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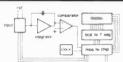
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|--|-----|
| CONSTRUCTIONAL PROJECTS | |
| DIGITAL FREQUENCYMETER by A. J. Buxton Gives digital readout of frequency measurement of up to 500MHz ADD-ON CAPACITANCE UNIT by R. W. Lawrence | 376 |
| Direct measurement of capacitance on your multimeter. Can be built on the free printed wiring board provided with this issue.* | 390 |
| Audio compass by M. Kenward An off-course alarm for use on self-steered yachts and power craft. Allows ears to replace eyes when steering a compass course at night | 394 |
| Generates those "Dalek"-type voice effects | 406 |
| GENERAL FEATURES | |
| USING CMOS DIGITAL I.C.s—5 by D. B. Johnson-Davies & A. M. Marshall Electronic switches and oscillators | 384 |
| SEMICONDUCTOR UPDATE by R. W. Coles A look at some recently released devices HELLS, BELLS AND DECIBELS by D. Maynard | 404 |
| Ever get confused about dB's? This article helps clarify the subject | 411 |
| Multiple Octave Organ—Time Switch—Burglar Alarm—Frequency Divider—Indicator for Discotheque PFL System—Light-on Indicator—Courtesy Light Timer—Dual Fade for Slide Presentation—Low Voltage Indicator—Car Alarm—Recording Level Indicator—Touch Keyboard | 413 |
| NEWS AND COMMENT | |
| EDITORIAL—Under-Sold? NEWS BRIEFS | 375 |
| Summer School BOOK REVIEWS | 382 |
| Selected books we have received POINTS ARISING | 382 |
| How Inventive Competition—Digi-Probe—Opto-Coupled R.P.M. Meter SPACEWATCH by Frank W. Hyde | 382 |
| Soviet Venus Probes—Powersat—Set Backs MARKET PLACE | 383 |
| Interesting new products INDUSTRY NOTEBOOK by Nexus | 410 |
| What's happening inside industry PATENTS REVIEW | 412 |

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Our June issue will be published on Friday, May 14, 1976 (for details of contents, see page 405)

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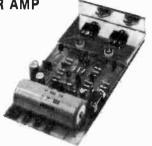
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68 - 83

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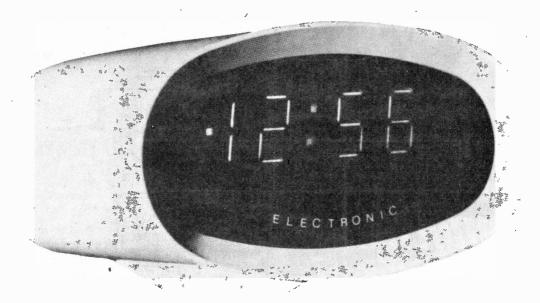
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TECHNICAL SPECIFICATION: (1) Output 4 watts RMS output. For 12 volt operation on negative or positive earth. (2) Integrated circuit output stage, pre-built three stage IF Module. Controls volume manual tuning and five push buttons for station selection, illuminated tuning scale covering full, medium and long wave bands. Size chassis 7" wide 2" high and $4\frac{3}{4}$ " deep approx.

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3" required to clear base of mechanism approx

This is an advanced kit not suitable for those without electrical knowledge and those unable to solder



DISCO AMP



Reliant Mk IV Mono Amplifier, ideal for the small disco or house parties. Output 20 watts RMS into

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INPUT SENSITIVITIES - Input - 1). Crystal mic. guitar or moving coil mic, 2 and 10mV. (Selector switch for desired sensitivity.) — Inputs -2), 3), 4). Medium output equipment - ceramic cartridge, tuner, tape recorder, organs, etc. — all 250mV sensitivity. AC Mains, 240V operation. Size approx: 121"×6"×31 20.00 +£1.35 p&p.

8 TRACK HOME CARTRIDGE PLAYER



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INCORPORATES: Pre-Amp with full mixing facilities, including switched input

BLE DISCO CONSO



TECHNICAL SPECIFICATION

TECHNICAL SPECIFICATION:

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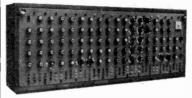
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(P.E. Feb. 1973 to Feb. 1974)

(P.E. Feb. 1973 to Feb. 1974)
The well acclaimed and highly versatile largescale mains-operated Sound Synthesiser complete
with keyboard circuits. All function circuits may be
used independently, or interconnected. The greater
the number of circuits, the greater the versatility.
Other circuits in our lists may be used with the
Synthesiser to good advantage.

THE MAIN SYNTHESISER

| Stabilised Power Supply | £12-05 |
|--|--------|
| Two Linear Voltage Controlled Oscilla | tors |
| and one Inverter-all 3 circuits: | £16-38 |
| PCB (2 are required)—each | £1-48 |
| Two Ramp Generators and Two Input | |
| Amplifiers—all 4 circuits | £5-62 |
| PCB (holds all 4 circuits) | £1.38 |
| Sample-Hold and Noise Generator— | |
| DCB (helds best simulate Generator— | £6.64 |
| PCB (holds both circuits) | £1.70 |
| Tone Control, £2.43; PCB, 80p | |
| Reverberation Amplifier | £6.36 |
| Sprine Line unit for Reverb Amp | £4.95 |
| Ring Modulator | £3.75 |
| Peak Level Meter Circuit | £1.50 |
| 100μA Panel Meter | €3.75 |
| PCB for Rev., R-Mod. & Meter Ccts., | €1.94 |
| Envelope Shaper, £5-35; PCB, £1-46 | |
| Voltage Controlled Amp. and Diff, Amp. | £6.86 |
| PCB (holds both circuits) | €1-32 |
| THE SYNTHESISER KEYBOARD CIR | CUITS |
| Can be used without the Main Synthesiser | |
| an independent musical instrument) | |
| 2 Log. Voltage Controlled Oscillators | €14-55 |
| PCB for both log VCO's | €2-60 |
| Divider, 2 Hold Circuits, 2 Modulation | |
| fiers, Mixer and 2 Envelope Shapers | £19-64 |
| PCB (Holds the first 6 circuits) | £1.80 |
| PCB for both Envelope Shapers | £1.55 |
| Kowhood Stabilized Bower Sweets | £1.33 |
| Keyboard Stabilised Power Supply | £7.30 |
| Printed Circuit Board | 94p |
| | |

SYNTHESISERS AND KEYBOARDS

P.E. JOANNA

(P.E. May to Aug. 1975)

| The new electronic piano that has swit | chable |
|---|---------|
| alternative voicing of Piano Honky-Tonk and I | Harpsi- |
| chord. All PCB's are "as published". | |
| Power Supply | £7.96 |
| Tone Generator and Top C Envelope Shaper | £9-25 |
| PCB for above | £1.30 |
| Envelope Shapers | |
| 12 sets (full requirement) | £32-16 |
| Set of 12 PCB's (full requirement) | £15.00 |
| Voicing and Pre-Amplifier Circuits | £8-37 |
| PCB for above circuits . | €1-84 |
| Power Amplifier | £14.50 |
| PCB for power amp | , 95p |
| | |
| | |

KEYBOARDS

Kimber-Allen Keyboards as required for many published circuits, including the P.E. Joanna, P.E. Minisser. The manufacturers claim that these are the finest moulded plastic keyboards made.

| present keyboar as meac. | |
|--|------------|
| 3 Octave Keyboard (37 notes C to C) | £20.50 |
| 4 Octave Keyboard (49 notes C to C) | €23-50 |
| 5 Octave Keyboard (61 notes C to C) | €27-00 |
| 3 Octave Reyodard (of notes C to C) | |
| Contact Assemblies for use with above k | eyboards: |
| Single-pole change-over (SP) as for P.E. J | canna and |
| P.E. Minisonic, Two-pole normally-op- | an make- |
| break (2P) as for P.E. Synthesiser, Speci | |
| | |
| assembly (4PS) having 4 poles, 3 of v | which are |
| normally-open make-break contacts and | the fourth |
| | |
| is a change-over contact—this special | assembly |
| enables the same keyboard to be used | with the |
| | |
| P.E. Synthesiser, P.E. Minisonic, and P.E. S | ynthesiser |
| simultaneously thus avoiding the cost of | more than |
| one keyboard. | |
| 3 October 4 October | |
| | |

| | Contact | | 3 Octave Set | 4 Octave Set | 5 Octave Set |
|---|---------|--------|-----------------|-----------------|-----------------|
| : | SP | 20p | £7-40 | £9-80 | £12-20 |
| | 2P | 24p | £8-83 | £11.76 | £14-64 |
| 4 | 4PS | 48p | £17.76 | £23·52 | £29-28 |
| 1 | Printed | Circui | * Boards | for use with | the shove |

Printed Circuit Boards for use with the above contacts and thus eliminating most of the interwiring required, are svailable—details in our lists. **PHONOSONICS**

P.E. MINISONIC

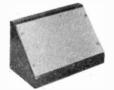
(P.E. Nov. 1974 to March 1975)

A portable, battery or mains operated, miniature sound synthesiser, with keyboard circuits. Although having slightly fewer facilities than the large P.E. Synthesiser, the functions offered by this design give it great scope and versatility.

| Bito it Bicat scope and versatility. | |
|--|-----------------|
| Two Voltage Controlled Oscillators Voltage Controlled Filter | £5·22 |
| and Voltage Reference Circuit Two Envelope Shapers and Two Voltage | €3-41 |
| Controlled Amplifiers Keyboard Controller and Hold Circuits | £7-25 |
| Keyboard Divider Resistors (select type t | o suit |
| keyboard used, all are 2% tolerance). 2 Octav 3 Oct., £1-48; 4 Oct., £1-96; 5 Oct., £2-44. | |
| H.F. Oscillator and Detector Ring Mod., Noise Gen. & Env. Inverter | £1.66 £5.27 |
| Two Power Amplifiers and Two Mixers | £3.55 |
| Battery Eliminator | £5-88 |
| Temperature Stabiliser | £1-47 |
| PCB to hold 2 VC0s, VCF and V-Ref | £2.02 |
| PCB to hold 2 ESs, 2 VĆAs, 2 Mixers, Ring Keyboard Control and Hold | Mod, £2-20 |
| PCB to hold 2 Power Amps, Noise Gen, Envilonmenter, HF Osc, and Detector | elope- £1-45 |
| PCB for Battery Elim. & Temp. Stab. | £1-35 |
| | |

FOR ADDRESS, INFORMATION REGARDING POST AND PACKING, VAT, LISTS, AND EXPORT TERMS SEE OUR OTHER ADVERT-ISEMENT ON OPPOSITE PAGE

Photos: 2 of our units containing some of the P.E. projects built from our kits and PCBs. (The cases were built by ourselves and are not for sale.)



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VOICE OPERATED FADER (P.E. Dec. 73)

For automatically reducing music volume during "talk-over" particularly useful for Disco work or for home-movie shows.

Component set incl. PCB

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Very effective circuit for reducing the hiss found in most tape recordings.

Component set (incl. PCB) Regulated power supply (incl. PCB)

P.E. MINIMIX 6

DETAILS IN LIST

GUITAR EFFECTS PEDAL (P.E. July 75)
Will modify an audio signal not only from a guitar
but from any audio source, producing 8 different
switchable effects that can be further modified by
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Alternative component set with panel £6-25 mounting switches Printed Circuit Board

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Stereo component set (excl. panel meter) Mono component set (excl. panel meter) Power supply component set Stereo main PCB Stereo sub-assembly PCB £24.25

VOLTAGE CONTROLLED FILTER (P.E. Oct. 74)
An independently designed VCF that can be used with the P.E. Synthesiser.

Component set Printed circuit board

ENVELOPE SHAPER AND V.C.A.

AUTO WAH-WAH

Component Set and P.C.B. £2.99.

RHYTHM **GENERATOR**

Programmable for 64,000 rhythm patterns from 8 effects circuits (high and low bongos, bass and soft cymbal), and with variable time signatures and rhythm rates. Really fascinating and useful. Tempo, Timing and Logic circuits (abuble-sided) (2-94)

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A multi-purpose sound controller, the functions of which include, envelope shaper, tremolo, voice operated fadar, automatic fader and frequency-

doubler.
Component set for above functions (excl. SWs) £6.58
£1.58 Printed circuit board 21.58
Optional extra—additional Audio Modulator, the use of which, in conjunction with the above component set, can produce "jungle-drum" rhythms.

Component set (incl. PCB)

PHASING UNIT (P.E. Sept. 73)

A simple but effective manually controlled unit for introducing the "phasing" sound into live or recorded music.

Component set (incl. PCB)

PHASING CONTROL UNIT (P.E. Oct. 74)
For use with the above Phasing Unit to automatically control the rate of phasing.

Component set (incl. PCB)

ENVELOPE SHAPER

The ADSR Envelope Shaper published in P.E. October 1975 and having manual control of its Attack, Release and Sustain functions.

Component set incl. PCB

WIND AND RAIN UNIT A manually controlled unit for producing the above-

named sounds.

Component set incl. PCB

POWER SUPPLIES

Sophisticated low-noise highly-stabilised power supply kits complete with PCB's and detailed information are now available. Details in list.

Other PCBs (all "as published") While stocks last Bench Power Supply (P.E. Sept. 1974)

CCTV:
Master Logic, Video Amp., Sync Mixer and
Cathode Switch PCB (P.E. Oct. 1974)
PCB for remaining Circuits (P.E. Oct. 1974) £2:20
Digital Power Supply (P.E. Aug. 1972)
50p

Electronic Piano: Pre-amp PCB (P.E. Oct. 1972) Power Supply PCB (P.E. Oct. 1972) Power Slaves: Power Supply PCB (P.E. Aug. 1974) 55n

Rondo: Pre-Amp PCB (P.E. Oct. 1973) Tone, Balance and Volume Control PCB (P.E. Oct.)

BIOLOGICAL AMPLIFIER (P.E. Jan./Feb. 73)

Multi-function circuits that, with the use of other external equipment, can serve as lie detector, alphaphone, cardiophone, etc.

Pre-Amplifier Module Component set and PCB

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Basic Output Circuits DASIC Output Circuita
Combined component set with PCBs, for alphaphone
cardiophone, frequency meter and visual feed-back
lamp driver circuits
£5:39

Audio Amplifier Module Type PC7

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Suitable for audio, digital, or general purpose.
Controllable through 4 decade ranges 10Hz to 100kHz. Switched attenuation through 10 ranges from 10V to ImV peak-to-peak.
Component set 48.88 £1.60

PCB for above components £5.70 ower Supply PCB for Power Supply

P.E. TUNING FORK

(P.E. NOVEMBER, 1975)

Main component set incl. PCB €13-50 €6-57 Power supply set incl. PCB

REVERBERATION UNIT (P.W. Nov./Dec. 72)

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Component set (ext. spring unit)

47.55 Printed circuit board 9 inch spring unit Panel meter (\$0µA) (optional) £1.76 £4.95 £3.75

SEMI-CONDUCTOR TESTER (P.E. Oct. 73)

Essential test equipment for the enterprising home Essential test each part of the stocks last.
Set of resistors, capacitors, semiconductors, potentiometers, makaswitches and PCB 48-44
43-75 €3.75 Panel meter (500µA)

PHOTOPRINT PROCESS CONTROL (P.E. Jan./Feb. 72)

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DETAILS IN LIST

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| ACI76 | 20p BSY95A | 222 2N3703 | 1AP | 3.9V 400mW | | 1.0/63 | 6p 100/63 | 13p | 2800/100390p | 0.01 34 | p 0⋅1/35 13p |
| BC107 | 13P MJE2955 | 110° 2N3704 | 12p 709 8-pin DIL | 40p 4.7 IW | 25p | 1.5/63 | 6p 50/16 | .6p | 3300/63 133p | 0.015 3 | |
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| BC109 | 177 0071 | 60p 2N3823E | | 32p 5-1V IW | 25p | 4.7/63 | 6p 220/10 | | 4700/25 75p | | p 1.0/35 13p |
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| BC149 BC157 | ORPI2 | 66P 2N5777 | 45p 748 8-pin DIL | 63p 6-2V 400mW | | 15/40 | 6p 220/63 | 2ip | | 0.1 4 | |
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| BCY71 | 22p 2N3053 | 18p Z5j | 8p EP27/3015F | 135p 20V IW | 25p | 100/10 | 6D 1000/40 | 54p | STOCKED | O.E. deli | veries subject |
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| | 100V 3A 15p | 600 V 1A 60p | | |
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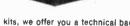
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SR50A (iiius.)—10-digit, 2 exponent, digit, 2 exponent, all trig and log functions, hyperbolic, X to the root of Y, radian and degree, factorial, memory, etc. Rechargable.



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Preamplifier

The HY5 is a mono hybrid amplifier ideally suited for all applications. All common input functions (mag Cartridge, tuner, etc.) are catered for internally, the desired function is achieved either by a multi-way switch or direct connection to the appropiate pins. The internal volume and tone circuits merely require connecting to external potentiometers (not included). The HY5 is compatible with all I.L.P. power amplifiers and power supplies. To ease construction and mounting a P.C. connector is supplied with each pre-amplifier.

Connector is supplied with each pre-amplifier.

FEATURES: complete pre-amplifier in single pack; multi-function equalisation; low noise; low distortion; high overload; two simply combined for stereo.

APPLICATIONS: hi-fi; mixers; disco; guitar and organ; public address.

SPECIFICATION: inputs-magnetic pick-up 3mV; ceramic pick-up 30mV; tuner 100mV; microphone 10mV; auxiliary 3-100mV; input impedance 4fkD at 1kHz. Outputs-tape 100mV; main output 500mV R.M.S. Active Tone Controls—treble ±12dB at 10kHz; bass ±12dB at 100Hz. Distortion—0·1% at 1kHz; signal/noise ratio 88dB. Overload—38dB on magnetic pick-up. Supply Voltage—±16-50V. Price £4.75 + £1.19 VAT. P. & P. free

HY30

15W into 80

The HY30 is an exciting New kit from I.L.P. It features a virtually indestructible I.C. with short circuit and thermal protection. The kit consists of: I.C., heatsink, P.C. board, 4 resistors, 6 capacitors, mounting kit, together with easy to follow construction and operating instructions. This amplifier is ideally suited to the beginner in audio who wishes to use the most up to date technology available.

FEATURES: complete kit; low distortion; short, open and thermal protection; easy to build.

APPLICATIONS: updating audio equipment; guitar practice amplifier; test amplifier; audio oscillator.

SPECIFICATION: Output Power—15W R.M.S. into 8Ω. Distortion—0-1% at 15W. Input Sensitivity— 500mV. Frequency Response—10Hz-18kHz - 3dB.

Price £4.75 + £1.19 VAT. P. & P. free

HY50 25W into 8Ω The HY50 leads I.L.P.'s total integration approach to power amplifier design. The amplifier features an integral heatsink together with the simplicity of no external components. During the past three years the amplifier has been refined to the extent that it must be one of the most reliable and robust High Fidelity modules in the World. FEATURES: low distortion; integral heatsink; only five connections; 7 amp output transistors; no external components

external components.
APPLICATIONS: medium power hi-fi systems; low power disco; guitar amplifier.
SPECIFICATION: input Sensitivity—500mV. Output Power—25W R.M.S. Into 80. Load Impedance—4-160. Distortion—0-04% at 25W at 14Hz. Signal/Noise Ratio—75dB. Frequency Response—10Hz-45kHz - 3dB. Supply Voltage—±25V. Size—105 × 50 × 25mm.

Price £6.20 + £1.55 VAT. P. & P. free



60W into 8Ω

The HY120 is the baby of I.L.P.'s new high power range, designed to meet the most exacting requirements including load line and thermal protection this amplifier sets a new standard in modular design.

TEATURES: very low distortion; integral heatsink; load line protection; thermal protection; five connections; no external components.

APPLICATIONS: hi-fl; high quality disco; public address; monitor amplifler; guitar and organ.

SPECIFICATION: Input Sensitivity—500mV. Output Power—60W R.M.S. Into 8Ω. Load Impedance—4-18Ω. Distortion—0-049% at 60W at INEX. Signal/Woise Ratio—90dB. Frequency Response—10Hz-45kHz -3dB. Supply Voltage—±35V. Size—114 × 50 × 65mm.

Price £14.40 + £1.16 VAT. P. & P. free

HY200

120W into 8Ω

The HY200 (now improved to give an output of 120 watts) has been designed to stand the most rugged conditions such as disco or group while still retaining true hi-fi performance. FEATURES: thermal shutdown; very low distortion; load line protection; integral heatsink, no external

PEATURES: Inernal shadown components.

APPLICATIONS: hI-fi; diaco; monitor; power slave; industrial; public address.

APPLICATIONS: hI-fi; diaco; monitor; power slave; industrial; public address.

SPECIFICATION: input Sensitivity—500mV. Output Power—120W R.M.S. Into 6Ω. Load Impedance—4-16Ω. Distortion—0:05% at 100W at IXHZ. Signal/Noise Ratio—96dB. Frequency Response—10Hz-45KHz = 3dB. Supply Voltage—±45V. Size—114 × 100 × 85mm

HY400 240W into 4Ω

The HY400 is I.L.P.'s "Big Daddy" of the range producing 240W into 4Ω! It has been designed for high power disco or public address applications. If the amplifier is to be used at continuous high power levels a cooling fan is recommended. The amplifier includes all the qualities of the rest of the family to lead the market as a true high power hi-fidelity power module.

power ni-ridently power module.

FEATURES: thermal shutdown; very low distortion; load line protection; no external components.

APPLICATIONS: public address; disco; power slave; industrial.

SPECIFICATION: Output Power—240W R.M.S. into 4Ω. Load Impedance—4-18Ω. Distortion—0·1% at 240W at 1kHz. Signal/Noise Ratio—94dB. Frequency Response—10Hz-45kHz – 3dB. Supply Voltage — ±45V. Input Sensitivity—500mV. Size—114 × 100 × 85mm.

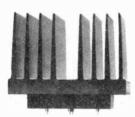
Price £29.25 + £2.34 VAT. P. & P. free

POWER SUPPLIES: PSU38—suitable for two HY30s £4-75 + £1-19 VAT. P. & P. free. PSU50—suitable for two HY50s £6-25 + £1:56 VAT. P. & P. free. PSU76—suitable for two HY120s £12:50 + £1:00 VAT. P. & P. free. PSU90—suitable for one HY200 £11:50 + 92p VAT. P. & P. free. PSU180—suitable for two HY200s or one HY400 £21 + £1:68 VAT. P. & P. free.



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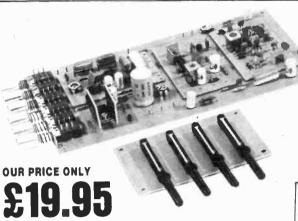
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High quality audio



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PRE-AMPLIFIER PA 100

Fitted with Phase Lock-loop Decoder

- **FET Input Stage**
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- Switched AFC
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STEREO

Typical Specification: Sensitivity 3µ volts Stereo separation 30dB Supply required 20-30V at 90 Ma max.

The 450 Tuner provides instant programme selection at the touch

The 450 Tuner provides instant programme selection at the touch of a button ensuring accurate tuning of 4 pre-selected stations, any of which may be altered as often as you choose, by simply changing the settings of the pre-set controls. Used with your existing audio equipment or with the BI-KITS STEREO 30 or the MK60 Kit etc. Alternatively the PS12 can be used if no suitable supply is available, together with the Transformer T461. The S450 is supplied fully built, tested and aligned. The unit is easily installed using the simple instructions supplied.

instructions supplied.

A top quality stereo pre-amplifier and tone control unit. The six push-button selector switch provides a choice of inputs together with two

really effective filters for high and low frequencies, plus tape output.

Frequency Response +1dB 20Hz-20kHz. Sensitivity of Inpute: 1. Tape Input 100mV Into 100k

- ohms 2. Radio Tuner 100mV into 100k

2. Radio runes ohms
3. Magnetic P.U. JmV into 50k ohms
9. U. Input equalises to RTAA curve within 168 from 20Hz to 20kHz.
Supply 20–35V at 20mA. Dimensions
—299 x 89 x 35mm.

MK60 AUDIO KIT

Comprising: 2 x ALS0's, 1 x SPM80, 1 x BTM80, 1 x PA100, 1 front panel and knobs. I kill of parts to include on off switch, neon indicator, stereo headphone sockets plus TEAK 50 AUDIO KIT.

TEAK SO AUDIO KIT: Comprising: Teak veneered cabinet size 16½ × 11½ × 3½in, other parts include aluminium chassis, heatsink and front panel bracket plus back panel and appropriate sockets etc. KIT PRICE 13-20 plus 62p postage.

STEREO 30 COMPLETE AUDIO CHASSIS



7 + 7 WATTS R.M.S.

The Stereo 30 comprises a complete stereo pre-amplifier, power amplifiers and power supply. This with only the addition of a transformer or overwind will produce a high qualify this, with only the addition of a transformer or overwind will produce a high qualify creamed producing suitable for use with a wide range of including capable of producing us stereo tuner, stereo tape deck etc. Simple of capable of producing high class settle, this unit is supplied with full interfactions, black front panel, kindle class switch, fuse and fuse holder and universal mounting brackets enabling it mains switch, fuse and fuse holder and universal mounting brackets enabling it. The producing the settle construction or the cabinet available, ideal for the beginner or the advanced constructor who requires Hi-Fi performance with a minimum of installation difficulty (can be installed in 30 mins.)

TRANSFORMER £2.45 plus 620 P. & P. £15.75

25 Watts (RMS)

Max Heat Sink temp. 90°C.
 Frequency response 20Hz.
 Distortion better than 0-1 at 1kHz.
 Supply voltage 15-50V.
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Especially designed to a strict specification. Only the finest components have been used and the latest solidstate circuitry incorporated in this powerful little amplifier which should satisfy the most critical A.F. enthusiast.

Stabilised Power Supply Type SPM80

SPM80 is especially designed to power 2 of the AL60 Amplifiers, up to 15 watts (r.m.s.) per channel simultaneously. With the addition of the Mains Transformer BMT80, the unit will provide outputs of up to 1-5A at 35V. SIze: $63\times105\times30\text{mm}$. Incorporating short circuit protection.

INPUT VOLTAGE OUTPUT VOLTAGE OUTPUT CURRENT OVERLEAD CURRENT DIMENSIONS TRANSFORMER BMT80 33-40V A.C. 33V D.C. Nominal 10mA-1-5 amps 1·7 amps approx. 105 × 63 × 30mm £2 · 60 + 62p postage

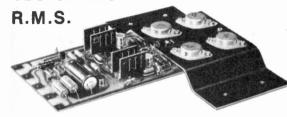
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IT'S POWERFUL

IT'S THE AL250

125 watts



POWER AMPLIFIER

Specially designed for use in-Disco Units, P.A. Systems, high power Hi-Fi, Sound reinforcement systems

The module has a sensitivity of 450mV and a frequency response extending from 25Hz to 20kHz whilst distortion levels are typically below 0.1%. The use of 4, 115W transistors in the output stage makes the unit extremely rugged while damage resulting from incorrect or short-circuit loads is prevented by a four transistor protection circuit.

The unit is intended for use in many applications such as disco units, sound reinforcement systems, background music players, etc.

SPECIFICATION:

Output Power: 125 watt RMS Continuous

Operating voltage: 50-80 Loads: 4-16 ohms

Frequency response: 25Hz-20kHz Measured at 100 watts

Sensitivity for 100 watts output at 1kHz: 450mV

Input impedance: 33k ohms

Total harmonic distortion 50 watts into 4 ohms: 0.1% 50 watts into 8 ohms: 0.06% S/N ratio: better than 80dBs
Damping factor, 8 ohms: 65
Semiconductor complement: 13
transistors 5 diodes
Overall size: Heatsink width

190mm, length 205mm, height



Enjoy the quality of a magnetic cartridge with your existing ceramic equipment using the new Bi-Pak M.P.A. 30 which is a high quality pre-amplifier enabling magnetic cartridges to be used where facilities exist for the use of ceramic cartridges only. Used in

racilities exist for the use of ceram conjunction are 4 low noise, high gain silicon transistors. It is provided with a standard DIN input socket for ease of connection. Supplied with full, easy-to-follow instructions.



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AL10-20-30

AUDIO AMPLIFIER MODULES

The AL10, AL20 and AL30 units are similar in their a AL10, AL20 and AL30 units are similar in their appearance and in their general appetification. However, careful selection of the plastic power devices has resulted in a range of output powers from 3 to 10 watte R.M.S. The versatility of their design makes them ideal for use in record players, tape recorders, stereo amplifiers and cassette and cartridge tape players in the home. Harmonic Distortion Po = 3 watts f = 0:25% Load record = 15 hom.

Frequency response \pm 3dB Po = 2 watts 50Hz-25kHz Sensitivity for Rated O/P—Vs = 25V. RL = 80 ohm f = 1kHz 75mV. RMS. Size: $75 \times 63 \times 25mm$.

ALIO 3W \$2.30 ALZ 5W \$2.65 AL30 10W \$2.95



NEW PA12 Stereo Pre-Amplifier completely redesigned for use with AL10 20 30 Amplifier Modules. Fea-AL10 20 30 Ampliffer Modules. Features include on/off volume. Balance, Bass and Treble controls. Complete with tape output. Frequency Response 20Hz-20kHz (-3dB)
Bass and Treble range ± 12dB Input Impedance 1 meg ohm Input Sensitivity 300mV
Supply requirements 24V. 5mA

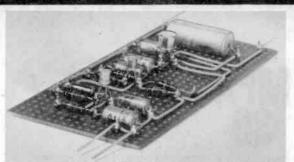
Supply requirements 24V, 5mA Size 152 × 84 × 33mm

Power supply for AL10/20/30, PA12, S450 etc. Input voltage 15-20V a.c. Output voltage 22-30V d.c. Output Current 800mA Max Size 60 × 43 × 28mm.

£1·20

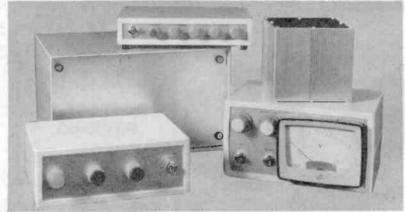
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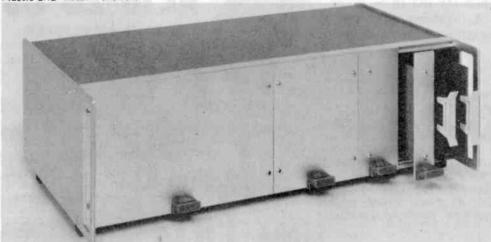




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UNDER-SOLD?

Any of the great achievements and commercial successes of electronics are due to the amazing cheapness of semiconductor devices, no less than to their technical versatility. But the first of these attributes could well prove an embarrassment or liability when considering its effect upon the popular image of electronics, and this is especially important now when the whole question of salaries and status of technical employees in the industry has come to the fore, as discussed by Nexus in this month's Industry Notebook.

Cheapness of components has helped reduce certain consumer type products to the expendable grade. Cheap transistor radios provided the first examples of modern electronic products which are sometimes deemed not worth repairing but are discarded when trouble appears. With the arrival of the digital watch, this custom could be carried to its ultimate absurdity. For if prices continue to fall as confidently predicted, it could eventually become more economical and certainly more convenient to throw away the cheaper type digital watch when the batteries expire and buy another.

There is a further interesting aspect well illustrated by this product, since the digital watch is also invading the fine jewellery market. These up-market models owe everything to their external appearance—to the case—since the electronic assembly might be identical to that used in a cheaper version. Cheap, common, and expendable plastics versus expensive, exclusive, and indestructible fine metals. Micro-electronics has made it all possible, but the case designers and makers

seem likely to skim off the cream.

The digital watch thus offers an illuminating but disturbing example of highly advanced technology selling for a song, and the packaging alone determining whether the final product be a cheap and expendable item or a lasting and valuable possession. Moreover, in more general terms, as the ordinary constructor knows only too well, it is not unusual for the major cost of an electronic project to be taken up by non-active components and also items such as the hardware used in the assembly of the components and to encase the completed project. We all welcome and enjoy low cost active devices, but to the technically-appreciative, values must seem somehow to have become reversed.

Almost too late it seems semiconductor makers sense that they have been blinded by their own technological success and have been unwise in waging price wars on one another in order to acquire a bigger portion of the cake. The short term gains have been considerable, but what of the future? Has then electronics sold itself short? Any cheapening of the technology, any equating of its products with, say, easy-come easy-go plastics commodities must in the long term be detrimental to the status and financial well-being of those employed in electronics. Perhaps the semiconductor industry should recall that charity begins at home, and that cut-price technology is not really in everyone's best interests, and that it often leaves the biggest plums for outsiders to gather.

F.F.B.

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DIGITAL FREQUENCY METER

THIS article describes the design, construction and testing of a digital frequency meter (D.F.M.). This particular instrument has been designed as a radio society construction project and with this in mind it was necessary to use straightforward, logical design.

Ease of fault-finding has been one of the main considerations and to this end a design has been produced which can be tested and maintained using

simple test gear.

The entire logic is contained on a single printed circuit board, and the four-digit display (in this case seven-segment light emitting diodes) is on another board. The power supply and the range switching are the only items that need free wiring.

The basic unit to be described has a 50 ohm input impedance and can measure up to at least 50MHz. Modifications will be described to extend

By A.J. BUXTON

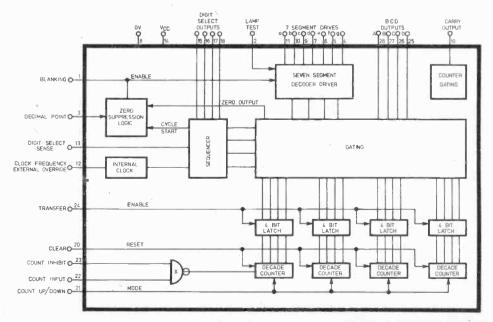
the frequency range to 500MHz and to give a high input impedance.

A major innovation in this instrument is the use of a large scale integrated (l.s.i.) circuit to replace the majority of the logic. The Ferranti ZN1040E counts, stores, decodes and drives up to four seven-segment displays.

THE ZN1040E

The ZN1040E is a large scale integrated circuit fabricated using the "collector diffusion isolation" (c.d.i.) process. Fig. 1 shows the internal functions contained within this device together with the pin connections.

Fig. 1. The internal functions and pin connections of the Ferranti ZN1040E integrated circuit



SPECIFICATION . . .

| 10.00 to 99.99kHz |
|---------------------|
| 100-0 to 999-9kHz |
| 1.000 to 9.999MHz |
| 10.00 to 99.99MHz |
| 50 ohm |
| 40mV |
| |
| 400V |
| 10Hz on Range 1 |
| 5MHz |
| ± 10p.p.m. per year |
| |
| ± 10p.p.m. (10°C to |
| 55°C) |
| |

The device is contained in a 28-lead plastic encapsulated package. By directly driving from the multiplexed, seven-segment outputs or by decoding the binary coded decimal (b.c.d.) outputs, any contemporary display can be used.

The seven-segment drivers can sink a current of 80mA, which results in an average current of 20mA

per segment when multiplexed.

When free-running, the internal multiplex clock oscillator gives a frequency of about 500kHz. This frequency can be lowered by the addition of a capacitor to pin 12. In this instrument a $0.01\mu F$ capacitor is used to give a frequency of 3kHz.

A direct drive at TTL logic levels will override the

multiplexing to the driven frequency.

The ZN1040E requires a single 5V supply and consumes an internal current of 90mA. It is fully compatible with TTL devices.

CIRCUIT DESCRIPTION

A circuit diagram of the complete unit minus the power supply is shown in Fig. 2. This circuit shows the basic unit with a 50 ohm input impedance. All the circuitry is contained on two printed circuit boards: one for the logic and input circuits and one for the display. The two boards are shown as dotted lines in Fig. 2.

The circuit is more easily understood if con-

sidered in sections.

THE OSCILLATOR

The oscillator is the single most important function within a digital frequency meter as the accuracy depends almost entirely on the crystal oscillator.

Variations in temperature, crystal age and supply voltage all affect crystal frequency. Adding all the effects together, one can be faced with an error of

30Hz in 1MHz or 0.003 per cent.

Initial crystal frequency inaccuracy can be trimmed out using a capacitor (VC1). This can also be used to trim out the effects of ageing. There is admittedly room for improvement of the oscillator used in this design but it is simple and in line with the basic design concept.

A 5MHz crystal (X1) is used, this frequency being useful as temperature and mechanical stability are optimised at this frequency.

COMPONENTS . . .

MAIN UNIT

| Resistors | | | |
|-----------|--------------------------|---------|---------------------|
| R1-R5 | 270Ω (5 off) | R25 | 2·2kΩ |
| R6-R15 | 100Ω (10 off) | R26 | 470Ω |
| R16 | 2·2kΩ | R27 | 1kΩ |
| R17 | 100Ω | R28 | 3⋅3kΩ |
| R18 | 150Ω | R29 | 2·2kΩ |
| R19, R20 | 5.6 k Ω (2 off) | R30 | 470Ω |
| R21 | 15kΩ | R31 | 10kΩ |
| R22 | 10kΩ | R32 | 1kΩ |
| R23 | 1kΩ | R33-R36 | 470Ω (4 off) |
| R24 | 100Ω | | |
| All ±5% | ¦or ∦W | | |

Capacitors

| Ci . | υ,ουυμε |
|----------|------------------------|
| C2-C4 | 0.05μF 6V disc (3 off) |
| C5 | 10pF mica |
| C6 | 0·01μF disc |
| C7 | 0.05µF disc |
| C8 | 50μF 10V elect |
| C9 | 0·05μF disc |
| C10 | 30pF mica |
| C11 | 0·05μF disc |
| C12 | 0·1μF 6V disc |
| C13 | 100μF 10V elect |
| C14 | 30pF mica |
| C15 | 10pF mica |
| C16, C17 | 330pF mica (2 off) |
| C18, C17 | 0.05μF disc |
| C19 | 470pF disc |
| | |
| C20 | 0·05μF disc |
| C21 | 1,000pF 6V disc |
| C22-C28 | 0·05μF disc (7 off) |
| C29 | 2,200μF 25V elect |
| C30 | 330μF 16V elect |
| C31 | 0·1μF 6V disc |
| C32 | 100μF 6V elect |
| VC1 | 3-60pF trimmer |

6.800nF

Transistors and Diodes

| TR1-TR4 | ZTX4403 (4 off) |
|-----------|------------------|
| TR5, TR6 | ZTX300 (2 off) |
| TR7 | ZTX312 |
| TR8, TR9 | ZTX500 (2 off) |
| TR10-TR12 | ZTX312 (3 off) |
| D1 | 4-7V 400mW Zener |
| D2_D4 | 7S170 (3 off) |

| integrated Circuits | | | | | | |
|---------------------|---------|----------|----------------|--|--|--|
| IC1 | NE592 | IC6 | ZN7400 | | | |
| IC2 | ZN74196 | IC7 | ZN7403 | | | |
| IC3 | ZN1040E | IC8-IC14 | ZN7490 (7 off) | | | |
| IC4 | ZN7474 | IC15 | 78M05 | | | |
| IC5 | ZN74123 | | | | | |

Display

LED1-LED4 DL707 (4 off)

Switches

| 51 | 2 pole 4 way rotary |
|----|---------------------------|
| S2 | Single pole on/off toggle |
| S3 | D.p.d.t. mains toggle |

Miscellaneous

Mains primary, 8-0-8V 500mA secondary (Douglas MT207CT)

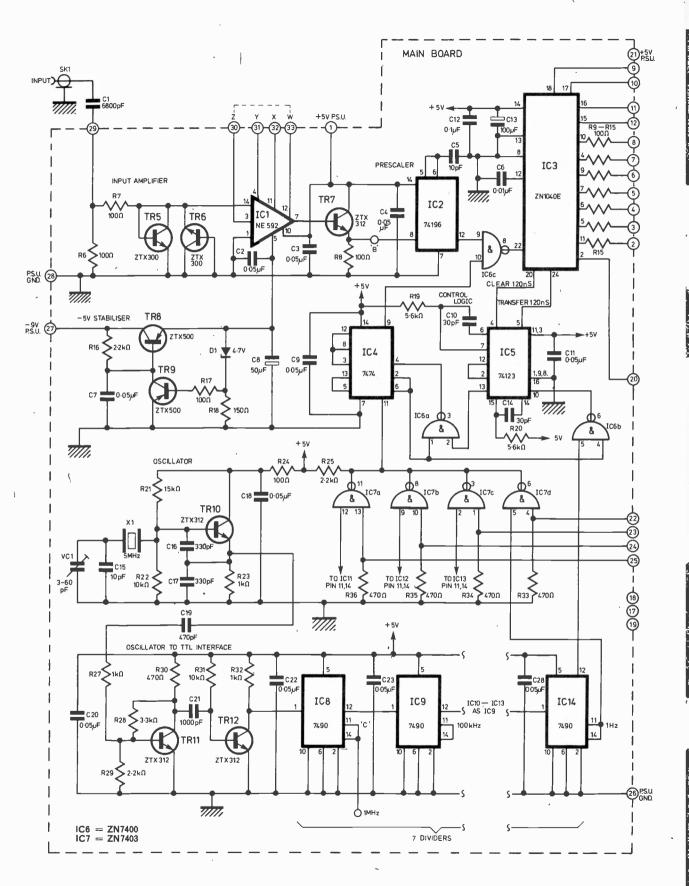
5MHz crystal X1

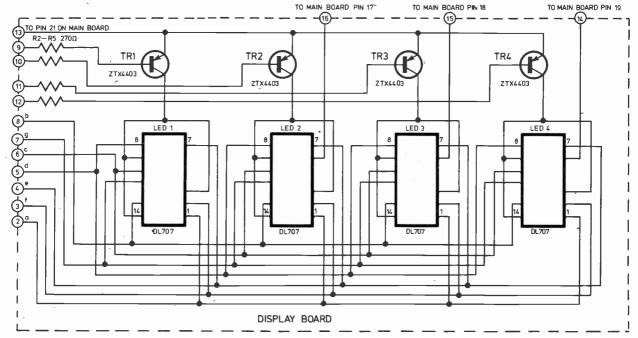
SK1 BNC socket

FS1 2A 20mm fuse and holder

9-way tag strip

Filter for display, p.c.b.s, sockets for i.c.s if required, case, nuts and bolts, standoffs, etc.





TO PIN 20 S2 LAMP TEST

10kH

1MHz O

10MHz

R26

470Ω

R1

2700

RANGE

TO PIN 22

TO PIN 23

TO PIN 24

TO PIN 25

TO PIN 18

TO PIN 17

TO PIN 19

Fig. 2. Circuit diagram of the Digital Frequency Meter (50 ohm version). The dotted lines indicate the boundaries of the two printed circuit boards. The circles with numbers inside refer to the pads on the circuit boards to which wires are connected

Transistor TR10 and associated components form the basic oscillator whose output is fed to the amplifier TR11 and then to TR12 which interfaces the signal to TTL logic levels. As mentioned earlier, the frequency of this clock oscillator is set by trimming the 3 to 60pF capacitor VC1.

THE CLOCK DIVIDER CHAIN

The clock oscillator frequency is divided down to generate logic control pulses. These pulses determine the time for which the main signal gate (IC6c) is open. They also control the transfer of information to the displays and the clearing of the counters in the ZN1040E.

This four-range, four-digit counter has four orders of magnitude of full scale display, so four lengths of timing pulse are needed to cover them.

Full scale ranges are 99.99MHz (in practice limited to 50MHz by the limitations of the ZN1040E), 9.999MHz, 999.9kHz and 99.99kHz.

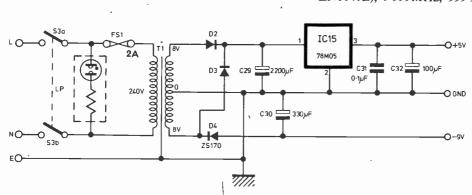


Fig. 6. Circuit diagram of the power supply which produces the 5V and -9V lines to the main board

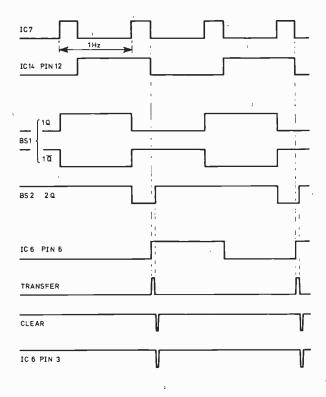


Fig. 3. The timing of the control pulses at various points in the circuit

If the counter is to display, say, 6.800MHz, then 6,800 pulses must pass to the counters. A decade divider connected to the input (IC2) divides the input frequency by ten, giving a frequency of 680.0kHz at the signal gate input (IC6c pin 9). This means that to let 6,800 pulses through, gate IC6c must be open for 1/100th of a second (10ms). The figure "6.800" will then be displayed, the range switch S1 inserting the decimal point to compensate for the prescaler.

The four ranges thus require the following gate times:

| Frequency Range | Time gate open (secs) |
|-------------------|-----------------------|
| 10.00 to 99.99kHz | 1 |
| 100·0 to 999·9kHz | 0·1 (100ms) |
| 1.000 to 9.999MHz | 0.01 (10ms) |
| 10.00 to 99.99MHz | 0.001 (1ms) |
| | |

To obtain these length pulses the 5MHz clock is divided by six and a half decade counters (IC8 to IC14). The remaining divide-by-two is used to start the transfer, clear and reset logic.

Control pulse selection is effected by selecting one of the open collector NAND gates in IC7 using switch S1b. Each of the four gates is connected to a different point in the divider chain. The non-selected gate inputs are held low by the resistors R33 to R36. The outputs of the four NAND gates are WIRED-OR connected via resistor R25.

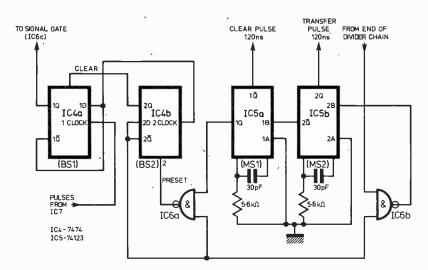
THE CONTROL LOGIC

The control logic determines when a transfer or clear pulse is required and when the signal gate can be opened, thus ensuring a correct sequence of events. The timing diagram (Fig. 3) shows the sequence when the fastest range is selected and the circuit of Fig. 4 shows the control logic in more detail.

The output from the end of the divider chain (IC4, pin 12) is a one second high, one second low series of pulses.

Consider the state when the two bistables of $\underline{IC4}$ have been set by a pulse from IC7, so that $2\overline{Q}$ is high and output 1Q is high. The next negative edge from the divider chain will produce a positive edge at the output of IC6b. This will trigger monostable MS2, producing a 120ns positive "transfer" pulse at

Fig. 4. The control pulse generation circuitry in more detail. The logic shown here produces the clear and transfer pulses required by the ZN1040E and the signal gate control pulses



its 2Q output. This pulse transfers the information from the counters to the latches and hence to the

display in the ZN1040E.

When the 2Q output of MS2 returns to low, its $2\overline{Q}$ output goes high, triggering monostable MS1 which also produces a 120ns "low" pulse. This pulse is used to clear the counters to 0000. Meanwhile the 1Q output is high for 120ns, taking the output of IC6a low which sets BS2's 2Q output high, clearing BS1 whose 1Q output goes low, thus closing the signal gate IC6c. The logic is now set for the timing period.

TIMING SEQUENCE

The 7474 is a positive edge triggered bistable. On receiving the first positive edge from IC7 after being set, BS1 is triggered. 1Q goes high thus opening gate IC6c. 1Q goes low which has no effect on 2 CLOCK

input as a positive edge is required.

The pulse from IC7 goes low, this having no effect on 1 CLOCK. However, when it goes high again (after the required timing period of one second) 1Q will go low thus closing the signal gate. At the same time $1\overline{Q}$ goes high which triggers BS2, setting 2Q low and clearing BS1. $2\overline{Q}$ remains high in readiness for the next negative edge which starts the whole sequence.

The action of the bistable BS1 divides the pulses from IC7 by two. A 100Hz frequency, with 2.5ms high and 7.5ms low pulses, causes the gate to be

open for 10ms.

COUNTING AND DISPLAY

After the counters of the ZN1040E are cleared, the signal gate will be opened for a fixed period. The frequency of the pulses entering the count input (pin 22) will be a tenth of the frequency to be displayed. The ZN1040E has a minimum count rate of 5MHz so the measured frequency can be as high

as 50MHz or greater.

The pulses at the count input are counted on the four cascaded decade counters (Fig. 1). When the signal gate is closed the control logic generates a pulse to transfer the counter information to the latches. The clear pulse then sets the counter to zero. Should there be more than 9,999 pulses, the most significant digits will be lost, only the four least significant digits of the number of pulses being retained.

This feature is most useful when measuring a frequency with more than four significant digits. If, say, 29.215MHz is to be measured, the instrument can be deliberately over-ranged to read 9.215MHz, the "2" being remembered from the measurement

on the next range.

An internal clock generates the multiplexing signals which control the gating that scans the latches,

and addresses the digit select output.

When any particular digit is addressed, the latch information relevant to that digit is presented at the seven-segment decoder/driver output. As each display is addressed with a one-in-four time slot, the average power supplied to each segment is 0.25 the peak power.

Resistors R9 to R15 are used to limit the output current to about 25mA peak, 6mA per segment

average is adequate for most applications.

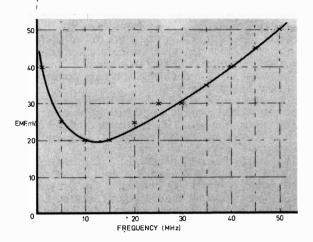


Fig. 5. Frequency plotted against sensitivity for the NE592 integrated circuit amplifier

The frequency of the internal clock can be lowered by the addition of a capacitor or overriden by driving pin 12 with an external TTL clock. A capacitor of $0.01\mu F$ has been used in this design to give a

multiplex frequency of 2.8kHz.

The displays used in this meter are four DL707 (LED1 to 4). Being common anode l.e.d. displays, they are suitable for driving directly from the ZN1040E, i.e. without interface circuitry. The anode pull-up transistors TR1 to TR4 are used because of the high currents that are required if an "8" is to be displayed (all segments used). A current of 200mA peak can flow in this case. Resistors R2 to R5 limit the current flowing into the bases of these transistors.

Decimal point selection is carried out using the same switch as is used for the gate period selection

(S1).

PRESCALER CIRCUIT

In order to measure frequencies higher than the 5MHz limit imposed by the ZN1040E, it is necessary to pre-divide the input frequency. IC2 is a 74196 decade divider capable of operating at 50MHz. It is wired as a divide-by-two then a divide-by-five. The 10pF capacitor C5 connected to the divide-by-two output (pins 5 and 6) acts as a load to prevent instability under no-signal conditions.

Though the frequency capability of the ZN1040E is 5MHz and of the 74196 50MHz, these are minimum figures; a typical pair of i.e.s will operate

above this range.

INPUT AMPLIFIER

The input impedance of the instrument as shown in Fig. 2 is 50 ohm. If a high input impedance is required, then the buffer board to be described next month will be required.

A capacitor at the input (C1) protects the input from d.c. bias potential up to 400V. Two transistors (TR5, TR6) connected as diodes are used to limit the input voltage to IC1. Transistors are used as a

cheap alternative to high speed switching diodes. If diodes are used here they must have a reverse recovery time of less than 6ns if the full capabilities of the instrument are to be realised. Resistor R7 limits the current in these two transistors.

The power input to the instrument must not exceed

the power handling of R6.

The input amplifier IC1 is a wideband video amplifier type NE592 connected in the inverting mode.

The emitter follower TR7 is used to interface IC1 to IC2. Under no signal conditions, 2·1V will be measured at "B".

The i.c. has four outputs (W, X, Y, Z) used to set the gain. By linking X and Y a gain of 400 at a bandwidth of 40MHz is obtained. The graph of Fig. 5 shows frequency plotted against sensitivity.

Shorting W and Z gives a gain of 100 with a 90MHz bandwidth. A $10k\Omega$ variable resistor between X and Y allows a variable gain of unity to

400.

The -5V line required by the NE592 is supplied by the simple stabiliser (TR8 and TR9) fed with -9V

THE POWER SUPPLY

The power requirements of the instrument are 5V at 500mA, and -5V at 30mA. The power supply and stabiliser for the +5V line is shown in Fig. 6. The -9V line is fed to the stabiliser on the main printed circuit board which produces the -5V for IC1.

The current drain is 350mA with no-signal input and 500mA with all eights displayed.

Next month: Constructional details, high impedance buffer and v.h.f. prescaler

NEWS BRIEFS

Summer School for Teachers

THE Department of Electrical Engineering Science at Essex University will be holding its annual Electronics Summer School for teachers during the week July 12–16 and, this year, three courses Linear Circuit Design, Digital Circuit Design and Small Computer Systems will be run simultaneously.

The Linear Circuit Design course is concerned with the use of transistors and operational amplifiers in analogue applications and the basic circuits of a hi-fi ampli-

fier are investigated in detail.

The Digital Circuit Design course concentrates on the use of the transistor as a switch and develops a design using integrated logic circuits; a digital patchboard is used to introduce the concepts of combinational and sequential logic design.

Small Computer Systems is a new course which should be of interest to mathematics teachers as well as those interested in electronics; the aims of the course are to introduce a typical small computer, the PDP-8, to investigate how it is used and to discuss its function in schools.

Further information on the Summer School can be obtained from Mr R. J. Mack at the Department of Electrical Engineering Science, University of Essex, Wivenhoe Park, Colchester CO4 3SQ.



BUUK K BEVIEWS

INTRODUCTION TO QUANTUM ELECTRONICS

By P. A. Lindsay Published by Pitman 202 pages, 240mm × 160mm. Price £6.00

QUANTUM Electronics is no longer confined to the scientific laboratory. An important and growing technology has emerged based on the practical utilisation of electromagnetic radiation interaction with matter on the atomic scale through the medium of devices such as lasers. The applications of lasers are likely to increase in the future and already they play an important part in industry and in the medical field.

Thus the subject covered by this book could be a very rewarding one for the engineering student to pursue. The term "Introduction" might be misleading. This is an advanced level textbook and it explores the subject in a rigorous analytical manner with extensive use of maths. The author is Professor of Physical Electronics at King's College, University of London.

D.D.R.

MULLARD DATA BOOK 1976 176 pages, 134 × 96mm. Price 50p.

This is a handy pocket reference containing abridged data on the Mullard range of components for use in consumer applications, including valves, semiconductor devices, TV tubes, capacitors and resistors. Equivalents and comparables are also listed.

For easy reference different coloured pages are used for each of the main sections; blue for semiconductors, yellow for picture tubes and receiving valves and green

for capacitors and resistors.

The book is obtainable from specialist components stockists or direct from Technical Press Ltd., Freeland, Oxford, OX7 2AP.

POINTS ARISING

HOW INVENTIVE ARE YOU COMPETITION

Full results will appear next month. Unfortunately it was not possible to include them in this issue, as originally hoped.

DIGI-PROBE (April 1976)

In Fig. 7 (p. 292) the resistor on the left-hand edge of the top board should be annotated R16. Also the lead from the junction of R15, R16 and R17 should go to IC2 pin 12 and not as shown to pin "e" on the DL704 display. The lead from pin "e" of the display should be connected to the other side of R16.

OPTO-COUPLED R.P.M. METER (February 1976)

Some constructors have had difficulty in obtaining the MS4A photo-cell specified. This can be obtained from: Davian Electronics, PO Box 38, Oldham, Lancs, OL2 6XJ.

This is an error on the p.c.b. master (page 146). The track in the top left-hand portion of Fig. 2 which connects the collector of TR1 to the positive supply line (shorting out R2) should be removed.



SOVIET VENUS PROBES

The Soviet satellites *Venera 9* and *Venera 10*, continuing their orbiting studies of Venus, have measured the temperature of the clouds near their upper boundary. This was at a level of -35 degrees centigrade. Records of the glow on the night side of the planet indicate that the spectrum differs from that of the Earth glow.

The electron density on the day side is much higher than the night side and about 90 per cent less than that of the Earth. Another feature is that the ionosphere of Venus appears to be closer to the planet and much thinner than that of the Farth

The pictures that have been sent back so far have encouraged the Soviet investigators to examine the radio method of exploring through the cloud layer. Although some five years ago Yuri Spiridinov had devised a system of measuring relief using data sent back by Mariner 5, this was not pursued because the general consensus of opinion was that the surface of the planet would be mainly smooth.

The technique involves the critical refraction layer of the Venusian atmosphere about 30 kilometres or so above the surface. The angle of refraction of the radio beam is so great that it must also be reflected by the surface. Using the split beam technique, similar holography in the visible spectrum, one half of the beam passes below the critical level and the other half above the critical level level.

A signal sent from Earth will be received by a space probe on the dark side, and will be the sum of the direct and reflected wave. Thus, a picture can be built up from the

recordings and the result is, when computerised, a picture of the surface in the radio frequency spectrum. More than one line scan is needed of course, but since Venus moves very slowly on its axis, 243 terrestrial days, and the probe needs to be in radio shadow, a line by line scan is easily obtained.

Although the original data received from Mariner 5 was insufficient to produce a full picture, nevertheless the contour was shown at two frequencies. The indicated variation of height ranged from 0.3 to 2.7 metres. This agreed very well with the pictures that were received from the probes landed on the surface. This technique could be applied in a number of other cases and may prove a very useful tool of the future.

OUTER BOUNDARY

Spacecraft *Pioneer 10* crossed the orbit of Saturn on February 10 and headed out to the boundary of the solar system. On that date it was some 1,000 million miles from the Earth. Its velocity was about 26,000mph.

The equipment has continued to function normally and data continues to be sent back. It is considered that with the sensitivity of the Deep Space Network, *Mariner 10* will be in communication until it reaches the orbit of Uranus and maybe further. The orbit of Uranus is about 2,000 million miles from the Earth.

POWERSAT

The American Congress now has the results of Boeing's power generation satellite proposals. This will require some 30 spacecraft, each of which will have a system of converting solar energy to microwaves which are beamed to Earth. The system has been described in detail in an earlier Spacewatch.

The Earth stations will be situated on the equator in desert areas such as Nevada in America. Provision will have to be made for heavy lifting transporters to raise some of the structures. These transporters will be about 90ft high with a cluster of 21 engines around a 100ft diameter base. The cost, if the pilot experiments are successful, would be something of the order of 60,000 million dollars over a period of 30 years.

SET BACKS

A number of casualties have resulted from the new American finance cuts in the space budget. Some of the cuts mean that decades may pass before missions can be set up again.

It is the Space Science area that has suffered most. A Jupiter orbiter probe for launch in 1981 has been deferred. The Moon orbiter and the fly-by for Comet Encke have also been abandoned. Although, here there is a possibility that *Helios* could be diverted so that the opportunity is not lost.

A tragic loss to astronomy is the withholding of further finance for the 94in orbiting telescope. It will not be possible to advance this project for at least 18 months.

The Venus *Pioneer* programme which will release probes for different depths of penetration into the Venusian atmosphere will still go ahead.

The mission which was planned for a journey via Jupiter, Saturn, Uranus has been postponed and this is the one which means decades in terms of delay because the astronomical positions will not be suitable. This was the "sling-shot" mission where the precise position of the trajectories would have enabled the gravitational effects to help the vehicle on its way.

FUTURE PLANS

However, some good news is available and the studies planned for the next 11-year period of solar activity will go ahead. The mission will cost 85 million dollars using a 3,000lb satellite which will be known as the Solar Maximum Mission. This will be the first modular design to carry instrumentation retrievable by Shuttle.

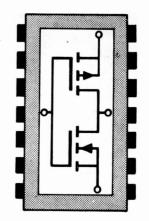
At the time of going to press, four launchings have taken place this year. They are: Helios B, the second of the German Solar probes; Communications Technology Satellite, a joint effort of NASA and Canada; Intelstat IV-A-B, owned by International Telecommunications Organisation and Marisat, launched for Comsat General Corporation. Marisat-B will follow in May and Marisat-C later in the year.

The RCA Satcom, second of the

The RCA Satcom, second of the domestic communications satellites, was due for launch in March. A NATO satellite 3-A will be in geostationary orbit in April for North Atlantic Treaty Organisation Relay. LAGEOS, which is Laser Geodynamic Satellite for predicting ocean surface conditions and circulating patterns. It will also be concerned with earthquake hazards and is due for launch in April. Comstar I-A and Comstar I-B will be launched in May and August.

Finally, the *Tiros* Operational Satellite for the National Oceanic and Atmospheric Administration will be placed in orbit in September.

Using CMOS digital I.Cs



By D.B. JOHNSON-DAVIES & A.M. MARSHALL B.A.

PART 5

This part concerns electronic switches and oscillators with practical circuit examples.

MONOSTABLES

The monostable is basically a single-shot oscillator. It produces an output pulse of constant width independent of the duration of the input pulse, thus curtailing long pulses and extending short ones. The simple differentiating circuit of Fig. 5.1 performs the first function, as shown by the waveforms in (a). The period of the output pulse depends on the transfer voltage V_T of the inverter as the time constant RC charges from V_{SS} to V_{DD}, and will vary between devices from about 0.4RC seconds with $V_{\scriptscriptstyle T}$ = 30 per cent of $V_{\rm DD}$ to 1.2RC seconds with $V_{\rm T}$ = 70 per cent of $V_{\rm DD}$. If, however, the input pulse is shorter than this period, as in the waveforms (b), the capacitor does not charge fully to V_T and the output pulse will be constrained to the length of the input pulse. In other words this circuit will only act as a pulse shortener.

This differentiating circuit can be used as a simple delay unit, and Fig. 5.4 shows a frequency doubler using two such circuits, one triggering on each edge

of the clock pulse.

For the circuit of Fig. 5.1 to function as a monostable, it must be made to latch on until the full output pulse has been delivered. This is achieved in Fig. 5.2 by using a NoR gate to hold the input to the differentiating circuit "high" until the capacitor has charged to $V_{\rm T}$. This excellent monostable does however suffer from the variation in period between devices, mentioned above.

The circuit of Fig. 5.3 can be used if a more predictable period is needed. Two gates fabricated on the same chip will have closely matched transfer voltages, and by using two identical RC time constants, the between device variations are effectively cancelled out.

SCHMITT TRIGGERS

At the interface between analogue and digital circuits comes the Schmitt trigger, which gives a snappy "yes" or "no" for an undecided analogue input signal. The perfect Schmitt has a characteristic as represented in Fig. 5.5. The Schmitt, if presented with a slowly rising input voltage, will switch sharply

off at $V_{\rm UT}$ (the upper threshold voltage) and will not switch back on again until the voltage has fallen below $V_{\rm LT}$ (the lower threshold voltage). This difference $V_{\rm UT}^-V_{\rm LT}$, is called the hysteresis, and it prevents the circuit from going into oscillation when the input is held at one of the thresholds.

One way of obtaining hysteresis is to make the transfer point unstable by applying positive feedback, as in Fig. 5.6. The feedback is equal to R1/R2, and this should be less than the combined gain of the inverters for switching to occur. The average threshold voltage $V_{\rm T}$ can be varied, if required, by connecting a resistor R3 to $V_{\rm DD}$ for $V_{\rm T}$ of greater than $V_{\rm DD}/2$, and to $V_{\rm SS}$ for $V_{\rm T}$ less than $V_{\rm DD}/2$.

Another type of Schmitt trigger, unique to cmos, makes use of the variation of the transfer characteristic of multi-input gates described earlier. Fig. 5.7 shows a circuit with a hysteresis of about 30 per cent of $V_{\rm DD}$. This can be reduced to 15 per cent of $V_{\rm DD}$ if required by taking one of the three inputs of gate A to $V_{\rm DD}$. The other two gates are arranged as a familiar R-S latch.

TRANSFER CURVE

If one of the inputs of a two-input gate is held at somewhere between the two logic levels (i.e. between 3 and 7 volts with a 10 volt supply) the transfer curve for the other input is altered as shown in Fig. 5.8. The Schmitt triggers of Fig. 5.9 make use of this property of cmos gates. The circuit in (a) using NAND gates triggers at above $V_{\rm DD}/2$, whereas using NOR gates as in (b) gives trigger levels below $V_{\rm DD}/2$. In both circuits the hysteresis can be varied from 0 to 40 per cent of $V_{\rm DD}$ by altering $V_{\rm x}$.

SCHMITT PACKAGES.

As an alternative to constructing Schmitt triggers from discrete gates, the CMOS family contains a few ready-made Schmitt packages. The 4093 contains four 2-input NAND gates each with Schmitt circuits on both inputs. The 40106 is a hex-inverter with Schmitt inputs, and the package outline is the same as the 4069. In both these devices $V_{\rm T}$ is approximately $V_{\rm DD}/2$, and the hysteresis is 2V with a 10V supply.

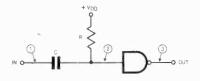
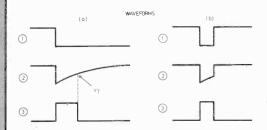


Fig. 5.1. Simple differentiating circuit. The period of the output pulse depends on the transfer voltage $V_{\rm T}$ of the inverter. For explanation of waveshapes below, see text



10kn 3 5 0 0 UT

Fig. 5.4. Frequency doubler using two differentiating circuits, one triggering on each edge of the clock pulse, as can be seen from the waveshapes

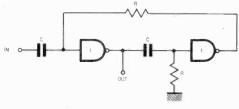
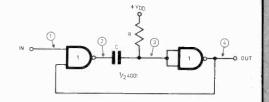


Fig. 5.3. With gates fabricated on the same chip and identical RC time constants output pulse periods can be more accurately predicted



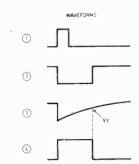


Fig. 5.2. Monostable circuit achieved by connecting a NOR gate to hold "up" the input to the differentiating circuit until the capacitor has charged to $V_{\rm T}$

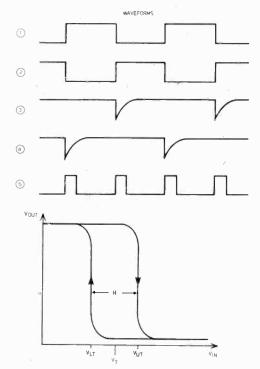


Fig. 5.5. The ideal Schmitt trigger characteristic. It can be defined either in terms of $V_{\rm LT}$ and $V_{\rm UT}$ (the lower and upper thresholds) or in terms of $V_{\rm T}$ and H (the average threshold voltage and hysteresis)

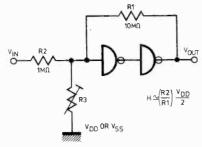


Fig. 5.6. Schmitt trigger formed from two inverters with positive feedback. R1 can be from 1 to 100 times R2. With the values shown (R3 not connected) and a supply of 10V, $V_{\rm LT}=5.0 {\rm V}$ and $V_{\rm UT}=5.8 {\rm V}$ approximately

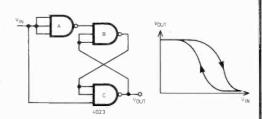
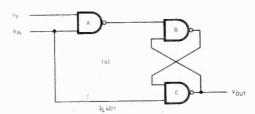


Fig. 5.7. Schmitt trigger using three-input gates



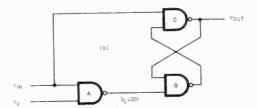


Fig. 5.9. Schmitt trigger circuits with hysteresis determined by the voltage $V_{\rm X}$. (a) With NAND gates the circuit triggers at a voltage greater than $V_{\rm DD}/2$. (b) Equivalent circuit with NOR gates triggers at below $V_{\rm DD}/2$

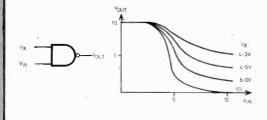
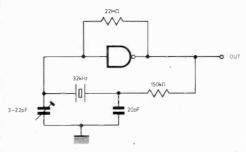


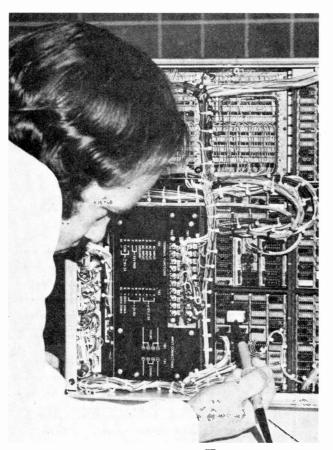
Fig. 5.8: Transfer curve variations for non-logic levels \textbf{V}_X at one input of a two-input NAND gate. The supply is 10V



000 000 100pF 22kΩ FREQ ≈ 1/2n/CC 100mH

Fig. 5.10. Crystal oscillator

Fig. 5.11. Showing an L/C oscillator the frequency of which being stable to within about 0.001 per cent for a 2V change in the supply voltage



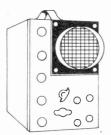
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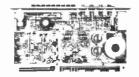


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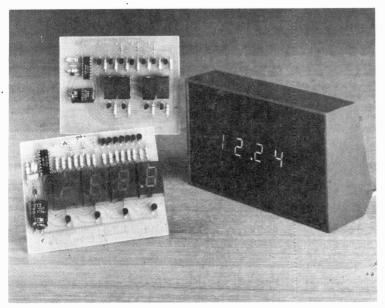


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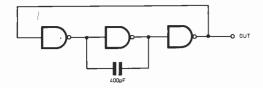


Fig. 5.12. Ring oscillator which uses only one capacitor which is charged and discharged through the inverters

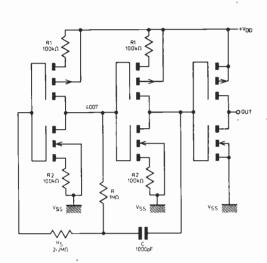


Fig. 5.14. Low-power astable with current limiting resistors R1 and R2. These can be any value up to about 470k Ω . With the values given the frequency is about 450kHz

STABLE OSCILLATORS

For more critical applications, stable oscillators can be made by connecting a crystal or L-C network as a feedback network across an inverter. A crystal oscillator circuit is shown in Fig. 5.10, and crystals resonating at up to several megahertz can be accommodated by altering the values of the two capacitors. Fig. 5.11 shows an L-C oscillator, the frequency being stable to within about 0.001 per cent for a 2V change in the supply voltage.

cent for a 2V change in the supply voltage.

The ring oscillator of Fig. 5.12 uses only one external capacitor which is charged and discharged through the MOSFETS of the inverters. It will oscillate at between 1kHz and 10MHz for values of C from 1µF to 1pF.

The Schmitt trigger will operate as an oscillator giving a range of 1Hz to 1MHz with suitable values of R and C (Fig. 5.13). Six discrete oscillators can be built with one 40106 package.

LOW POWER

Where power consumption is critical, as in batterypowered circuits, it may be worth modifying these simple oscillator circuits given in the previous part in order to conserve a few milliwatts.

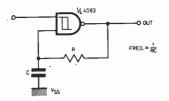


Fig. 5.13. Schmitt used as an oscillator

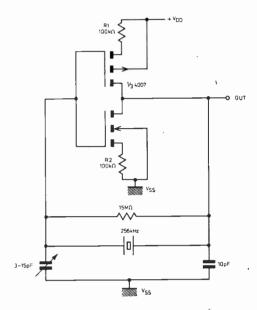


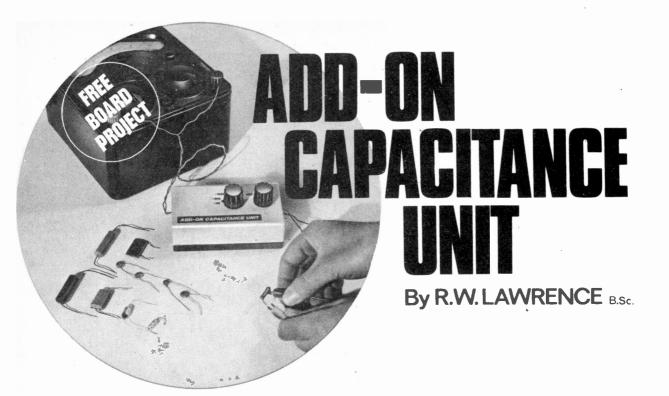
Fig. 5.15. Low-power crystal oscillator. Frequencies of up to 10MHz are possible with a supply of 15V

The quiescent current drawn by a gate is negligible; of the order of nanoamps. The major part of the dissipation of a CMOS oscillator occurs during the transition between states, due to the charging and discharging of circuit capacitances, and therefore increases with frequency. This dissipation can be reduced at the expense of decreased output drive capability by the addition of resistors between the source and $V_{\rm SS}$, and the drain and $V_{\rm DD}$ of the MOSFET pair, thus decreasing the current that flows during conduction. The 4007 dual complementary pair plus inverter provides access to the individual MOSFETS and so can be used in such circuits.

Fig. 5.14 shows a low-power oscillator constructed from a 4007 package, with a frequency of about $1/2 \cdot 2RC$. The power consumption at 10 volts falls from about 5mW with R1 and R2 shorted as in the simple oscillator circuit, to about 200μ W with R1 = $R2 = 100k\Omega$. Due to the increased output impedance the oscillator is very sensitive to loading, and so an inverter is added as an output stage.

The crystal oscillator of Fig. 5.15 requires only about 30μ W with a supply of 5 volts, and the presence of R1 and R2 has the added effect of stabilising the frequency against variations in supply voltage.

continued on page 408



THE measurement of capacitance has always been more difficult than the measurement of resistance, voltage, etc.

The traditional method of performing the operation is with some form of impedance bridge, but this can involve a lengthy ritual of balancing and adjustment to obtain a final reliable reading.

The circuit to be described will allow instant measurement of capacitance from less than 1pF to greater than $10\mu\text{F}$, displaying the result on an ordinary multimeter.

THEORY OF OPERATION

The add-on capacitance unit uses simple, conventional techniques and relatively few components. Referring to the block diagram (Fig. 1) it will be seen that there are three basic sections: an oscillator, a virtual earth amplifier, and a precision rectifier arrangement whose output feeds a voltmeter (a multimeter set to a range whose f.s.d. lies between 1-3V).

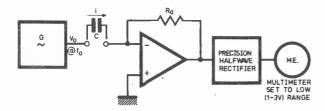


Fig. 1. Block diagram of the Add-on capacitance unit

If we assume the sinewave oscillator is set to a frequency f_0 , its output voltage is V_0 , and the unknown capacitance value is C, then simple theory yields the current flowing into the virtual earth as being:

$$i = \frac{V}{Z} = \frac{V_0}{1/2\pi f_0 \tilde{C}}$$

This current is directly proportional to the admittance (the reciprocal of impedance) of the capacitor which, in turn, is proportional to the value of the capacitance and the frequency.

VIRTUAL EARTH

Since the current cannot flow into the inverting input of the operational amplifier, an equal and opposite current from the output will flow via the feedback resistor R_a such that the two cancel out at the inverting input providing the so-called "virtual earth".

The voltage appearing at the output of the op. amp. will thus be $i \times R_a$. However, since i itself is proportional to capacitance and frequency (of the oscillator) and the output of the virtual earth amplifier is proportional to i, it follows that this output voltage will also be proportional to the feedback resistor R_a as well as the capacitance and frequency.

In practice R_a and the frequency f_0 are switched to allow a very wide range of capacitors to be measured (less than 1pF to well over $10\mu\text{F}$) with good accuracy (dependent on the quality of the meter and components, but can be as good as 1-2 per cent)

The output from the virtual earth amplifier is then rectified with a precision rectifier and presented to the voltmeter (multimeter) for display. The precision

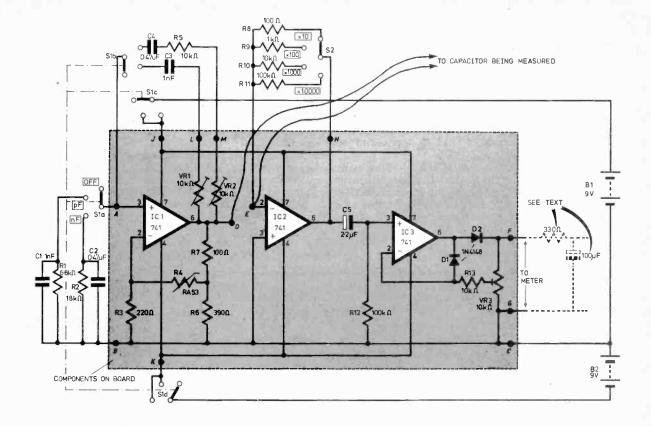


Fig. 2. Full circuit diagram

rectifier merely uses a further op. amp. to overcome diode forward voltage drops and thus obtain accurate rectification down to low output levels.

The circuit diagram is shown in Fig. 2.

INTEGRATION

The output from the unit consists of half sine-waves, and it is left to the meter to integrate these and provide a continuous reading. No problems were encountered with the larger type of meters (AVOs, etc.), but with smaller ones needle "judder" may cause annoyance. If this arises the effect can be alleviated with the simple addition of two extra components.

If a $100\mu F$ capacitor is connected across the output of the unit via a 330Ω resistor and the meter output is taken across the capacitor, the integration process is greatly improved and the judder cut down considerably. The addition of these components increases the meter reading a certain amount and therefore the gain of the rectifier stage must be reduced to maintain accurate calibration.

COMPONENTS

The only components that are required to be of any appreciable accuracy or stability are the range resistors R8 to R11. If possible these should be 1 per cent types, otherwise 5 per cent types can be used if they are "hand-picked" with an accurate ohmmeter.

The integrated circuits are all 741s. Although it was initially suspected that bandwidth/slew rate limitations would prohibit their use this was not found to be the case in practice, and high accuracy was maintained throughout all ranges. This obviously keeps the price down and maintains appeal to the economy-minded constructor.

Resistors mounted on the Veroboard have to be small if they are to be mounted horizontally. There is no reason why slightly larger resistors should not be used provided they are end-mounted.



STABILISATION -

The thermistor specified is the popular R53 type. When used in Wien bridge oscillators of conventional design these have the property of stabilising the output at a little less than 1V r.m.s. This was found to be rather low for this application and hence a potential divider has been inserted between the output of the 741 and the thermistor.

This causes the thermistor to think that the output level is lower than it is and the circuit stabilises at an output level of around 2V r.m.s. as opposed to the

original 700-800mV.

One of the unfortunate side effects of using some types of thermistors as amplitude stabilising elements is the time required for the output to stabilise after range switching. This is particularly so in this case where a large frequency change is performed. If it is felt that the settling time is too long (it in fact

then be checked to be at approximately at earth potential (this is a good test as it is a quick method of checking all is well throughout the complete circuit). Solder bridging, missing Vero breaks and components not properly soldered in are the sort of faults usually found to be at the root of any problems encountered.

The oscillator section should begin to oscillate within a few seconds of switching on; checking and re-checking once again being necessary if no output is obtained.

Calibration should commence with the rectifier gain potentiometer VR3 being set to minimum gain (slider nearest to D2 cathode). The two operating frequencies 20Hz and 20kHz should then be set as accurately as possible with a scope. If one is not available then VR1 and VR2 should be adjusted to their mid-positions.

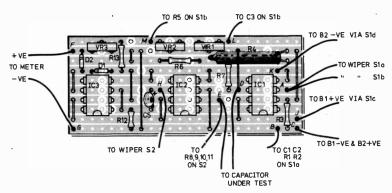


Fig. 3. Component layout and board-cutting details

amounts to about 3 or 4 seconds) an alternative f.e.t. stabilised arrangement can be substituted (see "Modifications").

CONSTRUCTION

A certain amount of dexterity is required in the construction of the Veroboard as space is very much at a premium. If the specified components are used no great problems should be encountered, and the unit can easily be built on the free board provided.

Construction should commence by cutting the breaks on the Veroboard with either a proper Vero spot-face cutter or a drill of correct size. Components should then be soldered in with care to avoid bridging of parallel tracks. Wire links can be made from stripping ordinary single cored connecting wire or using greater than 22 s.w.g. tinned copper wire from other sources.

C1, R1, C2, R2 and R5-9 are mounted on their respective switches to lessen the number of components on the Veroboard. Obviously, if a larger piece of board is available they can be mounted adjacent to the other components.

CALIBRATION AND TESTING

Firstly, it is worthwhile mentioning that initial setting up and testing of the device is made easier by having an oscilloscope at hand.

As a precautionary measure the current supplied to the unit should be measured when the unit is first tested. This should be in the region of 5-10mA using 9V supplies. The outputs of the 741s (pin 6) should

COMPONENTS

Resistors R1 6.8kΩ 1kΩ 1% R10 10kΩ 1% R2 $18k\Omega$ R3 220Ω R11 100kΩ 1% RA53 bead type thermistor (R.S. Com-R4 ponents-access via Doram) R5 $10k\Omega$ R12 $100k\Omega$ R6 390Ω R13 10k Ω *R14 330 Ω (270 Ω – 1k Ω , see text) R7 100Ω 100Ω 1% *R15 100kΩ All resistors 10 W 5% unless otherwise specified Capacitors C1, 3 1nF plastic or ceramic C2, 4 0.47μF plastic or ceramic (pref. type C280) C5 2·2μF tantalum 10V *C6 2.2µF elect, 10V **Potentiometers** VR1-3 $10k\Omega$ min. vertical

Semiconductors

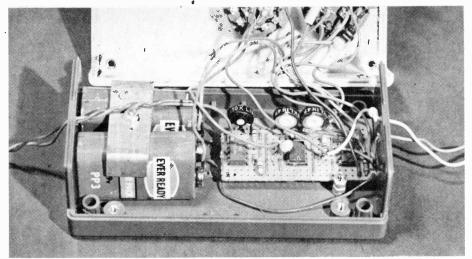
D1-3 1N4148 *D4 1N4148

*TR1 2N3819 IC1-3 741

Miscellaneous

R.S. Components "midget" wafer switches, 3-pole 4-way, and 4-pole 3-way. Case: Vero plastic box 120 imes 65 imes 40mm code no. 65-2518. Knobs and hardware, crocodile clips, two PP3 **batteries**

 Components marked with an asterisk required for optional modification only—see text



Internal layout of the add-on unit. The batteries are held in place with an aluminium bracket and a 30mm CSK 6BA bolt. There is enough room either side of the free board to allow it to be held in place with the 6BA bolt/nut arrangement as shown

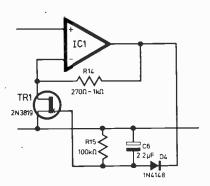


Fig. 4. Alternative f.e.t. stabilising network around oscillator section

PRECISION CAPACITORS

At some stage in the calibration procedure it is necessary to refer to either one, or (preferably), a range of accurate capacitors. These can often be found on ex-equipment circuit boards which are generally on sale at many electronics stores. An ideal range would contain such values as 10pF, 100pF, 1nF, $1\mu F$, $10\mu F$, all within 20 per cent tolerance. Obviously it may prove difficult for some constructors to obtain such capacitors, in which case less accurate ones will have to be resorted to. The majority of the above mentioned capacitors are in fact used for checking and it is possible to calibrate the capacitance unit successfully with only one 10,000pF, exploiting the fact that two ranges overlap (10,000pF and 10nF). It may therefore be considered worthwhile to invest in one precision 10,000pF capacitor and use standard types for spot checks throughout the other ranges.

Set the nF/pF switch to nF and check that the oscillator output is about 1.5-2V r.m.s. Set the multiplier switch to ×10. Connect the 10,000pF capacitor to the test leads and the "meter output" to

an appropriately adjusted multimeter (a low voltage d.c. range with an f.s.d. between 1 and 3V). The capacitance unit is designed to give 1V output for "full-scale" reading on each range; hence, if a 1V range is available this would do best.

The rectifier gain control should now be increased with VR3, and if all is well it should be possible to adjust the output level such that the meter is reading 1V. The nF/pF switch should now be set to the pF position and the multiplier switch to 10,000 (corresponding to 10,000pF f.s.d.). The meter should read in the region of 1V and any discrepancy adjusted out with the 20kHz trimmer VR1.

If this cannot be done, and no scope was initially available to set the two operating frequencies reasonably accurately, VR1 should be adjusted to give as near 1V output as possible and VR3 then used to set it exactly. In doing this the nF range will be misaligned, and therefore, with the 10,000pF capacitor still connected, and the range and multiplier switches once again set to read 10nF, VR2 should be used to adjust the output to read 1V once more. It is a question of juggling with the three calibration potentiometers (VR1-3) as outlined above until the unit is satisfactorily calibrated, although it is worth stressing that an oscilloscope can save quite a lot of time in this process.

MODIFICATIONS

Earlier it was mentioned that the response time of the thermistor was rather long and that it could be reduced by inserting an f.e.t. stabilising arrangement in place of it. The modified section is shown in Fig. 4. The output of the oscillator is rectified and then used to bias the gate of an n-channel f.e.t. If the output level reduces the f.e.t. is turned on which increases the gain of the amplifier and stabilises the level. In practice the value of the feedback resistor R14 is a little critical; if it is too large the output level will not be held stable, and if too small, no output will result. A value of between 270 Ω and $1k\Omega$ was found to be suitable.



Some time ago we were asked to design and construct an inexpensive unit to enable a blind man to steer a yacht on a straight course. The design, which is a direct result of that request, is fully described in this article.

fully described in this article.

In addition to being of immense help to blind sailors, the design will also assist those sailors who use wind vane steering, as it can provide an off course alarm, and also power boat enthusiasts, as it can be used to steer a straight course without the need to look away from the water ahead. It could also prove very useful on a long passage where a compass course must be sailed, particularly at night, as it allows the use of ears rather than eyes, which can become tired.

The audible output from the unit is provided through a crystal earpiece and can be a high frequency, no output or a low frequency. The no output indicates that the yacht is on course and the high or low frequency that the yacht has gone off course in one direction or the other. The width of the no output (or dead) band can be varied from about 5 degrees (2.5 degrees off course on either side) up to about 50 degrees (25 degrees off course either side) this is to suit the conditions and the response of the boat/helmsman and is adjusted by the helmsman with a sensitivity control.

In use the boat is put on course, the compass is revolved until the unit gives no output at maximum sensitivity and the helmsman then steers to keep no output, adjusting the volume and sensitivity to suit himself. When used as an on off course alarm a relay switches on a loud alarm to indicate that the boat has gone off course by more than the amount previously set.

CIRCUIT OPERATION

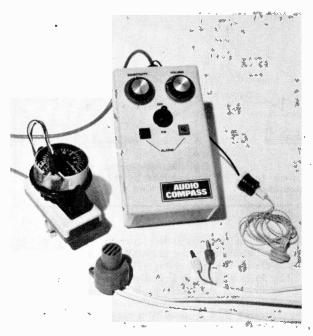
Two Hall effect probes are mounted on a suitable compass to detect the position of the magnet inside that compass. The Hall effect probes (H1 and H2) are fed with a constant voltage by TR1 (Fig. 1), the voltage being derived from the forward voltage drop of D1 and D2 in series (about 14V). The output from each probe is fed to an input of the 741 op. amp. IC1, one to the inverting input and one to the non-inverting input. Provided both inputs are at the same level the output at pin 6 will be zero (comparator arrangement) this can be corrected by adjustment of the offset control VR1.

If the pole of the compass magnet is between the two probes the output from them will be similar. If the pole moves towards one probe the output from that probe will increase (see section on Hall effect later) and from the other decrease—this will cause the output of IC1 at pin 6 to rise or fall at a rate dependent on the setting of the sensitivity control VR2 (this provides a variable degree of negative

feedback to IC1).

The output from pin 6 is fed directly to the bases of TR2 and TR3 which act simply as switches to prevent the relays from loading the output of IC1. If the output goes high, TR2 is turned on, thus connecting the two relays across the 0V and +9V lines. Relay RLA will be turned on, thus connecting the supply to the unijunction oscillator formed by TR4 and its associated components and producing an audible output in the crystal earpiece connected to SK1. Relay RLB will not turn on due to the presence of D3.

If however the output at pin 6 goes low TR3 will be turned on thus operating RLA and RLB, this



The complete Audio Compass also showing the audible warning device used as the off course alarm

not only connects the oscillator but also shorts out R5, thus greatly increasing the frequency of the oscillator and hence of the output at SK1. The audible note thus indicates towards which probe the compass magnetic pole has moved.

The sockets SK2 and SK3 across RLA1 may be used to trigger an audible alarm, powered by the yacht's or other supply, to give an audible off course alarm. This facility can be set to trigger from about 2.5 degrees off, to about 2.5 degrees off by means of VR2 but does not indicate which way off course the yacht has gone (more about this later), and when in operation prevents the use of the normal audible output. The facility is added for those who use some form of wind vane self steering. It will provide an audible alarm if the yacht has been steered off its original course by the preset amount. The alarm recommended is the RS type audible warning device 12V or 24V, as required.

COMPONENT NOTES

One or two further points concerning the circuit operation should be made clear before we proceed, these concern the components used and their siting in the unit. It was found necessary to provide a stabilised supply for the two probes as their output varies considerably with the current flowing through them. The simple supply formed by TR1, R1, D1

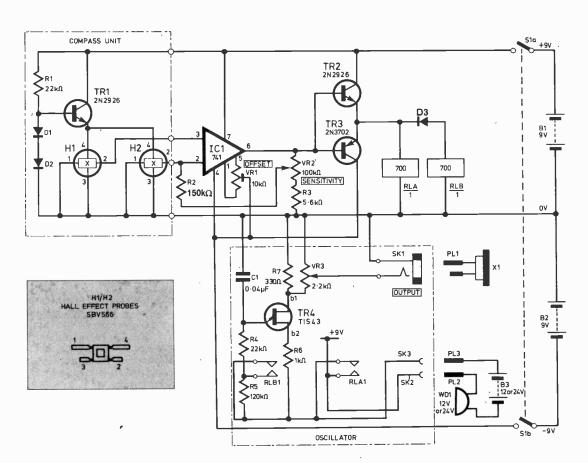


Fig. 1. The complete circuit diagram of the Audio Compass

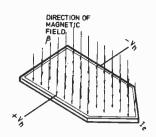


Fig. 2. Generation of Hall voltage

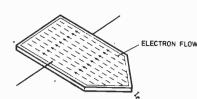


Fig. 3a. Electron flow in a conductor or semiconductor

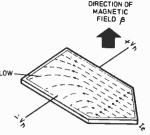


Fig. 3b. Distorted electron flow caused by the magnetic field indicated

and D2 was found to be perfectly adequate, provided internal cells are used and the unit is not connected to the boats supply. The components forming this stabiliser are sited as near the two probes as possible in order to negate any lead resistance which may prove troublesome.

The values of resistors R2 and R3 set the limits to the sensitivity of the unit and those shown were found to be most suitable. Reduction of R3 will decrease the minimum dead band, but if this is taken too far the unit will be difficult to set up and it would become impossible to keep within the dead band when in use.

Similarly, reduction of R2 will increase the dead band, but if this is taken too far, the limits of the sensing probes will be reached and either no output will result or only one note may sound. Experimentation with these values, either up or down, will not harm the unit and some constructors may find it helpful to do this. It is not recommended that preset resistors are permanently employed as their value could easily be altered with a knock.

It should be fairly obvious from the circuit description above that relay RLB must operate at the same instant or preferably before RLA. If this is not the case the output will always start at a low frequency and then go high if the voltage at TR2/TR3 emitters goes low.

To prevent this, the working voltage of both relays must be checked and that which operates at the lowest voltage used for RLB; the operating voltage will probably be around 3V. For this same reason a germanium diode must be used for D3 since the voltage drop across this will only be about 0.2V, instead of 0.7V for a silicon diode.

The two diodes used in the stabiliser circuit must be silicon diodes and are used to provide a "Zener" voltage of about 1.4V.

HALL EFFECT

The Hall Effect was discovered by E. H. Hall about 90 years ago and the principle involved accounts for the deflection of cathode ray beams in magnetically deflected tubes, so it has been employed for some considerable time, although many readers may not be aware of it.

Basically the effect causes a voltage (the Hall voltage) to be set up in a conductor or semiconductor in the presence of a magnetic field when an excitation current flows through the conductor or semiconductor. The effect is illustrated by Fig. 2. The

current I_e is the excitation current flowing in the material which is in the presence of a magnetic field β this causes the Hall voltage V_h to be set up.

The Hall voltage is actually caused by the effect of the field on the electrons flowing in the conductor. The electron flow is illustrated in Fig. 3a and the distorted flow caused by a magnetic field in Fig. 3b.

The electrons tend to build up along the edge of the conductor and, since they are negatively charged give rise to the Hall voltage as indicated. The maximum Hall voltage is limited because the abundance of negatively charged electrons tends to repel further electronis (like charges repel), hence a state of equilibrium is reached when the magnetic force equals the repulsion of further electrons. This state is reached in much less than a microsecond and the Hall voltage will therefore quickly follow any variations in magnetic field. If the excitation current is varied, a greater number of electrons are introduced and hence $V_{\rm h}$ increases.

It is thus easy to see why V_h is directly proportional to both I_e and β .

PRACTICAL CONSIDERATION

In the application described the Hall voltage is minute since the field around the compass magnet is also very small. In addition to this an offset voltage is set up in the device which causes a continuous voltage of about 1.5V per ampere (excitation current) to appear in addition to the Hall voltage. This offset voltage can be greatly reduced by the design and material of the probe—of the order of 2mV or less per ampere—but such probes are expensive (about £30 each—as opposed to about £1 each for those used).

The effect of the offset voltage is taken care of in the circuit of Fig. 1 by using the 741 a comparator so that it only senses the difference in the input voltage and not its level. Since two similar probes are used the offset voltage on each will be similar and any slight variations can be cancelled by the offset control VR1 (a multiturn preset) which varies the bias on the two input circuits of IC1.

We have shown that variations in the excitation current will provide variations in the Hall voltage. To provide stability both probes are fed by the stabiliser. Although this does not hold the current through each probe constant it has been found to be perfectly adequate since the probes are similar and therefore have a similar resistance/temperature

characteristic. They are also mounted relatively close to each other.

The current through each probe has been set to about 15mA to provide enough sensitivity, consistent with reasonable battery life when using a PP9 battery. This current could, if required, be increased—by increasing the Zener voltage set by D1-D2—up to a maximum of 75mA for each device. If this maximum is approached, steps must be taken to ensure that no one probe is exceeding that current.

HOUSING

The construction of the unit has been kept as simple and straightforward as possible. It was decided that to be of use to the blind yachtsman it

COMPONENTS . . .

Resistors

 R1
 22kΩ R4
 22kΩ

 R2
 150kΩ R5
 120kΩ

 R3
 5.6kΩ R6
 1kΩ

All ±10% ¼W carbon

Capacitor

C1 0·039μF

Potentiometers

 $\begin{array}{lll} \text{VR1} & 10 k\Omega \text{ multiturn preset} \\ \text{VR2} & 100 k\Omega \text{ lin. carbon} \\ \text{VR3} & 2 \cdot 2 k\Omega \text{ log carbon} \\ \end{array}$

Semiconductors

H1, H2 SBV 566 Hall effect probes (2 off—Electrovalue)

D1, 2 any small silicon diodes (2 off)
D3 any small germanium diode

TR1, 2 2N2926 TR3 2N3702 TR4 TIS43 IC1 741 op amp

Miscellaneous

RLA1, 2 6-9V d.c. 700 coil reed relay (348-970 Doram 2 off)

SK1 Line jack socket and plug (PL1) to suit X1 SK2, 3 Plastic encapsulated banana sockets and plugs (PL2, 3) to suit (2 off each)

S1 D.p.d.t. switch with thread to match dolly cover—see miscellaneous

B1 PP9 9V battery and clips B2 PP3 9V battery and clips

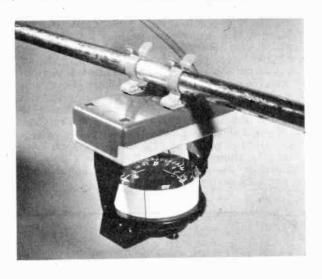
X1 Crystal earpiece with plug and lead at least 1 metre long.

WD1 Audible warning device 12V or 24V as required (Doram). Only required for off course alarm function.

Cases 188 × 110 × 60mm and 100 × 50 × 25mm Vero or Bocon (West Hyde Developments) plastic boxes with interlocking lid; cable gland ENCGQ (West Hyde Developments); plastic dolly cover for S1 (WS234 Home Radio Components); knobs pointer (2 off—see text); Veroboard 0·1in matrix approx. 100 × 100mm; connecting wire; 4B.A. fixings; 4 way cable at least 2 metres (see text); three suction pads, two terry clips for 25mm diameter tube (stern pulpit).

Compass

Sestrel Junior dingy compass with gimbålled mount (see text).



One way of mounting the compass unit on the rail. It could also be inverted so that the compass is more easily accessable

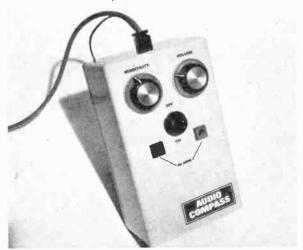
would not only need to be portable but also easily able to be fixed and used on any yacht, as few blind people own their own boats.

It is necessary to mount the compass where it can be adjusted to set the course and where it is free from knocks. To this end the compass unit has been equipped with two Terry clips so that it can be fitted to the stern pulpit of most yachts.

Similarly, the control unit which measures about 190 × 110 × 65mm is fitted with rubber suction pads so that it can be attached to any smooth flat surface near the helmsman. The two units are linked by a single four-way lead. This lead must be long enough to cover most situations (about 2 metres).

The control unit carries the batteries and has an output for the earpiece as well as sockets for an audible alarm. Both boxes carrying circuitry should be fairly splash proof and all metal work must be able to stand up to salt water type environment.

The control box of the Audio Compass, this is fitted with three suction pads for mounting purposes



Obviously if the unit is to be used only on one craft or if it is to be used only as an off course alarm, it could be permanently fixed and in the latter case could be completely housed below deck. The off course alarm only application allows certain sections of the circuitry to be omitted, more about this later, however, since the cost of these sections is relatively low we would advise the constructor to build the complete unit so that the audio compass can be used should the need arise. This also means that the owner would be able to offer a blind crew a useful position and, from the author's own experience, this could prove to be valuable and interesting for both parties.

CONSTRUCTION

Construction of the two units is shown in Figs. 4 and 5. There are no special precautions other than saying it is probably safer to use a holder for IC1. This is useful when changing i.e.s as we have found that there are a number of duff ones about. It is also necessary to take the usual precautions when soldering D3, since this is a germanium device and thus easily damaged by excess heat.

The output socket for the crystal earpiece is mounted on a 300mm length of twin-cable which passes out of the case through the cable gland. This adds extra length to the lead and allows the box to remain sealed (it is difficult to get a sealed jack

CONTROL UNIT

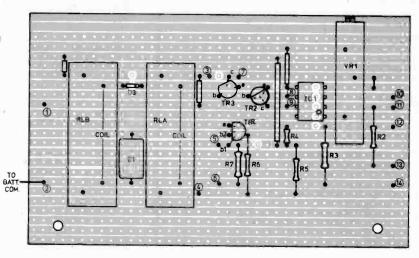
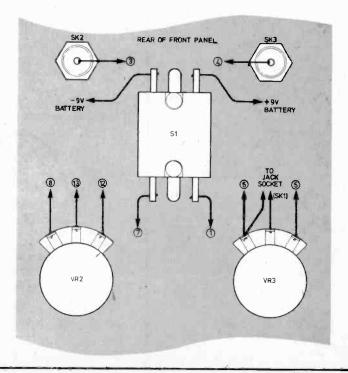


Fig. 4. Construction and wiring of the control unit. Veroboard layout is shown above with connecting points indicated by numbers which tie up with the lower diagram and Figs. 5 and 6



socket). The socket can be a "line" type or can be mounted in any suitable small container and may be easily changed if it becomes badly corroded.

The fitting and wiring of the two probes is shown in Fig. 6. These probes are very small and must be handled and soldered with great care in order not to damage the leads. They do not seem to be particularly heat sensitive but excess heat should be avoided. The probes are eventually covered with Araldite to protect them and fitted—square marked side inwards—against the plastic ring which is fitted over the compass, in line vertically with the magnet.

Construction of the compass unit is shown in Fig. 6. The materials used should be plastic or brass as

indicated, because these are non magnetic and corrosion resistant. The revolving ring is made of Contiboard white iron-on edging which is used glue side inwards with the ends overlapped and "ironed" together to form a ring.

INITIAL TESTING

Before testing the unit the supply current on the positive line should be checked to ensure the probes are not consuming too much current. Supply current should be about 30 to 50mA (depending on the output of IC1) and definitely not more than 60mA. If all is in order the unit can be tested for correct operation.

COMPASS UNIT

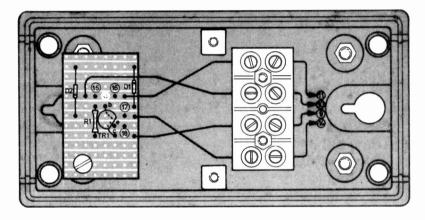


Fig. 5. Layout and wiring of the compass unit. The lead outlets can be sealed with silicon compound

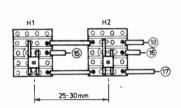
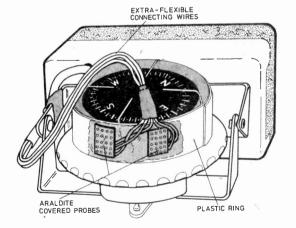


Fig. 6. Fitting and wiring of the two Hall effect probes. Basic arrangement of the compass unit is also shown, the wires to the probes should be extra-flexible to allow the compass to swing freely



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* Complete-right down to strap and batteries.

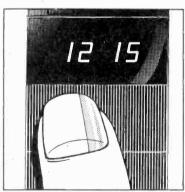
*Guaranteed. A correctlyassembled watch is guaranteed for a year. It works as soon as you put the batteries in. On a built watch we guarantee an accuracy within a second a day-but building it yourself you may be able to adjust the trimmer to achieve an accuracy within a second a week. The Black Watch by Sinclair is unique.
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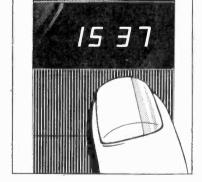
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- c) decoder circuits
- d) display inhibit circuits
- e) display driving circuits.

...and how it works

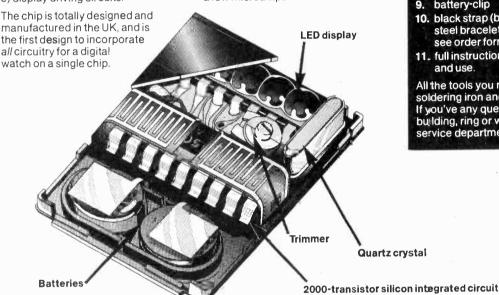
A crystal-controlled reference is used to drive a chain of 15 binary dividers which reduce the frequency from 32.768 Hz to 1 Hz. This accurate signal is then counted into units of seconds, minutes, and hours, and on request the stored information is processed by the decoders and display drivers to feed the four 7-segment LED displays. When the display is not in operation, special power-saving circuits on the chip reduce current consumption to only a few microamps.

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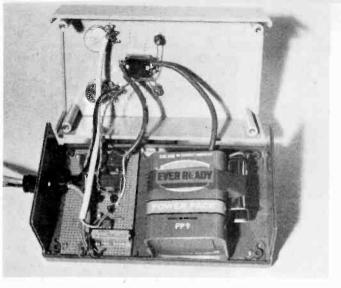
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To: Sinclair Radionics Ltd, FREEPOST, St Ives, Huntingdon, Cambs., PE17 4BR.



Internal view of the control box showing general layout. Foam rubber can be used to hold the batteries in place

To do this switch on and, with the sensitivity control turned fully up and the probes away from the compass, adjust the offset control VRI until no output results or until the output frequency is just on the point of changing. Next introduce a metal screwdriver between the two probes and move it between the probes. The magnetism usually contained in the screwdriver should be enough to cause the two output signals to be produced, depending on which probe is approached.

If the unit does not function correctly the output of the i.c. can be checked, it should vary from +7 to -7 volts with variation of magnetic field at the probes. Once this is established a similar voltage should appear at the emitters of TR2 and TR3 and this should cause RLA and RLB to operate. Check this by measuring the resistance across RLA1 and RLB1. If all is well but no output results the fault must be in the unijunction oscillator, check the wiring and test for faulty components.

Voltages on IC1 pins 2 and 3—the Hall voltage

Construction of the compass unit. Use of a connecting block allows the two units to be separated



plus offset—should be about 0.3V and it may be possible to see slight variation of this on a high impedance voltmeter (20,0002/V plus) if one pole of a magnet is brought close to the relevant probe.

ALARM ONLY

Should it be decided to construct only an off course alarm the unijunction oscillator, relay RLB and D3 may be omitted. The contacts of RLA1 then go only to SK2 and SK3 and are wired to the alarm and external supply as shown in Fig. 1.

The omission of these parts will save very little current and make little difference to the duration of the battery supply. With the above omissions the alarm will sound whichever way off course the craft has gone and thus no indication of direction is provided. If direction indication is deemed necessary for the alarm function, two different alarms should be employed e.g. that specified and a bell. The second alarm being wired to RLB1—which, together with D3 must be retained—in the same way as indicated for WD1 and RLA1. In addition to this a second germanium diode must be inserted in series with RLA, in the opposite polarity to D3. Thus when the output voltage of TR2/3 goes positive RLA will operate and when negative RLB will operate.

If as suggested earlier, the complete unit is constructed although only to be used as an alarm, the output earpiece can be left disconnected while in use—this will not affect operation of the unit or do any harm.

FINAL ASSEMBLY

The compass is gimballed in one direction only to take care of the heel of the craft, the floating card and magnet can move to overcome any pitching. The probes must be covered in Araldite and fixed to the ring on the compass housing in line with the magnet. A course setting line can be drawn between the probes.

It has been found that Araldite will not produce a good bond on the plastic ring and this is all to the good as it means that the probes and their Araldite

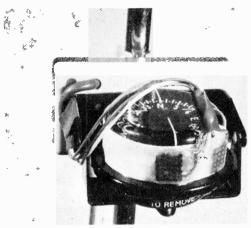
covering may be prised off if necessary.

The possibility of using compasses other than that specified can be investigated simply by affixing the probes in the most suitable position (as near to, and on the same plane as the magnet) with insulation tape and trying the unit. The compass should be of good enough quality to function correctly without violent swings when in use.

Once in place the probes and their wiring can be protected by a couple of layers of plastic insulation tape. It must be noted that the ring should not be continually rotated on one direction as this will eventually break the leads. If this is thought to be a problem a stop should be fitted to the rotating section to prevent it going past 360 degrees.

When complete the unit can be set up by arranging the compass so that the north pole lines up with the line between the probes. Preset VR1 should then be adjusted with VR2 at maximum sensitivity, until no output results or the frequency just changes. The unit is then ready for use.

The complete unit is intended to be reasonably water resistant and to this end a cable gland is used where the wires enter the main case. Also a flexible plastic dolly cover is used to protect S1 from the influx of water.



Another method of mounting the compass unit. It should be remembered that the gimbal takes care of yacht heel

The simplest method of sealing the two potentiometers is to employ knobs with a fairly large diameter and flat underside. Two cut-down babies' teats are then glued to the case so that when the knobs are fitted they push down on the rubber ring forming a reasonable seal. The teats can be easily and cheaply replaced when worn.

The cable entries to the compass unit can be sealed with silicon bath sealing compound and this could also be used around the joint on the smaller case once final testing is complete. The larger case must be easily taken apart to facilitate battery charging.

IN USE

Due to the design of the unit similar output notes and dead band are produced with respect to both the north and south poles of the compass. This is not a problem once the boat is on course but should none the less be noted.

The off course signal will continue to sound, should a correction not be made, until the craft has passed through 180 degrees. Because of this action it is always best to set the probes to sense one pole,

say north, as this then provides a standard output with variation in course, e.g. if going off course in an easterly direction a high note would sound if in a westerly direction a low note. Should the other pole be sensed, these notes would reverse.

Due to the fact that the compass specified cannot be corrected and that its environment will change, it should not be used as an accurate course indicator. It is better to put the craft on the correct heading and set the audible compass (at maximum sensitivity) to suit. It is possible to make up a normal deviation chart for the compass, if it is mounted in a fixed position, to enable accurate setting should this be required.

The prototype compass has been successfully tested in various yachts and it has been found that in most sea conditions the movement of the craft gives rise to bleeps from the unit before a continuous note sounds, these bleeps gradually increasing in length as the craft goes off course until a continuous note sounds. This provides a good indication of the rate of change of heading, of how far off course one has gone, and therefore of the amount of correction required. This also provides good indication when coming back on course, since the reverse then happens with the bleeps getting shorter until silence prevails.

A similar output will result when an off course alarm is employed—if the first few bleeps do not arouse the crew the continuous note soon would.

COST

The complete unit can be constructed for approximately £20, about half of this being the cost of the compass specified. The audible alarm, if required, will add approximately £1.50 to the overall cost. Please note that the above prices are only estimates and do not include V.A.T.

ACKNOWLEDGEMENT

The author wishes to thank Des Sleightholme, editor of Yachting Monthly, who put forward the original idea, for his assistance in testing the unit and Jeff Bull who acted as a "guinea pig" and provided valuable criticism from the blind helmsman's point of view.

A happy man. The Audio Compass allows Jeff Bull, who is totally blind, to take full control of the helm without any directional assistance from other crew members



SEMICONDUCTOR IPONTE By R.W. COLES

A8400 S1-1020G FX205 S1-1030G S1-1010G, S1-1050G,

V-F-V BREAKTHROUGH

There has been available for a number of years, an extremely useful and versatile class of circuit modules known as V to F's or F to V's, to those professional engineers fortunate enough to be able to justify their expense. Yes, you guessed it, the reason why V to F's and F to V's have not been seen in these pages before is because they have been much too expensive for amateur use. I am very pleased to report that this situation has now changed with the introduction by Teknis Electronics of a monolithic V-F-V which knocks spots off the expensive hand-made modules on the grounds of cost, size and performance!

The abbreviation V to F stands for "voltage-to-frequency" and F to V stands for "frequency to voltage" and the new device from Teknis, the A8400, will do both, unlike some of its more expensive predecessors which were often just single-function

devices.

The usefulness of a device which can convert a d.c. input voltage into a directly related output frequency of between 0 and 100kHz, and vice versa, is really quite mind boggling. Fancy turning your frequency counter into a digital voltmeter with 0.05 per cent linearity and 5 digit resolution? Just hook up an A8400 as a V to F and feed the output into your counter and you've done it—just like that ...

Or, do you want to record slowly changing d.c. signals on a tape recorder with simple replay? Use an A8400 connected as a V to F to turn those d.c. signals into audio tones, then replay them later through an A8400 connected as an F to V—it's that easy. The possible applications go on and on, and are limited only by your imagination, the availability of a cheap monolithic device brings to amateurs the advantages enjoyed by instrumentation engineers for years.

The A8400 does cost rather more than a 741, in fact about £12 in small quantities, but this is about a third of the cost of its nearest rival, and a bargain in my book!

PSEUDO-SINE

Consumer Microcircuits Ltd. are a British firm who make a very useful range of m.o.s. integrated circuits intended for use in audio-tone signalling and control system applications. Their range already includes tone transceivers, frequency sensitive switches and tone triggered timers, and has recently been extended with a fascinating little device known as the FX205 sinewave oscillator. As expected the FX205 is as unique as the other circuits in the Consumer Microcircuits range, and could well be useful for use in a wide range of amateur projects, from radio control systems to intercoms.

The FX205 génerates a stable audio tone of between 25Hz and 5kHz using only a single external resistor and capacitor, the output signal being of a "pseudo-sinewave" shape generated entirely by the digital circuitry of the chip. Internal circuitry includes an astable oscillator, a monostable, a digital to analogue converter and a four bit binary counter.

In operation the astable is timed by the external RC network and the resulting output is divided down by the counter, the outputs of which drive the D to A converter which is weighted so as to produce the "pseudo-sine" output signal which is sufficiently pure for use as a signalling tone. The internal monostable can be used, if desired, to produce "tone bursts" up to ten seconds in length under the control of an external trigger signal, which could be just a push switch closure.

Á "tone enable" input is also provided for use when gated operation is required, and the option is available of using an external synchronising signal instead of the internal oscillator. Where multiple-tone signals are required, the outputs of several FX205s can be "WIRE-OR'd" together.

Fig. 1. A8400 as a V to F converter

PAINLESS POWER

Monolithic audio power amplifiers are limited in power dissipation due to chip size constraints, so if you want to make those woofers throb with a bit more than the paltry 10 watts afforded by even the sturdiest monolithic devices, you'll have to either use a discrete design or go in for a pre-packaged hybrid.

A new series of hybrid amplifiers with output powers of 10, 20, 30 and 50 watts is now available from Rastra Electronics Ltd., and you may find that one of these is more cost-effective than a conventional discrete design, especially if you are suffering from the dreaded "wiring-up-itis" (wiring-up-itis, has of course been known to make expensive woofers disappear up their own infinite baffles, to make 2N3055's glow like

beam tetrodes, and make grown men cry!)

The new hybrids from Rastra the S1-1010G, S1-1020G, S1-1030G and S1-1050G are made in Japan by Sanken and are complete power amplifiers suitable for Hi-Fi, musical instruments and public address applications. The output stage is a quasi-complementary class B type using passivated power transistors with good "second-breakdown" resistance, and built-in current limiting on the S1-1030G and S1-1050G. The performance specification seems quite good, for the S1-1050G for example, full power bandwidth is from 20Hz to 20kHz while delivering 20V r.m.s. to an 8 ohm load with a 66 volt supply. Full power t.h.d. is 0.5 per cent maximum, and the signal to noise ratio is typically 90dB.

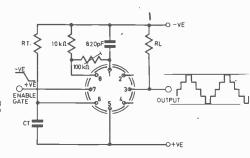


Fig. 2. FX205 as a tone-burst generator. The burst length is determined by $R_{\rm T}$ and $C_{\rm T}$

NEXT MONTH!

OUT AND ABOUT with PE



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Incorporating a 9-channel control unit for use with all types of models, this system features 7 channels with full proportional control and 2 channels which provide basic "on-off" control. The system operates on a time-division multiplex principle, and compares very favourably with the more expensive commercial units on the market at the moment

PLUS

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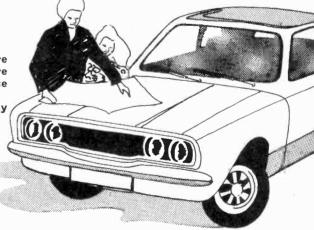
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ELECTRONICS

Our June issue will be published on Friday, May 14, 1976

PLEASE NOTE:

It is in your interest to place a firm order with your newsagent—in advance. Back numbers are not available, so make sure of your copy now!

Simple EUMPUTER VUIE

By E.A. PARR B.Sc.

ORIGINALLY intended to generate a computer sounding voice for an amateur dramatic society, this device can be used to make "Dalek" type voices, and as such can provide hours of entertainment for children.

The circuit is simple, easy to set up, uses little current, can be battery operated, and is suitable for fitting into a child's space suit or Dałek outfit, as well as its original application.

The output level is 500mV, hence it is compatible with both the AUX input on most amplifiers (for stage use) and the many available i.c. power amplifiers for battery operation in a child's toy.

CIRCUIT DESCRIPTION

The usual way of producing a mechanical voice is by synthesiser techniques such as ring modulation. An oscillator giving a sine wave output is used to amplitude modulate the audio signal.

A circuit similar to this was tried, but whilst it worked and gave good results, it was somewhat tricky to set up, and there were doubts about its long term stability.

VOICE' INPUT

MODULATION INPUT

Fig. 1. Voice input before and after modulation

The final circuit behaves in a similar way to a conventional amplitude modulator, but the modulating waveform is a square wave (Fig. 1).

The circuit diagram of the final circuit is shown in Fig. 2. IC1 is a 741 operational amplifier arranged as an inverting amplifier. The circuit is designed for a single power supply, hence R3, R4 provide a mid rail voltage at their junction. The gain of the amplifier is determined by the ratio R5/R2. The microphone used has an output of 15mV so the gain is set to 30 to give the required 500mV output.

COMPONENTS . . .

Resistors R1 $10k\Omega$ (100k Ω for high output microphone) R2 $1k\Omega$ (39k Ω for high output microphone) R3 R4 1kΩ R5 39k Ω R₆ 1kΩ R7 100kΩ R8 22kΩ All resistors 10% ‡W carbon **Potentiometers** VR1 50kΩ lin. VR2 50kΩ lin. VR3 500kΩ lin. All horiz, min. presets Capacitors 0·1μF plastic or ceramic C1 C2 25μF 16V elect. 1μF 16V elect. C4 0-1µF plastic or ceramic Integrated circuits, diodes IC1 IC2 555 D1 general purpose silicon diode (1N914, 1N4148, etc.) Relay RLA R.S. Components (access through Doram) type: D.I.L. reed relay, Form A (for 6-12V

Veroboard $2\frac{1}{2}$ in \times 3in (65mm \times 80mm), case and

hardware to suit

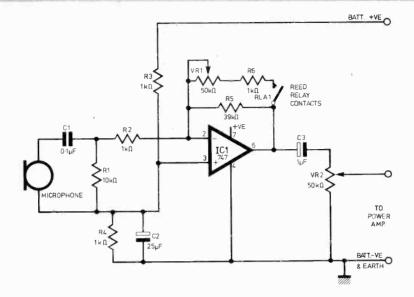


Fig. 2. Circuit diagram of the modulator

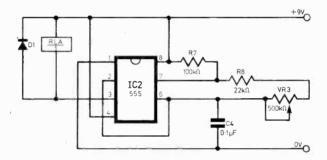


Fig. 3. Details of the modulation oscillator

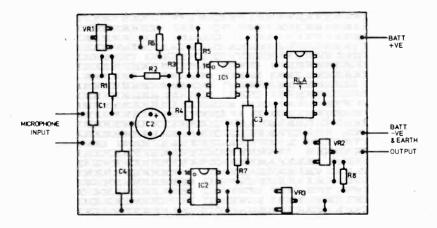


Fig. 4. Component layout and Vero cutting details

When relay RLA1 contact closes, the gain is reduced and is given by the ratio (VR1 + R6) in parallel with R5)/R2.

RV1 therefore controls the "depth" of the modulation and thus the amount of distortion.

MICROPHONE

The moving coil microphone used was somewhat bassy, so capacitor Cl was included to give a certain amount of bass cut. As the gain of the amplifier is determined by negative feedback, it is very easy to add shaping should such features as bandpass filtering be required.

If a ceramic or other high output microphone is used, resistors R1 and R2 should be increased in value to reduce the gain of the amplifier.

CONSTRUCTIONAL DETAILS

The circuit is constructed on 0.1 in Veroboard, and layout and track cutting diagrams are given in Figs. 3 and 4. These are straightforward and should present no problems.

Trim pots are used on the circuit although there is no reason why the pots should not be mounted remotely.

To sum up: VR1 controls the depth of the distortion, VR2 the volume, VR3 the rate of distortion. In theory VR1 should affect the volume, but in practice at the levels of distortion necessary, the effect is not unduly noticeable.

MODULATION OSCILLATOR

The relay is "buzzed" by an oscillator (shown in Fig. 3) constructed from the ubiquitous 555 timer. The frequency of oscillation is controlled by R7, R8, C4 and VR3.

VR3 controls the "rate" of the modulation. The relay can be driven up to 250Hz but it was found that the best results were given in the range 20-60Hz.

Diode D1 clips any inductive spikes generated as the relay coil de-energises. This is included in the reed relay used in the prototype.

It might be thought that the life of the relay would be very short being maltreated in this manner, but as the relay used (and most reeds) have a mechanical life in excess of 10 million operations the author did not feel this posed any problem.

Contact life is not so easy to assess as it is determined by two conflicting factors. A large switched current causes contact burn, conversely a small arc helps to clean oxidation off the contacts. The current being switched in this circuit is infinitesimal, so the contact life will be determined by the dirt on the contacts. It is impossible to say when failure will occur, but the prototype has been working for several months without showing any signs of iminent death.

The supply can be anywhere in the range 6 to 15 volts (with suitable choice of reed relay). The prototype was built for 9 volts operation.

With a 9 volt supply, the current consumption is about 12mA.

CMOS DIGITAL I.C.s

continued from page 389

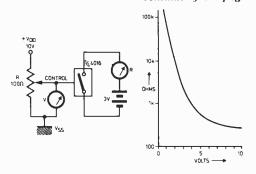


Fig. 5.16. The bilateral switch as a voltage-controlled variable resistor. The curve shows the variation in resistance with control voltage. The measuring arrangement is also shown.

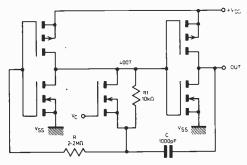


Fig. 5.17. Voltage-controlled oscillator. The voltage $V_{\mathbb{C}}$ determines the frequency, and with a 10V supply a range of between 10 and 15kHz is obtained with the values shown

VOLTAGE CONTROLLED CIRCUITS

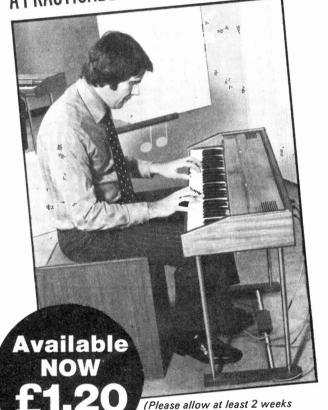
The bilateral switch has so far been considered as an almost perfect switch; its resistance changes from about 300 ohms with the control pin at V_{DD} to several megohms with the control grounded. However, it can also operate as a voltage-controlled variable resistor (VVR) if non logic-level voltages are applied to the control input (Fig. 5.16).

The resistance depends somewhat on the voltage levels at the terminals of the bilateral switch, and this causes slight distortion of the transmitted signal. The voltage at either terminal should not go above $V_{\rm DD}$ or below $V_{\rm SS}$. This simple vvr features extremely good isolation between the control input and the terminals, the resistance being greater than 10¹² ohms, and can be used as the basis for voltage controlled filters, amplifiers and oscillators. A single n-channel device can also act as a vvr, and a similar curve is obtained although the minimum "on" resistance may be as high as 1,000 ohms. A simple vco (voltage controlled oscillator) based on this and built from a single 4007 package (one device is not used) is shown in Fig. 5.17. The paralleled resistance of the n-channel MOSFET and R1 varies between approximately 1,000 ohms with the MOSFET "on", and R1 with MOSFET "off". A range of between 10 and 15kHz is obtained with the values shown for V_c of between 0 and 10 volts.

Next month: Retriggerable monostable and digital low pass filters

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MARKET PLACE

Items mentioned in this feature are usually available from electronic equipment and component retailers advertising in this magazine. However, where a full address is given, enquiries and orders should then be made direct to the firm concerned. All quoted prices are those at the time of going to press.

CASES

To complement their range of Minicases, Olson Electronics have just introduced a new range of robust, sloping front instrument cases.

Ideal for housing many of the constructional projects published in this magazine, particularly test gear, the cases are made from 20g mild steel and the 45 degree sloping front panel from 20g aluminium. The cases are only 95mm high by 95mm deep and supplied in three width sizes: 150mm, 200mm and 250mm. The front panel is 100mm by the required width.

Supplied with four rubber feet they are sprayed in light brown hammer finish and the front panels are finished in light grey semi-gloss enamel.

Full particulars of these excellent cases can be obtained from Olson Electronics Ltd., Factory No. 8, 5-7 Long Street, London, E2 8HJ.

WORK HOLDER

A unit which allows the constructor a free hand when soldering components into small circuit boards is the latest product from Special Product Distributors.

Called the JA500 Reversible Assembly Frame, a small board is clamped in position and a foam pad, in a covering lid, holds the components to be soldered firmly in position which allows the work piece to be turned over for soldering.

The frame will handle circuit boards up to 220mm × 170mm and the overall dimensions of the assembly is 250mm × 280mm.

Further details and price of the Reversible Assembly Frame can be obtained from Special Product Distributors Ltd., 81 Piccadilly, London, WIV, 0HL.

CERAMIC SOUNDERS

There are very many practical applications for audible warning or indicating devices, some of which include paging, systems failure, etc. where the sound output requirement, whilst being less than, say, an intruder alarm, has the composite advantages of reliability and efficiency.

ITT are marketing a range of five piezo ceramic sounders of sound outputs varying below 93dB. The tones available are continuous or pulsed.

Details are available from ITT Components Group Europe, Materials Division, Edinburgh Way, Harlow, Essex.

NEW TOOLS

A new range of high quality American tools for electronics are being offered by West Hyde Developments. These consist of 4½in curved needle phiers, 5½in longnosed phiers, 4½in side-cutters and 4in face-cutters.

Made from finest alloy steels, they have p.v.c. handles and are supplied in strong p.v.c. pockets which can

be easily hung up.

As well as the tools, there are two mirrors with useful features; one has a magnetic base, the other a variable angle head that can be remotely controlled.

Further details are available from West Hyde Developments Ltd., Ryefield Crescent, Northwood, Middlesex.

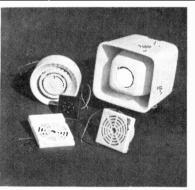
CATALOGUE

The new 100-page Electronics Catalogue from Tandy now lists a very large range of components from light emitting diodes and integrated circuits to calculator keyboard and printed circuit etchant kits.

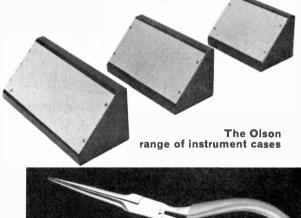
Although the semiconductors seem rather expensive they are all guaranteed to be first quality and not rejects or "fall-outs".

The catalogue is devoted mainly to their vast range of audio hi-fi equipment and includes complete systems. Test gear, car radios and aerials are also included.

Copies of the 1975/76 Electronics Catalogue can be obtained from Tandy Corporation (Branch UK), Bilston Road, Holyhead Road, Wednesbury, Staffs.



Ceramic sounders from ITT







Quality tools from West Hyde



One of the things which usually causes students problems is the use of the decibel. In specifications it is quite common to find it used as the unit for gain. Somet mes the decibel is used for the power gain of an amplifier and sometimes for the voltage gain. Often the unit is used erroneously, and we must be sure of the meaning presented to us.

THE DECIBEL DEFINED

First, let us look at the definition of the decibel. The "deci" means "one tenth of" and the bel is a logarithmic unit of the ratio of two powers. Normally we use the unit when measuring gains or losses. Consider Fig. 1 which shows an amplifier of input impedance Z_1 with a load impedance Z_2 . I_1 and I_2 represent input and output currents, while V_1 and V_2 are input and output voltages respectively.



Fig. 1 Loaded power block from which equations are derived

Let us assume that V_1 is 10mV, Z_1 is 10k $\Omega,\ V_2$ is 10 volts and Z_2 is 10 $\Omega.$ Then by Ohm's Law:

$$I_{t} = \frac{V_{t}}{Z_{t}} = 0.1 \mu A$$

and

$$I_2 = \frac{V_2}{Z_2} = IA$$

Voltages and currents are all r.m.s. Numerically, the power gain (G) is therefore:

$$G = \frac{V_2 \cdot I_2}{V_1 \cdot I_1} = \frac{10 \cdot I}{10^{-2} \cdot 10^{-7}} = 10^{10}$$

Note that this is a number. It means that the output power is ten thousand million times greater than the input power. The voltage and current gains are respectively:

$$\frac{V_2}{V_1} = 10^3 \text{ and } \frac{I_2}{I_1} = 10^7$$

Obviously the voltage gain multiplied by the current gain is equal to the power gain.

So far we have made no mention in our calculations of decibels. If the input power is P_1 , and the output power P_2 , then the gain in bels is:

$$G = \log_{10} \frac{P_2}{P_2} = 10 \text{ bels}$$

The decibel is only one tenth of a bel and therefore there are ten times more decibels than bels for a given gain.

$$G = 10 \log_{10} \frac{P_2}{P_1} = 100 \text{ decibels}$$

VOLTAGE GAIN IN DECIBELS

We sometimes find voltage gains expressed in decibels, and this is where the error and confusion arise. The definition we used said that the decibel contains a power ratio. We can rewrite our expression for gain as follows:

$$G = 10 \log \frac{V_2^2 \cdot Z_1}{Z_2 \cdot V_1^2} dB$$

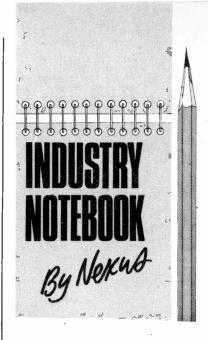
When, and only when, $Z_1 = Z_2$ we can say that:

$$G = 10 \log \left[\frac{V_2}{V_1} \right]^2$$
 db which in turn gives us:

$$G = 20 \log \frac{V_2}{V_1} dB$$

Students find difficulty in remembering when to use 10 log and when to use 20 log. If in doubt, always use 10 log and always consider power. Having said that we are then faced with information that gives voltage gains in decibels when the input and output impedances of the device are different. Theoretically, the figures are meaningless but in practice the person specifying the gain has used 20 log V₂/V₁ regardless of the fact that it does not apply. In our example, the voltage gain would be incorrectly stated as 60dB.

Finally, may I appeal to writers of specifications to either stick to power gain figures or else to quote the maximum sensitivity of the amplifier. We would then have the figures we are really interested in. That is the input voltage (and impedance) required to produce the quoted maximum output power.



SALARY AND STATUS

Looking through the situations vacant columns in the professional electronics press it is clear that experienced engineers are still in demand both at home and overseas. But it is equally clear that the salaries offered to professional engineers have increased only relatively marginally during the past three years while unqualified people have enjoyed unprecedented increases in income.

Registered dock workers, for example, now enjoy a guaranteed minimum of £3,000 a year whether they work or not. Coal face workers are in sight of £5,000 a year. Shift workers on London Transport are in the £3,000 to £4,000 bracket, and complaining assembly-line workers in automobile plants are not nearly as bankrupt as their employers. There are even well-authenicated examples of unemployed people drawing up to £5,000 a year from the State, providing they have enough children and hire-purchase commitments.

Now and again one spots what looks, from the salary point of view, a winner. Up to £8,000, for example, was recently offered for a product planning manager in communications technology which, in this instance, meant satellite communications. Candidates were required to have "the maturity, standing and personality to negotiate at all Jevels from Director downwards and the necessary drive to lead a team in expanding the company's capability in the microwave field and particularly space".

But that was only the beginning. A candidate also needed to have had practical field experience,

have developed hardware, and preferably have commercial experience in the preparation of tenders. He must have knowledge of the national and international agencies concerned with space communications and, of course, all the technical standards in force. It would also be helpful if the candidate had some knowledge of line transmission and analogue and digital modems, multiplexing and switching equipment, data programs and video circuits.

The job entails forecasting the forthcoming market and defining the hardware needed, and producing in collaboration with development engineers, a programme to ensure that hardware is available at the right time at the right price. Quite rightly, the advertisement states that "This is possibly one of the most important appointments to be made in the Company for some time."

Clearly then, this is a key job which was no doubt keenly contested and ably filled. But it seems strange that such an important position, central to the company's future prosperity and that of possibly hundreds of work people should, in gross money terms, be worth no more than two bus drivers or one and a half hewers of coal, however worthy the drivers and hewers may be. After tax, of course, the differential becomes even less attractive.

MAINSTREAM

If we now drop our sights a little and look at the mainstream of engineers we find experienced chartered engineers attracting salaries in the range £3,000 to £4,000 and technician engineers from £2,000 to a little over £3,000 for the best people.

Generally, the best payers are the Civil Service and the nationalised corporations. But, even here, salaries tend to be low. A communications technician for a gas board with at least five years' experience of u.h.f./v.h.f. mobile radio and a sound knowledge of the principles of microwave/multiplex links and digital systems can start with as little as £2,361.

At an armed services resettlement briefing for electronics tradesmen earlier this year, people soon to leave the services were surprised and dismayed to learn that their service pay and allowances were superior to the salaries they could command in "civvy street". They were mostly mature people, many with family responsibilities, to whom a salary of £2,500 and the need to find accommodation represented a major fall in standard of living and probably quality of life as well. They'd be better off to stay on.

WORK OF LOVE

From a strictly financial point of view electronic engineers, be they of chartered or technician status or even totally unqualified academically, are their own worst enemies. They tend to love their work and regard it as a vocation more than a job. If they need to have employment to live, then there is nothing they'd rather be in than electronics with its everchanging technology and novelty, and its intellectual challenge. Provided they were receiving a reasonable reward they were contented.

Unhappily, 25 per cent per annum inflation has overtaken the professional electronics engineer, and those in the lower pay brackets are now barely above the poverty line. With inflation currently at 15 per cent and scheduled not to drop to single figures before the end of the year, the more poorly paid will soon be in distress and the better-off still steadily sinking in real terms.

POINT OF CONFLICT

Council of Engineering Institutes has now come out firmly with the proposal that professional engineers should join a trade union. By the Government sanctioning and even encouraging the widespread introduction of the closed shop, this move was perhaps inevitable. A great number of engineers will discover that if they are not union members they will have no job. A second compelling reason for the recommendation is that union muscle, ruthlessly applied, always achieves its objective. This is an established fact of which there are many recent examples.

The professional engineers are now in a dilemma. Professionally they have one code of conduct and as union members they will have another and these will often be in conflict. In a universally closed shop, to defy union instruction can mean expulsion from the union and thus expulsion from employment for the remainder of a working life. But equally, to comply with union instruction may involve both agonies of conscience and breaches of professional codes of conduct.

How this muddle of loyalties will be resolved remains to be seen. Perhaps there is no solution except to emigrate to the United States or West Germany where industrial affairs are conducted more logically and where real merit is rewarded realistically.

MULTIPLE OCTAVE ORGAN

THIS is my original circuit for a simple organ, using the NE555V, which can play through several musical octaves on a limited keyboard of eight keys in two different ways.

The circuit (Fig. 1a) uses a NE555V operated in its astable mode, frequency of oscillation being given

as
$$f_1 = \frac{1}{t} = \frac{1.44}{(R_{in} 8 + 2R_B)C}$$
.

Thus
$$\frac{f_2}{f_1} = \frac{R_{\rm A1} + 2R_{\rm B1}}{R_{\rm A2} + 2R_{\rm B2}}$$

The musical notes are in the ratio of 9/8: 10/9: 16/15: 9/8: 10/9: 9/8: 16/15.

This also shows that the musical ratio depends only on the ratio of the resistors R1 to R8, R_B being kept constant; also the capacitor between pin 6 and pin 1 of IC1 kept constant.

From eqn 1, with the note C at 262Hz, S1 at 2:

R1=53k Ω (i.e. 33k Ω + 20k Ω)

 $R2=47k\Omega$

 $R3 = 42k\Omega$ (i.e. $20k\Omega + 22k\Omega$)

 $R4=39k\Omega$

 $R5=34.5k\Omega$ (i.e. $33k\Omega + 1.5 k\Omega$

 $R6 = 30k\Omega$

 $R7 = 27k\Omega$

 $R8 = 25.8k\Omega$ (i.e. $24k\Omega + 1.8k\Omega$).

S1 is a single pole, 3-way switch used for octave selection. At position 1 the notes range from C_1 to $C^{\prime\prime\prime}$, i.e. 131Hz to 262Hz. Similarly at position 2, the range is C^\prime to $C^\prime\prime$ (262-524Hz) and position 3 covers $C^{\prime\prime\prime}$ - $C^{\prime\prime\prime\prime}$ (524Hz-1,024Hz).



A selection of readers suggested circuits, it should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought. Any idea published will be awarded payment according to its merits. Why not submit YOUR IDEA?

Please Note

Articles submitted for publication should conform to the usual practices of this journal, e.g. with regard to abbreviations and circuit symbols. Diagrams should be on separate sheets, not inserted in the text.

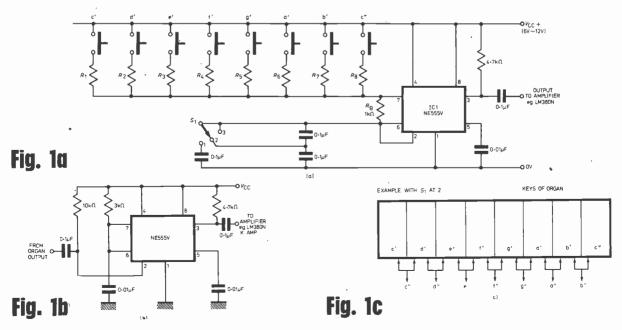
As the organ notes consist of a pulse of fixed duration (determined by $R_{\rm B}$ and capacitor selected by S1) repeated at musical frequencies, it is desirable to clamp the output pulses to a fixed duration to produce a "smooth" octave selection. A suitable monostable circuit using a NE555V is shown in Fig. 1b.

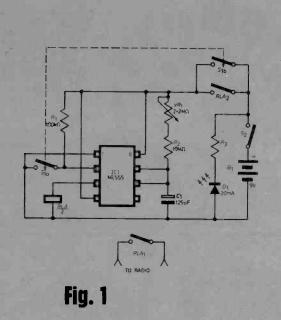
One of the inherent disadvantages of a simple organ is that the pressing of two or more keys will give only a note. However, this is exploited here to play two musical octaves on the eight keys without using the octave selection switch SI. It can be shown from eqn 1 that pressing key c' and key d' will produce note of C" and that this occurs systematically as shown in Fig. 1c below.

This method will enable one to play notes in the upper octave without bothering to operate S1.

The output is melodious as it consists of a pulse of short duration repeated at musical frequencies; a tweeter is recommended at the amplifier output to reproduce these short pulses more clearly. For simplicity the semitone keys are omitted but can easily be added by calculating the required resistor from eqn 1. With the semitone keys added, there will be 13 keys and the corresponding ratio of each frequency to the one before it is 1.0595. Since the musical ratio is virtually dependent on R1 to R8, they should be preferably better than ±5 per cent. Close tolerance capacitors should be used for S1 for octave selection as they maintain musical ratios of the musical octaves.

Pek Yaw Kee, Sarawak, E. Malaysia.





AUTOMATIC TIME SWITCH

This automatic time switch was designed to switch a radio and itself off after about half-an-hour, so that I could leave the radio on and go to sleep. The tuner has a start/reset switch which is illuminated by an I.e.d., see Fig. 1.

ated by an I.e.d., see Fig. 1.

The circiut uses a NE555 timer as a monostable. The delay period is adjusted by VRI which compensates for the tolerances of R2 and C1. The relay is a 6V 2-pole make type, with as high a coil resistance as possible. S1 is a 2-pole make switch and K3 is selected to suit the l.e.d. The relay contacts RLA1 interrupt the positive supply line to the radio.

P. Levey, London, S.E.26.

FURTHER USES FOR UNIJUNCTIONS

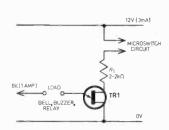


Fig. 1. Burglar Alarm

R ARELY does one see the Unijunction transistor being put to any use other than as a relaxation oscillator. It can of course be put to many diverse uses.

In Fig. 1 it is used as a Burglar Alarm. Even if the microswitch circuit is remade after it is broken the bell, buzzer, etc. will stay on Most common unijunction transistors will sink up to one amp, and so relatively heavy loads can be used without resorting to a relay. To reset the alarm, one of the load leads is broken.

In Fig. 2 the Unijunction transistor is used as a Frequency Divider.

If half-wave rectified a.c. from the mains is put in the input, the first stage divides by five, as with the second, and the third divides by two. Surplus unijunctions and transistors can be used, but the capacitor charging resistors may have to be changed. Generally if each stage is disconnected from the previous one, it should run at a slightly lower frequency than its expected working frequency. The circuit can be adapted readily for other applications as it is cheaper than TTL dividers.

A. F. Rabagliati, Oundle, Northants.

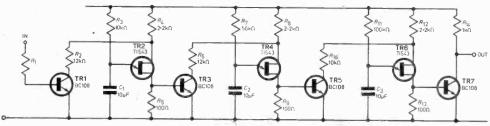


Fig. 2. Frequency Divider

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|-------------|----------|-------|---|--|
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| 1-6A " | (800V) | 70p+ | н | |
| 2-0A " | (200V) - | 72p+ | н | |
| 2-0A " | (600V) - | 90p+ | н | |

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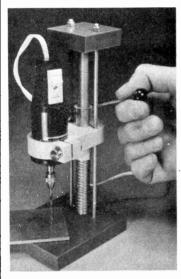


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VISUAL INDICATOR FOR DISCOTHEQUE PFL SYSTEMS

R EADERS who run mobile discotheques, like myself, may be interested in this simple yet effective visual cueing device to be used in place of headphones on existing equipment with PFL (Pre-fadelisten) facilities. For those readers not familiar with PFL, it is a system which allows the operator or DJ to locate the start of a second record whilst a first is playing, and so eliminate the time gap between one record and the next.

This device described, gives the operator a visual indication of the start of a record by means of an l.e.d. modulated in brightness by the

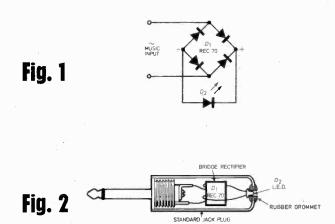
music signal.

The circuit, see Fig. 1, consists of an REC70 bridge rectifier D1 and a small red l.e.d. type TlL209, D2, connected as shown. The music signal is rectified by the bridge and produces a varying d.c. voltage across the l.e.d.

The prototype was constructed inside a standard jack plug, of the type with a long plastic barrel, see

Fig. 2.

The system has been tested with several makes of disc mixer, and found very successful. In most cases a gain control for the PFL is incor-



porated in the mixer, and when using the visual cueing light, this invariably needs to be set at maximum for highest sensitivity. In this case the d.c. peak voltage is unlikely to exceed 3V and result in any damage to the l.e.d. With this setting, it may be found that once

the record is playing the l.e.d. appears continuously on, but this is no disadvantage as the cueing light has only to indicate the start of the record.

S. E. Grist, Guildford, Surrey.

"LIGHTS ON" INDICATOR

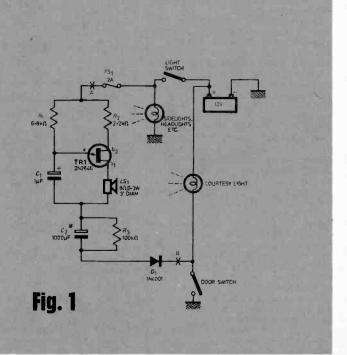
This is a useful aid for motorists in that it gives a warning that the car lights are still on when attempting to get out of it.

The circuit (Fig. 1) is a simple unijunction transistor oscillator which gives a continuous note for about five seconds when the door is opened, that is, when the door switch is closed. The period setting can be changed by altering the value of C2.

When power is removed from the circuit it will reset in five minutes.

As the audible warning is for negative earth vehicles, for positive earth interchange connections at A and B.

R. A. Sudron, Shadwell.



COURTESY LIGHT TIMER

THE circuit in Fig. 1 is designed approximately 20 seconds after the car door is closed, allowing time to fasten seat belts, etc. The timer starts when the switch contacts open, and the light is extinguished automatically after the delay period has elapsed.

TR3 and Darlington pair TR4 and TR5 form a complementary bistable which is triggered on when TR5 collector is earthed by the switch S1, whose contacts carry the current for the interior lamp, LP1.

When SI contacts open, the lamp current flows through TR5. About 1.5V is dropped across this, turning on TR1 via R3; C1 then charges through TR1 and R1. When C1 has charged to about 5V, TR2 conducts and diverts base current from TR3. The bistable then turns rapidly into the off state, discharging C1 via D1 and R2 ready for the next operation. Battery drain in the off state is about 1mA, which is taken by R3.

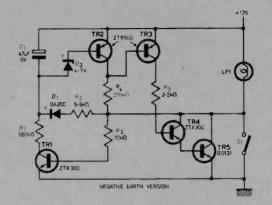


Fig. 1

For loads of up to 6W no heatsink is needed for TR5 and a very compact unit can be built, possibly in the lamp housing itself. Loads of up to 36W can be switched with a heatsink. If the load is shorted the bistable should switch off without damage.

The circuit shown is for negative earth vehicles. A positive earth version can be made using a BD132 for TR5, transposing ZTX300 and ZTX500 transistors and reversing the polarities of C1, D1 and D2.

P. Albericci, Stockport

The following might be of interest to some of your photographically minded readers.

The latest fashion for Dual Fade Slide Presentation seemed a natural subject for solid state control, so triac circuitry came to mind. Most modern slide projectors use a low voltage halogen lamp and the low voltages necessitated a slightly different approach to circuitry.

Fig. 1 shows the basic interface circuitry which was built into a projector. This had spare pins available on its standard 6-pin DIN socket (pin 3 to earth, pin 2 is the slide change solenoid). The triac is simply wired in parallel with the winter large of the slitch of the slitch

existing lamp on/off switch.

Fig. 2 shows the simple manual control used to fade the projector lamp. Zeners D1. D2 take the place of the diac used in mains voltage circuits. The high value of capacitance is required to provide the relatively large gate current to the triac which is sluggish in the low voltage conditions. VR1 is a slider potentiometer for ease of use during a show, and VR2 is a preset which enables the full scale of the slider to be used.

A pair of projectors using this circuitry has been used for several successful slide-tape shows and the

DUAL FADE FOR SLIDE PRESENTATION

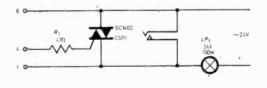


Fig. 1

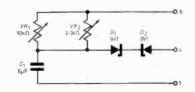


Fig. 2

colour change of the lamps during dimming has not been found to be objectionable.

A simple remote control of the lamp can be provided by a switch between pins 4 and 6. A tape con-

trol system is being developed using circuitry similar to the voltage controlled dimmer in *Ingenuity Unlimited* page 320, April 75.

P. Woods, Meanor, Derbys.



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| 10µF | 25V | 7p | 470µF | 63V 20p |
| 22uF | 25V | 7p | 1000µF | 10V 12p |
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| 47µF | 40V | 8p | 1000µF | 25V 20p |
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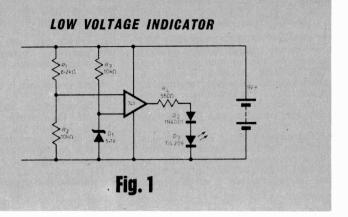


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This circuit (Fig. 1) was designed for use with an electronic voltmeter to indicate when the battery voltage falls below 7.5V where the accuracy of the meter begins to deteriorate.

The circuit can be made to switch at any voltage by altering R1, R2, D1, and by swopping pins 2 and 3 there is a choice of either normally on or normally off operation. The normally off arrangement is shown as in this state the circuit only takes 1.4mA.

P. Boscott, Banbury



CAR ALARM

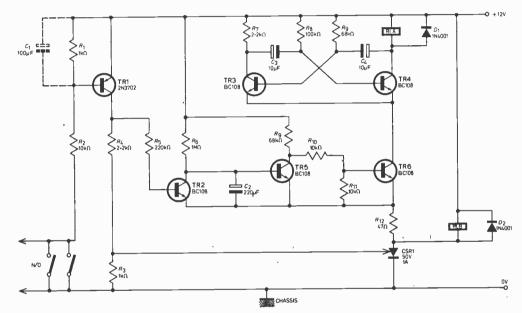


Fig. 1

THE requirements to be met for the car alarm were that it should give an audible/visual alarm for a preset interval and then reset to a "ready" state, the car meanwhile being immobilised. The quiescent power consumption must also be low.

The following circuit was devised which gives an alarm lasting about 20 seconds (bleeps horn and/or flashes headlamps) and breaks the ignition circuit, after which it resets ready to be triggered again. The methods used to trigger the alarm are door courtesy switches and/or a trembler switch. This alarm has the advantage over other types that it attracts attention and immobilises the car, but does so without being a public nuisance and without draining the battery (the alarm might be set off by an innocent party accidentally).

With power applied, in the quiescent state, the CSR1 is switched off and current is only drawn through

TR2, this being about 20 micro-amps.

If any of the alarm switches are earthed TR1 conducts, both causing TR2 to conduct and switching on the CSR. TR2 thus shorts the timing capacitor each time a switch is made and the timing period starts from this point. The CSR supplies power to the Schmitt trigger and, as TR6 is conducting initially, to the multivibrator. RLA contacts then open and close periodically to give the alarm. These contacts can be connected to the horn or headlamps but must therefore be of suitable rating. The writer used a miniature 700 ohm relay which closed at 20 milliamps and fitted heavier 5 amp contacts salvaged from defunct defunct microswitches so obtaining a 10 amp capacity relay at low cost.

As the timing capacitor charges up, TR5 base voltage is raised until the Schmitt switches, TR6 being cut off and TR5 conducting. TR5's current is less than the hold-

ing current of the CSR which switches off, leaving the circuit in its quiescent state again.

Relay RLB is enabled when the CSR is on, and must be a latching type, either electrically or mechanically. The latter is probably preferable as the ignition reset switch can be hidden away.

If trouble is experienced by spurious triggering of the alarm, this should be cured by connecting a capacitor across TR1 base as shown and decoupling the supply if required.

Layout is completely non-critical, as are components. BC108's were used because they were to hand, but lower gain types are suitable. Note that TR1 is pnp, the rest are npn. The CSR was a surplus item. The time delay can be altered by varying the values of R6 and C2.

D. W. Bickley, Wolverhampton.

RECORDING LEVEL INDICATOR

RDINARY tape recorder VU meters cannot respond quickly enough to sudden loud peaks. One can therefore record at too high a level without knowing, resulting in distortion. Peak-reading meters solve this problem to some degree, but are complex and not always totally successful.

The circuit (Fig. 1) eliminates this problem, and can easily be added to almost any transistor tape recorder. If the peak level of the input a.c. signal exceeds a certain level,

the 555 timer wired as a monostable is triggered, illuminating the l.e.d. for about 0.4 sec, as a warning that the recording level is too high. VR1 sets the trigger level, low resistance corresponding to a high trigger voltage, between 0 and 2.5V.

Input impedance is over 10k\(\Omega\) for most settings of VR1, and the unit can be connected direct to the output of the record amplifier. It should however be connected in front of the tape head driver, as this is a constant-current driver, not constant-voltage.

D1 may be any l.e.d. D2, C3 and R4 stabilise the trigger level against

changes of $V_{\rm cc}$. If $V_{\rm cc}$ is stabilised, these components can be omitted, connecting point X to $V_{\rm cc}$ and leaving pin 5 of the NE555 unconnected, VR1 should now be $100 {\rm k}\Omega$. This circuit will work for any $V_{\rm cc}$ from 6 to 15V, although R2 may need reducing to 680Ω at low voltages. The maximum current demand with l.e.d. on, is $20 {\rm mA}$, and less than 5mA with it off. In use, it is best to set it to trigger at a level corresponding to $+2-3 {\rm dB}$ record level.

N. R. Arnot, Welwyn Garden City, Herts.

TOUCH KEYBOARD

For those not wishing to spend 120 on keyboard mechanics for their synthesiser, I have devised an electronic alternative.

The complete circuit is shown in Fig. 1. The contacts are made by etching a keyboard on fibreglass p.c.b. The circuit marked A is dupli-

cated for as many keys as required. A finger pressed on the contacts switches the transistor pair, producing about 5.3V across the resistor. The diodes "code" the key position into a 6-bit binary signal passing on to circuit B. (The key shown is the 13th.)

This circuit is a sampling digitalanalogue convertor, which takes an input from the keyboard when a key is pressed.

The output may be taken to a

buffer stage as shown, allowing the keyboard to be compressed, expanded or offset up and down the spectrum. An integrator would produce a portamento effect.

A typical key design is shown in Fig. 2. If single plate operation is required the circuit of Fig. 3 could replace the two transistor circuit of Fig. 1, but it may be found unreliable.

N. B. Sargeant, Fleet.

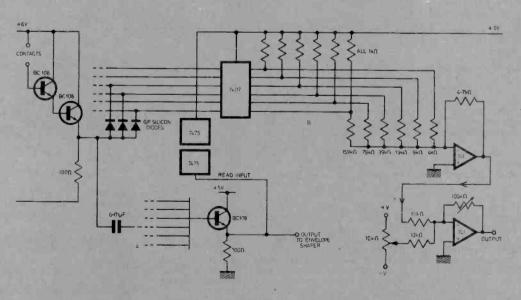


Fig. 1

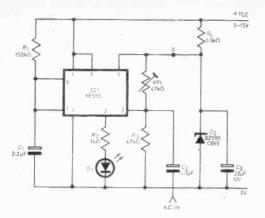


Fig. 1

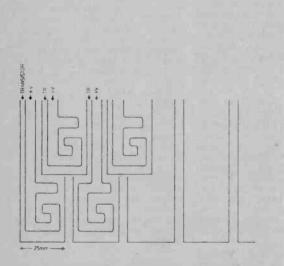


Fig. 2

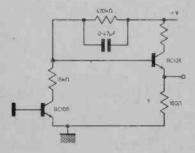


Fig. 3

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For this reason, readers should remember that most of the official publications of the British Patents Office can be consulted free of charge at over two dozen libraries dotted around the United Kingdom. Fortunately, this situation is unlikely to change, because it would undermine the basic principle of patenting, whereby an inventor is awarded a monopoly in return for disclosing details of his invention to the public in a Patent Office publication.

Free access to any patent mentioned in this column should currently be available through the public, commercial or central library in the following towns:

Aberdeen; Aberystwyth; Belfast; Birmingham; Bradford; Bristol; Coventry; Edinburgh; Glasgow; Huddersfield; Hull; Leeds: Leicester; Liverpool; London (British Museum: Science Museum: Science Reference Library attached to the Patent Office); Loughborough (University of Technology); Manchester; Middlesbrough; Newcastle upon Tyne; Norwich; Nottingham; mouth; Portsmouth; Preston; Sheffield; Swindon; Wolverhampton.

LICENSING GUIDE

The British Library recently published another of its extremely useful "Guides to Literature". These are available free by post from the Bayswater Branch of the Science Reference Library (10 Porchester Gardens, Queensway, London W2 4DE), or on personal request from the SRL attached to the Patent Office at Southampton Buildings, Chancery Lane, London WC2.

Each guide has the same general format; a background to the subject and clear references to all the most useful literature that is available to the public in the SRL.

So far there have been no publications specifically on electronics topics (subjects covered have been artificial polymers, automotive fuels and odd protein sources), but news of any guideline on a selected area of electronics will be reported if and when it is published.

The latest guideline relates to "Patent Licensing Opportunities", and could be of considerable interest to both inventors and manufacturers working in the electronics field. Some of the source references given relate to regular publications which publicise both inventions available for licence and potential licensees seeking inventions; other references relate to the legal aspects of licensing, both here and abroad.

In the latter context, it is important to bear in mind that since we have joined the EEC the situation in Europe has become somewhat confused. Briefly, the Treaty of Rome forbids any restriction or distortion of competition within the EEC and thus would appear to ban any exclusive licence, i.e. any licence that gives any one manufacturer in a territory the right to corner a market without fear of competition from other manufacturers.

In 1962 the Common Market Commission issued its now famous, so-called "Christmas message" which appeared to condone exclusive licenses if tied to a patent. But this 1962 exemption has been steadily confused and eroded. Currently, to the publicly admitted dismay of the CBI, inventors and manufacturers must realistically regard any straightforward exclusive licence in Europe as void under the Treaty of Rome.

There is legal machinery for asking the Commission in Brussels to give its advance opinion on a draft licence, but this is a lengthy procedure, riddled with red tape. Thus anyone with an electronic invention to license and hopes of profit without problems, is best advised to steer clear of licensing any one manufacturer to the

exclusion of others. Likewise firms are best advised to avoid entering into exclusive licences if humanly and commercially possible.

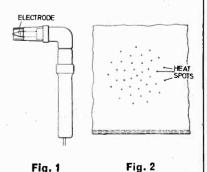
REMOVING DENTS

A simple but allegedly previously ignored approach to straightening out dents in car bodywork is claimed by Erwin Schill, of Switzerland, in BP 1 403 164.

According to the inventor, it is well known that to use a welding tool to soften the damaged metal leaves stresses in the sheet after removal of the dent. The proposed solution is to use a welding tool in the manner of a hammer, so that a multitude of tiny spots are heated briefly to a high temperature, rather than a whole area.

The necessary tool is shown in Fig. 1; the handle incorporates a hammer head with a central copper electrode which is surrounded by a safety sheath. The dent is flattened using short tapping movements so that the electrode briefly contacts the metal and heats spots of around 1mm square to 1,000°C for a fraction of a second at a time. The material surrounding each contact point draws in and if the spots are peppered over the surface to be treated (Fig. 2) the result is an overall flattening without undesirable stressing of the metal.

BP 1 403 164



Copies of Patents can be obtained from the Patent Office Sales, St. Mary Cray, Orpington, Kent - Price 75p each

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SPECIFICATION

- SPECIFICATION

 1 4 digit LED display

 10 digit mantless with sign and 2 digit exponent with sign for data entry or results (10⁻¹⁰ ~ 10¹⁰)

 Automatic selection of correct notation for result display (scientific or floating point)

 Dome keyboard for excellent response and preventing displays after input

- Dome keyboard for excellent response and p double entry input
 BASIC FUNCTION (+, -, ×, +) AND MEMORY
 Algebraic mode operation
 Constant operations
 Chain operations
 Chain operations
 Chain operations
 Chain operation
 Oisplay and Y register exchangeable
 One accumulating memory
 Diaplay and memory exchangeable

SPECIAL FUNCTION

- **ECIAL FUNCTION
 Trigonometric functions (sin. cos. tan)
 Inverse trigonometric functions (sin", cos", tan")
 Hyperbolic functions (sinh, cosh, tanh)
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 Radian or degree selectable
- π constant

- π constant Logarithms (in. log)
 Anti-logarithms (e^{*}, 10')
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 Reciprocal (1/x)
 Square root (√x)

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1420 — SENIOR

14 digit LED display
10 digit mantissa with sign and 2 digit exponent with sign for data entry or results (10⁻⁹⁶~10⁹⁶)



- Automatic selection Automatic selection of correct notation for result display (scientific or floating point). Dome keyboard for excellent response and preventing double entry input. Algebraic mode operation Chain operations.

- Chain operations
 Change sign operation
 Three memories
 Display and memory exchangeable
 Trigonometric functions
 (sin, cos. tan)
 Inverse trigonometric functions (sin-", cos.", tan-")
 Radian or degree
 selectable
- Radian selectable
- π constant
 Logarithms (In. log)
- Anti-logarithms (e', 10°) Combinatorial functions (n', (\$), (n),) Normal distribution function (Pr(x))
- Normal distribution function (Pr(x)) Gamma function ($\Gamma(x)$) Group operations ($\Sigma\pm$, \mathcal{O} , X, π xx) Group operations ($\Sigma\pm$, \mathcal{O} , X, π xx) Power function (Y) Reciprocal (T(x)) Square T(x) Square (X?) Sum of squares (ΣX ?) Summation (ΣX)

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 Change sign operation
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 M + X³)
 Trippopmetric functions
- M + X²)
 Trigonometric functions
 (sin. cos. tan)
 Inverse trigonometric
 functions (sin ', cos ',
 - Radians and degrees exchangeable
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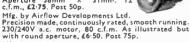
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| | 2N456 2N456A | 0-80 | Orange 2N3053 | | 2N5192 | 1 - 24 | AF106 | 0 · 40 | BC166 | 0.25 | BF159 | | L005T1 | 1 - 50 | OC35 | 1 - 16 |
| | 2N455A 2N457A | 1.20 | 2N3053 2N3054 | 0 - 25 | 2N5195 | 1 - 46 | AF109R | 0 · 40 | BC187 | 0.27 | BF160 | 0 - 23 | | 0 - 98 | OC42 | 0.50 |
| | 2N49/A 2N490 | 4 - 00 | 2N3054 2N3055 | 0.60 | 2N5245 | 0 - 29 | AF114 | 0 - 35 | BC207 | 0 · 12 | BF163 | 0 - 32 | | 2 - 07 | OC45 | 0 · 32 |
| ı | 2N490 2N491 | 4 - 38 | 2N3055 2N3390 | 0.65 | 2N5294 2N5295 | 0 · 48 | AF115 | 0.35 | BC208 | 0 - 11 | BF166 | 0 - 40 | | 0.75 | OC71 | 0 - 17 |
| | 2N492 | 5.00 | 2N3390 2N3391 | 0 - 28 | 2N5295 | 0.48 | AF116 AF117 | 0 - 35 | BC212K | 0 - 16 | BF167 | 0 - 25 | | | OC72 | 0 - 25 |
| ш | 2N493 | 5 - 20 | 2N3391A | 0 - 29 | 2N5298 | 0.50 | AF118 | 0 - 35 | BC212L | 0 - 16 | BF173 | 0 - 27 | | 0 - 48 | OC81 | 0 - 25 |
| 8 | 2N696 | 0 - 22 | 2N3392 | 0.15 | 2N5457 | 0.29 | AF124 | 0 - 35 | BC214L | 0 - 18 | BF177 | 0 - 29 | | 0.38 | OC83 | 0 - 24 |
| 8 | 2N697 | 0.16 | 2N3393 | 0.15 | 2N5458 | 0.26 | AF125 | 0.30 | BC237 BC238 | 0 · 16 | BF178 | 0.35 | | 0 - 40 | ORP12 | 0.55 |
| я | 2N698 | 0.82 | 2N3394 | 0.15 | 2N5459 | 0 - 29 | AF126 | 0 - 28 | BC238 | 0.15 | BF179 BF180 | 0 - 43 | | 0-47 | R53 SL414A | 1-80 |
| ж | 2N699 | 0.59 | 2N3402 | 0-18 | 2N5492 | 0 - 58 | AF127 | 0 - 28 | BC251 | 0.15 | BF181 | 0 - 36 | | 0.00 | SL610C | 2 - 35 |
| 8 | 2N706 | 0 - 14 | 2N3403 | 0 - 19 | 2N5494 | 0 · 58 | AF139 | 0.65 | BC253 | 0.25 | BF182 | 0.35 | | 0-40 | SL611C | 2 - 35 |
| 8 | 2N706A | 0 - 16 | 2N3414 | 0.20 | 2N5496 | 0.61 | AF186 | 0 · 46 | BC257 | 0-16 | BF183 | 0.55 | | 0 - 40 | SL612C | 2 - 35 |
| 8 | 2N708 | 0 - 17 | 2N3415 | 0 - 21 | 2N5777 | 0 - 45 | AF200 | 0-85 | BC258 | 0-16 | BF184 | 0 - 30 | | 0 - 38 | SL620C | 3 - 50 |
| | 2N709 2N711 | 0.50 | 2N3416 | 0.24 | 2N6027 | 0 - 45 | AF239 | 0.65 | BC259 | 0-17 | BF185 | 0 - 30 | | 1-00 | SL621C | 3 - 50 |
| 8 | 2N718 | 0.23 | 2N3417 2N3440 | 0 - 29 | 3N128 3N139 | 0.73 | AF240 | 0.90 | BC261 | 0 - 25 | BF194 | 0 - 12 | | | SL623 | 5 - 24 |
| я | 2N718A | 0 - 28 | 2N3441 | 0.97 | 3N140 | 1 - 42 | AF279 AF280 | 0 - 70 | BC262 | 0.25 | BF195 | 0 - 12 | | 0 - 44 | SL640C | 4-00 |
| М | 2N720 | 0.57 | 2N3442 | 1 - 40 | 3N141 | 0-81 | AL102 | 1-00 | BC263 | 0 - 25 | BF196 | 0.13 | | 0 - 41 | SL641C | 3 - 10 |
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| | 2N916 | 0 - 28 | 2N3638A | 0 - 15 | 40361 | 0.40 | BC107 | 0.14 | BC302 | 0 29 | BF200 | 0 - 18 | LM7812 | 1.99 | SN76023N | 1-60 |
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| | 2N929 | 0 - 25 | 2N3641 | 0 - 17 | 40363 | 0.88 | BC109 | 0.14 | BC307 | 0.17 | BF244 | 0.21 | LM7824 | 1 99 | ST2 | 0.20 |
| | 2N930 | 0 - 26 | 2N3702 | 0 - 12 | 40389 | 0 · 46 | BC113 | 0 - 15 | BC308A | 0 - 15 | BF245 | 0-45 | MC1303 | 1 - 50 | TAA263 | 1 - 20 |
| | 2N1302 2N1303 | 0-19 | 2N3703 | 0.13 | 40394 | 0 56 | BC115 | 0 · 17 | BC309C | 0.20 | BF246 | 0 - 58 | MC1310 | 2 · 50 | TAA300 | 1-84 |
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| | 2N1306 | 0.31 | 2N3700 | 0.18 | 40408 | 0.35 | BC117 | 0 · 21 0 · 14 | BC337 | 0 - 20 | BF255 | 0 - 19 | MC1352P | 0.60 | TAA611C | 2 · 18 |
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| и | 2N1308 | 0-47 | 2N3709 | 0.15 | 40410 | 0.52 | BC121 | 0.35 | BCY30 BCY31 | 0-80 | BF258 BF259 | 0.53 | MC1489 ME0402 | 2·75 0·20 | TAA661B TBA641B | 1 · 03 2 · 25 |
| п | 2N1309 | 0-47 | 2N3710 | 0.15 | 40411. | 2.00 | BC125 | 0.16 | BCY32 | 1.15 | BFR39 | 0.55 | ME0402 ME0404 | 0 - 20 | TBA651 | 1 - 69 |
| | 2N1671 | 1-54 | 2N3711 | 0.15 | 40594 | 0.74 | BC126 | 0.23 | BCY33 | 0-85 | BFR79 | 0-24 | ME0412 | 0.18 | TBA800 | 0.89 |
| | 2N1671A | 1-67 | 2N3712 | 1-20 | 40595 | 0-84 | BC132 | 0 · 30 | BCY34 | 0.79 | BFS21A | 2 - 30 | ME4102 | 0.11 | TBA810 | 0.98 |
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| | 2N1907 2N2102 | 5 · 50 0 · 60 | 2N3715 | 1 50 | 40603 | 0.58 | BC136 | 0 - 17 | BCY40 | 0.97 | BFS98 | 0 - 25 | MJ481 | 1 - 20 | TIL209 | 0 - 30 |
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| | 2N2148 | 0.94 | 2N3771 2N3772 | 1 - 80 | 40669 | 1.00 | BC140 BC141 | 0.68 | BCY58 | 0 - 30 | BFX30 | 0.34 | MJ491 | 1 · 45 | TIP29C | 0-80 |
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| | 2N2218A | 0 - 47 | 2N3789 | 2.06 | AC126 | 0.20 | BC143 | 0.25 | BCY71 | 0-17 | BFX85 | 0 · 25 | MJE340 | 0-48 | TIP30C TIP31A | 0.85 |
| 8 | 2N2219 | 0 - 42 | 2N3790 | 2 - 40 | AC127 | 0 - 40 | BC147 | 0.10 | BCY72 | 0.18 | BFX87 BFX88 | 0 - 28 | MJE2955 MJE3055 | 1 · 20 0 · 75 | TIP31C | 1-00 |
| | 2N2219A | 0.52 | 2N3791 | 2 - 35 | AC128 | 0.35 | BC148 | 0.09 | BD1.15 | 0.75 | BFX89 | 0.90 | MJE3033 | 0.75 | TIP32A | 0.74 |
| | 2N2220 | 0 · 25 | 2N3792 | 2.60 | AC151V | 0.27 | BC149 | 0.11 | BD116 | 0.75 | BFY50 | 0.30 | MJE371 | 0.75 | TIP32C | 1 - 25 |
| | 2N2221 | 0.18 | 2N3794 | 0.24 | AC152V | 0.49 | BC153 | 0.18 | BD121 | 1-00 | BFY51 | 0 - 28 | MJE520 | 0.60 | TIP33A | 1-01 |
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| | 2N2222A | 0.25 | 2N3820 2N3823 | 0 - 29 | AC153K AC154 | 0 - 40 | BC157 | 0.16 | BD124 | 0-67 | BFY53 | 0 - 18 | MP8111 | 0 - 32 | TIP34A | 1.51 |
| | 2N2368 | 0 - 17 | 2N3904 | 0.19 | AC176 | 0.41 | BC158 BC160 | 0 - 16 | BD131 BD132 | 0.40 | BFY90 | 0 - 75 | MP8112 | 0 - 40 | TIP34C | 2 - 60 |
| | 2N2369 | 0 - 20 | 2N3906 | 0 - 19 | AC176K | 0.40 | BC167B | 0.15 | BD132 BD135 | 0·50 0·21 | BRY39 BSX20 | 0 - 38 | MP8113 MPF102 | 0 - 47 | TIP35A TIP36A | 2·90 3·70 |
| | 2N2369A | 0 . 22 | 2N4036 | 0.67 | AC187K | 0 - 35 | BC168B | 0.15 | BD136 | 0.22 | BSX20 | 0 - 28 | MPSA05 | 0.25 | TIP41A | 0.79 |
| | 2N2646 | 0.55 | 2N4037 | 0.42 | AC188K | 0 - 40 | BC168C | 0 15 | BD137 | 0.24 | BU104 | 2-00 | MPSA06 | 0.31 | TIP41C | 1.40 |
| | 2N2647 | 0.98 | 2N4058 | 0 - 18 | ACY18 | 0 - 24 | BC169B | 0 - 15 | BD138 | 0.26 | BU105 | 2 - 25 | MPSA12 | 0 - 35 | TIP42A | 0.90 |
| | 2N2904 | 0 40 | 2N4059 | 0 - 15 | ACY19 | 0 - 27 | BC169C | 0.15 | BD139 | 0.71 | C106D | 0.65 | MPSA55 | 0 - 21 | TIP42C | 1 - 60 |
| | 2N2904A 2N2905 | 0.45 | 2N4060 | 0.15 | ACY20 | 0 - 22 | BC170A | 0.15 | BD140 | 0.87 | CA3018A | 0.85 | MPSA56 | 0 - 31 | TIP49C | 0 - 70 |
| | 2N2905 2N2905A | 0.50 | 2N4061 2N4062 | 0-15 | ACY21 | 0 26 | BC171 | 0-16 | BD529 | 0.80 | CA3020A | 1.80 | MPSU05 | 0-65 | TIP53 | 1-70 |
| | 2N2906 | 0.33 | 2N4062 2N4126 | 0.13 | ACY28 ACY30 | 0 - 20 | BC172 | 0 - 12 | BD530 | 0-60 | CA3028A | 0.79 | MPSU06 | 0.58 | TIP2955 | 0-98 |
| | 2N2906A | 0 - 42 | 2N4126 2N4289 | 0.34 | AD142 | 0.57 | BC177 | 0 - 19 | BDY20 | 1.05 | CA3035 | 1.37 | MPSU55 | 0.63 | TIP3055 | 0 - 50 |
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| 2N2219 | 0-25 | BCY31 BCY32 | 0-45 0-85 | GEX44 GEX45/1 | 0-08 0-45 | OC59 OC66 | 0-60 0-50 | 7437 | 0-87 |
| 2N2869A 2N2444 | 0·16 1·99 0·75 | BCY32 BCY33 BCY34 BCY38 | 0-88 0-45 | GEX941 GJSM | 0.45 | OC70 | 0.18 | 7488 7440 | 0-87 0-28 |
| 2N2613 2N2646 | 0-75 0-50 | BCY88 | 1.00 | GJ4M | 0-50 0-50 | 0C71 0C72 | 0-98 | 7441AN | 0-92 |
| 2N2904 | 0-20 | BCY89 BCY40 | 1-50 0-80 | GJ5M GJ7M | 0.25 | 0C78 0C74 | 0-50 0-80 | 7442 7450 | 0-7 9 0-16 |
| 2N2906 2N2907 | 0-20 0-28 | BCY42 | 0-80 | HG1005 | 0-50 0-50 | OC75 | 0-80 | 7451 7453 | 0-16 0-16 |
| 2N2924 2N2925 | 0·18 0·15 | BCY70 BCY71 | 0-18 0-22 | HS100A MAT100 | 0-80 | OC76 OC77 | 0-80 0-54 | 7454 | 0-16 |
| 2N2926 | 0-12 | BCZ10 BD121 | 0-60 | MAT101 MAT120 | 0-25 | OC78 | 0-25 0-80 | 7460 7470 | 0-16 0-36 |
| 2N3054 2N3055 | 0-48 0-45 | BD128 | 1-00 1-00 0-65 | MAT121 | 0.25 | 0C79 0C81 | 0-29 | 7472 7478 | 0-88 0-41 |
| 2N 37 02 | 0.11 | BD124 BDY11 | 1-45 | MJE340 MJE520 | 0-47 0-68 | OC81M OC81DM | 0-20 0-18 | 7474 | 0-48 |
| 2N3705 2N3706 | 0·15 0·11 | BF115 BF167 | 0-20 0-25 | MJE2955 MJE3055 | 1.87 0.77 | OC81Z | 0-45 0-88 | 7475 7476 | 0-59 0-45 |
| 2N3707 2N3709 | 0-13 0-10 | BF173 | 0.28 | MPF102 | 0-40 | OC82 OC82D | 0-25 | 7430 | 0-60 0-87 |
| 2N3710 | 0-11 | BF181 BF184 | 0-85 0-22 | MPF108 MPF104 | 0-36 | OC83 OC84 | 0-60 | 7482 7488 | 1.10 |
| 2N3711 2N3819 | 0-11 0-88 | BF185 BF194 | 0-22 0-10 | MPF105 | 0-85 0-86 | OC114 | 0-2R | 7484 7486 | 1-00 0-47 |
| 2N 4289 2N 5027 | 0.80 | BF195 | 0.18 | NKT128 NKT129 | 0-45 | 0C122 0C128 | 1.00 1.10 | 7490 | 0-55 |
| 2N5088 | 0.58 | BF196 BF197 | 0·15 0·15 | NKT211 NKT218 | 0-25 0-25 | OC189 OC140 | 0·75 1·14 | 7491AN 7492 | 1.00 0.70 |
| 28301 28304 | 0.59 1.15 | BF861 BF898 | 0-25 0-25 | NKT214 | 0-84 | OC141 | 0.80 | 7493 7494 | 0-70 0-80 |
| 28501 28703 | 0.75 1.00 | BFX12 | 0.20 | NKT216 NKT217 NKT218 | 0-40 0-45 | OC169 OC170 | 0.20 | 7495 | 0-80 |
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| AC126 AC127 | 0-25 | BFX87 BFX88 | 0-85 0-84 | NKT275 NKT277 | 0-25 | OC206 OC207 | 1·10 1·00 | 74121 74122 | 0-50 0-70 |
| AC128 AC187 | 0-15 0-21 | BFY10 BFY11 | 0-50 0-50 | NKT278 | 0-25 1-00 1-00 | OC460 | 0-20 | 74128 74141 | 1-00 0-90 |
| AC188 ACY17 | 0-20 0-75 | BFY17 | 0-40 | NKT301 NKT304 | 1.00 | OC470 OCP71 | 0-80 1-20 | 74145 | 1-20 |
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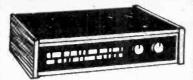


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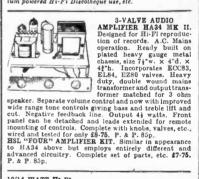
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| 1330 1331 1552 1522 15533 177 156 177 156 177 157 179 159 177 179 179 179 179 179 179 179 179 17 | 749 p 741 p | 99 291p 0 291p 1 81p 1 8 | OP AMPS 301A 709 710 741 747 748 776 CA3130S LM3900 MC1458 NES36T LINEAR ICc CA3028 CA3048 CA3048 CA3090AQ ICL8038CC LM380 LM381 MC1310P MC1495L MC1495L | Ext. Comp. 8 pin DIL Ext. Comp. 8/14 pin DIL Diff. Comp. 14 pin DIL Int. Comp. 8/14 pin DIL Int. Comp. 8/14 pin DIL Dual 741 14 pin DIL Ext. Comp. 8 pin DIL Prog. Op. Amp. T099 CMOS Op. Amp. 16 pin DIL Duad Op. Amp. 16 pin DIL Duad Op. Amp. 16 pin DIL FET Op. Amp. T099 Diff. Cascade Amp. 5 rransistor Array Quad Low Noise Amps. FM IF System 16 DIL FM Sterse Decoder VCO Funct. Gen. 2W Audio Amp. Sterse Dre Amp. FM Sterse Dec. Multiplier Bal Mod/Demod. | 40p 30p 55p 25p 39p 160p 108p 75p 300p 112p 62p 250p 250p 900p 115p 900p 115p 900p 115p | VOLTAGE F 723 14 pin DiL Data Sheets Vol. Regs. 10p each 1488 Dual 1 Adjustable fr OPYO ELE(OPYO 3: OPY1 2: ORP12 5: ORP61 8: 2N5777 4: SCR-THYRIS1 1A 50V TOS 1A 100V TOS 1A 400V Stud 3A 400V Stud 3A 400V Stud 7A 400V V | 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 | amp V 7805 1 V 7812 1 V 7815 1 V 7818 1 V 7824 1 J 306p. Promin. to ± | + Ve 2 | Ve AC128/7 15p AC128 AC128 AC128 AC141/2 15p AC141/2 AC178 15p AC178 15p AC149 15p AC1 | 12p 12p 20p 14p 46p 38p 18p 18p 18p 10p 11p 9p 11p 12p 12p 17p 20p 17p 20p 17p 20p | "RAMSIS" BFY51 BFY52 BRY39 BRY39 BU105 BU105 BU106 ML2955 MESA06 MPSA06 MPSA06 MPSA06 C28 C35 C44/2 C44/5 CC71 CC72 CC32 CC33 TIP2955 | TORS 16p 17p 17p 18p 175p 175p 18p 18p | N2904/5 2N2928FB 2N2928VG 2N3928VG 2N3953 2N39053 2N39045 2N39045 2N3702/3 2N3702/3 2N3706/9 2N3707 2N3708/9 2N3707 2N3708/9 2N3708/9 2N3707 2N3908/9 2N3908 | 1 |
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| 22 15:03 3 17:14 17:15 17:16 17:16 17:16 17:17 18:17 1 | 749 pp 749; pp 741; pp | 11 81p 23 43p 33 43p 34 48p 36 48p 37 7 295p 00 116p 00 116p 00 64p 18 90p 12 22 53p 12 22 53p 22 75p 22 75p 23 776p 33 681p 41 70p 44 70p 44 770p 44 770p 45 776p 55 177p | 710 741 747 748 747 748 776 CA3130S LM3900 MC1458 NE536T LINEAR ICa CA3028 CA3048 CA3048 CA3088E CA3090AQ ICL8038CC LM380 LM381 MC1310P MC1495L MC1496L | Diff. Comp. 14 pin DIL Int. Comp. 8/14 pin DIL Dual 741 14 pin DIL Ext. Comp. 8 pin DIL Ext. Comp. 8 pin DIL Oual 70. Amp. 14 pin DIL Oual Op. Amp. 7099 CMOS Op. Amp. 8 pin DIL Dual Op. Amp. 14 pin DIL Dual Op. Amp. 8 pin DIL FET Op. Amp. 7099 Diff. Cascade Amp. 5 Transistor Array Ouad Low Noise Amps. FM IF System 16 DIL FM Stereo Decoder VCO Funct. Gen. 2W Audio Amp. Stereo Pre Amp. FM Stereo Dec. Multiplier | 55p 25p 67p 39p 160p 108p 61p 75p 300p 112p 62p 250p 250p 900p 115p 200p 220p 2360p | Data Sheets Vol. Regs. 10p each 1468 Dual 1 Adjustable fr OPTO ELEE OCP70 3: OCP71 12: ORP12 25: ORP60 7: ORP61 8: 2N5777 4: SCR-THYRIS1 1A 50V TOS 1A 400V TOS 1A 400V TOS 3A 400V Stud 3A 400V Stud 7A 400V | 12 0n 15 18 24 15 18 24 16 18 24 16 18 24 16 18 24 16 18 18 18 18 18 18 18 18 18 18 18 18 18 | V 7812 1 V 7815 1 V 7815 1 V 7824 1 V 7824 1 300p. Promin. to ± 130p 150p 150p 150p 250p HT106 1A Plastic: C 4A/400V 2N444 8A | 50p 7912 2: 50p 7915 2: 50p 7918 2: 50p 7924 2: eset at ± 1: 20V max. LEDs Tit209 1 (Red) Tit211 3 (Green) Tit32 2 (Intrared) 700V 15 | 15 | 20p 12p 14p 46p 39p 18p 35p 43p 10p 11p 9p 10p 11p 15p 20p 17p 20p 12p | BRY39 BSX19/20 BU105 BU105 BU108 MJ2955 MJE340 MJE2955 MPSA06 MPSA06 MPSU06 MPS | 39p 20p 175p 90p 49p 107p 37p 62p 78p 65p 70p 20p 20p 20p 25p 35p | 2N29260 2N2926YG 2N39553 2N3954 2N3955 2N3442 2N3702/3 2N3704/5 2N3707 2N3707 2N3707 2N3703 2N3904 2N39773 2N3866 2N38904 2N39905/6 2N4058 2N4058 2N4058 2N4050 2N4289 40360 | 1 1 1 5 5 5 5 1 5 1 1 1 1 1 1 2 5 9 2 2 2 1 1 2 4 |
| 33 17/104 | P 749:P 749:P 749:P 749:P 749:P 749:P 749:P 741:P 741: | 22 48p 43p 43p 43p 43p 44 81p 55 70p 66 84p 70 70 70 70 70 70 70 7 | 741 747 748 776 CA3130S LM3900 MC1-58 NE536T LINEAR ICe CA3028 CA3048 CA3048 CA3090AQ ICL8038CC LM380 LM381 MC1310P MC1495L MC1496L | Int. Comp. 8/14 pin DIL Dual 741 14 pin DIL Ext. Comp. 8 pin DIL Prog. Op. Amp. T099 CMOS Op. Amp. 8 pin DIL Quad Op. Amp. 14 pin DIL Dual Op. Amp. 8 pin DIL FET Op. Amp. T099 Diff. Cascade Amp. 5 Transistor Array Quad Low Noise Amps. FM IF System 16 DIL FM Sterso Decoder VCO Funct. Gen. 2W Audio Amp. Sterso Dec. Multiplier FM Sterso Dec. Multiplier | 25p 67p 39p 160p 108p 61p 75p 300p 112p 62p 250p 250p 900p 115p 200p 115p 200p | Vol. Regs. 10p each 1488 Dual 1 Adjustable fr OPTO ELE: OCP71 120 OPP12 120 OPP12 120 OPP12 120 OPP13 120 OPP13 14 50V TOS 1A 100V TOS 1A 400V TOS 1A 400V Stud 3A 400V Stud 3A 400V Stud 3A 400V Stud 7A 400V TOS 1A 400V TOS 1A 400V Stud 3A 40V Stud 3A 40 | 00 15 18 24 101. Reg. 00m ± 8V CTRONICS p Sevenip p 3015F p DL704 p DL747 ORS 43p 45p 55p | V 7815 1 V 7818 1 V 7824 1 300p. Promin. to ± 130p 150p 150p 250p BT106 1A Plastic: C 4A/400V 2N444 8A | \$9p 7915 2: \$9p 7918 2: \$9p 7924 2: \$9p 7924 2: seet at ± 1: 20V max. LEDs T1L209 1 (Red) T1L211 3 (Green) T1L32 1 (Infrared) T00V 105D 5: 5:000V 2: | AC176 | 12p 14p 46p 38p 18p 18p 35p 10p 11p 9p 10p 11p 12p 17p 20p 17p 20p | BSX19/20 BU105 BU108 MJ2955 MJE340 MJE2955 MJE3055 MPSA06 MPSU06 MPSU06 OC28 OC35 OC41/2 OC44/5 OC72 OC83 TIP2955 | 20p 175p 312p 90p 48p 107p 70p 37p 62p 78p 98p 65p 70p 20p 20p 25p 35p 85p | 2N3053 2N3054 2N3055 2N3442 2N3702/3 2N3704/5 2N3707 2N3708/9 2N3773 2N3866 2N3804 2N3905/6 2N4058 2N4050 2N4289 40360 | 15 55 15 11 11 11 12 25 9 22 22 11 11 12 4 |
| 05 177 1999 22199 22191 25513 3414 6514 6522 1922 1923 36632 2832 28337 2844 1544 170 442 644 2644 444 6444 6444 6444 6444 6 | P 749-P 749-P 749-P 749-P 749-P 741-P P P 741-P P P 741-P P P 741-P P P P P P P P P P P P P P P P P P P | 81p 70p 70p 70p 70p 70p 70p 70p 70p 70p 70 | 748 776 CA3130S LM3900 MC1-58 NE536T LINEAR ICe CA3028 CA3046 CA3048 CA3089E CA3090AQ ICL8038CC LM380 LM381 MC1310P MC1495L MC1496L | Ext. Comp., 8 pin DIL Prog. Op. Amp. 1099 CMOS Op. Amp. 8 pin DIL Quad Op. Amp. 14 pin DIL Dual Op. Amp. 8 pin DIL FET Op. Amp. 17099 DIH. Cascade Amp. 5 Transistor Array Quad Low Noise Amps. FM IF System 16 DIL FM Sterso Decoder VCO Funct. Gen. 2W Audio Amp. Sterso Pre Amp. FM Sterso Dec. Multiplier | 39p 160p 108p 61p 75p 300p 112p 62p 250p 250p 300p 115p 200p 120p 360p | 10p each 1468 Dual 1 Adjustable fr OPYO ELEI OCP70 3: OCP71 3: OCP71 5: ORP61 8: 2N5777 4: SCR-THYRIS] 1A 50V TOS 1A 100V TOS 1A 400V Stud 3A 400V Stud 3A 400V Stud 7A 400V Stud 7A 400V | 24 /oi. Reg. om ± 8V CTRONICS p Seven p Displa: p 3015F p DL704 p DL707 p DL747 ORS 43p 45p 56p 53p | V 7824 1 300p. Promin. to ± Segment ys 130p 150p 150p 250p BT106 1A Plastic: C 4A/400V 2N4444 8A TO66: 2N3 | 59p 7924 2* seet at ± 1 20V max. LEDs T1L209 1 (Red) T1L211 (Green) T1L32 2 (Intrared) 700V 15 1060 5 2 600V 22 | Sp | 46p 38p 18p 18p 35p 43p 10p 11p 9p 10p 11p 13p 15p 20p 17p 20p | BU108 MJ2955 MJE3955 MJE3955 MJE3955 MPSA06 MPSA12 MPSU06 MPSU56 OC28 OC41/2 OC44/5 OC71 OC72 OC83 TIP2955 | 312p 90p 49p 107p 70p 37p 62p 78p 98p 65p 70p 20p 20p 25p 25p 35p | 2N3054 2N3055 2N3442 2N3702/3 2N3704/5 2N3706 2N3707 2N3706/9 2N3773 2N3866 2N3905/6 2N4058 2N4060 2N4289 40360 | 55 15 11 11 11 12 5 5 12 11 12 12 14 14 14 14 14 14 14 14 14 14 14 14 14 |
| 06 41) 08 39) 08 177 09 2220 1511 255 111 255 | P 749: 749: 749: 749: 749: 749: 741: 741: 741: 741: 741: 741: 741: 741 | 55 70p 66 84p 77 295p 70 116p 70 295p 70 116p 70 20 116p 70 21 32p 71 32p 72 22 53p 73p 72 28 90p 73 29 74 70p 76 20 76 20 77 | 776 CA3130S LM3900 MC1458 NE536T LINEAR ICe CA3028 CA3046 CA3048 CA3088E CA3098C LM380 LM381 MC1310P MC1495L MC1495L MC1496L | Prog. Op. Amp. T099 CMOS Op. Amp. 14 pin DIL Ouad Op. Amp. 8 pin DIL Dual Op. Amp. 8 pin DIL FET Op. Amp. T099 Diff. Cascade Amp. 5 Transistor Array Ouad Low Noise Amps. FM IF System 16 DIL FM Stereo Decoder VCO Funct. Gen. 2W Audio Amp. Stereo Pre Amp. FM Stereo Dec. Multiplier | 160p 108p 61p 75p 300p 112p 62p 250p 250p 900p 115p 200p 220p 360p | 1468 Dual 1 Adjustable fr OPTO ELEC OCP70 3: OCP71 12: ORP12 5: ORP61 8: 2N5777 4: SCR-THYRIS1 1A 50V TOS 1A 100V TOS 1A 400V Stud 3A 400V Stud 7A 400V Stud 7A 400V | 701. Reg. om ± 8V CTRONICS p Seven p Display p 3015F p DL704 p DL707 p DL747 OR8 43p 45p 56p 53p | 300p. Promin. to ± Segment ys 130p 150p 250p BT106 1A Plastic: C 4A/400V 2N4444 8A TO66: 2N3 | LEDs T1L209 (Red) T1L211 (Green) T1L21 (Intrared) (Intrared) | AD181/2 AF114/5 AF114/5 AF116/7 AF139 BP BC107/8 BC107/8 BC147/8 BC157 BC158/9 BC157 BC158/9 BC169C BC177 BG158/9 BC178 BC178 BC178 BC178 BC178 BC178 BC178 | 39p 18p 18p 35p 43p 10p 11p 9p 10p 11p 13p 15p 20p 17p 20p 12p | MJ2955 MJE340 MJE2955 MJE3055 MPSA06 MPSA12 MPSU06 MPSU56 OC28 OC35 OC41/2 OC44/5 OC71 OC72 OC83 TIP2955 | 90p 49p 107p 70p 37p 62p 78p 98p 65p 70p 20p 20p 25p 35p 85p | 2N3055 2N3442 2N3702/3 2N3704/5 2N3706 2N3707 2N3708/9 2N3773 2N3866 2N3904 2N3905/6 2N4058 2N4060 2N4289 40360 40361 | 5 15 1 1 1 1 25 2 2 1 1 1 2 1 1 1 1 2 1 1 1 1 |
| 707 399 177 399 222 199 1517 322 199 1522 1922 1933 3630 15337 28837 2844 44 45 45 45 45 45 45 45 45 45 45 45 4 | 749 749 749 749 749 749 749 741 741 741 741 741 741 741 741 741 741 | 6 84p 7 295p 70 116p 07 32p 10 64p 18 90p 21 32p 22 53p 22 73p 26 78p 28 90p 30 81p 41 70p 44 173p 551 77p | CA3130S LM3900 MC1458 NE536T LINEAR ICe CA3028 CA3046 CA3048 CA3089E CA3090AQ ICL8038CC LM381 MC1310P MC1495L MC1496L | CMÖS Óp. Amp. 8 pin DIL Quad Op. Amp. 14 pin DIL Dual Op. Amp. 8 pin DIL FET Op. Amp. 7099 Diff. Cascade Amp. 5 Transistor Array Quad Low Noise Amps. FM IF System 16 DIL FM Sterso Decoder VCO Funct. Gen. 2W Audio Amp. Sterso Pre Amp. FM Sterso Dec. Multiplier | 108p 61p 75p 300p 112p 62p 250p 500p 900p 115p 200p 220p 360p | Adjustable fr OPTO ELEC OCPTO 3: COP71 12: ORP12 5- ORP61 8: 2N5777 4: SCR-THYRIS1 1A 50V TOS 1A 100V TOS 1A 400V Stud 3A 400V Stud 7A 400V Stud 7A 400V | om ± 8V CTRONICS P Seven P Display P 3015F P DL707 P DL707 P DL747 OR8 43p 45p 56p 53p | Segment ys 130p 150p 250p BT106 1A Plastic: C 4A/400V 2N4444 8A TO66: 2N3 | LEDe T1L209 1 (Red) T1L211 3 (Green) T1L32 7 (Intrared) 700V 15 600V 20 | AF114/5 AF118/7 AF139 AF239 BC107/8 BC107/8 BC109C BC147/9 BC158 BC158/9 BC158/9 BC158/9 BC178 BC178 BC178 BC178 BC178 BC178 BC178 BC178 BC178 | 18p 18p 35p 43p 10p 11p 9p 10p 11p 13p 15p 20p 17p 20p 12p | MJE340 MJE3955 MJE3055 MPSA06 MPSA12 MPSU06 MPSU56 OC28 OC41/2 OC41/2 OC41/5 OC72 OC83 TIP2955 | 107p 70p 37p 62p 78p 98p 65p 70p 20p 20p 20p 25p 35p 85p | 2N3702/3 2N3704/5 2N3706 2N3707 2N3708/9 2N3773 2N3866 2N3904 2N3905/6 2N4058 2N4060 2N4289 40360 40361 | 1 |
| 09 220 1511 2512 2513 3444 6516 3220 1517 3220 1552 3330 1533 3440 1514 442 644 | 741 10 741 | 00 116p 07 32p 10 64p 18 90p 21 32p 22 53p 23 73p 26 76p 90p 32 76p 36 81p 41 70p 45 76p 48 173p 50 135p | LM3900 MC1458 NE536T LINEAR ICI CA3028 CA3046 CA3048 CA308BE CA3090AQ ICL8038CC LM381 MC1310P MC1495L MC1495L MC1496L | Ouad Op. Amp. 14 pin DIL Dual Op. Amp. 8 pin DIL FET Op. Amp. TO99 Diff. Cascade Amp. 5 Transistor Array Ouad Low Noise Amps. FM IF System 16 DIL FM Stereo Decoder VCO Funct. Gen. 2W Audio Amp. Stereo Pre Amp. FM Stereo Dec. Multiplier | 61p 75p 300p 112p 62p 250p 250p 900p 115p 200p 220p 360p | OPTO ELEC OCP70 3: OCP71 12: ORP12 5: ORP60 7: ORP61 8: 2N5777 4: SCR-THYRIST 1A 50V TO5 1A 400V TO5 3A 100V Stud 3A 400V Stud 7A 400V | TRONICS P Seven p Display p 3015F p DL704 p DL707 p DL747 ORS 43p 45p 55p 53p | Segment ys 130p 150p 150p 250p BT106 1A Plastic: C 4A/400V 2N4444 8A TO66: 2N3 | LEDs T1L209 1 (Red) T1L211 3 (Green) T1L32 7 (Intrared) 700V 15 105D 5 2600V 26 | AF139 AF239 BC107/8 BC109/C BC147/8 BC149 BC158-9 BC158-9 BC158-9 BC169/C BC179 BC179 BC179 BC179 BC182/3 | 35p 43p 10p 11p 9p 10p 11p 13p 15p 20p 17p 20p 12p | MJE3055 MPSA06 MPSA12 MPSU06 MPSU56 OC28 OC35 OC41/2 OC44/5 OC71 OC72 OC83 TIP2955 | 70p 37p 62p 78p 98p 65p 70p 20p 20p 20p 25p 35p 85p | 2N3704/5 2N3706 2N3707 2N3708/9 2N3773 2N3866 2N3804 2N3905/6 2N4058 2N4060 2N4289 40360 40361 | 2 |
| 1511 25111 25511 25111 2 | p 741 p 741 ip 741 | 07 32p 10 64p 18 90p 21 32p 22 53p 22 53p 73p 28 90p 32 76p 36 81p 41 70p 45 76p 48 173p 50 135p 51 77p | MC1458 NE536T LINEAR ICI CA3028 CA3046 CA3048 CA3089E CA3090AQ ICL 8038CC LM380 LM381 MC1310P MC1495L MC1496L | Dual Op. Amp. 8 pin DIL FET Op. Amp. T099 Diff. Cascade Amp. 5 transistor Array Quad Low Noise Amps. FM IF System 16 DIL FM Sterso Decoder VCO Funct. Gen. 2W Audio Amp. Sterso Pre Amp. FM Sterso Dec. Multiplier | 300p 112p 62p 250p 250p 500p 300p 115p 200p 220p 360p | OCP70 3: OCP71 12: ORP12 5: ORP60 7: ORP61 8: 2N5777 4: SCR-THYRIST 1A 50V TO5 1A 100V TO5 3A 100V Stud 3A 400V Stud 7A 400V | p Seven p Display p 3015F p DL704 p DL707 p DL747 ORS 43p 45p 56p 53p | Segment ys 130p 150p 150p 250p BT106 1A Plastic: C 4A/400V 2N4444 8A TO66: 2N3 | TiL209 1 (Red) TiL211 3 (Green) TiL32 (Infrared) 700V 15 106D | AF239 BC107/8 BC109C BC147/8 BC149 BC157 BC158/9 BC157 BC158/9 BC177 BC178 BC179 BC182/3 | 43p 10p 11p 9p 10p 11p 13p 15p 20p 17p 20p 12p | MPSA08 MPSA12 MPSU06 MPSU56 OC28 OC35 OC41/2 OC44/5 OC71 OC72 OC83 TIP2955 | 37p 62p 78p 98p 65p 70p 20p 20p 25p 35p 85p | 2N3706 2N3707 2N3708/9 2N3773 2N3866 2N3904 2N3905/6 2N4058 2N4060 2N4289 40360 40360 | 2 |
| 111 25:12 25:13 34:14 65:16 32:17 32:21 19:22 19:23 36:25 33:32 28:33 28 | p 741 p 741 | 10 64p 18 90p 21 32p 22 53p 23 73p 28 90p 32 76p 36 81p 41 70p 45 76p 48 173p 50 135p 50 135p | LINEAR ICs CA3028 CA3048 CA3048 CA3090AQ ICL8038CC LM380 LM381 MC1310P MC1495L MC1496L | Diff. Cascade Amp. 5 Transistor Array Quad Low Noise Amps. FM IF System 16 DIL FM Sterso Decoder VCO Funct. Gen. 2W Audio Amp. Stereo Pre Amp. FM Stereo Dec. Multiplier | 112p 62p 250p 250p 500p 600p 115p 200p 220p 360p | OCP71 124 ORP60 7: ORP61 8: 2N5777 4: SCR-THYRIST 1A 50V TO5 1A 100V TO5 1A 400V Stud 3A 400V Stud 7A 400V | P Displa; p 3015F p DL704 p DL707 p DL747 ORS 43p 45p 56p 53p | 130p 150p 150p 250p BT106 1A Plastic: C 4A/400V 2N4444 8A TO66: 2N3 | (Green) TIL211 (Green) TIL32 (Intrared) 700V 15 1060 5 600V 20 | BC107/8 | 10p 11p 9p 10p 11p 13p 15p 20p 17p 20p 12p | MPSU06 MPSU56 OC28 OC35 OC41/2 OC44/5 OC71 OC72 OC83 TIP2955 | 78p 98p 65p 70p 20p 20p 25p 35p 85p | 2N3708/9 2N3773 2N3866 2N3904 2N3905/6 2N4058 2N4060 2N4289 40360 40361 | 2 |
| 13 34 14 65 16 32 17 32 20 15 22 19 23 36 25 33 27 40 30 15 32 28 37 28 40 15 41 70 42 64 | ip 741: ip 741: | 21 32p 22 53p 23 73p 26 78p 28 90p 32 76p 36 81p 41 70p 45 76p 45 76p 48 173p 50 135p 51 77p | CA3026 CA3046 CA3048 CA3089E CA3090AQ ICL8038CC LM361 MC1310P MC1495L MC1496L | Diff. Cascade Amp. 5 Transistor Array Quad Low Noise Amps. FM IF System 16 DIL FM Sterso Decoder VCO Funct. Gen. 2W Audio Amp. Stereo Pre Amp. FM Stereo Dec. Multiplier | 62p 250p 250p 500p 300p 115p 200p 220p 360p | ORP12 5- ORP60 8: 2N5777 4: SCR-THYRIST 1A 50V TO5 1A 100V TO5 1A 400V TO5 3A 100V Stud 3A 400V Stud 7A 400V | p 3015F p DL704 p DL707 p DL747 ORS 43p 45p 56p 53p | 130p 150p 150p 250p BT106 1A Plastic: C 4A/400V 2N4444 8A TO66: 2N3 | TIL211 (Green) TIL32 (Intrared) 700V 15 1060 5 | 75p BC147/8 BC149 BC155/9 BC158/9 BC169C BC177 BC178 BC178 BC179 BC182/3 | 9p 10p 11p 13p 15p 20p 17p 20p 12p | MPSU56 OC28 OC35 OC41/2 OC44/5 OC71 OC72 OC83 TIP2955 | 98p 65p 70p 20p 20p 25p 35p 85p | 2N3773 2N3866 2N3904 2N3905/6 2N4058 2N4060 2N4289 40360 40361 | 2 |
| 14 65 16 32 17 32 20 15 22 19 23 36 25 33 27 40 30 15 32 28 37 28 40 15 41 70 42 64 | 741: 12 741: 12 741: 13 741: 14 741: 15 741: 16 741: 17 741: 18 741: 18 741: 18 741: 18 741: | 22 53p 23 73p 26 76p 32 76p 32 76p 36 81p 41 70p 45 76p 48 173p 50 135p 51 77p | CA3046 CA3048 CA3089E CA3090AQ ICL8038CC LM380 LM381 MC1310P MC1495L MC1496L | 5 Transistor Array Quad Low Noise Amps. FM IF System 16 DIL FM Stereo Decoder VCO Funct. Gen. 2W Audio Amp. Stereo Pre Amp. FM Stereo Dec. Multiplier | 62p 250p 250p 500p 300p 115p 200p 220p 360p | ORP61 8: 2N5777 4: SCR-THYRIST 1A 50V TO5 1A 100V TO5 1A 400V TO5 3A 100V Stud 3A 400V Stud 7A 400V | DL704 P DL707 P DL747 ORS 43p 45p 56p 53p | 150p 250p BT106 1A Plastic: C 4A/400V 2N4444 8A TO66: 2N3 | 71L32 (Infrared) 700V 15 106D 5 | BC149 BC157 BC158/9 BC169C BC177 BC178 BC179 BC179 BC182/3 | 10p 11p 13p 15p 20p 17p 20p 12p | OC28 OC35 OC41/2 OC44/5 OC71 OC72 OC83 TIP2955 | 65p 70p 20p 20p 20p 25p 35p 85p | 2N3866 2N3904 2N3905/6 2N4058 2N4060 2N4289 40360 40361 | |
| 16 32 17 32 20 15 22 19 22 3 36 25 33 27 40 30 15 32 28 37 28 40 15 41 70 42 64 | 741: 1p 741: | 23 73p 26 76p 28 90p 32 76p 36 81p 41 70p 45 76p 45 173p 50 135p 51 77p | CA3048 CA3089E CA3090AQ ICL8038CC LM380 LM381 MC1310P MC1495L MC1496L | Quad Low Noise Amps. FM IF System 18 DIL FM Stereo Decoder VCO Funct. Gen. 2W Audio Amp. Stereo Pre Amp. FM Stereo Dec. Muttiplier | 250p 250p 500p 300p 115p 200p 220p 360p | 2N5777 4: SCR-THYRIST 1A 50V TO5 1A 100V TO5 1A 400V TO5 3A 100V Stud 3A 400V Stud 7A 400V | P DL747 ORS 43p 45p 56p 53p | 250p BT106 1A Plastic: C 4A/400V 2N4444 8A TO66: 2N3 | (Infrared) 700V 15 106D 5 1/600V 20 | BC157 BC158/9 BC169C BC177 BC178 BC178 BC179 BC182/3 | 11p 13p 15p 20p 17p 20p 12p | OC35 OC41/2 OC44/5 OC71 OC72 OC83 TIP2955 | 70p 20p 20p 20p 25p 35p 85p | 2N3905/6 2N4058 2N4060 2N4289 40360 40361 | |
| 20 15 22 19 23 36 25 33 27 40 30 15 30 15 32 28 37 28 40 15 41 70 42 64 | 741; p 741; ip 741; ip 741; ip 741; ip 741; ip 741; ip 741; | 28 90p 32 76p 36 81p 41 70p 45 76p 48 173p 50 135p 51 77p | CA3089E CA3090AQ ICL8038CC LM380 LM381 MC1310P MC1495L MC1496L | FM IF System 18 DIL FM Stereo Decoder VCO Funct. Gen. 2W Audio Amp. Stereo Pre Amp. FM Stereo Dec. Multiplier | 250p 500p 300p 115p 200p 220p 360p | SCR-THYRIST 1A 50V TD5 1A 100V TO5 1A 400V TO5 3A 100V Stud 3A 400V Stud 7A 400V | 0R8 43p 45p 56p 53p | BT106 1A Plastic: C 4A/400V 2N4444 8A TO66: 2N3 | 700V 15 106D 5 | BC158/9 BC169C BC177 BP BC178 BC179 BC182/3 | 13p 15p 20p 17p 20p 12p | OC44/5 OC71 OC72 OC83 TIP2955 | 20p 20p 25p 35p 85p | 2N4058 2N4060 2N4289 40360 40361 | |
| 22 19 23 36 25 33 27 40 30 15 32 28 37 28 40 15 41 70 42 64 | p 741: ip 741: ip 741: ip 741: ip 741: ip 741: ip 741: | 32 76p 36 81p 41 70p 45 76p 48 173p 50 135p 51 77p | CA3090AQ ICL8038CC LM380 LM381 MC1310P MC1495L MC1496L | FM Stereo Decoder VCO Funct. Gen. 2W Audio Amp. Stereo Pre Amp. FM Stereo Dec. Multiplier | 500p 300p 115p 200p 220p 360p | 1A 50V TD5 1A 100V TO5 1A 400V TO5 3A 100V Stud 3A 400V Stud 7A 400V | 43p 45p 56p 53p | Plastic: C 4A/400V 2N4444 8A TO66: 2N3 | 106D 5 | BC177 BC178 BC179 BC182/3 | 20p 17p 20p 12p | OC71 OC72 OC83 TIP2955 | 20p 25p 35p 85p | 2N4060 2N4289 40360 40361 | 2 |
| 23 36 25 33 27 40 30 15 32 28 37 20 40 15 41 70 42 64 | ip 741 ip 741 ip 741 ip 741 ip 741 ip 741 | 36 81p 41 70p 45 76p 48 173p 50 135p 51 77p | LM380 LM381 MC1310P MC1495L MC1496L | 2W Audio Amp. Stereo Pre Amp. FM Stereo Dec. Multiplier | 115p 200p 220p 360p | 1A 50V TD5 1A 100V TO5 1A 400V TO5 3A 100V Stud 3A 400V Stud 7A 400V | 43p 45p 56p 53p | Plastic: C 4A/400V 2N4444 8A TO66: 2N3 | 106D 5 | BC177 BC178 BC179 BC182/3 | 17p 20p 12p | OC72 OC83 TIP2955 | 25p 35p 85p | 40360 40361 | |
| 27 40 30 15 32 28 37 28 40 15 41 70 42 64 | ip 741 ip 741 ip 741 ip 741 ip 741 | 45 76p 48 173p 50 135p 51 77p | LM381 MC1310P MC1495L MC1496L | Stereo Pre Amp. FM Stereo Dec. Multiplier | 200p 220p 360p | 1A 400V TO5 3A 100V Stud 3A 400V Stud 7A 400V | 56p 53p | 2N4444 8A TO66: 2N3 | /600V 20 | BC179 BC182/3 | 20p 12p | TIP2955 | 85p | 40361 | |
| 30 15 32 28 37 28 40 15 41 70 42 64 | ip 741 lp 741 lp 741 lp 741 | 48 173p 50 135p 51 77p | MC1310P MC1495L MC1496L | FM Stereo Dec. Multiplier | 220p 360p | 3A 100V Stud 3A 400V Stud 7A 400V | 53p | TO66: 2N3 | | BC102/3 | 12p | | | | |
| 32 28 37 28 40 15 41 70 42 64 | p 741 p 741 p 741 | 50 135p 51 77p | MC1495L MC1496L | Multiplier | 360p | 3A 400V Stud 7A 400V | | | | | | | | | - |
| 37 28 10 15 11 70 12 64 | ip 741 ip 741 | 51 77p | MC1496L | | | | | | | BC184 | 14p | TIP30A | 60p | 40410 | |
| 41 70 42 64 | | 53 92p | | | | | | TO92: MC | R101 | BC187 BC212 | 32p | TIP31A | 56p | 40411 | 2 |
| 42 64 | | | MFC4000B | W Audio Amp. | 75p | TO5 + HS 16A 100V Plas | 97p | 0-5A/15 2N5060 0 | | BC213 | 12p | TIP32A TIP33A | 63p | 40594 40595 | - 1 |
| | | | MFC6040 | Electronic Attenuator | 140p | 16A 400V Plas | | 2N5062 0 | | ISO BUZIA | 17p | TIP34A | 124p | FETS | |
| | p 741 | 56 82p | NE555V | Timer 8 pin DIL | 40p | 16A 600V Plas | ic 240p | 2N5064 0 | | Sop BCY70 BCY71 | 20p 24p | TIP35A | 243p | BF244 | |
| 44 130 | | | NE556 NE561B | Dual 555 14 pin DIL PLL with AM Demod. | 108p 350p | | | | | BD131 | 39p | TIP36A TIP41A | 297p 70p | MPF102 MPF103/4 | . : |
| 45 100 46 108 | | | NE562B | PLL with VCO | 350p | TRIACS 100 | / 400V 5 | 00V | OTHER | BD132 | 43p | TIP42A | 76p | MPF105 | |
| 47 81 | | | NE565 | PLL | 216p | 3 amp 92 | | 40p | 40430 11 | | 54p | ZTX108 | 11p | 2N3819 | |
| 48 - 75 | | | NE566V | PLL Function Gen. | 200p | 6 amp , 95 | 150p 1 | 80p | 40486 11 40669 19 | | 79p 87p | ZTX300 | 16p | 2N3820 2N3823 | |
| 50 16 51 16 | | | NE567V | PLL Tone Decoder | 200p | 10 amp 117 | | 00p 50p | | 5p BF115 | 24p | ZTX500 ZTX504 | 19p 60p | 2N5457 | |
| | 79 741 70 741 | | 2567 SN72733 | Dual 567 Video Amp. | 400p 150p | 15 amp 156 | 220p 2 | anb | | BF167 | 25p | 2N697 | 14p | 2N5458/9 | |
| | lp 741 | | SN76013N | Pwr. Audio Amp+HS | 175p | BRIDGE | DIOI | DES | 1N914 | 4p BF173 BF194 | 27p | 2N698 | 32p | 3N128 3N140 | |
| | Sp 741 | | SN76023N | Pwr. Audio Amp+HS | 175p | RECTIFIER | | | 1N4001 | 6P BE105 | 10p | 2N706 2N708 | 13p 19p | 3N141 | |
| | 7p 741 | | TBA641B | Audio Amp | 275p | ‡A 100V 25 | | | 1N4004 1N4007 | 7p BF196 8p BF197 | 15p | 2N930 | 19p | 3N187 | 2 |
| 73 32 | 2p 741 | 182 89p | TBA800 | 5W Audio Amp. | 112p | 1A 100V 27 | | | 1N4148 | 4p BF197 BF200 | 15p 36p | 2N1131/2 | 19p | 3N202 | 1 |
| | 2p 741 | | TBA810 TBA820 | 7W Audio Amp. 2W Audio Amp. | 125p 100p | 1A 400V 36 | P OA70 | 10p | ZENERS | BF257/8 | 34p | 2N1304/5 2N1306 | 23p 30p | 40603 40673 | |
| | Bp 741 2p 741 | | TDA2020 | 20W Audio Amp. | 375p | 1A 600V 37 2A 50V 37 | | | 400mW | 11p BFR39/40 | 37p | 2N1613 | 22p | UJTe | |
| 80 54 | 4p 741 | 193 130p | XR2240 | Prog./Timer Counter | 400p | 2A 100V 44 | | | 1W 2 | BFR79/80 BFX84 | 37p 28p | 2N1711 | 22p | TIS43 | |
| | 5p 741 | | ZN414 | TRF Radio Receiver | 140p | 2A 400V 56 | P OA9 | 1 9p | OTHER | BEXAS/6 | 28p | 2N1893 2N2219 | 32p 22p | 2N2160 2N2646 | |
| 83 8 6 84 10 3 | 6p 741 3p 741 | | MM5314 | Clock IC 24 pin DIL | 460p | 2A 600V 60 | | | | OP BFX87 | 22p | 2N2221/2 | 22p | 2N4871 | |
| 85 130 | 0p 741 | 197 108p | | FILE SOCKETS BY TEXAS | -8 pin | 4A 100V 65 6A 100V 70 | | | | 17p BFX88 10p BFY50 | 26p | 2N2369 | 15p | 2N6027 | |
| 86 32 | 2p 741 | 198 214p | 14p; 14 pin | 15p; 15 pin 16p; 24 pin 54p. | | | O/C | - ор | | DF Y50 | 17p | 2N2484 54 SAND | 32p | (PUJT) | i |

INDEX TO ADVERTISERS

| | | • |
|--------------------------------------|--|---------------------------------|
| A.B.C. Electronics (Oldham) Ltd434 | Electrovalue Ltd366 | Olson Electronics366 |
| Adam Hall (P.E. Supplies)436 | Elliot Blunt Audio426 | Orchard Electronics368 |
| | Elvins Electronics426 | Osmabet |
| Alben Engineering356 | Elvins Electronics420 | Osmadet |
| Audio-Optics435 | | |
| Automated Homes436 | Field Electric Ltd434 | Phonosonics |
| | Flairline Supplies | Phototech (Europe)436 |
| Bamber, B., Electronics | riamine Supplies | Precision Petite416 |
| | | Pulse Electronics Ltd |
| Barclay Electronics369 | Goldring419 | Pulse Electronics Ltd |
| Barrie Electronics423 | Greenbank388 | |
| B.H. Components416 | Greenweld Electronics420 | Radio Component Specialists433 |
| Bib Hi-Fi Solder354 | Greenweid Electronics420 | Radio Exchangecover iii |
| Bi-Pak | | Ramar Constructor Services436 |
| | Harverson's Surplus439 | R.T. Services |
| Bi-Pre-Pak431 | H.B. Electronics416 | H. I. Services |
| Birkett, J428 | Helme Audio435 | R.S.T. Valve Mail Order Co438 |
| Boffin Projects436 | | Radio & T.V. Components362, 363 |
| Bridge364 | Henry's Radio430 | |
| British Institute of Engineering | | Salop Electronics436 |
| Technology360, 428 | I.L.P. Electronics Ltd | Saxon Entertainments Ltd |
| British National Radio & Electronics | | Saxon Entertainments Ltd |
| | Imtech (Exetrontine)425 | S.C.6. Components361 |
| School387 | International Electronics Unlimited365 | Selray Book Co |
| Burneze354 | Intertext ICS435 | Service Trading429 |
| Butterworths427 | Island Devices434 | Sinclair Radio400, 401 |
| Bywood Electronics432 | | Sintel430 |
| | and the same of th | 3111181 |
| 0.00 | Jones, J. C434 | Special Products360 |
| Cambridge Learning368 | J.W.B. Radio434 | Sugden, A. R358 |
| Chiltmead Ltd356 | | Swanley Electronics432 |
| Chromasonic Electronicscover ii | Kanadan Cundlina 405 | |
| C.J.L388 | Kensington Supplies435 | Tapetalk435 |
| Clef Products416 | | Technomatic Ltd440 |
| Copper Supplies436 | Lasky's356 | Technomatic Lid |
| Crescent Radio Ltd | London Electronics College435 | Teleradio Electronics436 |
| | London Licentonies conege | Time-Micro Electronics357 |
| Crofton Electronics436, 368 | | Trampus Electronics428 |
| | Magnum Publications435 | · |
| Design Engineering438 | Maplin Electronic Suppliescover iv | Vero Electronics |
| Doram415 | Marco Trading434 | Vero Electronics |
| Dziubas, M | Marshall, A., & Sons437 | • |
| DZIUDAS, WI | Mawson Associates435 | West London Direct Supplies432 |
| | | Wood Jeffreys388 |
| Eagle International430 | M.C.L434 | Wilmslow Audio |
| Eaton Audio364 | Milward, G. F420 | MILLISION MUDIO |
| Electronic Design Assocs426 | Minikits Electronics436 | |
| Electro-Spares436 | Modern Book Co | Young Electronics438 |
| Liverio operior | | |
| | | |
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International Giro facilities Account No. 5122007. Please state reason for payment, "message to payee".

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