tr>
<tr>
<td>Frequency response</td>
<td>CH1, CH2, CH3: 1 Hz to 20 MHz.</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>CH1, CH2, CH3: 0.5 V/div or 0.1 V/div ± 3%.</td>
</tr>
<tr>
<td>Signal Delay time</td>
<td>CH1, CH2, CH3: approx. 20 ns on CRT screen.</td>
</tr>
<tr>
<td>Voltage 300 (DC + peak AC)</td>
<td>CH1, CH2, CH3: 1.5 kV, domed -mesh type.</td>
</tr>
<tr>
<td>Input capacitance</td>
<td>CH1, CH2, CH3: 80 mm x 100 mm; accelerating voltage 12 kV.</td>
</tr>
<tr>
<td>Input impedance</td>
<td>CH1, CH2, CH3: 1 MΩ/25 pF.</td>
</tr>
<tr>
<td>Input coupling</td>
<td>CH1, CH2, CH3: AC, DC, or Gnd.</td>
</tr>
<tr>
<td>Frequency response</td>
<td>CH1, CH2, CH3: 1 Hz to 20 MHz.</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>CH1, CH2, CH3: 0.5 V/div or 0.1 V/div ± 3%.</td>
</tr>
<tr>
<td>Signal Delay time</td>
<td>CH1, CH2, CH3: approx. 20 ns on CRT screen.</td>
</tr>
<tr>
<td>Voltage 300 (DC + peak AC)</td>
<td>CH1, CH2, CH3: 1.5 kV, domed -mesh type.</td>
</tr>
<tr>
<td>Input capacitance</td>
<td>CH1, CH2, CH3: 80 mm x 100 mm; accelerating voltage 12 kV.</td>
</tr>
<tr>
<td>Input impedance</td>
<td>CH1, CH2, CH3: 1 MΩ/25 pF.</td>
</tr>
<tr>
<td>Input coupling</td>
<td>CH1, CH2, CH3: AC, DC, or Gnd.</td>
</tr>
<tr>
<td>Frequency response</td>
<td>CH1, CH2, CH3: 1 Hz to 20 MHz.</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>CH1, CH2, CH3: 0.5 V/div or 0.1 V/div ± 3%.</td>
</tr>
<tr>
<td>Signal Delay time</td>
<td>CH1, CH2, CH3: approx. 20 ns on CRT screen.</td>
</tr>
<tr>
<td>Voltage 300 (DC + peak AC)</td>
<td>CH1, CH2, CH3: 1.5 kV, domed -mesh type.</td>
</tr>
<tr>
<td>Input capacitance</td>
<td>CH1, CH2, CH3: 80 mm x 100 mm; accelerating voltage 12 kV.</td>
</tr>
<tr>
<td>Input impedance</td>
<td>CH1, CH2, CH3: 1 MΩ/25 pF.</td>
</tr>
<tr>
<td>Input coupling</td>
<td>CH1, CH2, CH3: AC, DC, or Gnd.</td>
</tr>
<tr>
<td>Frequency response</td>
<td>CH1, CH2, CH3: 1 Hz to 20 MHz.</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>CH1, CH2, CH3: 0.5 V/div or 0.1 V/div ± 3%.</td>
</tr>
<tr>
<td>Signal Delay time</td>
<td>CH1, CH2, CH3: approx. 20 ns on CRT screen.</td>
</tr>
<tr>
<td>Voltage 300 (DC + peak AC)</td>
<td>CH1, CH2, CH3: 1.5 kV, domed -mesh type.</td>
</tr>
<tr>
<td>Input capacitance</td>
<td>CH1, CH2, CH3: 80 mm x 100 mm; accelerating voltage 12 kV.</td>
</tr>
<tr>
<td>Input impedance</td>
<td>CH1, CH2, CH3: 1 MΩ/25 pF.</td>
</tr>
<tr>
<td>Input coupling</td>
<td>CH1, CH2, CH3: AC, DC, or Gnd.</td>
</tr>
<tr>
<td>Frequency response</td>
<td>CH1, CH2, CH3: 1 Hz to 20 MHz.</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>CH1, CH2, CH3: 0.5 V/div or 0.1 V/div ± 3%.</td>
</tr>
<tr>
<td>Signal Delay time</td>
<td>CH1, CH2, CH3: approx. 20 ns on CRT screen.</td>
</tr>
<tr>
<td>Voltage 300 (DC + peak AC)</td>
<td>CH1, CH2, CH3: 1.5 kV, domed -mesh type.</td>
</tr>
<tr>
<td>Input capacitance</td>
<td>CH1, CH2, CH3: 80 mm x 100 mm; accelerating voltage 12 kV.</td>
</tr>
<tr>
<td>Input impedance</td>
<td>CH1, CH2, CH3: 1 MΩ/25 pF.</td>
</tr>
<tr>
<td>Input coupling</td>
<td>CH1, CH2, CH3: AC, DC, or Gnd.</td>
</tr>
<tr>
<td>Frequency response</td>
<td>CH1, CH2, CH3: 1 Hz to 20 MHz.</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>CH1, CH2, CH3: 0.5 V/div or 0.1 V/div ± 3%.</td>
</tr>
<tr>
<td>Signal Delay time</td>
<td>CH1, CH2, CH3: approx. 20 ns on CRT screen.</td>
</tr>
<tr>
<td>Voltage 300 (DC + peak AC)</td>
<td>CH1, CH2, CH3: 1.5 kV, domed -mesh type.</td>
</tr>
<tr>
<td>Input capacitance</td>
<td>CH1, CH2, CH3: 80 mm x 100 mm; accelerating voltage 12 kV.</td>
</tr>
<tr>
<td>Input impedance</td>
<td>CH1, CH2, CH3: 1 MΩ/25 pF.</td>
</tr>
<tr>
<td>Input coupling</td>
<td>CH1, CH2, CH3: AC, DC, or Gnd.</td>
</tr>
<tr>
<td>Frequency response</td>
<td>CH1, CH2, CH3: 1 Hz to 20 MHz.</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>CH1, CH2, CH3: 0.5 V/div or 0.1 V/div ± 3%.</td>
</tr>
<tr>
<td>Signal Delay time</td>
<td>CH1, CH2, CH3: approx. 20 ns on CRT screen.</td>
</tr>
<tr>
<td>Voltage 300 (DC + peak AC)</td>
<td>CH1, CH2, CH3: 1.5 kV, domed -mesh type.</td>
</tr>
<tr>
<td>Input capacitance</td>
<td>CH1, CH2, CH3: 80 mm x 100 mm; accelerating voltage 12 kV.</td>
</tr>
<tr>
<td>Input impedance</td>
<td>CH1, CH2, CH3: 1 MΩ/25 pF.</td>
</tr>
</tbody>
</table>
obviously be of more importance to
out particularly well on Y\-perform-
other scopes in its class, the 5042 comes
coupled those users who require real portability
of the scope.

The Kikusui COS5042TM was supplied by Telsonic Instruments Ltd, Boynt Valley
Road, Maidenhead, Berkshire SL6 4EG. Tel: (0268) 73933

Grundig MO22

Grundig's MO22 oscilloscope is based on the MO20 (reviewed in our January 1988 issue), but it has, for instance, a second timebase and fully automatic control of the main timebase. Because of this, the triggering facilities and Y amplifiers will be discussed in detail again, as they are virtually identical to those found in the MO20. The MO22 retails at £499, excluding VAT.

The MO22 is, like the MO20, fitted with a non-removable mains lead which is terminated in a standard 2 pin IEC type plug. Layout is similar to the MO20, although, as can be seen from the photograph, the whole of the top half of the scope is taken up by the timebase and triggering controls, which include automatic timebase selection. The Y amplifier controls are mounted on the lower half. All controls are very easy to operate and clearly marked. Both the B timebase and Y amplifier range selection switches have no endstops, which can be inconvenient if the scope needs to be switched quickly to one of its end ranges.

Automatic triggering is provided on the MO22, along with high and low frequency coupling. The B timebase is also triggerable, although the triggering threshold is set by the single trigger level control, meaning that both timebases are triggered on the same threshold. In the vast majority of situations this should not be a significant limitation, and pays dividends since it ensures both traces are stable. The B trigger modes are continuous delay and triggered delay, in which mode the second timebase can either be triggered on the rising or falling slope of a waveform.

Triggering of the second timebase is effective across the whole bandwidth and extends to approximately 70 MHz in both automatic (p-p) and normal triggering modes. This is, however, when using the soft tuning facility for manual selection of the A timebase sweep speed.

When the A timebase was placed in automatic mode, a maximum reliable trigger frequency of 35 MHz was obtained, this being for the triggering of both the automatic facility and the timebase itself. A trigger holdoff facility is also provided, which is very effective in providing accurate triggering on a wide variety of waveforms. Its performance was particularly good on pulse and digital waveforms, providing a stable trace under almost any alteration of the frequency of the waveform and over a very wide range of timebase speeds (including automatic). External triggering is also good with a typical sensitivity of 400 mV and a maximum bandwidth approaching 40 MHz, allowing the external synchronization of most events.

Probably the main asset of the MO22 is its fully automatic main timebase, which enables very fast and easy operation of the scope when waveforms of a fairly constant amplitude, but not frequency, need to be measured. Timebase speeds range from 220 ns/div to 500 ns/div, or 50 ns/div if the x10 magnifier is brought into operation, this being covered in 18 steps, either by automatic or manual soft tuning via a continuously variable control. Timebase range indications is by 11 green LEDs. This takes into account the 9 'range' indicators, which are calibrated in the standard 1-2-

5 sequence, as well as two scaling LEDs, which indicate whether the range indicators are calibrated in micro or milli seconds. Auto mode is indicated by a single red LED, timebase speed still being given by the remaining indicators. When in soft tune mode, the continuously variable control gives a linear response: it is very easy to set the desired timebase speed. A large amount of hysteresis is provided between the range switching thresholds, preventing any
unsatisfactory.

Overall, I also found the automatic timebase an extremely useful facility with few failings, although as a very minor point it might have been helpful to have an automatic \( \times 10 \) deflection speed facility to increase the maximum speed under automatic control to 50 ns/div in place of the 500 ns/div for higher frequencies. The second timebase/delayed sweep is of the 'coarse' type, in that in most circumstances it is not possible to carry out accurate timing measurements in situations where a calibrated delay time multiplier would normally be required. Waveform expansions can, however, be carried out accurately by the second timebase. For unstable, or changing, frequencies, it is obviously advisable to use the soft tuning option of the main timebase, although where this is not the case, the autorange option can be used with good results. The analogue second timebase sweep speeds range from 2 ms/div to 0.5 \( \mu \)s/div, and can be used in one of two modes, either intensifying the trace to be magnified, or as the magnified sweep. It is worth noting that in common with most other 'coarse' delayed sweep systems only one timebase can be displayed at a time, i.e., either A or B, and not both, thus giving a maximum of two traces on the screen at any one time. Jitter is one part in 10,000, and as such is just visible on high magnification ratios, although it can be kept to a minimum in some situations by using the triggered delay facility. The delay time is variable by an uncalibrated control over 10 horizontal divisions, and as mentioned above can either be continuous or triggered.

Table 16

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>Unsatisfactory</th>
<th>Satisfactory</th>
<th>Good</th>
<th>Excellent</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRIGGER FACILITIES</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRIGGER PERFORMANCE</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEL'D SWEEP FACILITIES</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CRT BRIGHTNESS</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CRT FOCUSING</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Y-AMP ATTENUATION RANGE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INTERNAL CONSTRUCTION</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXTERNAL CONSTRUCTION</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OVERALL SPECIFICATION</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OVERALL PERFORMANCE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EASE OF USE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MANUAL</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Delayed sweep performance and facilities compared to other scopes with 'coarse' delayed sweep. Also CRT brightness and focusing compared to the digital display of this scope.

Overall, I found that this scope enables a very accurate, easy and convenient way of selecting the sweep speed, combining the speed of a conventional switched timebase speed control with the ease of use of a two-way 'up-down' rocker switch, which can be found in some other scopes with this facility. The LED display also gave a cleaner, and in my view easier, to read display than the conventional switched system, although it is perhaps not as easy to read as would be a 'coarse' 7 segment display, examples of which can be found on other digital timebase scopes. The automatic timebase facility itself is selected by placing the soft tuning control in a particular position, examples of which can be found on other digital timebase scopes. Timebase switching occurs at between two and six cycles/10 divisions, depending on the range, and whether the timebase is being scaled up or down. Switching between the ranges is very fast on most sweep speeds, but it was noticeable that there was a small time delay when changing down in sweep speed. This is not, however, clearly noticeable until changing down from, for example, 200 ms/div to 2 ms/div, when a delay of approximately 1 second is present. This increases to about 3 seconds when switching to 200 ms/div, the slowest sweep range. These are 'worst cases' and typically may be considerably faster, depending largely on the waveform and previous sweep setting. Performance of the autoranging system was good, lacking onto a large range of waveforms, from a sinewave to a complex pulse train.

Table 15

<table>
<thead>
<tr>
<th>ELECTRICAL CHARACTERISTICS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Line voltage: 100,220,240 VAC ±10%; internally adjustable.</td>
<td></td>
</tr>
<tr>
<td>Frequency: 45-65 Hz</td>
<td></td>
</tr>
<tr>
<td>Power consumption 35 Watts</td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL CONSTRUCTION

Dimensions: W 375 mm, H 180 mm, D 430 mm
Housing: steel sheet
Weight: approx. 8.5 kg

Y AMPLIFIER ETC

Operating Modes:
- CH1 alone, CH2 alone
- Dual CH1, CH2 (alternate or chopped (250 kHz))
- CH1 + CH2

Frequency range: 0...20 MHz (-3 dB)
Rise-time: 17.5 ns, 124.3 ns, 512.3 ns
Deflection factor: 12 steps
5 m/div...20 V/div ±3%, vernier control
Adjust max. sensitivity on 5 m/div range to 2 m/div (fully ccw)
Input coupling: AC, DC or Gnd.
Input impedance: 1 MΩ/25 pF
Max input voltage 400 V DC (peak AC)

X-Y MODE

CH1 X-axis and CH2 Y-axis. Less than 3° phase shift at 50 kHz
Bandwidth DC to 1 MHz (-3 dB)

SWEEP

Operating Modes:
- A; timebase A only;
- B; timebase B only
- A; timebase A only, B; timebase B only

A Sweep Time: 0.5 μs/div to 0.2 s/div, ±3% in 18 ranges, 1-2-5 sequence. Vernier control
B sweep: 0.5 μs/div to 20 μs/div, ±3% in 12 ranges, 1-2-5 sequence.

Range Selection: A automaitc or manual
Potentiometer: B switched
Sweep Magnification: 10 ±5% total error
Holdoff: variable up to 10:1
Delay modes: Trigger Delay
Sweep Coupling: DC, AC, RF
Sweep Magnification: 10 ±5% total error

TRIGGERING

Trigger modes: A; (pp) Normal
Trigger coupling: AC, DC, RF reject, DC reject TV frame and line(auto).
Trigger sources: CH1, CH2, Line, Exi
Triggering sensitivity: Internal ±1 div at 20 MHz, External ±0.5 V p-p at 20 MHz
Normal modes

MISCELLANEOUS

CRT make: Tektronix, measuring area 80 mm x 100 mm, accelerating voltage 2 kV
Compensation signal for divider probe; ampli-
phase: 1 V pp at 20 MHz, frequency 1 kHz,
Z modulation Sensitivity: 3 V (complete blanking)
Covered by 1 year warranty.

this, approximately 1000:1. For a 2 kV tube these figures are certainly above average, especially as the traces at these speeds were fairly well defined. Z modulation is provided as standard on the MO22 and exhibited a very good sen-
New photoelectric switches scan up to 8 metres

Featuring a unique design that offers the maximum possible component integration, the Siemens P refl ex and proximity photoelectric switches from STC Mercator have an operational range of up to 8 m (refl ex) and 0.3 m (proximity). Insensitive to ambient light, the WL (refl ex) and WT (proximity) series offer variable user-adjustable time delays, operate with both AC and DC, and have a new plug-in system for easy installation and servicing.

Sealed to either IP65 or IP67, the devices have a voltage range of 10 to 240 V AC or DC, and offer reverse polarity protection, interference pulse suppression, and short-circuit protected outputs. Further details from STC Mercator • South Denes • GREAT YARMOUTH NR30 3PX.

1300 nm detector with fibre pigtail

A long wavelength optical detector, the 13PD100-F, which has a 50/125 multimode fibre pigtail, and is produced by Telcom, is now available from Hero Electronics. The 13PD100-F is a p-i-n photodiode with a photosensitive area of nearly 8,600 μm². It has a responsivity of not less than 0.7 A/W at 1300 nm, and 5000 Lx. The output signals are, therefore, directly proportional to the illumination. This simplifies the electronic evaluation circuitry for controlling, for example, the aperture and exposure of a camera. Further information from Hero Electronics • Dunstable Street • AMPTHILL MK45 2JS.

Long-life photosensor

The light-sensitive TFA 1001 W photosensor incorporates an integrated photodiode and amplifier in a transparent miniature case with 6 leads. This component, intended for many applications (ranging from TV cameras to medical test strip analysis) operates at a constant sensitivity (5 μA/Lx) over a wide range of light intensity. For the transparent case compens, Siemens is using a new material with improved optical and thermal resistance. The temperature range now extends to 85 °C (the previous limit was 70 °C) and the lower limit has been improved from 0 to -20 °C. The TFA 1001 W is thus also suitable for equipment with a particularly long life such as cameras. With the TFA 1001 W, the output current rises linearly from 0.25 μA to 25 mA (typical values) between 0.05 lx and 5000 lx. The output signals are, therefore, directly proportional to the illumination. This simplifies the electronic evaluation circuitry for controlling, for example, the aperture and exposure of a camera. Further information from Siemens Ltd • Siemens House • Windmill Road • SUNBURG-ON-THEAMES TW16 8HS.

New photo sensors from Orion-Eurosem

Orion-Eurosem has available a wide range of photo sensitive devices, including infrared LEDs, photo detectors, interrupters, reflective sensors and fibre optic devices. Manufactured by Toshiba Semiconductors, the devices are suitable for use in all applications requiring photo sensitive control, including end-of-tape detection, fire alarms, smoke detection, TV remote controls, photoelectric switches, and so forth. Further information from Orion-Eurosem Ltd • Sunley House • Oxford Road • AYLESBURY HP19 3E0.
New sensor system development facility
ERA Technology has formed a special group— the Sensor Systems Programme Office — in response to industry's need for the development of short range remote sensing systems suitable for a wide range of applications
The group has a design capability covering a variety of sensors including electromagnetic, acoustic, optical and infra-red.
Projects are currently being undertaken in such areas as offshore drilling, civil engineering, process measurement, non-destructive testing and inspection, defence and robotics. Systems based on short-range radar have been developed and much of the design work involves the use of radio frequency techniques. Acoustic, magnetic and infra-red devices are also under consideration for multi-sensor systems used for surveillance and navigation.
Further information from ERA Technology Ltd. - Cleve Road • LEATHERHEAD KT22 7SA.

Micro miniature pressure probes
Entran's EPI-050 and EPI-060 pressure transducers measure static and dynamic pressure where very small size is of prime importance and access is difficult. Applications include wind tunnel and flight testing, engine test stand work, model studies, and bio-engineering research. Three standard mounting configurations and probes, each using a 50 mil (1.27 mm) external diameter diffused diaphragm, are available for measuring pressures from 0 to 2 p.s.i. (0 to 0.13 bar) to 0 to 300 p.s.i. (0 to 20 bar) with outputs up to 125 mV and resonant frequencies to 1.7 MHz. Additionally, barrel-shaped and threaded probes with or without protective screens and with custom diameter/length options are available.

Further information from Entran Ltd • 159 Albert Road • CROWTHORNE RG11 7LT.

Interconnect plug for proximity sensor system
IMO's Microchange, developed jointly by IMO/OMRON and the Brad Harrison Corporation, provides users with plug-in rather than hard-wired detection devices. This means that upon failure or replacement of either the cable or the detector only one element needs to be disposed of rather than both. Since nearly 30% of maintenance problems experience by proximity switch users emanate from the cable rather than from the device itself, this could lead to considerable cost savings.

Further information from IMO Ltd • 1000 North Circular Road • Staples Corner • LONDON NW2 7JP.

Modular positioning system
A new modular positioning system from Lambda uses 5-phase stepper motors that can be controlled manually, externally, or by computer. The 5-phase stepper motors provide a high basic resolution, smooth operation, and excellent dynamic properties. They offer a number of advantages over 4-phase types, such as improved equidistance of the stepping angle and high stiffness of magnetic snap-in positions. These turn guarantee high positioning accuracy during load movement.

The controller provides fine resolution control— 1,000 steps/rev — and is ideal for use with 3-axis positioners. Stepping frequency capability extends from 30 Hz to 15 kHz. IEEE-488 and RS232 interfaces, and suitable MS-DOS software, are optionally available to allow complete control over the system from a computer keyboard.

Further information from Lambda Photometrics Ltd • Lambda House • BArnold Mill • HARPENDEN AL5 5BZ.

Micro Lable thermistor strip
Thermographies' Micro Lable is an irreversible four-level thermistor strip that can be applied to any surface whose temperature requires to be measured. Changing from silver white to black on reaching a set temperature, the strip can be used with products requiring warranty protection from abuse.

Each 10x3 mm strip can indicate four levels of temperature, and the strips are available in nine groups with temperatures ranging from 40 °C to 224 °C. Response is not greater than 1 second. Micro Lable is of particular interest in electrical and electronics fields, but can obviously be used anywhere to monitor heat generation.

Further information from Thermographies Measurements Ltd • Bank House • Neston Road • Burton • SOUTH WIRRAL L64 5TA.
A WORD IN THE HAND MAKES THE MEASUREMENT FIRM

By David Simpson, National Physical Laboratory, Teddington, London

Though electronic sensors are now widely used for laboratory measurements, many instruments, especially the more accurate ones, still have to be read by someone. A hand-held computer terminal developed at the National Physical Laboratory helps observers to record readings from instruments faster and more reliably. When numbers are keyed into it, a speech synthesizer dictates them back to confirm that data have been entered as intended. It also warns against improbable readings.

Each year the National Physical Laboratory calibrates several thousand scientific instruments for customers who use them industrially to measure a wide range of parameters. Although there is a growing tendency to incorporate analogue or digital electrical outputs that enable readings to be recorded automatically by a computer, few of the instruments have such a facility. Vernier-scale barometers, dial-gauge proving-rings (for measuring force) and mercury-in-glass thermometers are good examples. Moreover, the interfaces of those sent in for checking which are electrical in nature are often not immediately compatible with the calibration laboratory's computer. So it is still quite normal for many observations to be made by eye and written down.

Most metrologists believe that observations made by eye are, as a rule, recorded more easily by jotting them down on paper than by using a keyboard that calls for extra concentration to avoid mistakes. They generally prefer to write their observations and transfer them to a computer later, when the data input can be carefully compared with their observation book.

The speaking computer terminal seemed a logical device to develop because a portable numeric keyboard that would audibly confirm what key had been punched would enable direct input of visual observations into a computer without calling for special concentration to detect keying errors. If you think "three" when you key and the terminal says "four", it is very unlikely the mistake will get past.

General design criteria

To optimize the terminal's usefulness to metrologists, who use a range of techniques in widely differing environments, a number of design features were considered: the synthesizer should be crisp, clear, have a local accent and, apart from speaking numbers from zero to nine, should be able to say things relevant to metrology such as "out of range", "measurement error", "problem with reading six" and so on. The terminal should be small enough to be held in the hand, so that the user can take it many metres from one instrument to another during a calibration; it should have a clear and bright display capable of displaying alpha-numeric prompts which may be easily read under a variety of lighting conditions; a simple keyboard employing high-quality switches; be capable of transmitting non-numeric "special function" (or "soft-key") character codes to the laboratory computer for control purposes (typically to mean "yes", "no", "abort", or "repeat last reading"), and communication with the laboratory computer should be via an IEEE 488-1978 interface. The hand unit should be cordless to avoid problems with trailing cables.

The terminal was built in collaboration with Peter Rush, of Triangle Digital Services, Walthamstow, London. Its final form complied with all but the last design consideration, that is cordless operation. While this would have been easier for users, it was thought impractical for two reasons. Firstly, neither radio nor infra-red communication could easily provide the degree of integrity required; some measurements need to be taken near sources of electrical interference or in Faraday cages, and line-of-sight communication between the terminal and its 'base-station' (linked to the laboratory computer) could not always be guaranteed. Secondly, the power required to provide a bright display ruled out the use of batteries. It was therefore decided to accept a thin cable linking the terminal with its base-station.

We settled on a hand unit that has a bright 16-character display, a loudspeaker, and a high-quality keyboard. In addition to the digit keys there are decimal and minus signs and four editing keys, two special function keys and a "send" introduction. A key-shift of the numeric keys gives ten other special function keys.

The terminal's cable, which may be up to
30 metres long, links the unit to the base-station containing the speech synthesizer, a power supply and both IEEE 488-1978 and RS232C interfaces for communication with the laboratory computer. The synthesizer has a vocabulary of 70 discrete words selected specifically for metrological purposes. It may be actuated by the terminal’s keyboard, to speak digits, or by the laboratory computer to speak any words from its vocabulary.

**Optimum characteristics**

The essence of the device is its ability to speak the value of numeric input data, and we had to experiment to find optimum synthesizer operating characteristics. Firstly it was programmed to speak only after a complete number had been entered. That is, typing “123</send>” evoked “one two three”. Secondly, “123</send>” was called up “One hundred and twenty-three”. Though somewhat novel, this format was not found to be very helpful when taking readings. A third mode is the one we adopted, in which digits are spoken immediately numeric keys are touched. To enable the synthesizer to keep up with a rapid sequence of key operations, it speaks digits quickly and, under very fast operation, truncates them to avoid a delay between pressing the key and starting to speak. For example, very rapid entry of, say “678” would cause “Six eight” to be spoken, but that is quite intelligible.

When the unit is in typical use, a program running on a laboratory computer sends a visual prompt to the terminal, reminding the metrologist standing near the instruments he is calibrating what measurement to take next. He keys in his observation, which is audibly confirmed as he does so. If it is correct, he sends it to the laboratory computer which processes the information and usually responds with the next prompt. The computer can trigger a short verbal opinion if it recognizes the number to be an unreasonable one.

The terminal handles visual prompts in two different ways: the first, most usual way, simply allows the prompt to disappear from the display as soon as numeric keys are pressed; the second allows numbers to be added to the end of a prompt and is used when many similar observations have to be made. For example, an instrument with six-figure resolution may have to be read repeatedly with changes only in the last few digits. After receiving the first reading in the normal way, the laboratory computer can send a partially numeric visual prompt such as “Bridge? 0.5884”, (simultaneously speaking it if required), enabling just the last digits of the number to be added to the right-hand side.

**Using the terminal in the laboratory.**

<table>
<thead>
<tr>
<th>Reading No.</th>
<th>Bridge Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.588438</td>
</tr>
<tr>
<td>2</td>
<td>38</td>
</tr>
<tr>
<td>3</td>
<td>40</td>
</tr>
<tr>
<td>4</td>
<td>43</td>
</tr>
<tr>
<td>5</td>
<td>41</td>
</tr>
</tbody>
</table>

When an instrument with, say, a six figure resolution has to be read repeatedly with changes in only the less significant digits, the laboratory instrument can send a prompt that allows just the last part of the number to be added. This is the electronic equivalent of entering readings in a laboratory observation book.

**New decade capacitance box**

The new CB610 has 6 decades of capacitance from 10 pF to 11.1111 μF with an accuracy of ±1% ±2 pF. Drift is <±0.3% ±1 pF in 1 year below 50 nF and <±1% above 50 nF. The dissipation factor is <0.002 at 1 MHz from 30 pF to 1 nF, <0.001 at 1 kHz on 1 nF to 50 nF and <0.01 on 50 nF to 11 μF. Maximum input is 250 Vdc, 160 Vac and 1 A at HF. These compact boxes have dimensions of 190 x 110 x 90 mm and weigh 550 g.

The decade capacitors are selected from components with stable dielectrics and the switches have silver plated self-wiping contacts with low losses up to 1 MHz. The minimum control setting of 10 pF includes the residual capacitance so the controls indicate total capacitance at all settings. The capacitors are isolated from the case and an RFI screen is joined to a separate terminal that is linked to the adjacent capacitor terminal during calibration.

**Quick and reliable**

The first NPL speaking computer terminal was built over three years ago and eight are now in service. They provide a quick and reliable means of recording data from instruments that do not give an automated read-out. They are helping us in many ways, from precision weighing to the calibration of mercury barometers, vacuum gauges, line standards and radiation dosimeters.

Most users prefer the terminal in its speaking-digit mode but some choose to enter numbers silently and have the full number dictated back after it has been entered. But both ways have been found to cut the concentration needed and make the process of entering numbers less tiring. Other benefits of the terminal have become apparent. On-the-spot prompting during calibration work not only helps the experienced metrologist but assists with the training of new staff: recording numbers directly into the laboratory computer with audible confirmation is quicker than writing them down and then typing them into a keyboard, later cross-checking a computer print-out with the observation book; results, comments or instructions may be dictated to the operator while he is concentrating, for example, on making observations through a microscope eyepiece; spoken warnings attract more attention than visual ones and provide much better diagnostics than a bleep. For example, if the user’s concentration fails and a gross mistake comes up such as typing in 1000 mbar instead of 20°C, a spoken “Really?” requests the data again points out the mistake much faster than a display can do. Cross-checking lists of data is easier when one list is spoken.

The NPL speaking computer terminal is now available from Triangle Digital Services, Walthamstow, London.
The following books are currently available: these may be ordered free from certain electronics retailers, or bookshops, or direct from our Brentford office.

<table>
<thead>
<tr>
<th>No.</th>
<th>Price VAT</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>301 Circuits</td>
<td>£8.26</td>
<td></td>
</tr>
<tr>
<td>302 Circuits</td>
<td>£6.26</td>
<td></td>
</tr>
</tbody>
</table>

**HINDERS**

Elektor Electronics binder ... £2.95

**FRONT PANEL**

<table>
<thead>
<tr>
<th>No.</th>
<th>Price VAT</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**SOFTWARE**

Software in EiRPMs No. Price VAT (€) (£)

<table>
<thead>
<tr>
<th>No.</th>
<th>Price VAT</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**PRINTED CIRCUITS**

Printers who wish to make their own PCBs for personal and personal use only are allowed to do so, but not in any circumstances be dealt with by telephone.

Components for projects appearing in Elektor Electronics are usually available from appropriate advertisers. If difficulties in supply of components are envisaged, a source will normally be advised in the article.

Consider all orders must be sent BY POST to our Brentford office using the appropriate form opposite. Please note that we cannot deal with PERSONAL CALLERS. Fax orders in any form are not taken. All customers must add postage and packing charges for orders over £15.00 as follows: UK: £1.00; Europe: £1.50; other countries: £2.00 surface mail or £3.00 airmail. For orders over £50.00 but not exceeding £50.00, these rate charges should be doubled. For orders over £50.00 in value, P & P charges will be advised.

Software is also available from TECHNOMATIC LIMITED (for address, see inside front cover).

In Sweden, printed-circuit boards should be ordered from ELECTRONIC PRESS Box 63 S-182 31 Danderyd Telephone: 08-753 03 05

**SUBSCRIPTIONS**

Subscriptions can be provided anywhere in the world; they may be ordered on the appropriate form opposite.

Letters of a general nature, or express suggestions, a source will normally be advised in the article.

Elektor Electronics are usually available anywhere in the world: they may be bought on request at the current cover price plus p&p charges will be advised. Photo copies of the relevant article can be obtained. Past issues are no longer available.

**TECHNICAL QUIRIES**

Although we are always prepared to assist readers in solving difficulties they may experience with projects that have appeared in Elektor Electronics during the Past THREE YEARS ONLY, we regret we cannot do so in any circumstances be dealt with by telephone.

**COMPONENTS**

Advertisers' responsibility is in all cases subject to and advertisements. In all cases, the Publishers' Standard Terms of Business apply (see reverse of Parts & Books Order Form opposite). The placing of space reservations by the advertisers or their agents is done by the Publishers to imply acceptance of, and agreements to be bound by, these conditions.

**ADVERTISEMENTS**

Elektor Electronics is published on the third Thursday of the month preceding cover date. Closing date for copy is five weeks before publication date for both colour and monochrome. The Publishers will not be liable for any loss sustained by any advertiser in the event of any advertisement appearing to any cause whatever, nor do they accept liability for printers' errors, although every care is taken to avoid mistakes. Advertisers' proofs, artwork, etc., are held at owners' risk and should be insured by them against fire or other damage. Copy and illustrations are in all cases subject to the Publishers' approval and must comply with the code of advertising practice in force in the country or countries of publication. The Publishers reserve the right to refuse, suspend, or cancel any advertisement or series of advertisements. In all cases, the Publishers!' Standard Terms of Business apply (see reverse of Parts & Books Order Form opposite). The placing of space reservations by the advertisers or their agents is done by the Publishers to imply acceptance of, and agreements to be bound by, these conditions.

**ADVERTISER SIZES**

<table>
<thead>
<tr>
<th>Size</th>
<th>Width</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full page</td>
<td>303mm</td>
<td>215mm</td>
</tr>
<tr>
<td>Half page</td>
<td>151mm</td>
<td>215mm</td>
</tr>
<tr>
<td>Quarter page</td>
<td>76mm</td>
<td>215mm</td>
</tr>
<tr>
<td>Classif ied</td>
<td>90mm</td>
<td>90mm</td>
</tr>
</tbody>
</table>

**PRINTED CIRCUITS**

Printers who wish to make their own PCBs for personal and personal use only are allowed to do so, but not in any circumstances be dealt with by telephone.

Components for projects appearing in Elektor Electronics are usually available from appropriate advertisers. If difficulties in supply of components are envisaged, a source will normally be advised in the article.

**EDITORIAL CALENDAR**

<table>
<thead>
<tr>
<th>Issue</th>
<th>Publication date</th>
<th>Copy deadline</th>
<th>Main theme</th>
</tr>
</thead>
<tbody>
<tr>
<td>EEE</td>
<td>March 1988</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*One week later for camera-ready copy.*
### RESISTORS

<table>
<thead>
<tr>
<th>No.</th>
<th>Value</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100k</td>
<td>1% ±0.00%</td>
<td>£1.00</td>
</tr>
<tr>
<td>2</td>
<td>20k</td>
<td>1% ±0.00%</td>
<td>£1.00</td>
</tr>
<tr>
<td>3</td>
<td>1k</td>
<td>1% ±0.00%</td>
<td>£1.00</td>
</tr>
<tr>
<td>4</td>
<td>10k</td>
<td>2% ±0.01%</td>
<td>£1.00</td>
</tr>
<tr>
<td>5</td>
<td>150k</td>
<td>2% ±0.01%</td>
<td>£1.00</td>
</tr>
<tr>
<td>6</td>
<td>1M</td>
<td>5% ±0.05%</td>
<td>£1.00</td>
</tr>
<tr>
<td>7</td>
<td>10M</td>
<td>5% ±0.05%</td>
<td>£1.00</td>
</tr>
<tr>
<td>8</td>
<td>100M</td>
<td>10% ±0.10%</td>
<td>£1.00</td>
</tr>
</tbody>
</table>

### CAPACITORS

<table>
<thead>
<tr>
<th>No.</th>
<th>Value</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10pF</td>
<td>1% ±0.00%</td>
<td>£1.00</td>
</tr>
<tr>
<td>2</td>
<td>10nF</td>
<td>1% ±0.00%</td>
<td>£1.00</td>
</tr>
<tr>
<td>3</td>
<td>100nF</td>
<td>2% ±0.01%</td>
<td>£1.00</td>
</tr>
<tr>
<td>4</td>
<td>1uF</td>
<td>1% ±0.00%</td>
<td>£1.00</td>
</tr>
<tr>
<td>5</td>
<td>10uF</td>
<td>5% ±0.05%</td>
<td>£1.00</td>
</tr>
<tr>
<td>6</td>
<td>100uF</td>
<td>10% ±0.10%</td>
<td>£1.00</td>
</tr>
</tbody>
</table>

### OPTOS

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10A optocoupler</td>
<td>£1.00</td>
</tr>
<tr>
<td>2</td>
<td>50A optocoupler</td>
<td>£1.00</td>
</tr>
<tr>
<td>3</td>
<td>100A optocoupler</td>
<td>£1.00</td>
</tr>
</tbody>
</table>

### DIODES & SCRs

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1N4001 SCR</td>
<td>£1.00</td>
</tr>
<tr>
<td>2</td>
<td>1N5401 SCR</td>
<td>£1.00</td>
</tr>
<tr>
<td>3</td>
<td>1N5402 SCR</td>
<td>£1.00</td>
</tr>
</tbody>
</table>

### TRANSISTORS

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2N3904 NPN</td>
<td>£1.00</td>
</tr>
<tr>
<td>2</td>
<td>2N3904 PNP</td>
<td>£1.00</td>
</tr>
<tr>
<td>3</td>
<td>2N2222 NPN</td>
<td>£1.00</td>
</tr>
</tbody>
</table>

### MISC.

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>50mW red LED</td>
<td>£1.00</td>
</tr>
<tr>
<td>2</td>
<td>1N4001 SCR</td>
<td>£1.00</td>
</tr>
<tr>
<td>3</td>
<td>1N5401 SCR</td>
<td>£1.00</td>
</tr>
</tbody>
</table>

**SEND YOUR ORDERS TO: BI-PAK BARGAIN, 105, ROYAL DOCKLANDS, LONDON, S.E.16. TELEPHONE: 01-537 8000.**

**November Carbon Film Resistors: 5% & 1% W.R.**

**VOLTAGE DECLAIERS**

<table>
<thead>
<tr>
<th>Price</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.00</td>
<td>1N4001 SCR</td>
</tr>
<tr>
<td>1.00</td>
<td>1N5401 SCR</td>
</tr>
<tr>
<td>1.00</td>
<td>1N5402 SCR</td>
</tr>
</tbody>
</table>

**Bi-Pak Bargain: March 1988**

**Remember you only ADD 15% P+P AND 15% VAT TO TOTAL ORDER**
The Dollar has fallen... and so have our Prices!!

**PRECISION GOLD** MULTI-METERS - OUTSTANDING VALUE FOR MONEY!

BUY NOW, THE TIME IS RIGHT!

<table>
<thead>
<tr>
<th>Professional</th>
<th>Wide Range</th>
<th>Versatile</th>
<th>Hobby</th>
<th>Pocket</th>
</tr>
</thead>
<tbody>
<tr>
<td>Has all the ranges!</td>
<td>With battery tester.</td>
<td>Measures temperature and capacitance.</td>
<td>Ideal for beginners.</td>
<td>Rugged, general purpose.</td>
</tr>
<tr>
<td><strong>£27.95</strong></td>
<td><strong>£11.95</strong></td>
<td><strong>£24.95</strong></td>
<td><strong>£6.95</strong></td>
<td><strong>£5.45</strong></td>
</tr>
</tbody>
</table>

- **£36.95** Wide Range
- **£35.95** Hobby
- **£27.95** Auto Ranging
- **£54.95** Professional
- **£5.45** Push Button
- **£37.95** Feature Packed
- **£35.95** Hobby
- **£27.95** Low Cost
- **£35.95** 4½ Digit
- **£36.95** Low Cost
- **£35.95** Hobby
- **£37.95** Low Cost
- **£35.95** Hobby
- **£27.95** Low Cost

**Plus** ORDER NOW AND GET A FREE CARRYING CASE WITH YOUR METER (WORTH UP TO £3.95)

**Maplin ELECTRONICS**

P.O. Box 3, Rayleigh, Essex. Telephone Sales (0702) 544161.

Shops at: Birmingham, Stratford New Road, Erdington. Tel. 021 384 8411.

Bristol, 301 Gloucester Road. Tel. 0272 232924.

London, 199-201 King Street, Hammersmith, W12 0EF. Tel. 01 748 0726.

Manchester, 8 Oxford Road, Tel. 061 232 0538.

Southampton, 46-48 Berth Valley Road. Tel. 0703 225481.

Southend-on-Sea. 282-284 London Road, Westcliff-on-Sea. Essex. Tel. 0702 554000.

We're passing on our exchange rate saving to you!

We're passing on our exchange rate saving to you!

Folks up a copy of our 1998 catalogue from any branch of VNVEMI at 1 for £1.60. Or to receive your copy by post send £1.50 + 40p p&p to our P.O. Box address. If you live outside the U.K. please send £2.75 or 12 International Reply Coupons.

All prices include VAT. Please add 50p towards postage. All items subject to availability.