Electronics Today

INTERNATIONAL AUGUST 1980

$1·75

300W AMP

Test Gear Survey

Transistor Tester

FET Special

Life Out There?

The search for extra-terrestial intelligence.

ARKON Electronics...
your place for sizzling summer buys!

CP••IO••1

An S-100 system card, wired and tested that will outperform the mass market systems in versatility, price and speed. It has all the CPU (8080) disc control (1771) and IO (8255) needed for a disc based CPM system. Interfaces, to all common 8" and 5¼" drives. (Shugart, Memorex, BASF, Siemens, Wang). Also features EIA RS-232 port (110 to 9600 baud), fully vecored interrupts (TMS5501), on board digital data separator,2K bytes EPROM,24 fully handshaked IO lines, dual mapped IO, cassette interface on board, fully buffered $495.00

ASCII ENCODED KEYBOARD

RCA VP-601 keyboard with 58 key typewriter format for alphanumeric entry. Modern flexible membrane key switches offer a contact life rated at greated than 5 million operations. A finger positioning overlay combined with light positive activation key pressure gives good operator "feel" and an on-board tone generator gives aural key press feedback. The keyboard operates from a single 5 volt DC power supply and the buffered output is TTL compatible. Complete with case $99.00

ASCII KEYBOARD KIT

60 key complete ASCII character set. Highest commercial quality key switches. Uses a KR 2376 ST encoder IC. Output compatible with TTL. Caps lock for upper case alpha characters. Repeat key. Parity and/or data invertable. Positive and negative keypressed and strobe signals. Requires 100 ma at +5 to 30 volts.

Complete kit all parts $99.95
Power supply kit $7.95

RE6416 VIDEO TERMINAL

Display:	16 lines of 64 characters
Format:	5x7 Dot matrix
Vert sync:	60 Hz Xtal controlled
Hor sync:	15,840 Hz Xtal controlled
Video o/p:	1v Peak to peak
IO:	Parallel, 20 Ma, RS232
Data rate:	110 to 9600 baud
Power:	5 V DC 1 A, + 12 DC .1A

RE6416: Kit of all parts $169.95
RE6416: Lower case option ....$ 16.95
RE6416: 5 V pow. sup. option ....$ 16.95
RE6416: ± 12 V pw. supply ....$ 16.95

S-100 MOTHER BOARD

Exclusively ARKON's...the A6S100 6 slot mother board, designed for the system builder using modern boards where few slots are required. Provision for semi-active termination.
A6S100 ....$19.95
S-100 edge connector ....$ 5.95

Fun, games, tests, helpers and more with a galaxy of ETI projects!

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3 chnl. colour organ, 300W PCB incl $18.95
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PCB's available at extra cost.

Finest quality for you from "Hammond"...transformers, power supplies, power bars, cabinets

A rainbow of electrolytic capacitors ...All types in endless supply.

Build creatively with "Vector Graphics" perforated breadboard!

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Each 16k of RAM (300 ns) See memory specials below ...$72.

S-100 BOARD KITS

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SBC-200	$435	VDB 8024	$475
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DOT MATRIX PRINTER

Outstanding reliability! Bi directional Anadex DP 8000 80 columns 112 characters per second (84 lines per minute) 100M character print head life $1350

Efficient test equipment... 4 outstanding "Hitachi" scopes. Also ammeters, volt meters, multi-meters.

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©MACRO assembler $115.00
©TEX text editor ....$ 95.00
©DES despooler ....$ 65.00
©CPM manual set ....$ 30.00
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©FORT//80 fortran for 8080, Z80, 8085 ....$ 99.00
©FORT//80 manuals $20.00
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C-BASIC II $175.00

For OSI C1P, on cassette
Star fighter ....$ 8.95
Alien invaders ....$ 8.95
Seawolfe ....$ 8.95
Tank for two ....$ 7.95
Bomber ....$ 8.95
Barrierball ....$ 7.95
Breakthru ....$ 7.95
Fighter pilot ....$ 5.95
Killerbot ....$ 5.95
Lunar Lander ....$ 4.95
Concentration ....$ 5.95
Chess for OSI $24.95
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Backgammon $12.95

Data Sheets
Graphic instructions ....$ 4.00
RS 232 for the C1P and superboard ....$ 3.95
Joystick instruction and plans ....$ 3.95
Reverse video for the C1P ....$ 3.95
G.T. conversion ....$ 1.00
Saving data on tape ....$ 4.00

Utilities
C1P cursor control $12.95
Renumberer ....$ 7.95
Autoloader ....$ 7.95

Ask for our giant list of software available for Apple™ Pet™ TRS-80™ by Programma Int'l, Instant Software, Creative Computing, Hayden and Softape.

TX-80 DOT MATRIX PRINTER

A tractor feed printer featuring 100 million character head life and printing speed of 150 characters per second using 96 ASCII characters. The plug fits any Centronics type interface making this printer compatible with all types of mini and micro computers thus giving a wide range of operations. Standard paper is available at Arkon and elsewhere. Various interfaces provided as options including EIA RS 232C. This provides outstanding equipment design! It provides the business and home computer markets with an exceptionally inexpensive, sturdily built and highly reliable dot printer.
TX80 with parallel interface $995.00

Replacement ribbons ....$ 4.00
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8220 TRS-80 cable expansion ....$ 57.00
8221 TRS-80 cable bus ....$ 40.00
8230 APPLE II cable ....$ 40.00
8110 PET 2001 interface board ....$ 83.00
8120 TRS 80 interface board ....$ 70.00
8130 APPLE II interface board $105.00
8140 RS232 interface board ....$ 95.00
8160 IEEE interface board $150.00

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SUPERBOARD memory expansion PCB (24K), data $50.00
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	14	$ .25	$ .35	$ .95
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	18	$ .35	$ .60	$1.25
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4002	$ .50	4013	$ .75	4585	$1.50
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		4019	$1.60		
		4020	$1.50		
		4021	$1.50		
		4022	$1.80		
		4023	$ .50		
		4024	$1.50		
		4025	$ .50		
		4026	$1.90		
		4027	$ .95		
		4028	$1.75		
		4029	$1.60		
		4030	$ .50		
		4033	$2.15		
		4034	$4.25		
		4040	$2.15		
		4042	$1.70		
		4044	$2.50		
		4046	$1.75		
		4049	$ .50		
		4050	$1.30		
		4052	$1.80		
		4053	$1.50		
		4060	$2.50		
		4063	$2.00		
		4066	$1.50		
		4068	$ .60		
		4069	$ .50		
		4070	$ .50		
		4071	$ .50		
		4072	$ .50		
		4073	$ .50		
		4075	$ .50		
		4076	$ .80		
		4077	$ .50		
		4078	$ .60		
		4081	$ .50		
		4082	$ .50		
		4085	$1.25		
		4086	$1.95		
		4089	$3.50		
		4093	$1.00		
		4094	$2.50		
		4501	$3.25		
		4502	$2.10		
		4508	$3.50		
		4510	$2.00		
		4511	$2.00		
		4512	$1.60		
		4515	$5.50		
		4516	$1.45		
		4518	$2.00		
		4519	$1.00		
		4520	$2.00		
		4522	$2.15		
		4526	$2.50		
		4528	$1.65		
		4531	$1.90		
		4532	$3.50		
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7402	$ .60
7403	$ .41
7404	$2.00
7405	$ .60
7406	$ .50
7408	$ .83
7410	$ .30
7416	$ .80
7420	$ .48
7427	$1.10
7430	$ .50
7432	$ .90
7433	$ .75
7437	$ .63
7440	$1.10
7441	$1.15
7442	$1.40
7447	$1.75
7448	$1.65
7451	$ .65
7454	$ .65
7473	$ .75
7474	$1.40
7475	$ .75
7476	$ .60
7483	$1.80
7484	$1.50
7485	$1.40
7490	$ .50
7491	$ .70
7492	$ .85
7493	$ .85
7495	$1.00
74107	$ .85
74121	$ .60
74122	$1.10
74123	$1.05
74125	$1.15
74141	$1.00
74145	$1.75
74151	$ .95
74153	$ .75
74154	$1.65
74157	$1.10
74161	$1.60
74162	$1.75
74163	$1.25
74164	$1.00
74165	$1.75
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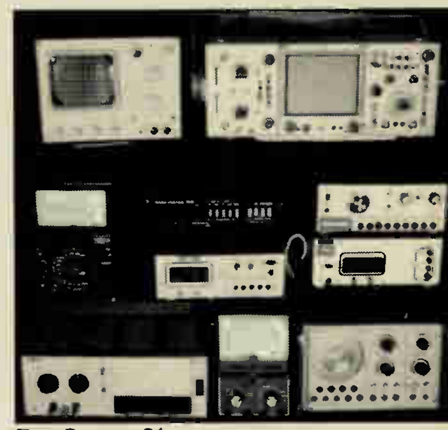
AUGUST 1980 Vol. 4 No. 8

FEATURES

PROJECTS



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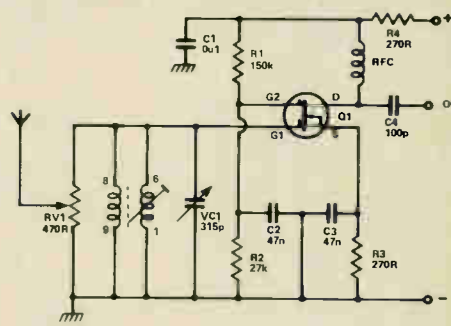

FET Special, p. 45

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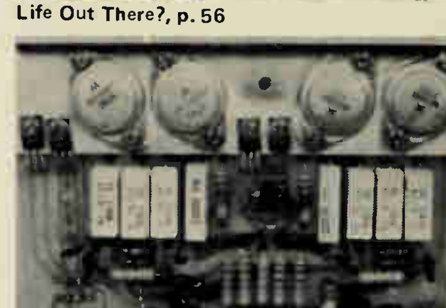
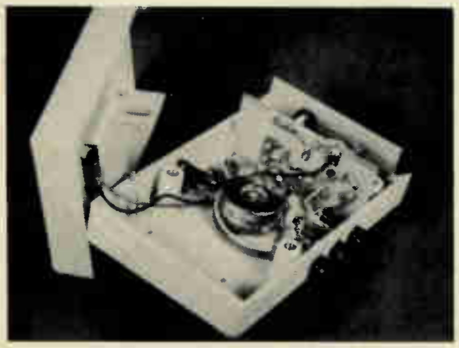


300W Amp, p. 12

Cover Photo: There's a lot of heat generated when you're driving at 300W — that's why the heatsinks are so large.

ISSN 0703-8984



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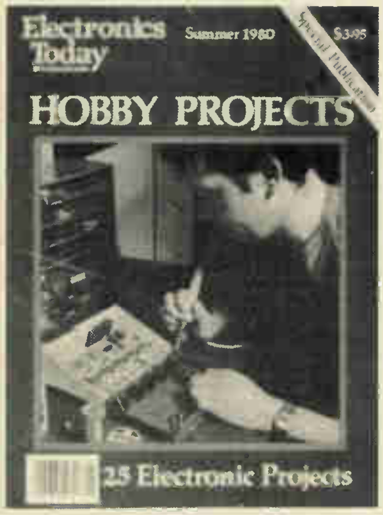
COLUMNS



ETI's New Special, p. 68

NEWS / INFO

ADVERTISERS' INDEX

LIABILITY
Whilst every effort has been made to ensure that all constructional projects referred to in this magazine will operate as indicated efficiently and properly and that all necessary components to manufacture the same are available, no responsibility whatsoever is accepted in respect of the failure for any reason at all of the project to operate efficiently or at all whether due to any fault in design or otherwise and no responsibility is accepted for the failure to obtain component parts in respect of any such project. Further no responsibility is accepted in respect of any injury or damage caused by any fault in the design of any such project as aforesaid.

EDITORIAL QUERIES
Written queries can only be answered when accompanied by a self-addressed, stamped envelope. These must relate to recent articles and not involve the staff in any research. Mark such letters ETI-Query. We cannot answer telephone queries.

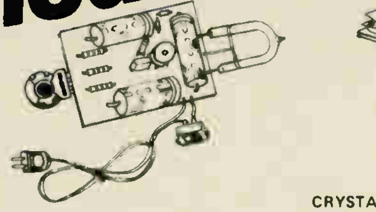
BINDERS
For ETI are available for $6.75 including postage and handling. Ontario residents add 7% PST.

SELL ETI
ETI is available for resale by component stores. We can offer a good discount and quite a big bonus, the chances are customers buying the magazine will come back to you to buy their components. Readers having trouble in buying ETI could ask their component store manager to stock the magazine.

COMPONENT NOTATION AND UNITS
We normally specify components using an international standard. Many readers will be unfamiliar with this but it's simple, less likely to lead to error and will be widely used everywhere sooner or later. ETI has opted for sooner!
Firstly decimal points are dropped and substituted with the multiplier, thus 4.7uF is written 4u7. Capacitors also use the multiplier nano (one nanofarad is 1000pF). Thus 0.1uF is 100n, 5600pF is 5n6. Other examples are 5.6pF=5p6, 0.5pF=0p5.
Resistors are treated similarly: 1.8M ohms is 1M8, 56k ohms is the same, 4.7k ohms is 4k7, 100 ohms is 100R and 5.6 ohms is 5R6.

PCB SUPPLIERS
The magazine does not supply PCBs but these are available from the following companies. Not all companies supply all boards. Contact these companies direct for ordering information.
B&R Electronics, P.O. Box 6326F, Hamilton, Ontario, L9C 6L9
Spectrum Electronics, Box 4166, Stn 'D', Hamilton, Ontario, L8V 4L5
Wentworth Electronics, R.R. No.1, Waterdown, Ontario L0R 2H0
Danocinths Inc, P.O. Box 261, Westland, MI 48185, USA.
Exceltronix Inc., 319 College St., Toronto, Ontario, M5T 1S2
Arkon Electronics Ltd., 409 Queen St. W., Toronto, Ontario, M5V 2A5.

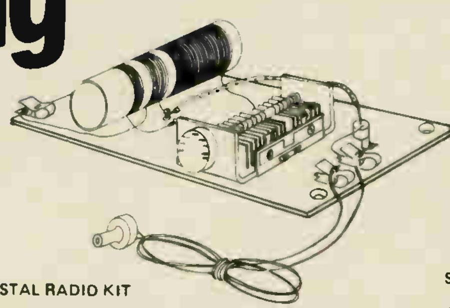
Announcing Edu Kit LTD.



STROBE LITE KIT

Fantastic for special effects. Variable speed Xenon flash gives you a "STILL MOTION" effect. A real attention getter.

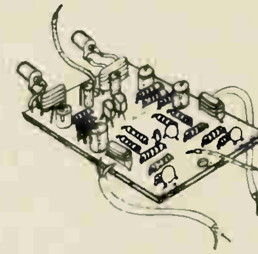
Model # EK80SL001 — PRICE: $21.95



CRYSTAL RADIO KIT

A self powered radio which uses a resonant circuit and detector for AM radio reception. An ideal project for the beginner

Model # EK80CR001 — PRICE: $8.95



STEREO PHONO PREAMP KIT

Anyone with a ceramic input receiver can enjoy the quality of a magnetic cartridge with this simple but very effective Stereo Phono Preamp.

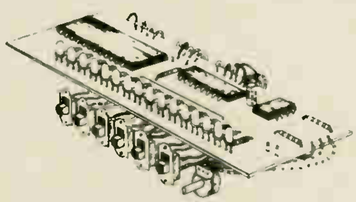
Specifications:	Standard RIAA
Frequency Response:	20Hz to 2KHz + 1.5dB
Input Sensitivity:	5mv input for 500mv output
Maximum Output:	700mv rms
Input Overload:	100mv rms
S/N Ratio:	Greater than 60dB

Model # EK80SP001 — PRICE: $11.25

16 CHANNEL LED CHASER KIT

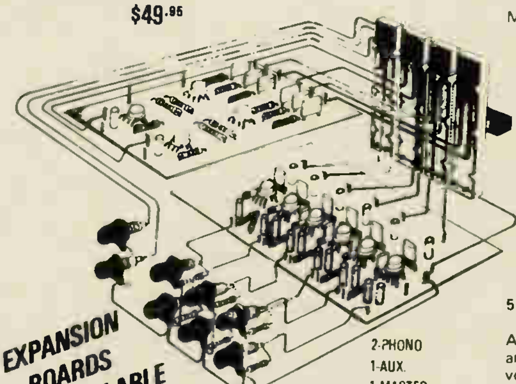
A very familiar sight seen at discos, department stores, and on neon signs. 16 LED's flash in sequence up-down or alternate. Adaptable to 120 vac. (Extra)

Model # EK80LC016 — PRICE: $22.95



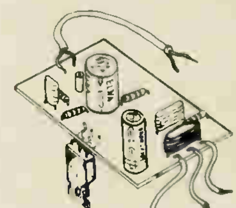
STEREO AUDIO MIXER Kit MODEL EK80AM001

$49.95



EXPANSION BOARDS AVAILABLE SOON

2-PHONO
1-AUX.
1-MASTER
EXPANDABLE
RESP. 20Hz - 20KHz
5V OUTPUT
.01% DIST.



16 CHANNEL MULTI-MODE LED CHASER KIT

We're proud to add this to our line. It's similar to our 15 channel led chaser but with many extra features. There are over 60 selectable modes. A few are: Up, Down, Skip, Pulse, Scramble, Single Pulse, Multi Pulse and many more. An optional 120 vac board is available. (Extra)

Model # EK80LCM16 — PRICE: $32.95

5 WATT IC AUDIO AMPLIFIER KIT

A general purpose 5 watt amplifier with Thermal Overload and Short Circuit Protection. Because of its low operating voltage and high power output, it allows the user to use it as an add-on amplifier for car stereo.

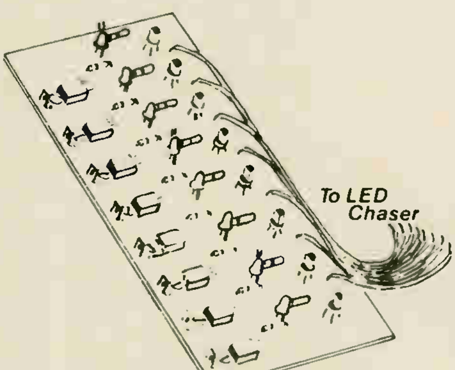
Specifications:	
Frequency Response:	40Hz to 15KHz B(-3dB)
Power Output:	5 watts at 4 ohms 7 watts at 2 ohms
Distortion:	5% at 7 watts at 2ohms
Load Impedence:	2 to 16 ohms
V Supply:	12 to 15vdc

Model # EK80A005 — PRICE: $19.95

0-28 VOLT POWER SUPPLY KIT

A true 0 to 28 volts capable of delivering 1 amp continuous. Full wave rectification, filtering and capacitance multiplication provides a clean dc source for sensitive audio and digital work. An ideal supply for the experimenter.

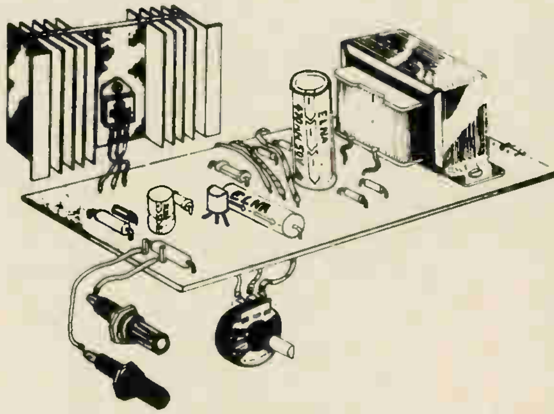
Model # EK80PS028 — PRICE: $39.95

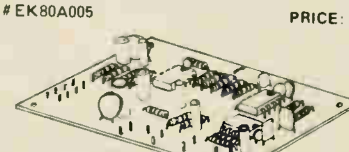


POWER SUPPORT 120

A 120 volt power board which allows you to connect regular lamps to our LED Chaser Kits. 8 channels are supplied per board with 150 watts per channel. They can be easily interfaced for 16 channels.

Model # EK80PLC120 — PRICE: $24.95





BBD AUDIO DELAY LINE KIT

A unique Special Effects Unit which gives a variable or fixed delay of Analog Signals. Reverb, Echo and Flanging

Specifications

Maximum Input	2.0v rms
Delay Time	6 to 30ms (int.osc.)
Distortion at 1v at 1KHz	0.3%
S/N at 2v input	67dB
V supply	+ 5vdc and 15vdc

MODEL #EK80BBD01 — PRICE: $69.95

1.5 to 24v POWER SUPPLY KIT

A variable Power Supply suitable for many digital and linear applications. Delivers an output current of 100ma. from 1.5v to 15v and 500ma. from 16v to 24v.

MODEL # EK80PS024 — PRICE $24.95

•ALL KITS COMPLETE WITH DETAILED INSTRUCTIONS & PCB.

•DEALER & EDUCATIONAL INQUIRIES INVITED.

535 Yonge St., Tor., Ont. M4Y 1Y5

NEWS

But What's It Got To Do With Electronics?

The adventurers of this world would not survive without sponsors. One goal that is particularly popular with these intrepids is the North Pole: dogsled, April 6, 1909. Commander Robert E. Peary; dirigible, May 12, 1926. Explorer Roald Amundsen: plane, May 9, 1926. Commander Richard E. Byrd and submarine, August 1958. U.S.S Nautilus; snowmobile, April 19, 1968. Ralph Plaisted; and by ship, August 17, 1977. U.S.S.R. Artika.

Those of you who want to update their Guiness Book of World Records you can add "HOT AIR BALLOON" April 11, 1980 piloted by Sidney and Elenor Conn of Calgary, Alberta.

This feat was sponsored by Jensen Sound Laboratories and the Conns' Calgary Stereo Shop "Joy of Sound".

Jensen International and Len Finkler Limited, distributors of Jensen Sound Products in Canada, (and we at ETI for that matter), salute Syd and Elenor on this superb achievement and thank them for taking Jensen to the Pole and giving substance to the Jensen theme "the thrill of being there."

Just imagine, high over the polar ice cap, a pair of Jensen Triaxials blasting out Supertramp, Donna Summers or whatever turns you on. Heaven . . .

Hot Plotter

The new Gulton Microplot 44 is designed to plot and print with microprocessor based systems. The printer/plotter, available in a desk top text version and a panel mount data logging version, incorporates a fixed head design.

Both versions accept analytical and computational data in a digital form and will plot this data, print the grid and scale, annotate the date with alphanumerics and print alphanumeric text with both X and Y axis orientation.

For more conventional applications: full character ASCII; 44 columns; double height and double density characters; programable tabs; standard interface; IEEE-488; RS232C; O.E.M. parallel and internal self test. Contact Mr. Roger Webster, Webster Instruments Limited, Unit 28, 1200 Aerowood Drive, Mississauga, Ontario L4W 2S7. Telephone: (416) 625-0600.

Vero Nice

Start looking for Vero products (cases, connectors and Veroboard) at your local dealers. Electronic Packaging Systems Limited has initiated a nationwide hobbyist retail program of Vero, OKW and OK Machine and Tool products. If you cannot find them, ask your dealer to order them for you. (EPS is also looking for dealers).

For a copy of the catalogue, 'Products For The Hobbyist', or retail information, write to Graham Moore, Electronic Packaging Systems, P.O. Box 481, Kingston, Ontario K7L 4W5, (613) 384-1142.

Hamtrading

Hams take note! Hamtrader's latest catalogue is available. To get your copy, write to Hamtraders, 45 Brisbane Road, Downsview, Ont. M3J 2K1. Telephone: (416) 661-8800.

Expose Yourself

News Digest is a regular feature of ETI Magazine. Manufacturers, dealers and clubs are invited to submit news releases to News Digest, c/o ETI Magazine. Sorry, submissions cannot be returned.

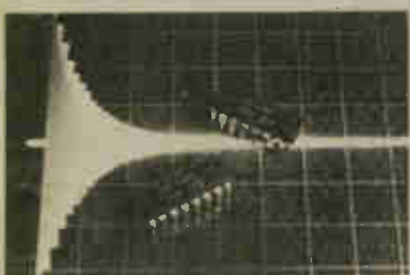
Audio Constructors Take Note

Analog Devices, Inc., has introduced a monolithic integrated circuit which attenuates audio signals. The AD7110 (patent pending) provides a 0 to 88.5 dB attenuation range, plus full muting, in steps of 1.5dB per increment in digital input code (six bits) with total harmonic distortion of −98dB, maximum, and intermodulation distortion of −92dB, maximum.

The device includes loudness compensation switches to enable low frequency (bass) boost at low volume settings. The signal-to-noise ratio is 100dB from 20Hz to 20kHz. The AD7110 is priced at $10. US in quantities of 100.

Unlike electro-mechanical components, the AD7110 has no moving parts and is not subject to wear. The device is expected to replace pots in many applications where it is important to limit noise and distortion.

For sales engineering information, talk to Don Travers, Analog Devices Semiconductor, 804 Woburn Street, Wilmington, MA 01887.



If I Have Apples III

The Apple III is a fully integrated computer system with built-in disk drive, up to 128K bytes of memory, colour and black and white video, and can accommodate a wide range of peripheral devices.

Two new application packages are offered for use on the Apple III. The Information Analyst, to be used in planning, forecasting, etc, and Apple III Word Processor software, to be used for preparing memos, letters and general typing, long documents, etc. Apple III prices range from $4,340. to $7,800. US.

Many of the benefits of the Apple III are made possible by a new Apple-designed central processor. It features a superset of the 6502 instruction set, relocatable base page register, relocatable stack, and 128K byte address range.

Peripheral devices request machine attention by interrupting the CPU (which optimizes speed), or the CPU may poll peripherals to see which need attention, minimizing the software required for peripheral control.

As we understand it, the basic system features a built in 5¼" floppy, two printer interfaces, and a 12" B/W monitor (even though the machine has colour capabilities).

At the time of this writing, shipments were predicted for July, so you should be able to see the Apple III in the stores.

Write to Apple Computer Inc., 10260 Bandley Drive, Cupertino, CA 95014.

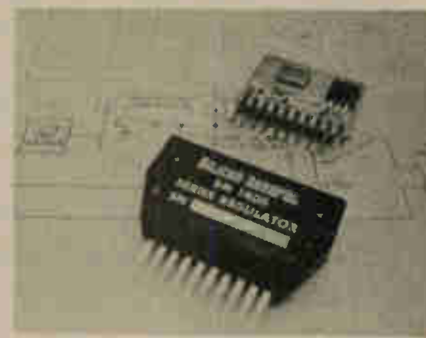
Quick 10A Power Supply

Building a complete, adjustable 10-amp series regulated power supply can be done with a new function module now available from Silicon General.

The new SM-1400 is a positive linear regulator into a module measuring approximately 2.3 X 1.2 inches. A few external components are required to complete the function. Overall component count is thus drastically reduced, along with design time, assembly, testing and replacement cost.

All critical output parameters, including voltage, overvoltage crowbar trip point, current limit and current foldback are programmable via external resistors. Remote voltage sensing is also possible with this configuration. Maximum output current is 10 amps, while maximum power dissipation capability is 150 watts and the voltage reference of 2.6V is accurate within one percent, eliminating the need for potentiometers in many applications. Voltage range is adjustable from 2.6 to 37.0 volts.

Price: $17.25 US in 100 piece quantities (don't know about individuals). Contact Silicon General, 11651 Monarch Street, Garden Grove, California 92641.



Cleaner Heads

Dasco Disk Cleaning Services Incorporated announces the availability of Compu Clean diskette head cleaners in Canada.

There are 4 models of the Compu Clean diskette head cleaner available to insure that all diskette drives in use today can be cleaned by one of the new products.

Write to Disk Cleaning Services, Incorporated, 380 Denison Street East, Markham, Ontario I3R 1B9.

Back Issues From ETI

February 1977

Features: CN Tower, Biorythm Calculator, VCT, 555 Timer Applications, Yamaha B1 Review, Scope Test Your Car.
Projects: 5W Stereo Amp, Philips Speaker System, Reaction Tester, Patch Detector, Heads or Tail, SCR Tester.

May 1977

Features: Projection TV, 741 Cookbook, Easier Way to Make PCBs, Choosing a Microcomputer.
Projects: Burglar Alarm, Ceramic Preamp, Ni-Cad Battery Charger, Power Supply, Fuzz Box, Stereo Rumble Filter.

July 1977

Features: A Generation Away, I^2L Explained, CB Supplement, Intro to Computers.
Projects: Mastermind, DVM, Overled, Turn Indicator Canceller.

May 1978

Features: Tools Catalogue, Data Sheet Special on Memory Chips, Microbiography.
Projects: White Line Follower, Add-on FM Tuner, Audio Feedback Eliminator.

July 1978

Features: Digital Multimeter Survey, Pinball Machines, Intro to Amateur Radio, TI Programmer.
Projects: Real-Time Analyser, Electronic Race Track, Proximity Switch, Accenuated-Beat Metronome.

August 1978

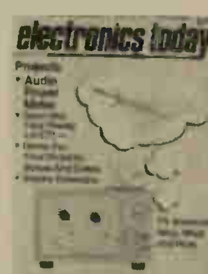
Features: Getting into Shortwave, Using a 'Scope, Semiconductor Guide, Intro To Amateur Radio 2.
Projects: Sound Level Meter, 2 Chip Siren, Induction Balance Metal Locator, Porch Light.

October 1978

Features: Personal Computing Commentary, CMOS Quickies, SSB by Phasing, History of Electronics in Medicine.
Projects: UFO Detector, CCD Phaser, Strobe.

June 1979

Features: Op Amps, Inside Info From Ultrasound, Computer Catalogue.
Projects: Colour Organ, LCD Thermometer, Colour Sequencer, VHF Antenna, Bip Beacon.



August 1979

Features: Casing Survey, Smoke Detectors, TV Antennas, Reed Switches, Magnetic Field Audio Amp, Industrial Electronics.
Projects: Audio Power Meter, Shootout, ETI-Wet Plant Waterer.

December 1979

Features: LM10 Circuits, Police Radar Speed Meters, Practical Guide to Triacs, Fluorescent Displays.
Projects: High Performance Stereo Preamp, Photographic Development Timer, Logic Trigger.

The back issues shown and described above are available direct from us. Please order by Issue, not by feature. They are $3.00 each or 5 for $10.00. Use card facing page 44, which lists other back issues available, or just send to:

BACK ISSUES
ETI Magazine
Unit 6,
25 Overlea Boulevard
Toronto, Ontario
M4H 1B1

Being Literate, the RCA Way

RCA's Solid State Division has been busy lately, and announce five new publications. First, a 60-page Microprocessor Product Guide, MPG-180C, that describes all the elements needed to build an efficient microprocessor system.

This product guide covers the line that constitutes the RCA 1800 COSMAC microprocessor family.

Also a 104-page Audio Amplifier Manual, designated APA-551.

Basic design considerations for audio preamplifiers and power amplifiers are presented. Practical preamplifier circuits are shown using integrated circuits and more than 25 practical power amplifier circuits with power outputs ranging from 0.3 to 300 watts and with performance data on each are presented.

Copies of this manual are available at $5.00 each. Single copies or bulk quantities may be ordered from RCA Solid State distributors or by sending cheques or money orders to RCA Solid State Division.

Next an updated and expanded edition of the RCA Power-Devices Directory, PTD-187G, is available from RCA Solid State Division.

This new 80-page edition provides descriptive data on the broad spectrum of solid-state power devices currently available from RCA. Selection matrices, ratings and characteristics data, and package information are shown for RCA power transistors, rf power transistors, power hybrid circuits, silicon controlled rectifiers (SCR's, GTO's and ITR's), triacs, diacs, and silicon rectifiers. This one's free.

Another power-device brochure, Power Devices for the Telecommunications and Communications Industries (TCI-320), is intended primarily for the telecommunications/communications industries.

This 8-page brochure covers switching transistors, hometaxial and Darlington transistors, SCR's, triacs and specialized devices of interest to designers in the telecommunications fields. It also includes a list of significant application notes.

If light is your thing, then check out this 36-page guide, the OPT-115, providing tabulated data and outline configurations for RCA's line of optical communications products. It includes a comprehensive treatment of device and system characteristics, a selection guide, and a section on optical communications terms and definitions.

Copies of these publications may be obtained by writing to RCA, Box 3200, Somerville, NJ 08876, or by calling (717) 397-7661, ext. 2337.

New But Not Here

One product currently available in the UK, and awaiting approval for North America, is a personal computer kit from Science of Cambridge.

The Sinclair ZX80 features a 1K ROM Basic which they claim is equivalent to 4K in most other machines. The kit price for this machine is approximately $200. Cdn. The ad pointedly doesn't say how much RAM is included, supposedly because of its more efficient interpreter.

What is interesting is that a similar machine, the 'MicroAce' is already available here for $140 US in a kit form. After a brief legal confrontation, MicroAce has been limited to only selling kit machines.

Meanwhile we're still waiting for the ZX80.

If you're interested in pursuing this further you can write to 18 MicroAce, 1348 E. Edinger, Santa Ana, California 92705, and Science of Cambridge, 6 Kings Parade, Cambridge, Cams. UK CB2 1SN.

A Good Connection

Sealectro has released a new 6 page brochure describing programming devices, circuit interconnection components, and R.F. coaxial connectors. You can get it from Zentronics, 1355 Meyerside Drive, Mississauga, Ontario L5T 1C9.

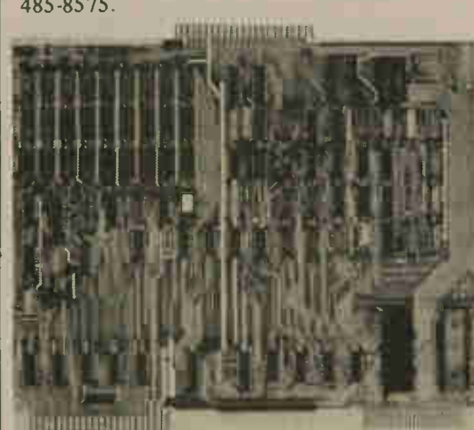
Take Aim and . . .

In its primary function, Memory-Mate provides 16-48K RAM expansion in 8 or 16K increments for AIM 65 boards. Assignable in 4K blocks, each RAM block is positionable anywhere in the system.

In addition, Memory-Mate boasts full parity protection to insure memory integrity, programmable write protection (in 4K blocks), four bi-directional I/O ports, and an optional STD BUS interface for I/O intensive applications.

Price of the Memory-Mate with 16K RAM (assembled and tested with 48 hour burn-in), connector to AIM and manual, is $475. US. 16K RAM expansion chip sets (including parity chip) are only $100 US.

Contact Forethought Products, 87070 Dikhobar Road, Eugene OR 97402. (503) 485-8575.



Another Future

Future Electronics Incorporated, announces the opening of their fifth Canadian stocking facility on June 2nd, 1980 in Calgary, Alberta, located at 5809 MacLeod Trail South, Unit 109, Calgary, Alberta T2H 0J9. Telephone: (403) 259-6408.

Additionally, you will find their retail outlet, Active Components, at the same address.

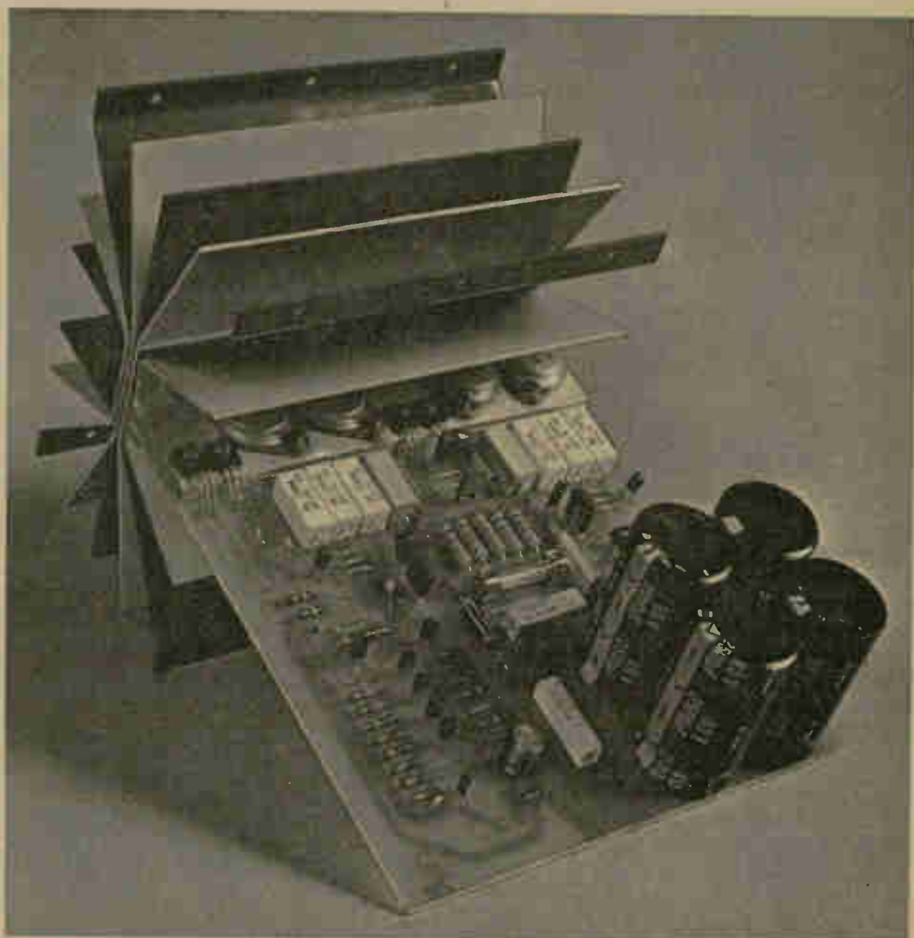
More Apple

Apple Computer Inc., a leading manufacturer of personal computers, introduces the Dow Jones News & Quotes Reporter, a software package that puts investors and corporate strategists in touch with the latest financial news.

When used with an Apple II personal computer, the diskette program retrieves (over telephone lines), displays and optionally prints selected past and current news stories from the Dow Jones News Service, the Wall Street Journal and Barron's magazine, as well as price quotations of more than 6,000 securities traded on the four largest US exchanges and over-the-counter NASDAQ.

What will really sell is a program that would talk to Rona Barrett. ●

'THE BRUTE'... 300W AMP



START HERE

Do not pass 'go', do not spend $300.

THIS IS a relatively expensive project, compared to our previous amplifier modules, the 50/100 and the more recent ETI-470. It is not recommended for beginners or inexperienced constructors. Although we have included protection for the output devices in the design it is obviously impossible to protect against circumstances which we cannot foresee. Follow the assembly and advice given in this article — especially regarding heatsinks and power supplies etc, and you'll be well assured of success. We must *stress* that any deviation from this design, other than the variations suggested, you do at your own risk.

If this is your first experience with such high power don't be embarrassed to follow the instructions slavishly until you are familiar with the unit and the get 'feel' of the technology. Check *everything* as failures can be disastrous, not to mention spectacular, if something goes wrong.

If we haven't put you off by this stage — read on !

SPECIFICATIONS

Power output	
8 ohm load	200 watts RMS
4 ohm load	310 watts RMS
Frequency response	
20 Hz to 20 kHz	+/- 0.5 dB
Hum and noise	
re 200 W into 8 ohm	- 105 dB
Input sensitivity	
8 ohm load	1 V for 200 W output
4 ohm load	1 V for 300 W output
Total harmonic distortion	see graph
Damping factor	
20 Hz - 3 kHz	65
5 kHz	55
10 kHz	45
20 kHz	35

HI-FI AMPLIFIERS are becoming more and more powerful, and with good reason. Modern recordings, especially direct cut discs, have a useful dynamic range approaching 40 dB between the quieter musical passages and the peaks of the crescendos. If the quieter passages are played at a power output of 100mW, which is not untypical in a domestic range of a good record without clipping the peaks would require an amplifier capable of delivering 1000 watts! This, coupled with the current trend amongst some manufacturers to build speakers having quite low efficiency, plus the number of people who like their music loud (*and* undistorted) makes the case for high power amplifiers very strong indeed.

Past amplifier projects have generally been limited to output powers of 50 watts or so. Designed around cheap, readily available transistors, they have proved very popular.

To gain a worthwhile improvement in subjective performance over an amplifier of 50 watts output, we must go for a four times increase at least, to 200 watts, as the ear has a logarithmic response, and anything less is barely noticeable. That might be stating the case a little simply, but it conveys the general idea.

Over the past years we've had many requests for a *high* power amplifier, but for the reasons stated previously, we have decided against it. It would have been possible to design a unit using a large number of readily available power transistors in the output — in fact, one design we have seen used a total of 24 devices in the output stage! Difficulties for the home constructor in this approach are obvious, regardless of expense.

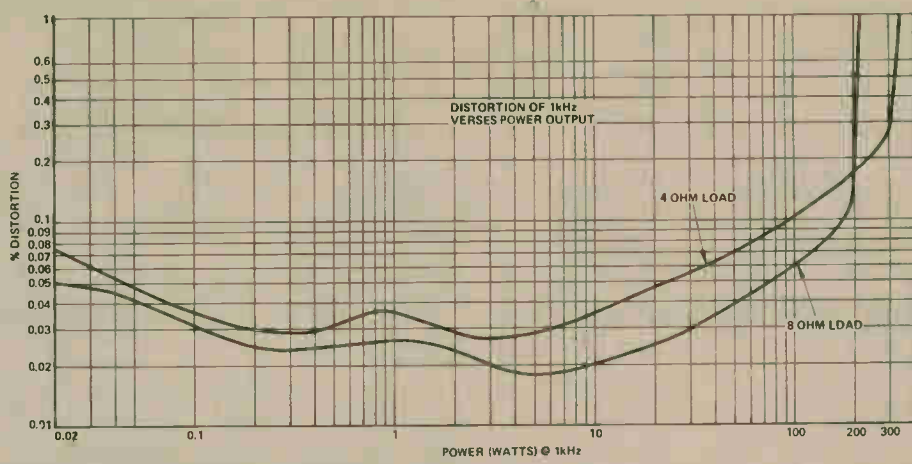
For various reasons, a bridge amplifier was ruled out when the design of this amplifier was considered. Hence, a plentiful source of suitable output transistors was first sought.

There are really not too many transistors available that meet the requirements. Firstly, adequate safe operating area (SOAR) is of prime importance. Next, and probably of equal importance, is availablity. Let's have a look at the SOAR problem first. Some high power transistors don't compare too well with the ubiquitous 2N3055 (and its complement, the MJ2955) when operated as an amplifier. Take a look at the set of curves plotted on the accompanying diagram. This compares the safe operating area curves of a number of power transistors. Operation of any power device must be confined to the area inside the device's curve at worst case. If the current/voltage operating point is allowed to fall outside the area of the SOAR curve during any part of the operating cycle for the device, it will be destroyed — with amazing rapidity. Now, the 2N3773 and MJ802 transistors have been around for some time and at first glance would seem good choices for a high power amp, but note that their SOAR characteristics are not much better than the 2N3055. In fact, at 40 V (Vcc) the MJ802 is actually worse. In contrast, the MJ15003 is quite a long way outside the curve for the 2N3055 and therefore have a much higher power rating when used in an amplifier. Hence, the MJ15003 and its complement — the MJ15004, were chosen as the output devices for this design. Secondly, these transistors are widely used in industrial applications and are available from a number of sources, thus they meet the availability requirement.

Another problem that arises with a design such as this is protection for the output devices. Amplifiers using transistors such as the 2N3055/MJ2955 can easily be protected with a fuse. In high power amplifiers where supply rails of 50 — 70 volts are necessary, the energy available (from the filter capacitors) will will easily destroy the transistor *and* the fuse — in that order. The answer is to use electronic current limiting in the output. This adds complexity, but is cheap insurance against accidental (or deliberate!) abuse. The curve showing the limiting effect on the SOAR characteristics of the MJ15003 for the protection network used in this amplifier is shown on the diagram with the other SOAR curves.

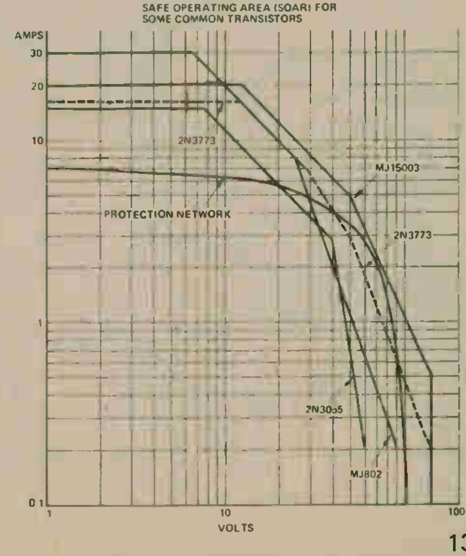
The main cost of the amplifier is in the output stage, transformer and heatsink. We therefore decided to go to a slightly more complex input stage to improve the performance. This type of amplifier usually uses a Class A driver which introduces second harmonic distortion. By using a complementary-differential input circuit we have been able to eliminate the Class A driver and therefore kept the second harmonic distortion very low indeed. The distortion curve shows the distortion is well under 0.1% until almost full power output. The 'bump' in the curve around one watt is the point where the output stage changes from Class A (peak output being less than the bias current) to Class AB operation.

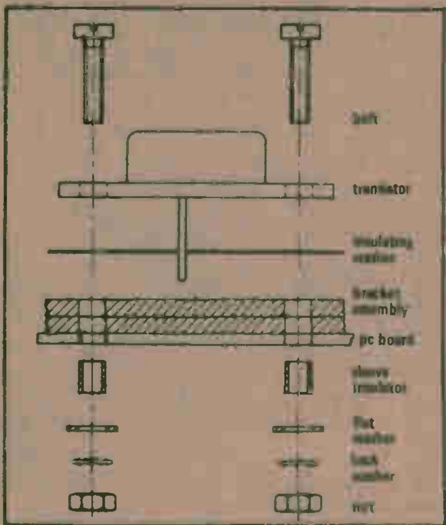
The complete amplifier, including the power supply components and output transistors, is assembled on a single pc board. An aluminum bracket holds the output transistors conducting heat from the output stage to the heatsink.



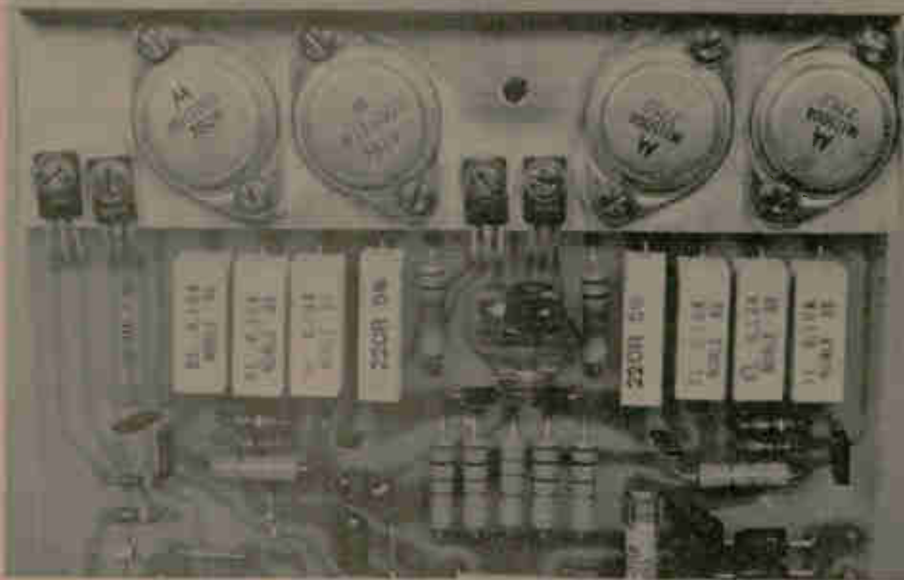
Total harmonic distortion versus power output at 1 kHz. The 'bump' at around 1 W is due to the output stage changing from Class A operation to Class AB operation.

Comparison between the Safe Operating Area characteristics of a variety of transistors, including the MJ15003 used in the output stage of this amplifier.

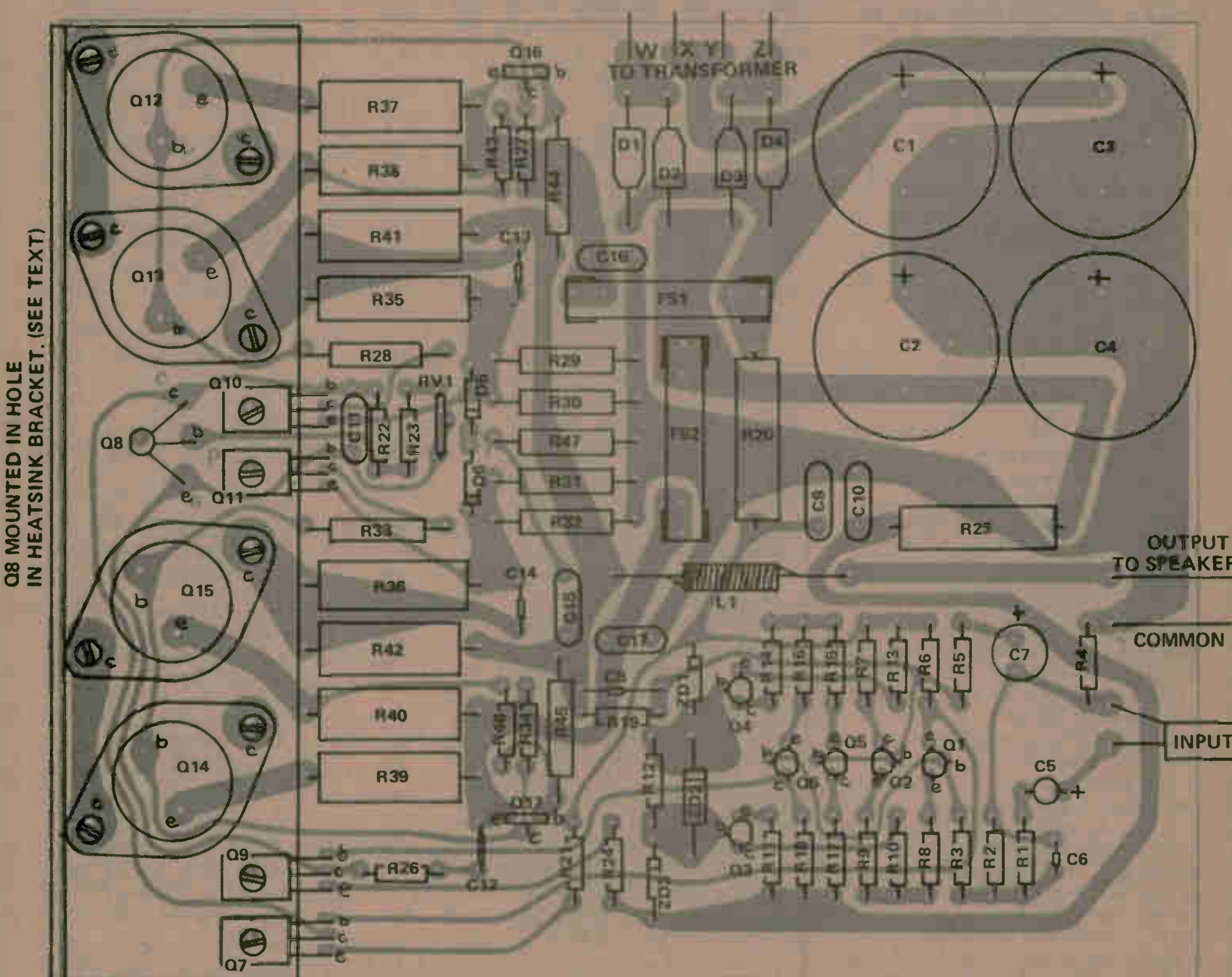




Exploded view of how the TO3 output transistors are assembled to the angle brackets and pc board.



Photograph of the completed output stage, prior to mounting to the heatsink assembly.



Only three sets of external connections are made to the pc board; input, output and power supply ac input from the transformer.

Start the construction by making the aluminum bracket. We used two length of 3 mm angle. This bracket is 3 mm thick and two must be placed back to back to make the required 6 mm thickness for adequate thermal conduction to the heatsink assembly. If you elect to use a commercial heatsink, a single 6 mm thick angle extrusion can be used, fixed to the flat side of the heatsink.

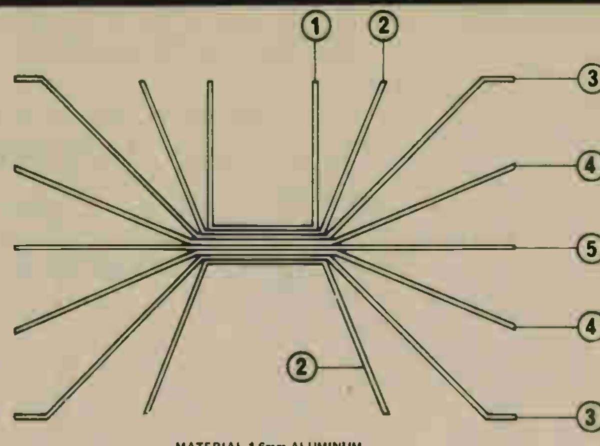
The easiest way to make the bracket assembly and ensure correct alignment of all the holes is to cut the two lengths of angle somewhat longer than necessary. The extra length will be cut off later. Clamp the two pieces back to back and drill a small hole at each enc so that they can be clamped togethei with nuts and bolts through this excess This allows you to shift the bracket assembly in a vice or what have you without getting them out of alignment Next, mark out the position of the transistor holes (use the pc board as a guide if you have it to hand already) on the broad side of one bracket and then the holes in the narrow side – the latter secure the bracket assembly to the heatsink. Use a scriber or other sharp-pointed instrument. Then drill the holes.

The hole for the thermal feedback transistor (Q8) *must* be a neat fit. The best way to accomplish this is to drill a slightly smaller hole and carefully enlarge it with the correct size drill. A reamer gives a conical hole and is not really suitable. Those holes marked 'C' on the bracket drawings can be tapped to take a 8/32 bolt if you plan on using the sheet metal heatsink described later.

Once you have drilled all the holes in the bracket assembly, cut off the excess at each end and file the edges smooth. Also, ensure that no 'burrs' are left on the lips of each hole. Chamfer then with a large drill held in your hand.

The next step is to make the heatsink assembly – that is, if you're not using one of the commercially-made alternatives suggested.

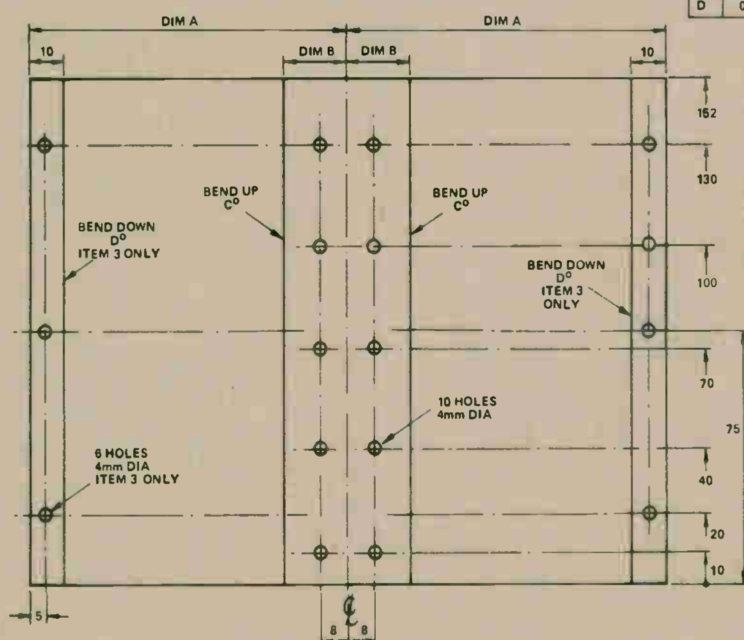
If you have access to a sheet metal bender, making your own heatsink is certainly the cheapest way out. The complete drawings are shown elsewhere. Referring to these, not that dimension 'A' and dimension 'B' varies for each fin, the appropriate measurements being given in the table accompanying the drawings together with the angle of a bend for each fin. Don't forget to allow



Dimensions and bending details for the sheet metal heatsink assembly we used.

MATERIAL 1.6mm ALUMINUM
FINISH BLACK ANODISED
ALL DIMENSIONS IN MILLIMETRES

	ITEMS				
	1	2	3	4	5
A	58	65	95	80	75
B	15	17	19	21	–
C	90°	67.5°	45°	22.5°	0°
D	0°	0°	45°	0°	o



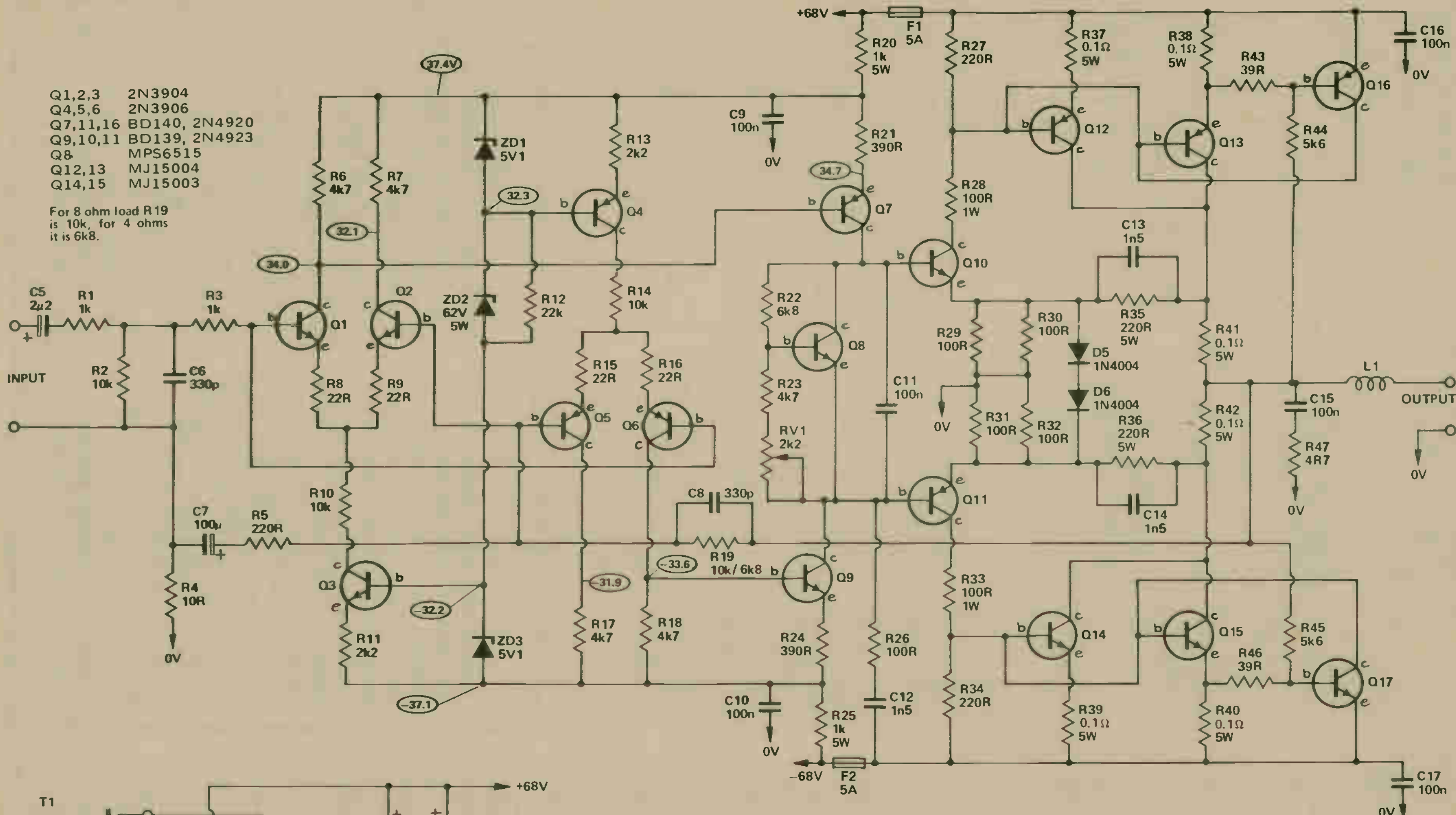
HEATSINKS

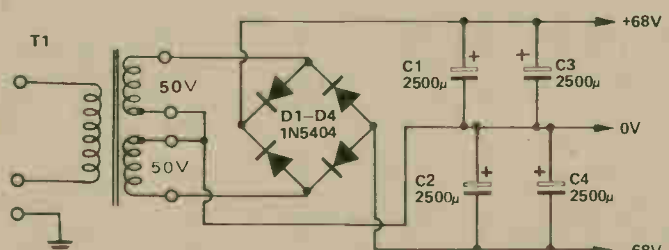
There are several alternatives you can choose from for heatsinking the amplifier output stage. The heatsink described, and shown in the front cover photograph, was made from sheet aluminum and has a thermal rating of 0.55°C/watt. This is the rating we recommend for any heatsink if the amplifier is to drive a four ohm load, particularly for pop group use. If it is driving an eight ohm load in typical domestic use, half the fins may be left out (every second one – the yellow ones!) resulting in a thermal rating for this heatsink arrangement of 0.75°C/watt.

The Philips 65D6CB heatsink has a rating of 0.65°C/watt and would be suitable for this amplifier in most applications, except for a pop group with four ohm loudspeakers, unless fan cooling is added.

A heatsink with about 1°C/watt rating and substantial fan cooling is another alternative.

Remember that dissipation in the heatsink will be about 200 watts at full power output. That means a temperature rise of 110°C above ambient if the amplifier is run continuously. Poached eggs anyone? Temperature rise with music or intermittent use is considerably less, of course, as average power dissipated is much lower.





Complete circuit diagram of the amplifier. Note that L1, not listed in the parts list below, is wound on a 1 W resistor — see text. Voltage readings are included as a guide.

The power transformer shown will power a pair of amplifiers (stereo) driving 8 ohm loads in typical domestic situations, but only a single module under other circumstances, particularly if driving a 4 ohm load.

For stereo applications use separate ground returns for each speaker to the common on the pc board and separately join the two commons.

If the module is to be used in applications other than a domestic hi-fi set up and driving a 4 ohm load, we recommend you add another MJ15003/MJ15004 pair and associated components. The angle bracket and heatsink assembly will need to be extended.

a small angle for the 'spring' in the metal. Angles can be within a few degrees as they aren't that critical to heatsink efficiency. Don't be too sloppy though.

We used a 1.6 mm thick aluminum sheet to construct the heatsink — *do not substitute a thinner gauge.* The bolts which secure the heatsink assembly to the bracket assembly also hold the whole heatsink assembly together.

It is easiest to drill the heatsink fins *before* bending them up, but you *must* mark out and drill the holes *accurately.* Mark one outer fin very carefully. Assemble the fins in order, making sure they are carefully aligned, then clamp the whole assembly and drill right through. Carefully de-burr all the holes.

At this stage you can do a trial assembly of the heatsink and bracket assemblies to see how it all mates — or not. If you have taken care with the drilling, then all should be well. Having confidence in your ability, we shall press on.

If you decide to paint the heatsink rather than having it anodised black, the mating surfaces should all be masked before spraying.

The whole heatsink 'business' is not assembled at this stage, final assembly comes later.

The next part is the easy part (! . . . . . . Ed.) . Having got the mechanicals off your chest, the electronics needs attention.

The components may be assembled to the pc board starting with the smaller resistors and capacitors. Carefully follow the overlay drawing. When you come to the 0.1 ohm, 5 W resistors note that they should be mounted about 2 - 3 mm off the board to allow a free air flow around them. Next mount the power supply electrolytics. Note that the recommended types have three pins projecting from the base. All three pins are soldered to the board and the capacitors can only be inserted one way round. The inductor L1 is made by winding a layer of 26 swg enamelled wire (or the nearest equivalent gauge) along the body of a 1 W resistor. The number of turns is not critical, just wind enough wire on the resistor to cover the body with one layer. The value of this resistor may be anything over 100 ohms. Two 5 A fuses are mounted on the pc board, held in place with fuse clips.

Next comes the semiconductors. Leave Q7, 8, 9, 10 and Q11 plus the output stage devices Q12, 13, 14 and Q15 until last. Be *careful* with the orientation of the diodes.

Now you can assemble the heatsink bracket to the pc board, plus Q7 to Q15 inclusive.

First smear heatsink compound on the two mating surfaces of the bracket assembly. Note that insulating washers are used on all the transistors, Q7 to Q15, mounted on the bracket assembly (except Q8 of course). Smear both sides of each washer with heatsink compound. Place the bracket pieces on the board — component side — and secure Q7, Q9, Q10 and Q11 with nuts and bolts. Only tighten the nuts finger tight at this stage. Now, take the whole board and place the bracket ends against a flat surface — such as the flat heatsink fin — and juggle the brackets until the end faces are flush. Check that all holes line up and then tighten the nuts and bolts.

The TO3 power transistors Q12, 13, 14 and Q15 may now be assembled to the bracket and pc board using the accompanying assembly diagram as a quide. We used spaghetti insulation to sleeve the bolts but pieces of heatshrink tubing would be better.

Don't solder any leads yet.

Allow time for the heatsink compound to spread under compression and finally tighten all nuts. Last of all insert Q8. Smear the inside of the hole to ensure good thermal contact.

Now you can solder all the transistor leads.

Check the component placement against the overlay now, just to ensure all is in order. If you wish, you can test the amplifier up to the driver stages for correct operation before assembling the unit to the heatsink. Remove the fuses before applying ac input from the transformer. Refer to the 'power up' procedure. If there are any problems, look for errors in component placement or orientation — particularly with diodes. If all is well, assemble the module to the heatsink and your're ready for the big test.

Powering Up

The set of output transistors are expensive to replace, therefore we recommend you follow this test procedure in the interest of conserving supplies of same.

The power supply ac input should be connected to the transformer (see the overlay) but no power applied. You'll need a multimeter of at least 20k ohms/V sensitivity.

1) Remove the two fuses.
2) Solder a small link across C11.
3) Solder a wire between this link and the output pad.
4) With no load connected and no input signal, switch the power on.
5) Check the supply rail voltages. These should be about 68 volts each (plus and minus).
6) Check the voltages on the cathode of ZD1 (should be about +37 V) and the anode of ZD3 (about −37V) with respect to 0 V.
7) If these two voltages differ with respect to each other by a volt or so, check other voltages around the input stage to determine the reason.
8) Check the dc voltage on the output (with respect to 0 V). It should be within 20 mV of zero.
9) Inject a sinewave signal into the input at a level of about 20 mV (RMS). Don't use a higher input level. Output should be 1 V RMS.

HOW IT WORKS

The amplifier can be divided into three separate parts. These are: the input stage — which consists of Q1 - Q9, a high gain, low power driver; the output or power stage — which only has a voltage gain of four but enormous power gain; and the power supply.

The input stage is a complementary-differential network, each 'side' with its own current source. Each transitor in this stage is run at a collector current of about 0.7 mA. Emitter resistors are employed to stabilize the gain and improve linearity. The output of Q1 - Q6 drives Q7 and Q9. The latter are virtually two constant-current sources run at about 7 mA collector current. With an input signal these 'current' sources are modulated out of phase — the collector current of one decreases while the other increases. This configuration provides quite an amount of gain.

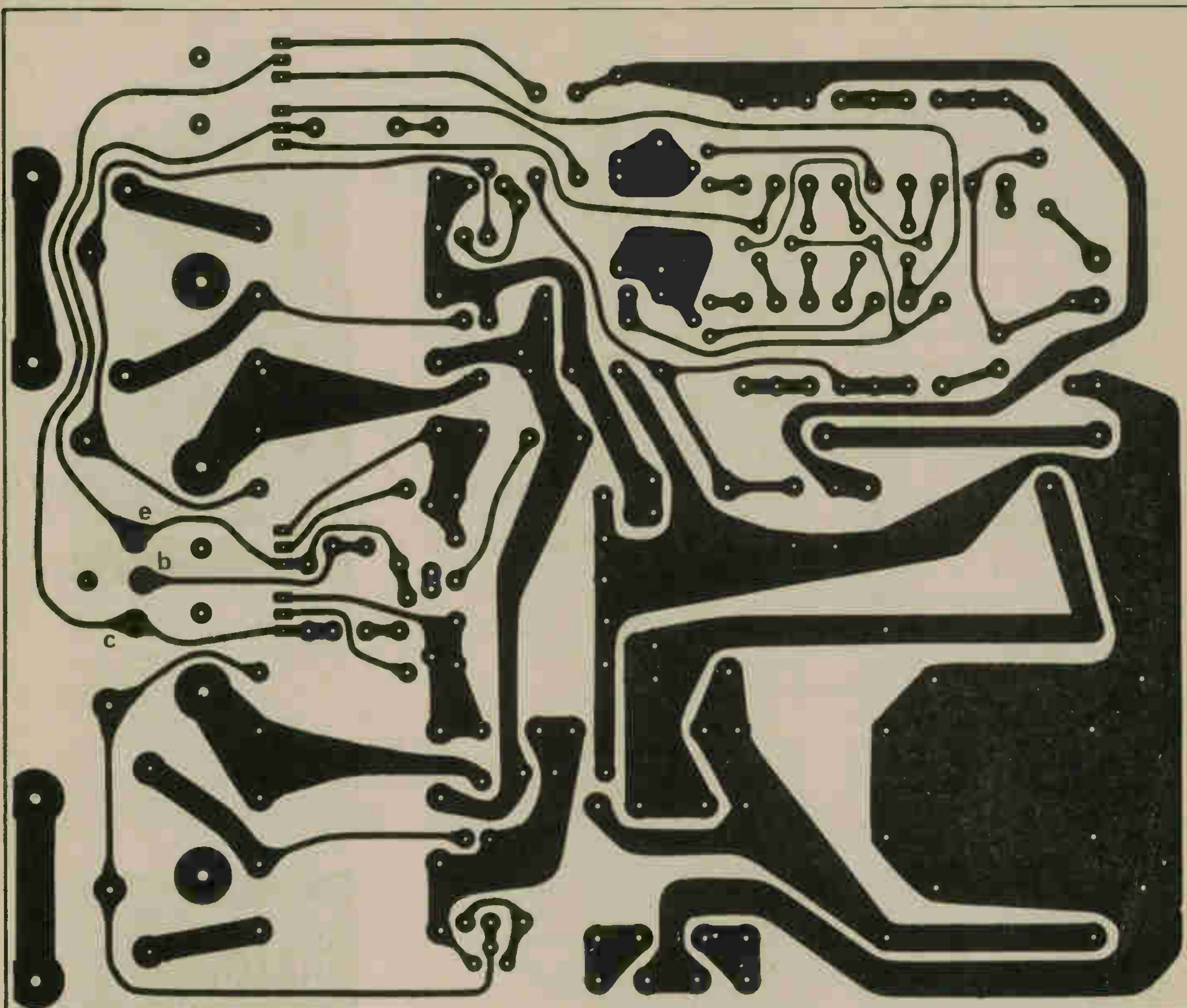
In between the bases of these two transistors is Q8, the thermal sensing - bias transistor. The voltage across Q8 may be adjusted by RV1, thus setting the quiescent bias current for the output stage.

The output stage, Q10 - Q15, has a gain of about five, set by R39 and R29 plus R30. Diodes D5 and D6 prevent reverse biasing of Q10 and Q11 (otherwise the output would be limited).

Protection of the output transistors is provided by Q16 and Q17 which monitor both current and voltage in the output transistors and bypass the base current if the limit is exceeded.

The power supply is a full-wave rectifier, with a centre-tap on the transformer giving the 0 V rail, providing +/− 68 volts. A total of 5000 uF is used across each supply rail for filtering. The supply rail, is derived from ZD1-ZD3 via R20 and R25.

Frequency stabilisation is provided by capacitors C8, 13, 14 and the RC networks R26/C15. Frequency response of the amplifier is set by C5 and C7 (lower limit), C8 sets the upper frequency limit.



PARTS LIST

Resistors all ½W, 5% unless noted

R1 . . . . 1k
R2 . . . . 10k
R3 . . . . 1k
R4 . . . . 10R
R5 . . . . 220R
R6, R7 . . . . . 4k7
R8, R9 . . . . . 22R
R10. . . . . . . 10k
R11. . . . . . . 2k2
R12. . . . . . . 22k
R13. . . . . . . 2k2
R14. . . . . . . 10k
R15, R16 . . . 22R
R17, R18 . . . 4k7
R19. . . . . . . 10k(6k8 for 4 ohm loads)
R20. . . . . . . 1k 5W
R21. . . . . . . 390R
R22. . . . . . . 6k8
R23. . . . . . . 4k7
R24. . . . . . . 390R
R25. . . . . . . 1k 5W
R26. . . . . . . 100R
R27. . . . . . . 220R
R28—R33 . . . 100R 1W
R34. . . . . . . 220R
R35, R36 . . . 220R 5W
R37—R42 . . . 0.1 ohm, 5W
R43. . . . . . . 39R
R44, R45 . . . 5k6 1W
R46. . . . . . . 39R
R47. . . . . . . 4R7 1W

Potentiometers

RV1 . . . . . . 2k2 trim

Capacitors

C1—C4 . . . . . 2500µ 80V RTP electrolytic (ELNA)
C5. . . . . 2µ2 35V tantalum
C6. . . . . 330p ceramic
C7. . . . . 100µ 25V electrolytic
C8. . . . . 330p ceramic
C9—C11 . . . . 100n polyester
C12—C14 . . . 1n5 polyester
C15—C17 . . . 100n polyester

Semiconductors

Q1—Q3. . . . . .2N3904
Q4—Q6. . . . . .2N3906
Q7 . . . . .BD140, 2N4920
Q8 . . . . .MPS6515
Q9, Q10 . . . . .BD139, 2N4923
Q11. . . . . .BD140, 2N4920
Q12, Q13 . . . .MJ15004
Q14, Q15 . . . .MJ15003
Q16. . . . . .BD140, 2N4920
Q17. . . . . .BD139, 2N4923
D1—D4. . . . . 1N5004
D5, D6 . . . . . 1N4004
ZD1. . . . . . . .5V1 300 mW (IN751A)
ZD2. . . . . . . .62V 5W (IN5372B)
ZD3. . . . . . . .5V1 300 mW (IN751A)

Miscellaneous

PC board
Heatsink - see text
Transformer 100 VCT, 5A— Hammond 167 P100
4 fuse clips, 2 X 5A fuses.

10) Switch off the main power and allow the filter capacitors to discharge. Remove the input signal.
11) Solder a 10 ohm ½W resistor across each fuse holder. Rotate the trimpot RV1 such that it is set at maximum resistance. Remove the short across C11 and the link from there to the output pad.
12) Switch on . . . if the 10 ohm resistors immediately vaporise you either have a short or some fault in the output stage!
13) If all is well, check the dc output voltage. It should be near zero.
14) Measure the voltage drop across one of the 10 ohm resistors placed across the fuse holders and adjust RV1 to give a reading of 1.0 V.
15) Switch off, allow the filter capacitors to discharge and remove the two 10 ohm resistors. Replace the fuses.
16) Connect suitably rated loudspeakers, warn the neighbours, connect a signal source to the input (turn down the volume), switch on the power and put the amp through its paces.

At this stage we'll leave the application of this module up to you. No doubt you have plenty in mind already.

Good luck! ●

Transistors

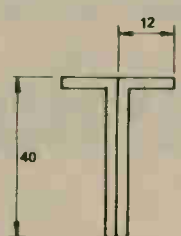
As far as we know, no-one has yet considered marketing a kit for this project.

Most of the components are readily available, the only really tough ones being the output transistors, Northern Bear Electronics and Kitstronic International. See classifieds for their ads.

For printed circuit boards, check the classified and the Table of Contents.

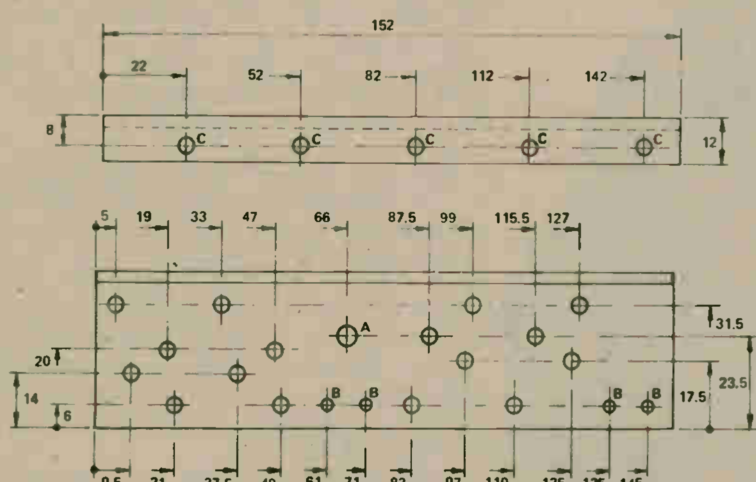
HOLES MARKED A 4.5mm DIA
HOLES MARKED B 3mm DIA
HOLES MARKED C 4mm DIA
ALL OTHERS 4mm DIA

MATERIAL 40 x 12 x3 ALUMINUM ANGLE EXTRUSION

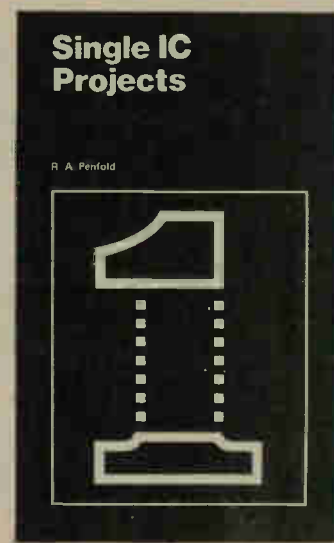


Drilling details for the heatsink bracket assembly. All dimensions are in millimetres.

MAKE 2 OPPOSITE HANDS



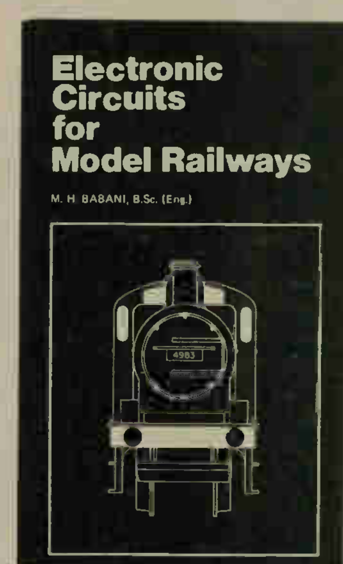
ETI Book Service



There are now a vast range of IC's available on the amateur market, the majority of which are not necessarily designed for use in a single application and can offer unlimited possibilities.

All the projects contained in this book are simple to construct and are based on a single IC. A few projects employ one or two transistors in addition to an IC but in most cases the IC is the only active device used.

BP65 . . . . **$6.25**



In this book a number of constructional projects and ideas are discussed. Details are given on how to build three types of model train controller and ideas on signalling are considered in detail.

BP213 . . . . **$4.50**

Use the card facing page 44 or send to: ETI Magazine, Unit 6, 25 Overlea Blvd., Toronto. Ontario. M4H 1B1

S100 BUS

Details On How It All Started.

The pin designation and printed circuit card size originally used in the Altair 8800 computer has become somewhat of a standard in both the US personal computing scene and elsewhere in the world. So much so that there are over 40 manufacturers supplying electronic and mechanical products for the Altair bus. The bus became known as the S100 bus.

Originally defined by MITS when they designed the Altair 8800 computer around the 8080 microprocessor, the S100 gained momentum as a 'standard' when IMSAI released their computer, again 8080 based, with this bus structure. Now the range of boards available includes memory expansion, the most common floppy disc controllers, graphics boards, multifunction and analogue I/O boards, video interfaces and even speech synthesis and recognition systems. 1977 saw a new dimension added to the S100 bus. This was the year when various other CPU's became available as S100 structured boards. These included the Z80, the 6800 and the ever popular 6502.

Expandability?

The huge variety of S100 format boards available has been largely responsible for its growing popularity. This wide choice has meant that you can tailor your own system by your needs by simply choosing the cards that you want. for example the addition of a graphics facility. You either spend a fortune on a graphics terminal or buy yourself a graphics board for your S100 system and not only save money but get a more flexible solution to your needs.

However the S100 system is not without its critics, not that other bus systems are perfect, and the real source of most of the arguements about the system are caused by the lack of information available on it. This lack of knowledge is not a very good thing when one is in the position of spending several tens of pounds on an add-on or hundreds on a system. At the present time the personal computer buffs are doing one of three things with the S100, ignoring it completely and using something else, buying a strict S100 system with proven boards and thirdly using the bus but with their own interpretation of the controls to suit their own microprocessor. Obviously the first and second groups will not have too much trouble but the third will need information on the bus structure. That information is what we hope to provide in this article.

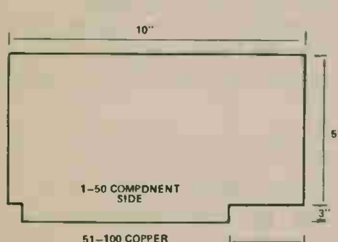


Fig. 1. Standard S100 cards are 10" by nominal 5.3". Some manufacturers change the height depending on circuit requirements. Edge connector spacing is 0.125", offset to prevent backward insertion of a board.

Criticisms?

The bus is also criticised because it is not completely standardised, the control signals are getting to be rather outdated and more complex than they need to be. The justification for the claims stated above is that when the manufacturers look at the specification for the device that they are building some control lines can be interpreted in different ways and hence although variations do exist the boards work. What worries the users is that whilst board A may work on the bus and board B may work on the bus board A will not necessarily work with board B! The only way round this confusion is to try out the board before actually parting with your money and here your users club will probably be able to help. As the S100 bus was designed around the 8080 when several of its support chips such as the 8228 and 8224 were not available there are more control signals on the bus than absolutely necessary. One good example is the provision of three lines to send the two clock phases and CLOCK. The newer processors have the oscillators built into the chip, others use only a single phase clock. However this surplus of control lines does have one advantage, that is the redundancy of information. To the system designer this is the flexibility that he can build into his system. The bus also has some unique control lines that he can build into his system. One example is the provision of a remote memory protect. The S100 definition allows for a memory protect flip-flop on the memory board. Applying a momentary positive pulse on the MEMORY PROTECT line sets this flip-flop and prevents data being written into memory on that board.

Designing Your Own S100

The physical facts of S100 are given in Fig. 1, a picture worth a thousand words. The bus supports sixteen address lines, allowing 65536 bytes of memory to be uniquely addressed. There are also two 8-bit data buses, one for data input (data flowing to the CPU) and one for data output (data flowing from the CPU to memory or peripherals).

There is also a set of control lines that are used for synchronisation, timing data flow control and status control because the Altair is an 8080 based computer many of the control signals can be found described in the Intel data sheets. They can be found by looking at the similarity of names in Table 1 to those in the Intel User's Manual.

The S100 Definition calls for each board to have its own voltage regulators. To this end there are lines carrying unregulated voltages. There is +8V on pins 1 and 51, +16V on pin 2 and −16V on pin 52. Ground is pins 50 and 100.

When you examine the different signals in Table 1 you will notice frequent reference to the front panel. In fact many of the controls signals are generated on it. The Altair 8800 required the front panel to control the CPU board. However the newer CPU boards do not use front panel boards and themselves generate most of the control signals that are required by the S100 bus. This has happened through the use of an on-board ROM monitor program. You will need to bear this in mind if you plan to design and build your own CPU card.

S100 Bus Structure

The S100 Bus Structure consists of 100 lines. These are arranged with 50 on each side of the plug-in cards. The 'P' prefix indicates a processor command or control signal while the 'S' prefix indicates a processor status signal. All bus signals with the exception of the power supplies are TTL levels.

BUS DEFINITION

PIN No.	SYMBOL	NAME	EXPLANATION
1	+8 V	+8 Volts	Unregulated input to +5 V regulators
2	+16 V	+16 Volts	Positive unregulated voltage
3	XRDY	External Ready	For special applications: pulling this line low will cause the processor to enter a WAIT state and allows the status of the normal Ready line (PRDY) to be examined
4	VI0	Vectored Interrupt Line 0	
5	VI1	Vectored Interrupt Line 1	
6	VI2	Vectored Interrupt Line 2	
7	VI3	Vectored Interrupt Line 3	
8	VI4	Vectored Interrupt Line 4	
9	VI5	Vectored Interrupt Line 5	
10	VI6	Vectored Interrupt Line 6	
11	VI7	Vectored Interrupt Line 7	
18	STA DSB	Status Disable	This input to the CPU board tri-states the buffers that output the status information to the bus. Signals affected are SINTA, SWO, SSTACK, SHLTA, SOUT, SMI, SINP, and SMEMR.
19	C/C DSB	Command/Control Disable	This input to the CPU board tri-states the buffers that output the 8080 control signals to the bus. Signals affected are SYNC, DBIN, WAIT, WR, HLDA and INTE.
20	UNPROT	Unprotect	Is an input to the memory protect flip-flop on a memory board. To protect the contents of such boards a positive pulse should be applied to pin 70 to set the protect flip-flop. A positive pulse on the UNPROT line will reset the flip-flop.
21	SS	Single Step	This signal indicates the processor is performing a single step. It comes from the front panel and is an input to the CPU.
22	ADD DSB	Address Disable	This input to the CPU tri-states all 16 address buffers and so isolates the 8080 address bus from the system address bus.
23	DO DSB	Data Out Disable	This CPU board input tri-states the data out buffers. Use of the signals on pins 18, 19, 22 and 23 effectively disconnect the CPU board from the system for DMA.
24	ϕ2	CLOCK PHASE 2	
25	ϕ1	CLOCK PHASE 1	
26	PHLDA	Hold Acknowledge	This CPU output indicates that the 8080 has entered the hold state and that the address and data outputs of the chip have gone tri-state (though not necessarily their buffers).
27	PWAIT	Wait	CPU output indicating 8080 in wait state.
28	PINTE	Interrupt Enable	CPU output indicating that the 8080 interrupt system is enabled and the chip will respond to interrupts.
29	A5	Address Line 5	
30	A4	Address Line 4	
31	A3	Address Line 3	
32	A15	Address Line 15	
33	A12	Address Line 12	
34	A9	Address Line 9	
35	DO1	Data Out Line 1	
36	DO0	Data Out Line 0	
37	A10	Address Line 10	
38	DO4	Data Out Line 4	
39	DO5	Data Out Line 5	
40	DO6	Data Out Line 6	
41	DI2	Data In Line 2	
42	DI3	Data In Line 3	
43	DI7	Data In Line 7	
44	SM1	M1	CPU status output; indicates instruction fetch cycle (important for front panel operation as machine must halt on M1).
45	SOUT	OUT	Indicates execution of an OUT instruction: address bus contains I/O port address and data bus will contain output data when PWR active. All memory boards should be disabled when SOUT or SINP at logic 1.
46	SINP	INP	As SOUT, but for an IN instruction. Data to be input should be placed on the data bus when PDBIN is active.
47	SMEMR	MEMR	CPU output indicating memory read in progress.
48	SHLTA	HLTA	CPU status output: halt acknowledge.
49	CLOCK	Clock	In the Altair this is the inverted output of the 2 MHz oscillator that generates the two phase clock.
50	GND	Ground	You have now read half way through this; congratulations on your perseverance and I hope you find what you're looking for!
51	+8 V	+8 Volts	See pin 1.
52	−16 V	−16 Volts	Negative unregulated voltage.
53	SSW DSB	Sense Switch Disable	CPU input; disables data input buffers so that data from the front panel sense switches may be strobed onto the processor's bidirectional data bus.
54	EXT CLR	External Clear	Generated by the front panel; is used by the Altair as a reset signal for I/O devices. In other systems it is tied together with RESET and POC.
55 −67			These pins were undefined on the original Altair system.
68	MWRT	Memory Write	A function of WR and SOUT, indicating data on data out bus is to be written into memory.
69	PS	Protect Status	An output from the memory board currently being addressed; indicates status of memory protect flip-flop.
70	PROT	Protect	Is the input to the memory protect flip-flop on the board currently addressed.
71	RUN	Run	Indicates the state of the RUN/STOP flip-flop.
72	PRDY	Ready	CPU board input that controls the run state of the processor. Pulling PRDY low causes the processor to enter a wait state until PRDY goes high again.
73	PINT	Interrupt Request	
74	PHOLD	Hold	Causes the processor to enter a Hold state and subsequently acknowledge by putting PHLDA high.
75	PRESET	Reset	Resets program counter to zero.
76	PSYNC	Sync	Identifies beginning of a machine cycle.
77	PWR	Write	Indicates data is being written to memory or I/O. Data on bus is stable while PWR is low.
78	PDBIN	Data Bus In	Processor output control signal indicating that data is being read into the CPU. Data on the the data bus should be stable while PDBIN is high.
79	A0	Address Line 0	
80	A1	Address Line 1	
81	A2	Address Line 2	
82	A6	Address Line 6	
83	A7	Address Line 7	
84	A8	Address Line 8	
85	A13	Address Line 13	
86	A14	Address Line 14	
87	A11	Address Line 11	
88	DO2	Data Out Line 2	
89	DO3	Data Out Line 3	
90	DO7	Data Out Line 7	
91	DI4	Data In Line 4	
92	DI5	Data In Line 5	
93	DI6	Data In Line 6	
94	DI1	Data In Line 1	
95	DI0	Data In Line 0	
96	SINTA	INTA	Indicates interrupt acknowledge.
97	SWO	WO	Processor output indicating write cycle.
98	SSTACK	Stack	Processor output indicating that the address bus holds the stack pointer.
99	POC	Power On Clear	When power is first applied this signal is generated to set up initial conditions on other boards in the system.
100	GND	Ground	

Audio Today

Our Audio Editor Wally Parsons returns to dbx and considers how a square wave is recorded.

READERS WHO ARE also fellow aficionados of science fiction will surely understand when I state that the truly great dream of the genre is not the building of rocket ships, travelling to distant worlds, robotics, the creation of life, or any of that, but, rather, the ability to travel in time, and better still, the ability to alter the present by altering the past. If I were to invent a time machine of some sort, I would truly love to bring to the present many of the pioneerng scientists and inventors, so that they might see for themselves the results of their discoveries and inventions. I would also like to bring back people like Beethoven so that he might be treated for his hearing degeneration, and Wagner, so that he might be able to hear and see the Ring of the Niebelung as he surely wanted to. And, yes I'm quite familiar with the theory of temporal paradox.

I suppose most of us with at least a modicum of imagination have, at one time or another, contemplated returning to the past with a new modern day invention, speculating on its impact on the past and the consequences for the future.

For example, suppose the newly introduced dbx-encoded discs could be introduced in 1962, by means of temporal travel (ignoring, for the moment, the impact of temporal travel itself). Presumably, it would have been welcomed with open arms, and altered the future of audio development.

To Everything There Is A Season

Back in 1962, stereo discs were only a few years old. The most serious problems to be solved were those of adequate and consistent channel separation, frequency response, and distortion at all levels, In part, this was due to the problems resulting from attempting to record two channels in one groove, using modulation angular differences of up to 90 degrees, but a greater part of the difficulties lay in the fact that we now had a combination of vertical and lateral modulation.

Through most of the acoustical period and all of the electrical period of recording, with the exception of a few years during the war, all recording on discs used lateral modulation, in which a groove was modulated by moving the cutting stylus from side to side in accordance with the signal. It should be appreciated that the depth of a groove is a function of the vertical force of the cutting stylus on the recording blank. With lateral modulation, it's not too difficult ("difficult" being a relative term, of course) to ensure that the cutter moves symmetrically around its reference by the vertical force of gravity (discounting Seeburg Juke Boxes, and the like), it isn't too difficult to ensure that the stylus responds symmetrically to lateral modulation forces.

But vertical modulation is another story entirely. Since a vertical force is applied to the cutting stylus to produce the basic groove, it follows that a modulating signal alternately adds to and subtracts from this force. In moving upward, the armature restoring force must be overcome, while in moving downward the resistance of the recording blank must be overcome. If these two forces happen to balance each other perfectly, all is well, but if not, a high level of distortion is generated. The playback system encounters the same problem because it too is kept in the groove by the force of gravity. And, to add further to life's trials and tribulations the problems are aggravated as levels increase.

Mother Nature is obviously *not* that nice little old lady in the Del Monte commercials. And she certainly is not on *our* side.

Everything Has Its Limits

It's a self-evident fact to everyone except those who play portable radios on that every amplifier has a maximum output which limits possible loudness, and every loudspeaker has a maximum loudness level beyond which you end up with the cone in your lap. Since a cutter is a distant relative of the loudspeaker, with a stylus instead of a cone, and since it is driven by an amplifier, it follows that such a system also has its limits. But even if that were not so, consider the effect of unlimited groove modulation.

A little reflection will indicate the impossibility of engraving a signal in the form of a square wave. In reality, a square wave records as a triangular wave on the disc, and a recorded triangular waveform reproduces as a square wave, as shown in Fig. 1. A pure square wave is identical to two fixed levels which are alternately switched. A fixed voltage applied to a cutter results in the cutter's moving in one direction at a constant velocity.

If the polarity of the applied signal reverses, which it does every half-cycle of a square wave, the cutting stylus instantly reverses direction (assuming perfection, of course). This can be observed by connecting a high compliance loudspeaker driver to an amplifier and a function generator putting out a square wave at about 1.0 Hz and noting the cone movement. Compare this with its behaviour on a sine wave signal, all the while observing the signal on a 'scope. Note the point on the waveform at which the cone changes direction. This will be especially obvious if the driver has a high level of mechanical or acoustical damping and if you keep the level low enough to avoid running into the suspension limits.

Since both the disc surface and the cutting stylus are both travelling at a finite velocity, and at an angle to each other, the final groove described is the vector sum of the two velocities at right angles to each other as shown in Fig. 2. Now, this groove may travel past a playback stylus at a high velocity, but this is nothing compared with the sudden deceleration and acceleration encountered upon reversal of direction.

If we increase lateral velocity, as in increased level, we find that the slope is greater, and the deceleration and acceleration are also increased. Similarly, if we reduce lineal velocity, as in the inner grooves, the same thing happens, as it also does if we increase frequency.

Back in the days when 7 cm/sec was used as a standard zero-reference, this limit was set by the pickups available. Then pickups improved, followed by improvements in cutters which exceeded the pickup capabilities, then pickups improved, and so on in an apparently unending circle.

All Good Things Come To An End

Well, the circle was not quite unending, and the limit, for all reasonable and practical purposes, seems to have been reached. If practical limits to cutter and pickup excursions didn't do the trick, plastic deformation characteristics would. Deceleration and acceleration forces result in extremely high unit pressures between stylus tip and groove, with resulting high temperatures, and there is a real limit as to how much deformation vinyl can take and still return to its original form. Even if we found some wonder material which lacked this limitation, the amount of space taken up by a modulated groove would impose severe limitations on playing time. Or would you like to go to larger discs?

Obviously, these limitations set the maximum peak level which can be recorded on a disc.

Since the dynamic range is the difference between the maximum recordable level, and the lowest level which remains acceptably above noise either from the groove or any subsequent devices, including the preamp, it follows that noise sources remain the final limit on recordable dynamic range.

Sad to say, it appears that the lowest noise level due to vinyl surface irregularities is very close to the theoretical minimum on today's best recordings, and preamps are available which are so quiet as to approach the inherent thermal noise levels of the source resistances. But even with a noiseless preamp and zero resistance pickups, the inherent noise floor of vinyl still limits us to a dynamic range not much better than 60 dB.

Dynamics Equalization

When studies of spectral distribution revealed that it was possible to boost high frequencies above the noise floor without encountering excessive groove velocities, then roll them off on playback, high frequency noise components were reduced.

By boosting *all* signal components at low *levels* so that the signal is above the noise floor, then reducing low levels in a complementary manner on playback, *all* noise components are reduced and dynamic range preserved.

Since the process is analogous to frequency equalization, it can properly be called Dynamics Equalization, and the term, is used here for the first time, to the best of my knowledge.

dbx encoded discs are compressed in the manner described on recording, and expanded (decompression?) on playback, so a dbx decoder could properly be called a Dynamics Equalizer.

The process raises the lowest levels sufficiently above the noise floor, that a few dB can be sacrificed to allow the maximum level to be lowered, thus minimizing tracking problems.

All that's left now, is to figure a way to reproduce all this dynamic range.

And that's what next month is all about. Stay tuned. ●

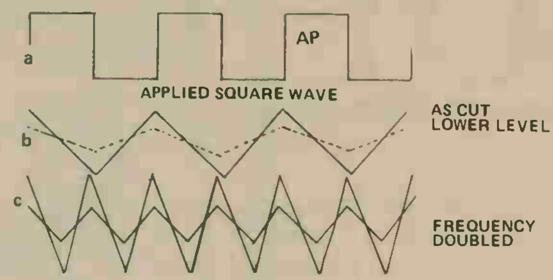


Fig. 1. How a square wave (a) looks when cut into the vinyl of the record.

FIG.2.

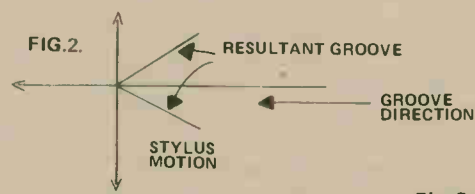


Fig. 2. The resultant groove.

Audio Today Products

Blaupunkt Model CR 5001 AM/FM Stereo Cassette Car Radio.

From the people who help put the Mercedes in the J R Ewing price range comes one of the little luxuries which give such vehicles all the comforts of home.

Featuring digital display of time and station, plus 5 push button station selectors, it also boasts four power amplifiers of 15 Watts each, suitable for driving four channels or a bi-amped system.

The various control functions are identified for high visibility under night conditions, and they include separate treble and bass controls, volume, balance and four-way fader.

The cassette unit features Sendust head, metal, chromium-dioxide, and ferro tape capability, plus Dolby on tape and FM. Frequency response is claimed to be 40 - 15,000 Hz on FM, and 40 - 14,000 Hz on tape.

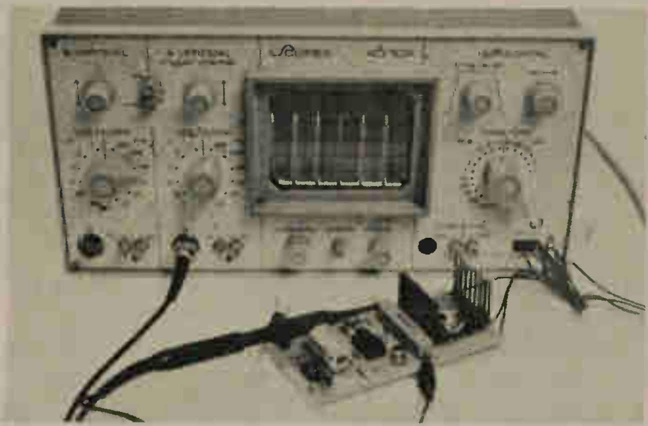
All Blaupunkt units feature ASU Noise suppression on FM, local/distance switch, stereo/mono switching, auto reverse, locking rewind, fast forward, manual and automatic cassette ejection on ignition and radio power off.

Contact Robert Bosch (Canada) Ltd., 6811 Century Avenue, Mississauga, Ont. L5N 1R1, or phone (416) 826-6060.

PROJECT

HEBOT II

A continuation of last month's article on our ingenious "robot."
Here we describe the inductive wire-tracking circuitry with full circuit details. There is also a simple constant-current nicad charger. Full details of all the circuit interconnections are given with notes for expansion.

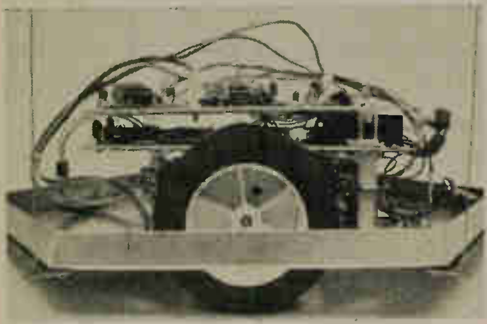


You can monitor the loop output current with an oscilloscope.

Before we go on to look at the monster we have created, a couple of points need to be cleared up. Though we used rechargeable nicad cells to power our Hebot, the circuitry will work quite happily with plus and minus six volt supplies when powered by dry batteries.

The second PCB is easier to mount above the first if capacitors C3, 4 are mounted so that they lie sideways. Also, to increase the gain of IC1, 2, 470k resistors should be mounted in parallel with input resistors R1, 2. There are no other changes to make on the first board.

On the second board, capacitors C1 and C10 have caused some problems. These capacitors should have a working voltage of at least ten volts. A 47µ capacitor may be used in place of either component. Resistor R4 should be changed from 100k to 270k and R5 from 820R to 8k2.



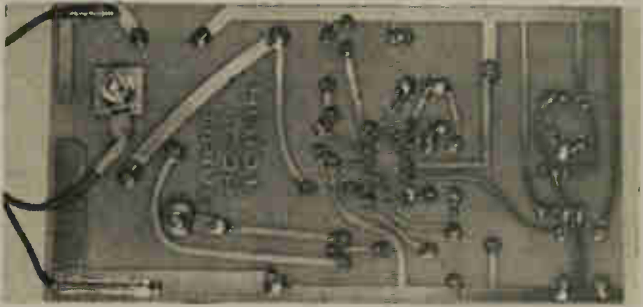
Note the 470k resistors mounted in parallel with the servo input resistors.

Following tests with Hebot tracking a wire energised by the loop driver circuit, it was found that capacitors Cx were unnecessary and wire links should be inserted in their place. Also flying leads should be used to connect pin E to G and F to H.

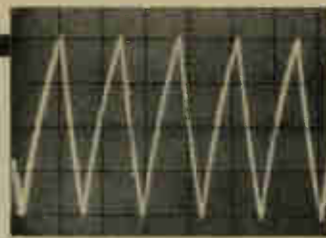
We have arranged our Hebot to perform a random walk' until it sees a light (We used a desk lamp placed at ground level) Hebot then steers towards the light unless its pick-up coils detect electromagnetic radiation from an energised loop. Then Hebot will follow the wire loop. If at any time Hebot collides with an obstacle then the normal manoeuvre circuitry takes over to steer Hebot out of trouble. The connections to achieve this behaviour are detailed below.

The connections to the manoeuvre circuitry remain the same;
pins 2, 3, IC8 to pin 4, IC4

Allow some clearance from the PCB for R12 and Q2.



There are connections to both sides of Q2 collector. We used solder-tags.


Triangle waveform across C2.


Output waveform across R12.

pins 9, 10, IC8 to pin 11, IC4
pin 12, IC11 (Avoid) to pin 13, IC3 'random walk' is achieved by connecting: A to pin 1, IC4
B to pin 12, IC4
+ve supply to pin 10, IC3
the letters refer to pins on the second board
for light seeking connect:
P to pin 14, IC4
Q to pin 5, IC4
the phototransistor collectors connect to N (from right sensor) and O (from left sensor). T to pin 11, IC3

The emitters both go to the negative supply and pins are provided on the board.
The connections for wire tracking are:
I to pin 15, IC4
J to pin 2, IC4
M to pin 12, IC3

Hebot's sensors were made from reed relay actuating coils with a resistance of 1.5k. No cores were found to be necessary. The right sensor connects to pin C while the left sensor connects to pin D. The free ends of the sensor coils should be connected to the adjacent pins which are electrically identical with pin 1, IC1.

You should now have used all the inputs to IC4. IC5 is not used and this position may be left vacant. The remaining pins of IC3 should be connected as follows. Pins 1, 2, 3, 4 should be connected to the negative supply. This can be simply achieved by soldering a piece of tinned copper wire across all four pins down to the negative pin as shown in our photos. Pins 14, 15 of IC3 remain unconnected.

Our Hebot emits a sqeak when it detects light. To achieve this connect pin Y to pin T. There are now two connections to pin T. This is okay. You can spot when Hebot detects the wire loop by connecting pin S to pin M. The LED will illuminate when the pick up coils are within range of an energised loop. Also, of course, control is transferred to the wire following circuitry unless Hebot encounters an obstacle.

With the Hebot circuitry interconnected as described above, you will have a free roaming robot which can negotiate obstacles, steer towards a light and follow a wire around your home. We found that reliable operation could be obtained with wire-sensor separations of over one inch so Hebot should cope with the thickest pile carpets (though the prototype has an annoying habit of filling itself with fluff!).

The loop driver circuit should be constructed in the usual way. Though not essential, use of our PCB will greatly facilitate construction. Our photos tell all really. We found best operation was achieved with peak currents of 2.5A which gave a mean current drain of 350mA. Under these conditions Q2 hardly gets warm at all. RV1 works In reverse; when fully clockwise there is no output. About mid-way should produce the desired results.

At this stage of development Hebot is an autonomous machine capable of very engaging behaviour. There is plenty of room for development. Board one will support a further four levels of control enabling more circuits to be accommodated on the chassis or control to be relinquished to an on-board micro-processor or via a link to your home computer. The possibilities are infinite and remember . . . We HAVE the technology! ●

PARTS LIST

RESISTORS (All ¼W, 5%)	
R1, R2, R8	100k
R3, R4	10k
R5	1M0
R6	470k
R7	10M
R9	47k
R10	150R
R11	3k9
R12	1R0 10W
POTENTIOMETER	
RV1	10k horiz. preset
CAPACITORS	
C1	1,000 electrolytic
C2	10n polyester
C3	3µ3 tantalum
C4	10p polystyrene
SEMICONDUCTORS	
Q1	2N3053
Q2	2N3055
D1	1N4148
ZD1	15V 1.3W
IC1	555
IC2	LM324
POWER SUPPLY	
12V	3A transformer
4A	bridge rectifier
4R7	10W resistor
2x	4,700µ 25V
CHARGER	
RESISTORS (All ¼W 5%)	
R1	1k0
R2	15R
CAPACITORS	
C1	1,000µ 25V
SEMICONDUCTORS	
Q1	2N1482
Q2	TIP33A
BR1	1A 50V bridge rectifier
transformer 12V 100mA	

HOW IT WORKS

Loop Driver

Hebot is able to follow a wire laid on the floor by detecting the magnetic field produced by current pulses flowing in the wire. We tried a number of different arrangements and found that Hebot could follow a single wire carrying current pulses of about two amps at a frequency of around seven hundred Hertz. By using more turns of wire in the loop, accurate tracking can be achieved at lower currents. However, it is difficult to lay out a loop consisting of more than two or three turns of wire and the system chosen represents the best compromise.

Resistor R10 and zener ZD1 provide a stabilised 15V supply which is smoothed by C1. A 700Hz signal is generated by IC1; a 555 timer configured in the astable mode. A diode is used to bypass R2 during the charging cycle. This enables a duty-cycle of 50% to be obtained. The approximate triangle waveform at the junction of R2, C2 is buffered by IC2b, a unity gain voltage follower, and appears at pin 7. A bias voltage of about 7.5V is available at pin 14 and supplies IC2a and RV1. IC2a acts as an inverting amplifier with a gain of about 20 whose input is the triangle waveform from IC2b. Adjustment of RV1 enables the output of IC2a to be offset. In this way, the signal at pin 1 may be varied from 0Vto positive peaks of up to 12V. The remaining section of IC2 together with Q1, 2 and R11, 12 forms a voltage to current convertor. For each volt across R9 at the input pin 10 of IC2c, one amp will flow in a piece of wire connected between the positive supply and collector of Q2. The maximum voltage that can appear at IC2a output is limited to 12V with a 15V supply by the op-amp characteristics. Potential divider R8, 9 limits the input to IC2c to 4V and maximum output current, in a working circuit, is thus limited to 4A.

A suggested power supply is included here. Though the average current is less than 500mA with peak currents of 2½A, the circuit may demand currents of up to 4A. For this reason, quite high current components have been chosen. If you have a current-limited power supply that can provide 15V at 500mA you can connect it in place of the bridge-rectifier and transformer. Use good quality components for the capacitors to cope with the high current pulses.

We tried loops of several shapes and sizes with good results. Hebot can cope with turns of up to one foot radius. Power should be supplied to the loop by twisted wires or figure of eight speaker cable. In this way the fields from the two supply wires cancel out and Hebot will not try to climb into your power supply.

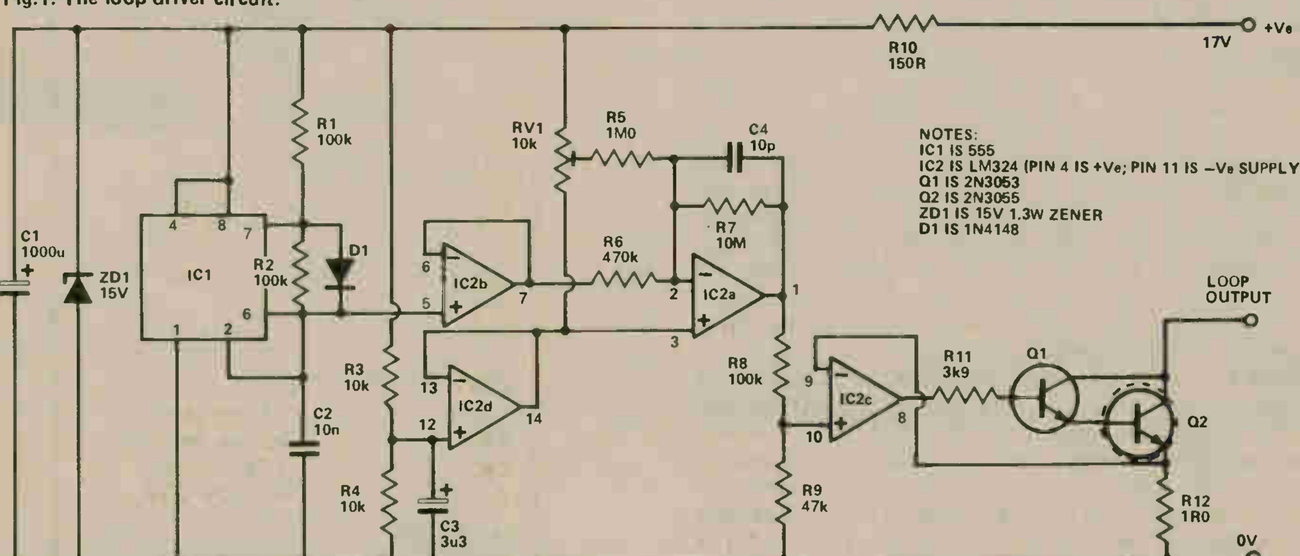
Nicad Charger

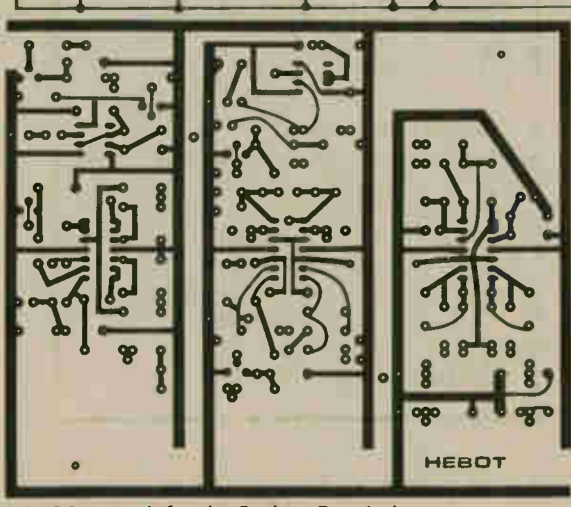
If you have used nickle-cadmium cells to power yóur Hebot, you will need a charger. We have included the circuit of a suitable charger which will supply a constant current of 40mA. R2 is the nearest preferred value. With 450mA/H cells a charging current of 45mA should be applied for fourteen hours. Assuming a Vbe of 0.6V for Q1 then the theoretical value of R2 to produce a current output of 45mA is 13.333 ohms. You can check the current by inserting a meter in place of the cells and adjust R2 accordingly. A 120R resistor in parallel with R2 would produce the calculated value of 13.333 ohms.

About 18V is developed across C1. The charging current flows via the cells through Q2, R2. Transistor Q1, 2 form a stabilised current sink. Current flow is determined by choice of R2. A current will flow sufficient to produce a voltage of 0.6V across R2. This tends to turn of Q1 which 'steals' base drive current tending to turn off Q2. In this way the sustem reaches a stable operating point.

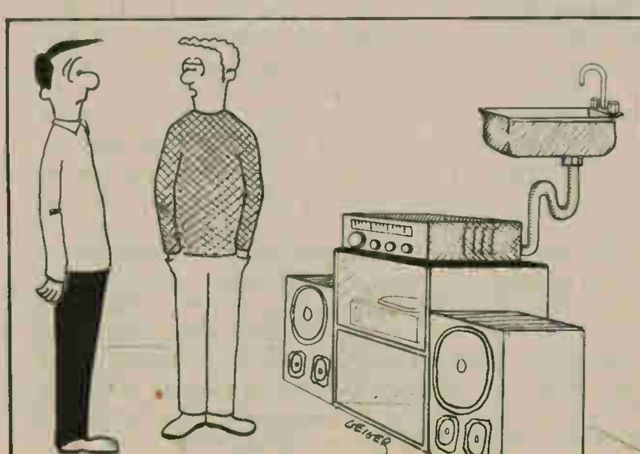
No PCB is given as the circuit is so simple. A small heatsink should be used with Q2. No other precautions are necessary.

Fig.1. The loop driver circuit.





The PC artwork for the Options Board, shown here half size. The component overlay can be found in last month's issue.



"Heatsink"

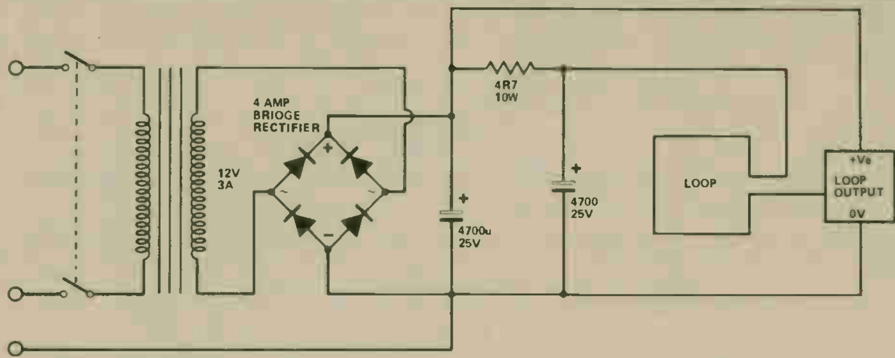


Fig.2. Interconnections for the loop driver.

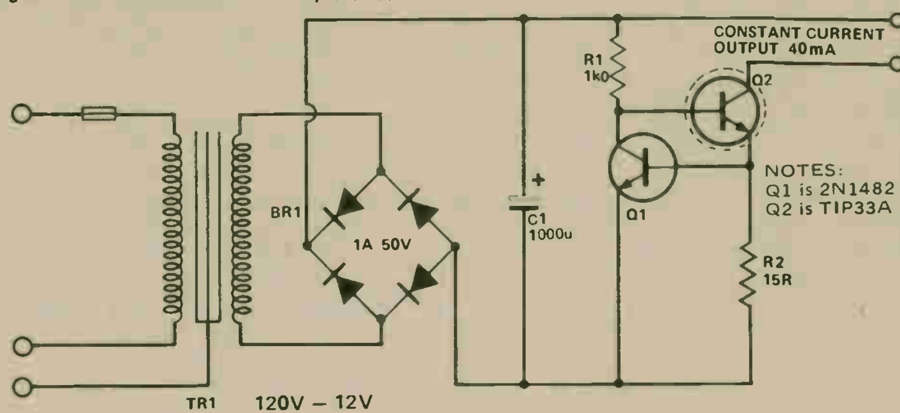


Fig.3. Simple charger circuit for AA nicad cells.

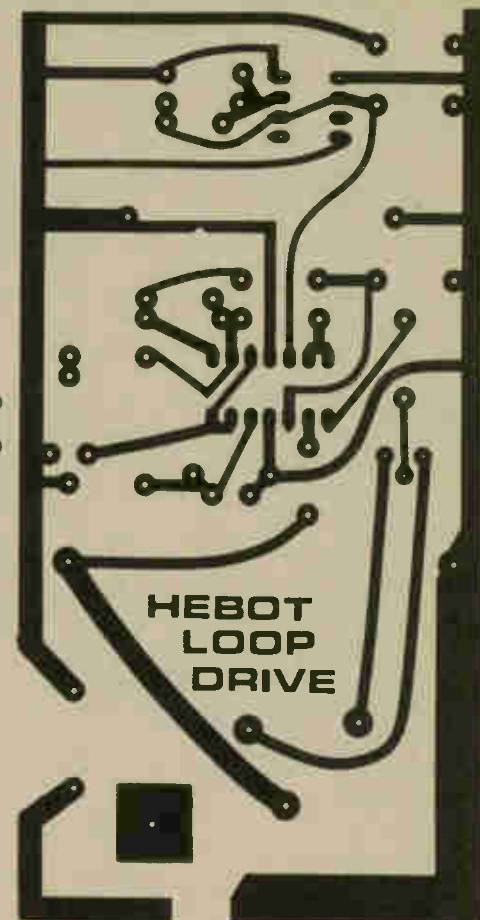


Fig.4. PCB for loop driver.

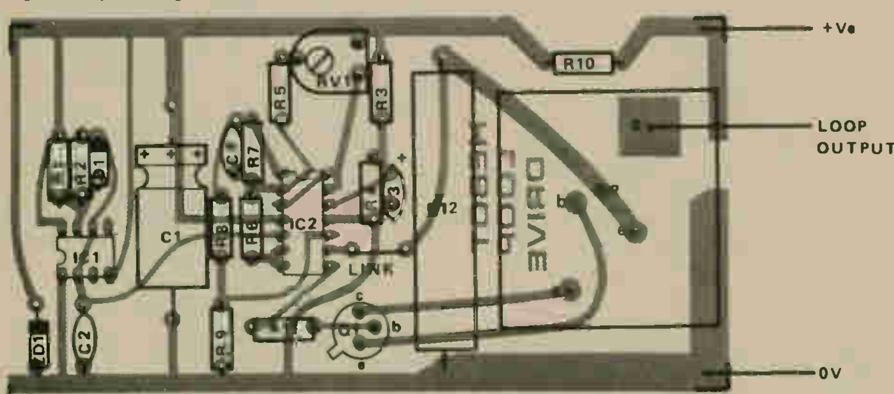
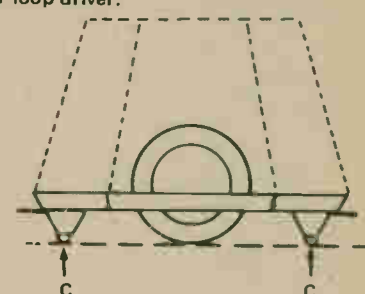
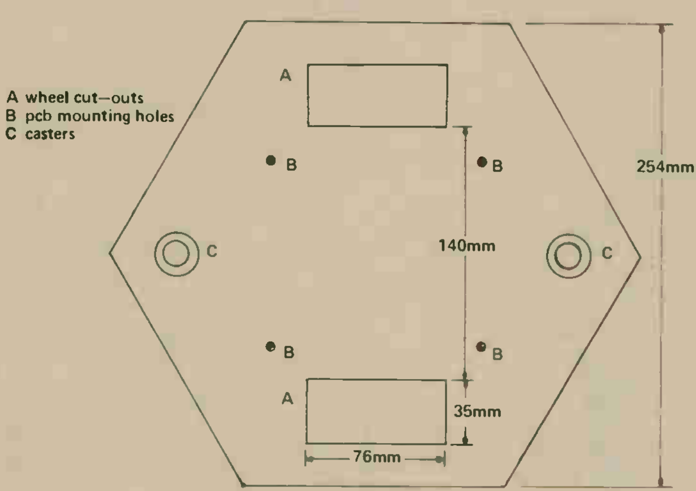


Fig.5. Overlay for loop driver.





The basic Hebot chassis.

HEBOT and Murphy's Law

Since our introductory article last month, Remcon has decided not to manufacture Hebot kits.

The basic chassis pan is depicted at left, it is easily formed from sheet aluminum. The wheels were 3" in diameter. None of this should give too much trouble.

Motors are another story. The ones we used are modified RC servomotors with the feedback pot and limiting stops removed. To duplicate the performance of our Hebot, you will require something that will turn at approx 60 rpm and deliver 30 in-oz of torque.

We have located a source of motors that appear to be suitable substitutes from Isotronic Electronics Ltd. You can get two motors for $44.00 postpaid. Send certified cheque or money order to:

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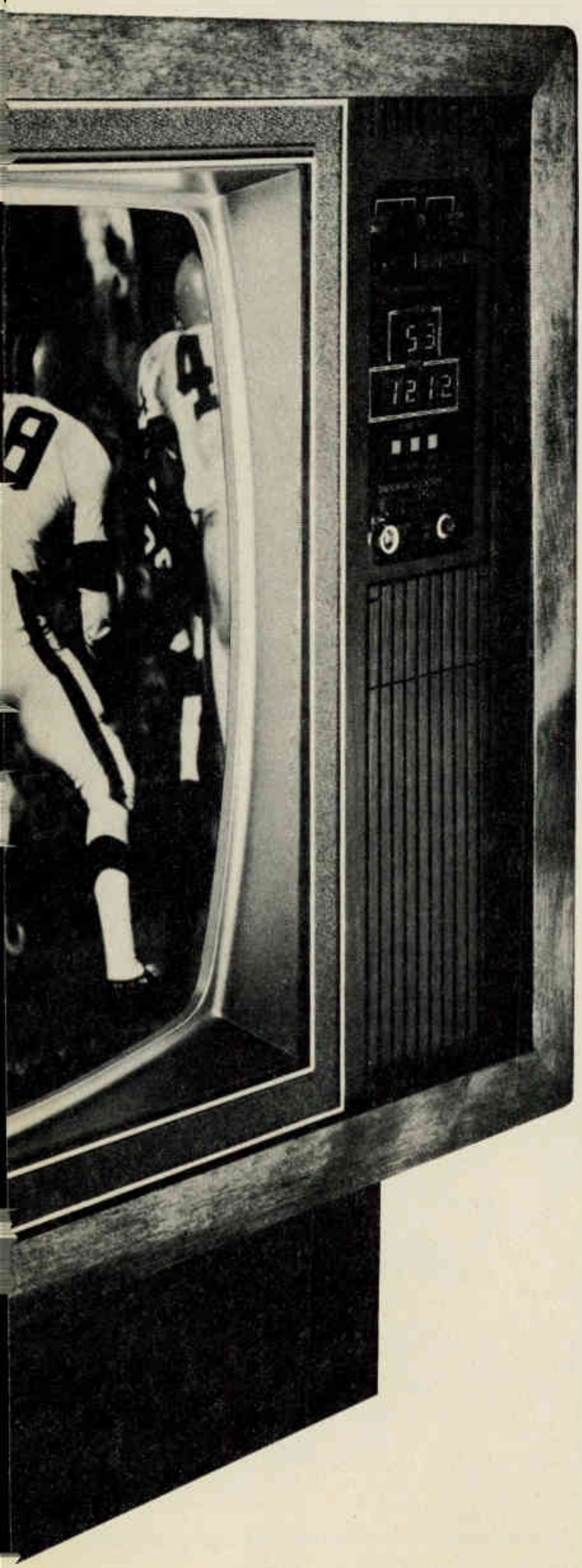

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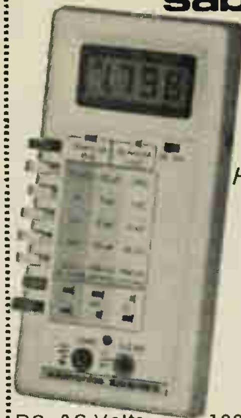

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TEST GEAR

If you're going to get seriously involved with electronics, you're going to have to buy or build some kind of electronic test equipment.

A display of test gear such as you find at many retail shops.

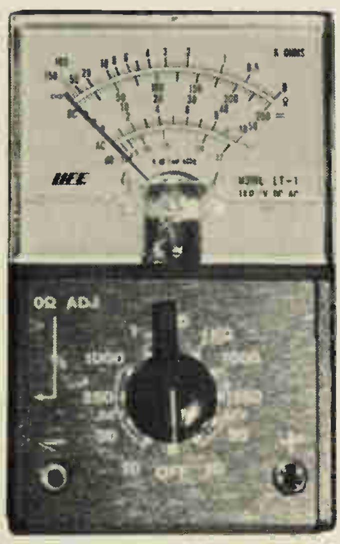
ANY READER seriously intending to test, troubleshoot, modify, design or experiment with electronics projects will need some kind of test gear (electronic test equipment). The types of test gear you will need depends on how seriously involved you are with electronics, what you particular fields of interest are, and how much spare cash you have to buy or build that test gear. In the next few pages we introduce you to some of the types of test gear that are available, and give advice on the types of gear you actually need.

Multimeters

One of the most basic types of test you can carry out on an electronic circuit is to measure a voltage or current. The type of instrument you need to carry out this test is a multi-range multi-function meter, or multimeter. These instruments enable you to measure, via a range switch and a pair of probes, a wide range of AC and DC voltages and currents: most instruments also have a facility for measuring resistance values, and a few have a facility for measuring capacitance values as well.

Multimeters come in three general classes, as follows:

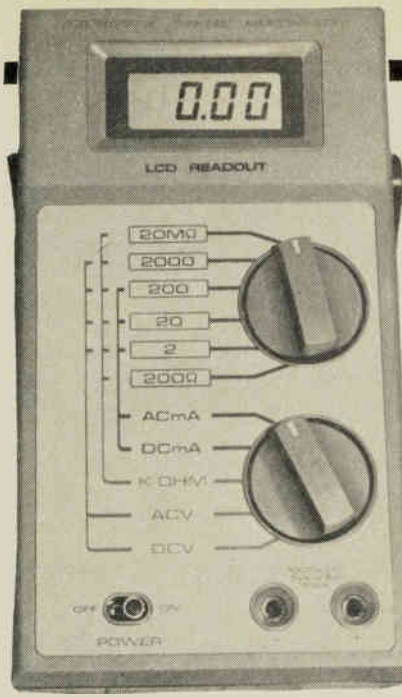
ANALOGUE MULTIMETERS are relatively simple instruments of electrical (rather than electronic) design and have a moving-pointer type of readout indicator (either a moving coil or a taught-band suspension meter) in which the pointer deflection is proportional to (an analogue of) the parameter being measured. An important quality of this type of meter is its *sensitivity* or its loading effect on the electronic circuit that it is being used to test. Sensitivity is specified in terms of thousands of ohms per volt, or k / volt: For general electronics work, a meter sensitivity of at least 20k / volt is required. Good quality analogue multimeters are provided with some kind of overload protection, so that the instrument doesn't vaporise when you connect it to a thousand volts when its controls are set to measure only one volt full scale deflection.



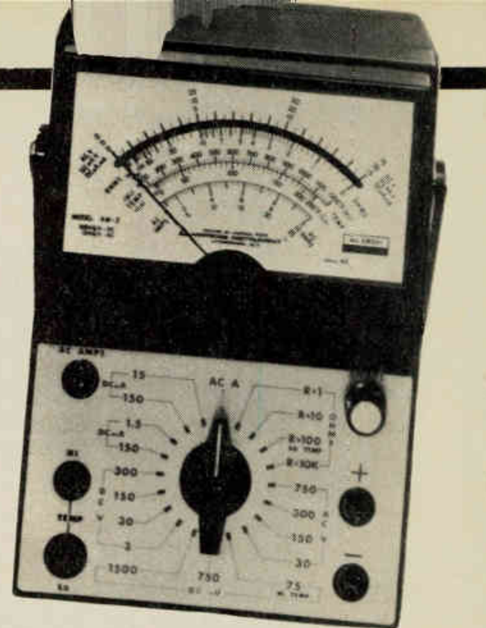
A small analogue multimeter. This sort of device sells for around $25.

ELECTRONIC MULTIMETERS are souped up versions of the analogue type: They have a built-in electronic amplifier to improve the basic instrument sensitivity and give improved (sometimes) overload protection, but use the same type of moving-pointer readout indicator as the normal analogue multimeter.

DIGITAL MULTIMETERS are 'all electronic' instruments: they use sophisticated electronic circuitry to convert the magnitude of the parameter under test into a numeric value which is displayed directly on a digital readout unit. These instruments have very good sensitivity. They also have a high degree of overload



The digital multimeter on the right uses a liquid crystal display (LCD) and costs about $125.



An electronic analogue multimeter. Prices start in the $100 range and work up to $420 for a unit such as this.

protection; you can, for example, set them to their 100mV range and then connect them straight across a 500 volt power line without doing any serious damage.

WHAT TO BUY? If you are just starting in electronics and expect to stay interested in the subject for some time, you are bound to need *at least* one multimeter. Start by buying a reasonable quality analogue instrument with a sensitivity of at least 20k/volt and with some kind of overload protection. At a later date you may find it worth while to build or buy an electronic or digital multimeter.

Waveform Generators

Most electronic circuits are concerned with processing waveforms in one way or another: Hi-Fi circuits are concerned with amplifying waveforms with a minimum of distortion: filters are concerned with imparting a kind of frequency distortion to incoming signals: A waveform generator of some kind is thus needed when testing most types of electronic circuit.

Waveform generators are usually classified either by the type of waveform they generate (sine, square, triangle, pulse, etc.), by the area of frequency coverage of the generator (AF, LF, RF, VHF, etc.), or by the technique used in generating the waveform (R-C or L-C oscillator, or function generator, etc.). The better known types of waveform generator are as follows.

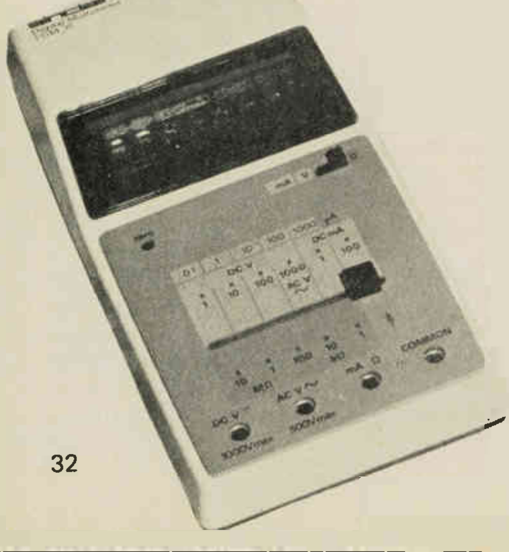
AF or LF SINE or SINE/SQUARE GENERATORS produce waveforms from below 20 Hz up to at least 20 kHz (AF types) or 100 kHz (LF types). The basic sine wave is usually produced from an oscillator that uses an R-C (Twin-T or Wien) tuning network and the resulting waveform is usually reasonably pure and typically has a harmonic distortion content of less than 0.5% at the normal test frequency of 1 kHz.

These generators invariably incorporate some kind of amplitude stabilisation circuitry, so that the mean output amplitude of the signal is constant at all frequency settings.

In spite of this amplitude stabilisation circuitry, most R-C generators suffer from a phenomenon known as *'bounce'*, in which the amplitude varies in an unstable manner as the frequency control is altered, but then settles down as frequency stability is obtained.

It is a simple matter to convert a sine wave into a square wave, so many AF and LF generators have a facility for generating either a sine or a square waveform, either simultaneously via individual outlets, or alternatively via a mode selector switch.

A good quality sine/square generator is an essential



A brace of digital multimeters from Sinclair (now called Thandar). Both have light emitting diode (LED) displays. The PDM 35 (left) sells at about $100, the DM235 (right) at about $180.

piece of equipment to anyone interested in designing or experimenting with AF or LF amplifiers or filters, and the keen reader is advised to build or buy one at the earliest opportunity.

FUNCTION GENERATORS usually produce a basic triangle wave, which is then modified into a sine form by special circuitry. They also produce a square wave. Often, these waveforms can be subjected to amplitude and/or frequency-modulation, either via external control terminals or via a built-in auxiliary generator. A major attraction of most function generators is that they cover a very wide frequency spectrum, typically from less than 0.1 Hz to above 100 kHz. A second attraction is that they do not suffer from amplitude 'bounce' as their operating frequency is altered. The only real disadvantage of most function generators is that their sine wave outputs have perceptible distortion (typically between 0.5% and 2%), and they are thus not suitable for distortion testing Hi-Fi amplifiers.

Function generators are nice instruments to own, but are not needed by the average electronics novice: When the novice blooms into an amateur, however, he (or she) may find it worth while building one of these instruments.

PULSE GENERATORS produce waveforms suitable for testing digital electronic circuits. They are usually provided with two built-in variable pulse generator networks (one giving a *delay* pulse and the other an *output* pulse) which can be triggered either via an external signal or via a built-in variable-frequency square-wave generator.

A pulse generator is not needed by the average novice, but is an essential item to any keen amateur interested in designing or experimenting with digital circuitry: Pulse generators make good do-it-yourself projects.

RF and VHF GENERATORS produce high-frequency basic (but often highly distorted) sine waves for testing radios, TV's, etc: The generated waveform can usually be subjected to amplitude and/or frequency modulation, either via external signals or via a built-in modulation generator.

These generators are essential items to anyone interested in servicing, repairing, or designing radios or TV's: if you need one, buy it rather than build it: DIY versions are difficult to construct, and very difficult to calibrate.

Variable Power Supplies

Variable power supplies enable you to power a circuit from the wall socket, rather than from batteries, and usually give a regulated output that is variable from zero up to at least 20 volts, at currents up to at least 1 amp: All good designs have some form of overload protection, so that the instrument does not disintegrate when you place that accidental short across its output.

Some designs of variable power supply provide only a single output (e.g., 0-20 V): Others provide either a split output (e.g., 0 to ± 20 V), or have two independent outputs (e.g., 2 × 0-20 V). The split-output type of power supply is ideal for powering experimental op-amp (operational amplifier) circuits.

A decent variable power supply is an essential item to any amateur interested in experimenting with electronic circuitry. DIY power supplies are easy projects to build.

RF signal generators generally start at 200 kHz and go up to 60 MHz, sometimes even higher on calibrated harmonics. This particular one sells for around $200.

Oscilloscopes & Accessories

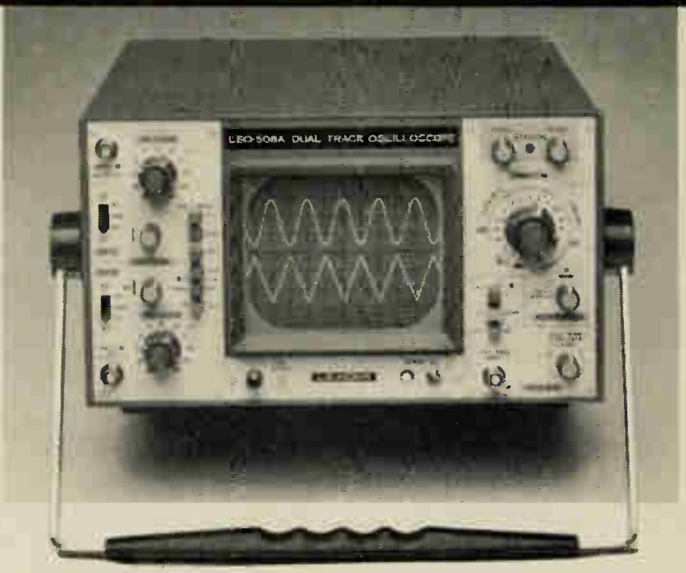
An oscilloscope is an instrument that lets you look at an actual waveform appearing in any part of a circuit. The instrument has a small TV-type of screen which has its face covered with a graduated scale or *graticule* which is marked in both the horizontal and vertical axis. The instrument also has a number of front panel controls which are calibrated in relation to the graticule scales. Thus, it is possible to display an unknown waveform on the 'scope and know, merely by looking at its shape and its relationship to the graticule and control settings, that it is (for example) a 15 kHz distorted sine wave with a peak-to-peak amplitude of 2.7 volts.

An oscilloscope is probably the most useful (but most expensive) instrument in any electronics workshop or laboratory. 'Scopes come in a variety of types, and can be used with a variety of accessories. The most important ones are as follows:

BASIC (SINGLE TRACE) OSCILLOSCOPES have a 'Y amplifier', which has its controls graduated in relationship to the vertical scale of the tube graticule, and an 'X amplifier' or *timebase*, which has its controls

If you're into any amount of bench work, a variable power supply is a must. Low cost kits are available for as little as $30 or you can go for maximum precision with this one for approx. $400.

Single trace scopes are the most usual type. This one has 5 MHz capability and retails for approx. $550.



Dual trace scopes are useful for viewing two waveforms at once. These instruments start at about $900.

graduated in relationship to the horizontal scale of the graticule. Modern 'scopes use a *triggered timebase*, which provides the X axis with meaningful calibration: Older 'scopes have a *free-running timebase*, which gives almost meaningless calibration to the X axis.

One of the most important parameters of a 'scope is its bandwidth, or frequency-display capability. Old fashioned 'scopes could handle AC-coupled inputs only and had typical bandwidths extending from 20 Hz up to about 1 MHz. Modern 'scopes are DC coupled and have bandwidths that extend down to zero at the low end and up to about 5 MHz on low-priced 'scopes, or 15-25 MHz on medium priced 'scopes, or 100-225 MHz on high-priced 'scopes.

DUAL TRACE OSCILLOSCOPES are capable of displaying two waveforms at the same time. This is useful, for example, if you want to look simultaneously at the input and the output waveforms of a circuit. These 'scopes have two calibrated and independent Y amplifiers, which provide the display drive. The final display is either obtained from a special *dual beam* tube, or more commonly, from a single-beam tube that has its beam electronically chopped to provide the illusion of two independent beams.

OSCILLOSCOPE TRACE DOUBLERS are add-on devices or accessories that can be used to give a single-trace 'scope a dual-trace capability.

Above: A LED frequency counter for about $150, and a prescaler (which divides the input frequency by 10) for about $140.

DUAL SWEEP (DUAL TIMEBASE) OSCILLOSCOPES are provided with two timebases, which can be used independently, alternately, or with one triggering the other. These 'scopes can let you do fancy things, such as look at a one microsecond wide pulse superimposed on a 1 kHz square wave and occurring 470uS after the leading edge of the square wave. (Not many amateurs need this facility.)

OSCILLOSCOPE CALIBRATORS are fairly simple accessories that enable the owner to measure and adjust the calibration accuracy of the Y and/or X axis of an oscilloscope.

WHAT TO BUY? A 'scope is the most useful instrument in any electronics workshop or laboratory, so if you can get one, do so. A single-beam single-timebase instrument is adequate for most amateur uses. Ideally, the Y amplifier should have DC-coupling, with an upper bandwidth limit of at least 3 MHz, and the timebase should be the triggered type: On the other hand, any 'scope is better than none at all, and good 'scopes tend to be rather expensive.

Miscellaneous Test Gear

C-R and LCR BRIDGES are specialised instruments that let you measure the precise values of resistors (R), capacitors (C), or inductors (L). They are nice instruments to own, but are only rarely used or needed by the novice. They are, nevertheless, fairly easy and interesting projects to build.

ANALOGUE FREQUENCY METERS look similar to a normal multimeter, but are designed only to measure frequency. Typical frequency coverage is 100 Hz to 1 MHz full scale, and typical accuracy is 2% or 3% of full scale. Sometimes these instruments are designed as DIY add-on units for use in conjunction with a normal multimeter, and are well worth building in this form.

DIGITAL FREQUENCY METERS give a direct read-out of frequency from a few Hz up to tens or hundreds of MHz, with a typical accuracy of .001% or better. They are very useful instruments for the serious experimenter or designer, but are fairly expensive to buy or build.

DISTORTION FACTOR METERS are specialised

Above: A wider ranging frequency counter: this one goes for about $200.

instruments for rapidly measuring the distortion content of audio-frequency waveforms. They are only essential instruments for the serious Hi-Fi designer and experimenter, but are fairly easy projects to build.

ANALOGUE VOLT/MILLIVOLT METERS are multirange electronic instruments with typical full-scale range coverage extending from 1 mV to 1000 V AC and/or DC. They are particularly useful for measuring low-level signals in audio amplifiers, etc., and are popular DIY (Do-It-Yourself) projects.

Starting a Workshop

If you are going to take electronics seriously, you're going to need some test gear. So what do you need? Our advice is to take the following four steps, and then progress from there:

1. The first instrument you will have to get, and one that you will always need, is a decent multimeter. Buy, rather than build one, and make sure it has a sensitivity of at least 20 k/volt, and has some kind of overload protection.

2. The next item to acquire is a waveform generator. If your field of interest is audio or LF, build yourself a decent sine/square generator. If you're a radio or TV buff, buy yourself an RF or VHF generator. If you only like digital circuits, build a pulse generator.

3. Build or buy a decent variable power supply. This is an essential item to anyone interested in designing or experimenting with electronic circuits.

4. Whatever your field of interest, try at some time to acquire an oscilloscope of some kind, no matter how tatty it is: These instruments add a whole new dimension to the field of hobby electronics. ●

WHERE TO GET THEM

We have compiled a listing of companies representing or manufacturing test gear manufacturers in Canada. Some of these will not sell directly to you, but will direct you to a dealer in your area. To simplify matters we have introduced four categories.

(O) oscilloscopes
(M) multimeters
(G) generators
(F) frequency meters

Atlas Electronics Limited
50 Wingold Ave., Toronto, Ontario M6B 1P7
Brands: B&K Precision, Amprobe
Categories: O, M, G, F

Bach Simpson
P.O. Box 5484, London, Ontario N6A 4L6
(519) 452-3200
Brands: Bach Simpson
Categories: M, O

BCS Electronics Limited
980 Alness Street, Unit 35,
Downsview, Ontario (416) 661-5585
Brands: Hameg, Coline
Categories: O

Beckman Instruments Incorporated
901 Oxford Street, Toronto, Ontario
M8Z 5T2 (416) 251-5251
Brands: Beckman
Categories: M

Daveco Agencies Limited
8126 Montview Rd., Montreal, Que. H4P 2L7
Brands: Daveco, Ritron
Categories: M

Duncan Instruments Limited
Unit 3,122 Millwick Drive, Weston, Ontario
M9L 1Y6 (416) 742-4448
Brands: Dartron, Radat, Advance, Ganz, Kontron, Mera, Valhalla, Unitronix
Categories: O, M, G, F

Electro-Meters Company Limited
Unit 8-9, 705 Progress Avenue, Scarborough,
Ontario M1H 2X1 (416) 438-6555
Brands: Modutec
Categories: M

Gladstone Electronics
1736 Avenue Rd., Toronto, Ont. M5M 3Y7
Brands: Sinclair (Thandar), Greenwich Instruments, H-C Multimeters
Categories: M, G, F

H. Rogers Electronic Instruments Limited
Unit 1, 595 MacKenzie Avenue, P.O. Box 310
Ajax, Ontario L1S 3C5
Brands: Hickok Electrical Instruments
Categories: O, M

H. W. Cowan Canada Limited
P.O. Box 268, Richmond Hill, Ont. L4C 4Y2
Brands: Eico, Tracer
Categories: O, M, G, F

Heath Company
1480 Dundas Street East, Mississauga,
Ontario L4X 2R7
Brands: Heathkit
Categories O, M, G, F

Hitachi Denshi Limited (Canada)
922 Dillingham Rd., Pickering, Ont. L1W 1Z6
Brands: Hitachi Oscilloscopes
Categories: O

Jerome & Francis Company
1015 Prospect Avenue, North Vancouver,
British Columbia V7R 2M5
Brands: Data Tech, Dage Function,
Gould Advance
Categories: M, G, F

Kumar & Company
3344 Mainsail Crescent, Mississauga,
Ontario L5L 1H2 (416) 828-0583
Brands: Sabtronics
Categories: M, F

L.G. Blunt Limited
33 Heritage Road, Markham, Ont. L3P 1M3
Brands: Grundig
Categories: O, M, G, F

Lenbrook Industries Limited
Unit 2, 1145 Bellamy Road, Scarborough,
Ontario M1H 1H5
Brands: Mura Corporation Multimeters
Categories: M

Metermaster Div. of R.H. Nichols Co. Ltd.
214 Dolomite Drive, Downsview,
Ontario M3J 2P8 (416) 661-3190
Brands: Metermaster, Avo, Non-Linear Systems
Categories: O, M, F

Omnitronix Limited
2056 Trans Canada Highway, Dorval,
Quebec H9P 2N4 (514) 683-6993
Brands: Leader Instruments, Uni Volt,
Uni Sound
Categories: O, M, G, F

R. Mack & Company Limited
820 S.W. Marine Drive, P.O. Box 58010
Vancouver, British Columbia, V6P 6C6
Brands: Sanwa
Categories: M

Radionics Limited
195 Graveline St., Montreal, Que. H4T 1R6
Brands: Keithley Multimeters, Exact
Categories: M, G

Tele-Radio Systems
301 Supertest Rd., Downsview, Ont M3J 2M4
Brands: Helper
Categories: M, G

Tenco Electronics Limited
P.O. Box 24804, Station "C", Vancouver,
British Columbia V5T 4E9
Brands: Kyoritsu, Tenco
Categories: M

Universal Enterprises, Incorporated
14270 N.W. Science Park Drive,
Portland, Oregon 97229 (503) 644-8723
Brands: Universal Enterprises
Categories: O, M

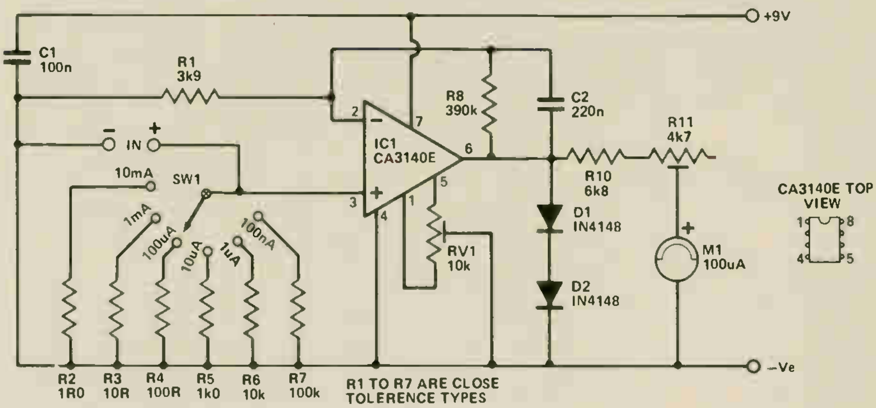
Webster Instruments Limited
Unit 28, 1200 Aerowood Drive, Mississauga,
Ontario L4W 2S7
Brands: Racal-Dana, Krohn-Hite
Categories: M, G, F

Weston Instruments
Division of Schlumberger (Can.) Limited
Unit 8, 1200 Aerowood Drive, Mississauga,
Ontario L4W 2S7 (416) 624-6660
Brands: Weston
Categories: M

Designer Circuits

NANOAMP METER

It is not possible to accurately measure currents of a few microamps or less using an ordinary panel meter or multimeter. In order to make such measurements it is necessary to use an active circuit such as the one shown here. It can be built as a self-contained unit or used as part of an instrument requiring a highly sensitive current meter. The sensitivity is from 100nA to 10mA. FSD in six ranges; the higher ranges being included to permit calibration, and because many multimeters have very few low current ranges.



M1 is connected in a 1 V FSD voltmeter circuit which also uses R10 and R11. The latter is adjusted to give the unit the correct sensitivity. IC1 is an Op Amp connected in the non-inverting mode and having a DC voltage gain of about 100 times (set by feedback network R8-R1). C2 reduces the AC gain to only about unity so as to improve stability and imunity to stray pick-up. The non-inverting input of IC1 is biased to the 0 V rail by whichever of the range resistors (R2-R7) is selected by SW1. In theory this gives zero output voltage and no meter deflection, but in practice it is necessary to compensate for small offset voltages using offset null control, RV1.

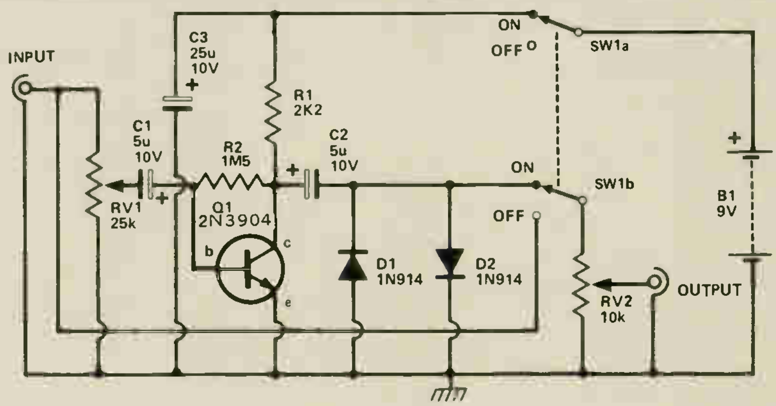
If an input current is connected to the unit, a voltage will be developed across the selected range resistor, this voltage being amplified to produce a positive meter deflection. With R2 switched into circuit, 10mA is needed to give full scale deflection of M1, since 10mA will cause 10mV to be developed across R2 (E = 1 x r, = 0.01 A x 1 ohm. = 0.01 V or 10 mV), and this will be amplified one hundfed fold by IC1 to give one volt at the output. On successive ranges the range resistor is raised by a factor of ten, reducing by a factor of ten the current required at the input to develop 10 mV and give full scale deflection of M1.

This arrangement relies on the amplifier having a very high input impedance so that it does not drop a significant amount of input current, and this is achieved by using a FET input op amp having a typical input resistance of 1.5 million meg ohms. D1 and D2 prevent the output voltage of IC1 from exceeding more than about 1.3 volts, and they thus protect M1 against overloads.

When adjusting RV1 start with its slider at the pin 5 end of the track (there should be a strong deflection of M1), and then back it off just far enough to zero the meter, and no further.

NOISE LIMITER

This circuit is particularly intended for those interested in DX-ing, that is, listening for distant radio stations. However, the same circuit has other uses such as reducing the scratch level on very old records (note that this is not the normal type of scratch filter circuit normally associated with Hi-Fi equipment). It also has uses in PA equipment where it can limit the input to the final stages and prevent overload distortion; distortion will still be present when an overload occurs but it is not as objectionable as that usually produced.



The circuit is designed to take almost any audio input but the output will have all peaks above a certain level, which can be adjusted,eliminated.

The circuit can either be wired into a receiver circuit or directly from a headphone socket in which case the headphones are wired to this unit instead. If wired into a circuit permanently, RV1 should take the place of the normal volume control and the output should be wired to the point which was previously connected to the volume control slider. An extra control plus a switch will also have to be mounted on the receiver front panel.

The output of the receiver, which as we have said can be from the volume control or the headphone socket, is taken to the input and amplified by Q1 which is connected in the common emitter mode. This transistor will considerably increase the audio level and this is applied via a DC blocking capacitor, C2 to the two silicon diodes D1 and D2. In the normal way these diodes will not have any bias voltage applied across them and so they will present a high resistance, and will not affect the output in any way. However, as soon as the output from the amplifier exceeds about 0.6V, the diodes will conduct and short the output to the negative line. Two diodes are needed, one connected each way around, so that both positive and negative going peaks are shorted out. The idea of the amplifier is to make sure that whatever the input level across RV1, it can be amplified so that at least 0.6 V can be applied across the diodes. Since RV1 is adjusted so that the level is always the same a volume control has been included in the circuit so that the output level can be controlled in the usual way; this is accomplished by RV2.

To limit the noise the input level is increased until the audio signal that is wanted is just distorting and then backed off slightly so that no distortion is heard on the peaks of the audio part of the signal. This will then mean that any audio peaks above that level will hardly be heard in the output as the peaks above the preset limit will be conducted to the negative line, RV2 is then adjusted as a normal volume control. If RV1 is adjusted well below the limiting level and RV2 is adjusted for normal listening levels, the circuit has no effect. However, it is a simple matter to include SW1 which will bypass the circuit. The supply voltage can be taken from a battery as shown in the circuit, the current drain being very small, or from the receiver's supply. If this is transistor operated with 9 V then there will be no difficulty but if the receiver uses a supply potential higher than 9 V then a suitable dropping resistor will have to be included.

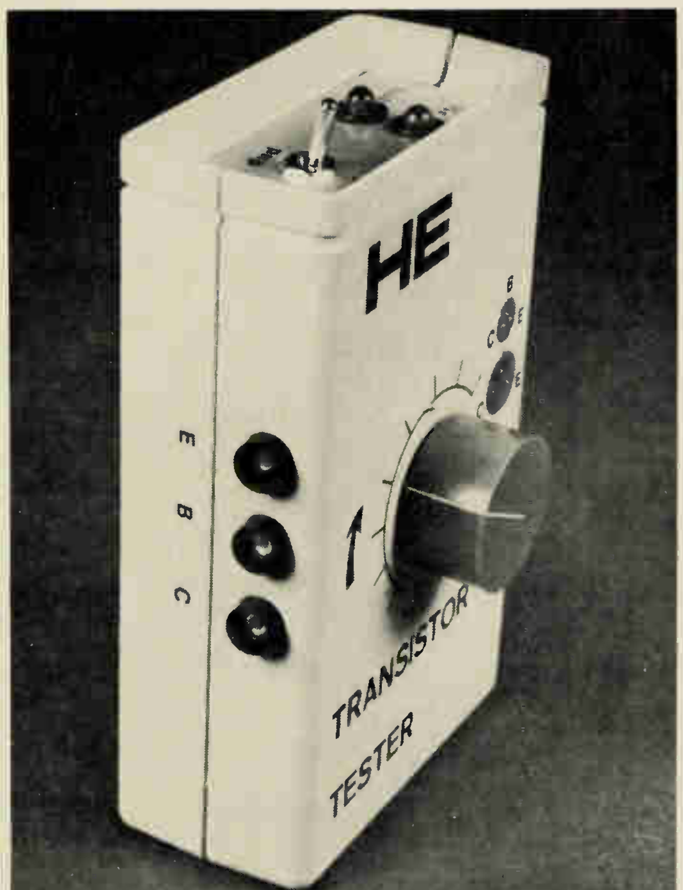
The effect of the noise limiter is quite remarkable and by switching the circuit in and out it is possible to compare the results. The noise will still be there but not at an annoying level and the signal will be very, very much clearer.

TRANSISTOR GAIN TESTER

This Transistor Tester is somewhat unusual in that it does not use a moving coil meter but a LED to give a visual indication of the transistor's gain.

A TRANSISTOR TESTER is probably one of the most useful pieces of test equipment (apart from a multimeter) that the aspiring electronics enthusiast could hope to own. Most commercial testers check a variety of parameters. However, if a tester could just measure the vital gain factor as well as giving a go-nogo indication this should prove to be quite adequate for most purposes.

The HE tester does just that, one unusual feature is the use of an LED (Light-Emitting Diode) to indicate the transistor's condition, rather than the usual moving-coil meter.



Two transistor sockets are fitted near the control (which has not been calibrated here) while sockets are fitted on the side of the case to take flying leads which can be fitted with croc clips.

Transistor Gain Measurement

In the common-emitter configuration the current gain I_C/I_B is known variously as Beta or h_{FE} and may vary considerably according to the particular value of collector current, collector-emitter voltage and temperature at which one decides to make the measurement. Thus for repeatability these current and voltage values at least should be known to be constant and this is achieved in this unit.

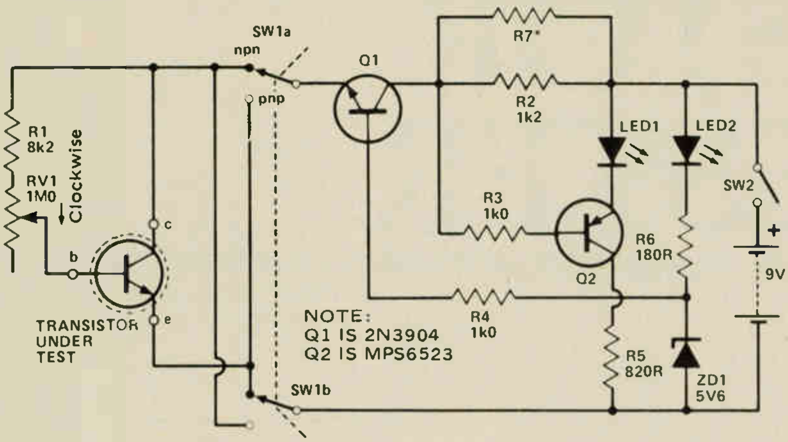
Construction

A PCB layout for the majority of components is given; due to the rather uncertain volt-drop across the particular LEDs used the current-sampling resistor R2 is made larger than needed and shunted during calibration by R7. If no calibrating milliammeter is available, fit R2 = 1 kilohm and omit R7, R3 and R4 limit currents to safe values regardless of possible short-circuits during transistor testing; R1 limits base current to the TUT to a maximum of 0.5 mA even when RV1 is at zero resistance. SW1 sets the transistor under test (TUT) collector to positive if NPN and to negative if a PNP type; SW2 is a push-to-test spring return type.

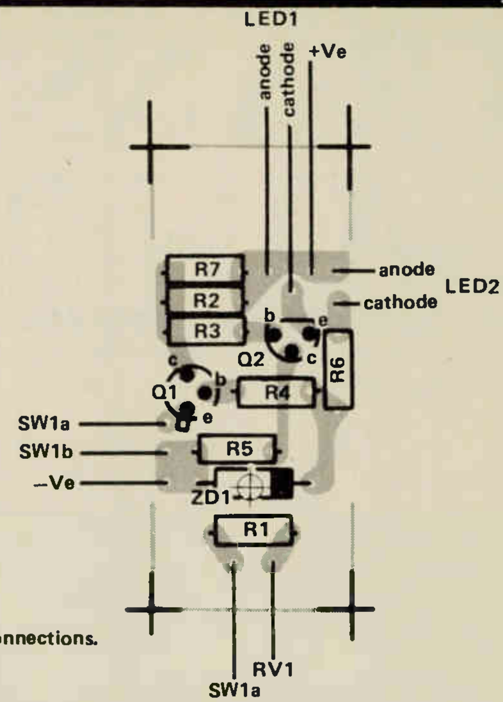
In the prototype the TUT may be connected with test clips on flying leads or plugged in to a transistor holder.

Fig. 3. Relating h_{FE} and required value of R_B assuming 5V supply in Fig. 2.

GAIN $h_{FE} = I_C/I_B$	$I_C = 2.5$mA I_B (μA)	R_B $1.84 \times h_{FE}$(kΩ)
5	500	9.2
10	250	18.4
15	166	27.5
20	125	37
30	83	55
40	62	73
50	50	92
75	33	140
100	25	184
150	17	275
200	2	370
300	8	550
400	6	730
500	5	920



The circuit of the Transistor Gain Tester.

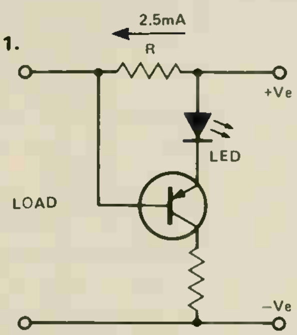


The component overlay on the PCB with the wiring connections.

HOW IT WORKS

A meter movement is both fragile and expensive (and surprisingly bulky, too) so an LED is used to indicate that the current through a resistor is of a known value, 2.5 mA being chosen as reasonable for many common transistor's collector current. Assuming that the potential difference (PD) across the LED in Fig. 1. is 2 V and across the base-emitter junction is

Fig. 1.

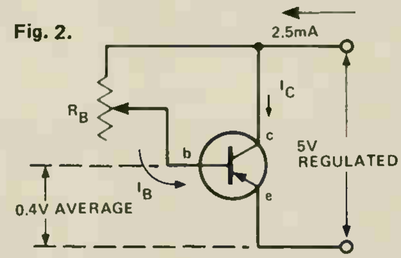


OV6, when the voltage across R reaches 2V6 the transistor amplifies the small base current that flows and passes a considerably larger current through the LED. The maximum current that the transistor and LED can pass is then limited by another resistor in the collector circuit.

The battery voltage is monitored by a second LED, a series 5V6 zener diode ensuring that when the battery voltage drops below about 7V5 the LED extinguishes. The zener diode provides a useful reference voltage to feed the base of a series NPN regulator transistor that will supply the transistor under test (TUT) with a fairly stable voltage of (5V6 - 0V6), i.e. 5V.

Base current to the (TUT) in Fig. 2, is taken very simply via a variable resistor fed from the stable collector voltage and thus calibration accuracy is maintained over the range of battery voltage 7V5 to 9 V.

Fig. 2.



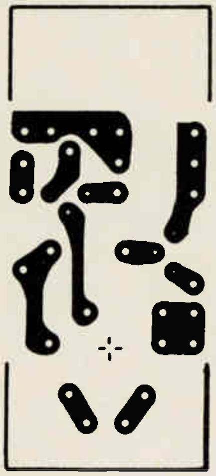
Calibration is derived from the I_C I_B relationship and Ohms Law as follows: the base-emitter volt-drop of a silicon transistor is typically OV6 while for a germanium transistor it is typically 0V2. Hence if the voltage at the 'top' of R_B is assumed to be 5V and the voltage at the 'bottom' as taken as an average value 0V4 (half-way between silicon and germanium values) then the current delivered by R_B to a transistor base obeys Ohms Law and is given by $I_B = 4V6/R_B$. Now since $h_{FE} = I_C/I_B$, a rearrangement of these formulae results in

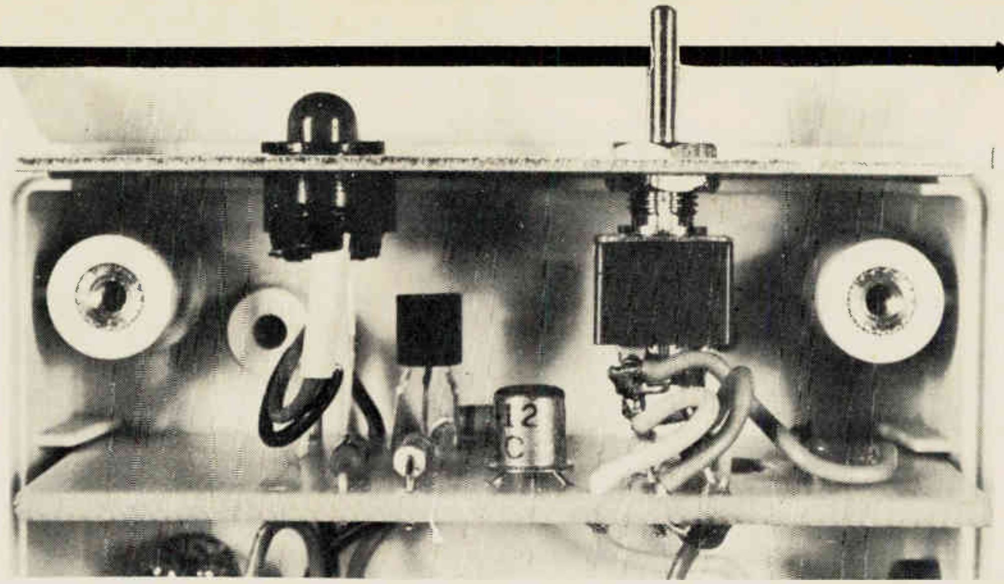
$$h_{FE} = \frac{I_C \times R_B}{4V6} = \frac{2.5mA \times R_B}{4V6}$$ or it may be given as $$R_B = \frac{4V6 \times h_{FE}}{2.5\ mA} = 1.84 \times h_{FE} \text{ kilohms}$$

A table of results, Fig. 3 is given relating h_{FE}, R_B and I_B for the particular voltages and currents used in this unit but the explanation given will allow other voltages for battery or zener diode to be used and a different collector current to be chosen if desired, the reader inserting these values in the formula and then reaching for his faithful calculator!

It should be noted that no correction has been made for the inclusion of the base current needed for transistors of gains less than twenty or so, the 2.5 mA 'collector' current indicated in these instances being the addition of (I_B + I_C). At gains greater than twenty the small lack of accuracy is masked by other tolerances.

The PCB pattern shown full size.





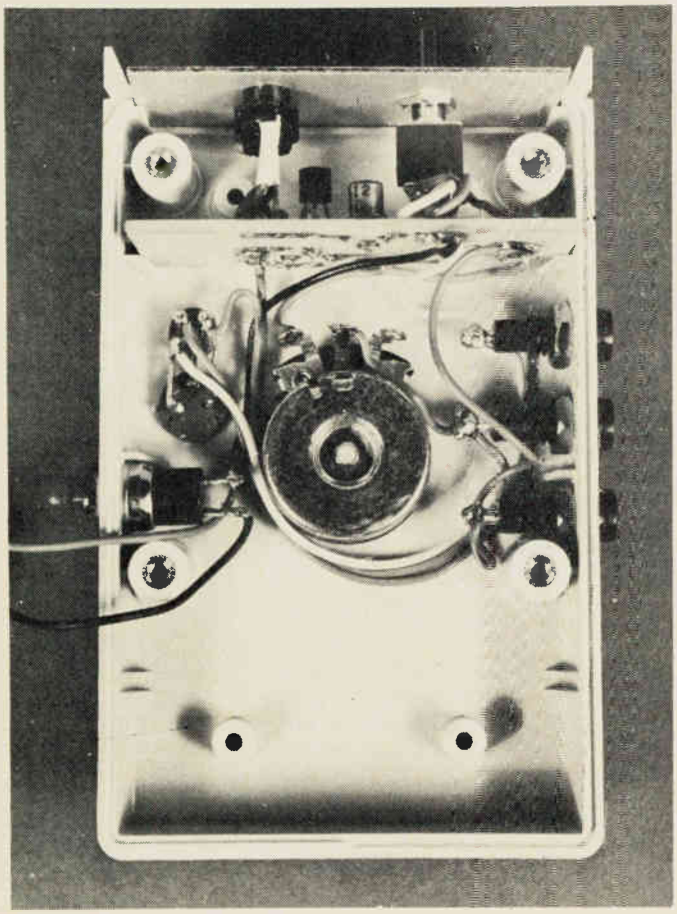
Close-up of the works behind the front panel.

PARTS LIST

RESISTORS. (All ¼ W 5%)
R1, 8k2
R2, 1k2
R3, 4, 1k0
R5, 820R
R6, 180R
R6, 180R
R7 See text.

SEMICONDUCTORS
Q1, 2N3904
Q2, MPS6523
ZD1, 5V6 400 mW Zener diode
LED 1, 2 TIL 209

MISCELLANEOUS
SW1 a/b DPDT switch (slide, or toggle)
SW2 SPST push to make
PCB to pattern
Transistor socket — see text.
Case to suit
9V battery and connector.



For neatness and versatility the e-b-c connections are made to a 3-pin DIN socket and two plugs used, one with flying leads and the other with a TO18 socket fixed in place with epoxy adhesive. There is of course no reason why you should not fit sockets and / or leads direct to the test unit.

Calibration

When assembled, connect a variable resistor of around 2k in series with a milliammeter across the collector-emitter connections of the TUT. Close SW2 — the 'battery check' LED will light — and adjust the variable resistor until the milliameter indicates 2.5 mA (or as you may choose otherwise). Now with a known 2.5 mA current flowing in the 'collector' circuit, offer different values of resistance across R2 (around 4k7 probably) until LED1 is well lit, the same brilliance as LED2 and yet such that a drop from 2.5 mA to, say 2.2 mA results in LED1 being extinguished. Having selected your value for R7 solder it in place on the circuit board and LED1 is now calibrated to light at 2.5 mA.

With SW2 closed, measure the collector-emitter voltage of the TUT. There *should* be some 5 V present but it is wise to actually measure and use the indicated voltage to aid your dial calibration if a particular zener diode of differing characteristics to that in the prototype is used.

Dial calibration is done last, quite simply, with an ohmmeter connected across the collector and base leads of the TUT, a transistor *not* in a circuit as well of course, and SW2 being open. Mark a card with h_{FE} values at appropriate points as RV1 pointer is adjusted in conjunction with Fig. 3, later trimming the card to shape, glueing down and then varnishing it beneath the pointer knob. In the prototype a dial was attached to a small knob and this dial calibrated and varnished.

In use, a transistor is connected to the flying leads or socket, PNP or NPN selected, SW2 pressed and RV1 adjusted until LED1 changes from 'off' to 'on', when the gain is indicated by the dial or scale. Simple, fast and short circuit proof!

It is worth remembering that the bigger germanium transistors have appreciable leakage as a matter of course and this leakage is frequently larger than 2.5 mA, the leaky transistor thus appearing to be short-circuit. As a general rule, if a silicon transistor leaks it is fit for the garbage only; an ohmmeter is still a very useful first test of a transistor's polarity and leakage. ●

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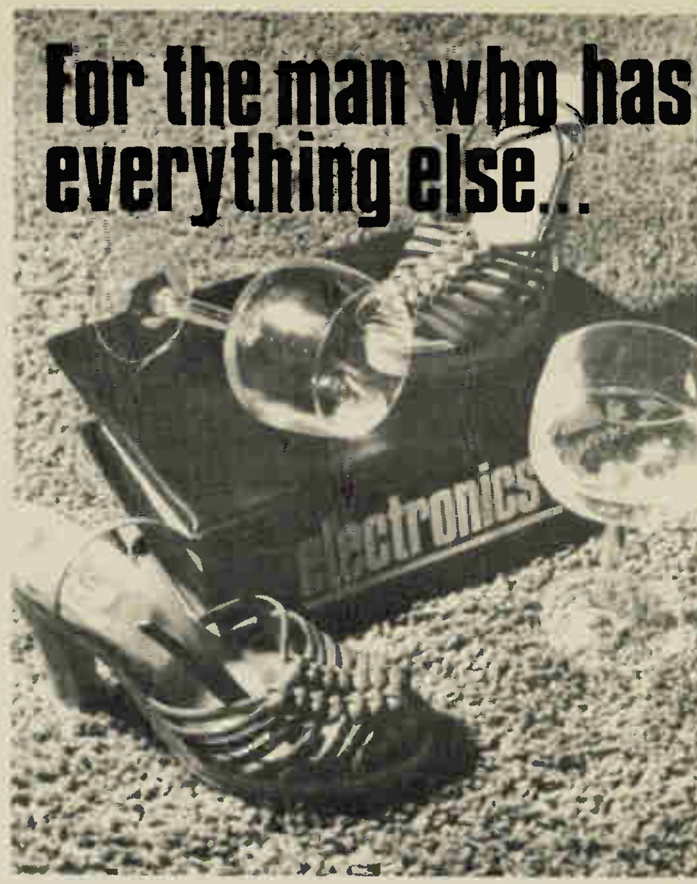

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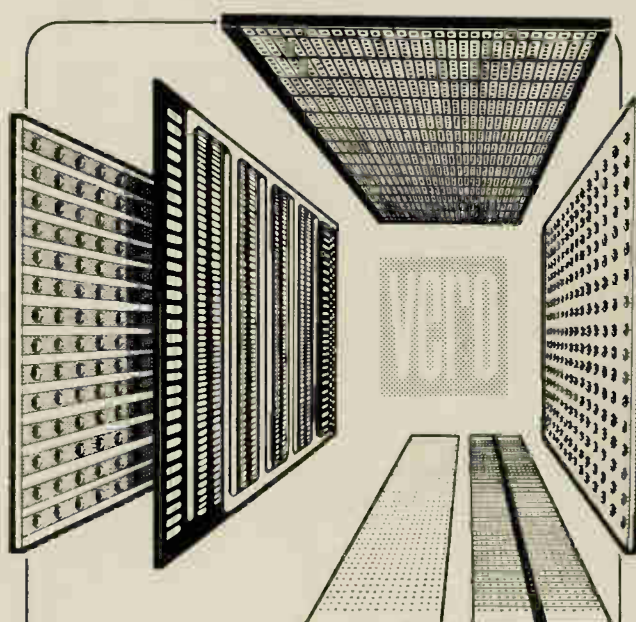

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Service News

Needless to say association members must associate. Here's how they did it in Toronto.

THE ONTARIO Television Electronics Association celebrated its third birthday at the Annual Convention in Toronto at the Prince Hotel on May 30, 31st and June 1st. The festivities got underway almost as soon as guests arrived and registered in the hotel situated in a park-like surrounding just south of 401 highway, slightly west of Don Mills Road. In the Crown room, an informal gathering took place after 7 pm, during which the outgoing President, Hank Steenhuysen, was "roasted" by his board of directors and friends. It was a good natured affair from which the "roastee" emerged "well-done".

Later that evening, and into the wee hours, things were cooking in the hospitality room on the fourth floor. This is where members from Ottawa, Cornwall, Kitchener, Kincardine, Owen Sound, London, and Kingston, could really get down to enjoying informal chit-chat.

Saturday morning, the group from Toronto paraded behind an enthusiastic trombonist into an empty room. Unbeknown to them, the boys from Ottawa had corralled all the other arriving delegates and guests around the corner out of sight, leaving the Crown room totally vacant, and stealing the show away from their hosts. Their success became more evident when people who were known not to be from Ottawa came marching in with the Ottawa boys, who were proudly and defiantly blowing toy whistles, and all were sporting "Chapter 12" banners across their chests. Not less than any of those was Toronto's own Ian Cameron!

To Business

After greeting delegates and guests, Len Longman introduced Larry Johnson, the first speaker, who gave a very interesting discourse on Accident Prevention in the Home and at Business. He made it quite clear that the onus for accident prevention in the industry falls not only on the employer, but on the employee. He showed how the government has become actively involved with the prevention of accidents, and described some of the penalties that can be levied on those not obeying the regulations.

The second speakers for the session were Mr. John Leichsenring and Mr. Paul Souliere, representing B.A.S.F., in a well-rehearsed program combining slides with sound, and the two men, speaking in relays, covering the subject of tape recording. They took the audience for a tour from the first days of magnetic recording before the 2nd World War, through reel to reel and up to today's cassette and video-cassette development. They introduced a special dealer-sponsored program which they would run at a participating dealer's shop, to let its customers evaluate their own equipment, and find out which tape worked best for them. It was pointed out that B.A.S.F. tape may not always be the one chosen for an individual unit, as some equipment worked better on other brands, depending on the orginal equipment design.

The third speaker of the morning, Mr. John Eakins, MPP for Victoria-Haliburton Riding spoke on Small Business, and Topics of General Interest. His main theme demonstrated his personal desire to have the government cater more to the needs of small business, and of greatest importance, the development of a more sensible technicians' apprenticeship program with government assistance. He emphasized the need for small businessmen to get together and lobby the government to recognize their wishes and to act on them. He explained how big corporaations hired professional lobbiers to work for their interests at the government level. The small businessman didn't stand a chance unless he organized and competed on a similar basis.

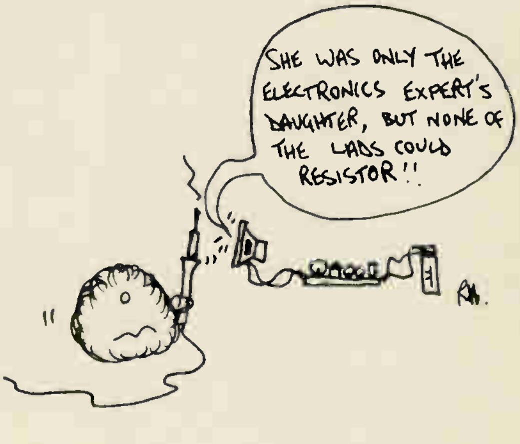
All three speeches were excellent, for which the association was most grateful.

In the afternoon, the guests were treated to a fashion show, put on by some of the ladies. Five gorgeous young women took turns to model designs of gowns and dresses supplied by the "Eadie's House of Fashions" shop on the premises. Of special interest to the most discerning gentlemen spectators, a selection of filmy nightgowns rounded out the show.

The Toronto Chapter of OTEA, formerly known as MTTSA, Metropolitan Toronto Television Service Association, currently celebrating its tenth anniversary, had combined its annual dinner dance with this occasion. On Saturday evening, over 150 people gathered in the Prince Ballroom for the banquet and dance.

Sunday morning, a new board of directors was elected, who chose as executive — President: Len Longman. 1st Vice-President: Chuck Steubing. 2nd Vice-President: Hans Kupfer. Secretary: Ray Logan. Treasurer: Bob Hannon. Past President: Hank Steenhuysen. Zenith Radio Corporation of Canada, represented by Glen Andrews and George Hess provided a preview of their Digital Electronics Course, a home study package incorporating make-it-yourself computer equipment, supplied by their recently-acquired Heath-Corporation. With the coming explosion of home computers, the job of maintenance would naturally fall on those shops presently servicing television and home electronics, and, although OTEA sponsored courses had already been in progress through George Brown, and other colleges, Zenith's course did not require attendance at school, and could be done at home or during slack times at shops.

The convention ended with the close of this business session, and the delegates headed home. Watch this column to learn where next year's will be held. ●

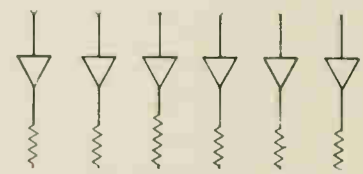


Electronics Today INTERNATIONAL SEPT 1980

NEXT MONTH

Telidon
Telidon is a Canadian Videotext System that is turning up everywhere. In next month's issue we'll tell you what's been done and where Telidon is going.

Digital to Analogue Techniques
Whether you're making music or doing process control, you'll need some means of changing those 8 bit words into voltage or current. Tim Orr tell you how.



Kirlian Photography
Most forms of energy have been identified and defined by modern science. One exception, however, is the so-called Kirlian aura or life energy that is said to exist around all living beings. Next month we'll take a comprehensive look.

Cassette Decks and Tapes
Next month we present a look at tape recording and the Compact Cassette. Originally scorned as a High Fidelity storage medium, cassette decks can now boast impressive specs.

Speaker Protection Unit
Save your speaker from disastrous overloads! Next month we'll present a simple yet reliable module.

Touch Switch
Get into vibrationless control. Our touch will control up to ten devices sequentially.

Home Burglar Alarm
Untrouble your mind with with our reliable Home Burglar Alarm. This simple unit will operate with both normally closed and normally open switches.

The articles listed here are in advanced stage of preparation. Circumstances, however, may alter the final contents.

COLUMN

QRM QRM QRM

The role of the individual amateur experimenter is somewhat diminished these days. Bill Johnson presents some thoughts on how to manage club projects.

WE AMATEURS HAVE traditionally been builders of equipment from scratch. The actual definition of the word 'scratch' has just changed a little, that's all. Whereas an amateur in the forties may have spent weeks looking for the parts to build an amplifier, the same today comprises an IC and a few common resistors and capacitors, easily found in the junk box. So it would seem then, that for the same amount of effort, we amateurs should be able to build gigantic arrays of electronic marvelry with the powerful parts now available to us. Such is actually very true - but with one limiting factor - the equipment being worked on is so large and extensive as to require the collaboration of a group of individuals or a club in the undertaking.

The average amateur no longer builds a complete transmitter, receiver, or the like in his basement. Transmitters and receivers have reached a state of perfection, and there is not likely to be much gained from experiments on an individual basis. The amateur body as a whole is moving into experimenting with systems. Systems such as VHF repeaters, amateur satellites, beacons, digital packet nodes and the like. The amateur is no longer an individual who sits in his basement isolated from the world except by the ether — he is becoming a social creature. In fact, observation of amateur practises and habits over the last ten years tends to indicate that the average amateur is doing less and less transmitting and more and more building. The increased crowding in our bands is easily explained by the increased numbers of amateurs.

The reason for all this is really quite simple. Money. In years gone by, the individual amateur has been able to construct the rudimentary equipment he needs with very little capital outlay in the way of tools and test equipment. He is now building increasingly complicated equipment and needs correspondingly more expensive tools to work with.

Also, the complexity of the digital systems that amateurs are now getting involved with means that only a few amateurs in any one club will be 'in the know', and others will join the group as a learning experience.

This grouping together of amateurs to work towards a common goal has brought about a need for a kind of person unknown before in amateur ranks — the club project leader. Sure, there have been individuals acting as managers of a club's various sub-function since amateur radio began. There have been TVI committee leaders, field-day co-ordinators, and leaders of group projects, etc., but the man I am talking about here acts as the chief engineer of a manufacturing company.

The 'club engineer' is usually as much a manager of people, resources and materials as he is a technical expert. As a matter of fact, an amateur club project is much more likely to be successful if this man is a very good organiser whose managerial talent is well-coloured with only a working knowledge of the project being worked on. Without such a man at the helm, the technical people will stand in one corner at meetings, the non-technical in another, and any newcomers will be turned off before they step inside the door.

After having been associated with a very complex technical project, the construction of micro-controlled VHF repeaters for Toronto FM's VE3RPT and VE3MPU, I have formulated the following game plan that has to be followed by the project leader if the project is to be successful:-

1) In the beginning, the project has to be defined. This may sound simple and irrelevant, but this step, if not properly carried out, will result in much grief later on, when the builders of the project have lots of ideas about how to change it and make it better before it is even working. As an example, let's take a look at how you would define a project to build a VHF repeater. The following questions would have to be asked, and the answers agreed upon:

a) What frequencies will it be on?
b) What coverage do we want?
c) Where will we put it?
d) Will it have an autopatch?
e) Will it have links to other repeaters?
f) Will it have a separate 450 channel for remote command and telemetry?
g) Will codes be available to users for functions such as repeater sensitivity check, user frequency telemetry, weather report rebroadcast, time signal, etc.?

The project leader has to gather all information from the club's executive, designers, builders, and eventual users of the project. Then, after a few meetings, the plan of action will be formed, and it will be time to start the design of the project.

2) The project leader's job in this phase is to break down the 'definition' of the project into groups of items that fall into similar categories, and appoint a qualified person to act as sub-manager in each category. For our VHF repeater example, these categories might be:

a) Political --- to interface with other clubs, repeater councils, and outside people such as prospective landlords etc. This group will ensure that the new repeater fits into the regional repeater plan, and is designed and installed in such a way and in such a place that it is of most use to the largest number of people. Also, it should be housed in a building with a suitable, amicable landlord.

b) Design --- there are two people to do the design, one specialising in RF and the other in digital techniques. These will take the definition and translate it into a hardware configuration. They will also ensure that complete documentation is kept for later servicing by somebody else - if they are smart.

c) Supply --- this person has a way with people - he will talk them out of huge quantities of resistors, capacitors, and the occasional complete radio for a 'very good price', to be used for the common good.

d) Construction --- this person will assign each of the individual modules, cards, chassis or subassemblies to willing volunteers and act as a general manager to see that everything fits together when the project reaches the final assembly stage.

3) When the project has been built, an implementation team is charged with putting the final touches to it, thoroughly testing it, and installing it in its final resting place. (Not necessarily in that order.)

4) As soon as possible after implementation, the project leader ties the ribbons by making sure that all parties that have had a hand in design and construction have thoroughly documented their work, and the complete package

of documentations is organised and indexed in such a way to be all that is needed to maintain the system. Designers and project managers who neglect this all-important task usually end up doing all the maintenance themselves!

The above are not hard and fast rules, nor does each job title imply a distinct and separate person. Indeed, in even the largest clubs I have seen all the management functions performed by one or two individuals. But the functions are there, however indistinct they may be, in any amatuer project from building satellites to building sonic nerfballs for the blind — if it is to suceed.

More next month,

73,
Bill Johnson, VE3APZ

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FET SPECIAL
Down the Gain Drain

The best way to get to know something is to get it on the work bench in front of you. This month we get hold of the FET and show you just what you can do with it.

This feature was prepared from '50 FET Projects' by F.G. Rayer, published by Bernard Babani. It is available direct from the ETI Book Service for $5.50. It contains many more circuits than are published in this feature.

Introduction

FIELD EFFECT TRANSISTORS find application in a wide variety of circuits. The projects described here include radio frequency amplifiers and converters, test equipment and receivers, as well as various miscellaneous devices which are useful in the home.

It will be found that in general the actual FET used is not critical, and many suitable types will perform satisfactorily. The FET is a low noise, high gain device with many uses, and the dual gate FET is of particular utility for mixer and other applications.

This article should be found to contain something of particular interest for every class of enthusiast — short wave listener, radio amateur, experimenter, or audio devotee.

FET Operation

Figure 1 will help clarify the working of the field effect transistor. (a) represents the essential elements of the device, which has Source lead S, Gate lead G, and Drain connection D. The path for current is from Source to Drain through the semi-conductor material, this path being termed the channel. With the N-channel FET, the carriers are electrons. The Source is connected to negative of the supply, and Drain to positive.

P-type gates are formed on the N-type channel, providing PN junctions. When these junctions receive reverse bias, areas surrounding them are emptied of electron carriers. These "depletion areas" reduce the width of the carrier channel, as at (b). As a result there is a drop in the passage of current carriers from Source to Drain. Increasing the bias causes the depleted regions to extend, and the channel grows smaller, reducing current even further. Eventually the gate can be made so negative that the channel is virtually closed. This is the pinch off region, and current is practically zero. The current from source to drain, and through external circuit items, can therefore be controlled by adjusting the gate voltage. Since the gate to channel junction area is reverse biassed gate current is extremely small, and thus the gate input impedance is very high. Generally, the gate current is negligible.

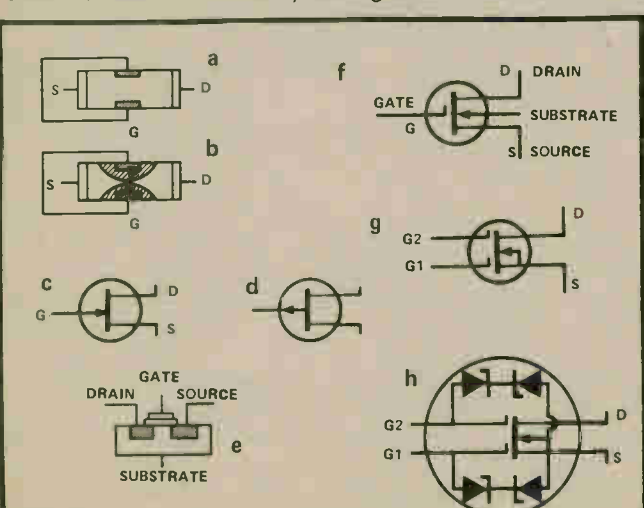

Fig. 1.

(c) is the symbol for this FET, with S indicating Source (negative), G for Gate, and D for Drain (positive). Such N-channel FETs are conveniently operated with a negative ground or source line. "D" is the symbol for a P-channel FET. Typical types and lead outs are shown later.

(e) represents an insulated gate FET. The gate is insulated from the channel by an extremely thin dielectric so tht there is no junction in the way described for (a). The substrate is P-type material with positive hole carriers. When the gate is made negative, positive charges move from the substrate towards the gate, so that the width of the conducting channel is reduced, and thus also the current from drain to source.

Medium Frequency Amplifier

This circuit, Figure 2, is primarily intended for use over the 1.7MHz to 30MHz range, and will be found to provide considerable gain. RF amplifiers of this kind are generally used to improve long distance short wave reception, to increase volume, and to reduce second channel interference on the higher frequencies.

To avoid winding coils and permit easy band changing, Denco (Clacton) miniature plug in coils may be used. These are the "Blue" (Aerial) ranges, valve type. The most useful coils will be Range 3, 1.67-5.3MHz, or 580 to 194 metres; Range 4, 5-15MHz, or 60 to 20 metres; and Range 5, 10.5-31.5MHz, or 28 to 9.5 metres. Exact coverage depends on the setting of the adjustable cores, and will also be modified if VC1 is of different value. The coils are inserted in a B9A type holder. If only a single range is wanted, the coil can be mounted by its threaded end, and leads are then soldered directly to the pins.

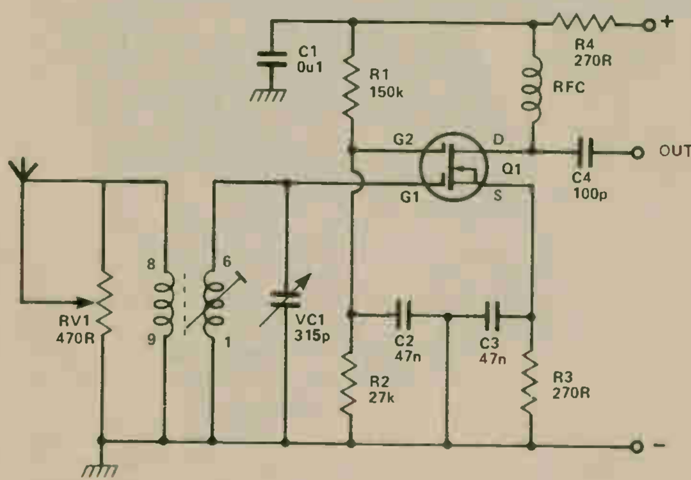

Fig. 2. Circuit diagram for a Medium Frequency RF amplifier.

RV1 is an adjustable aerial input control, as overloading may easily arise with strong signals. R1 and R2 provide the voltage for gate 2, and R3 is for source bias.

The drain circuit is arranged for capacitor coupling by C4 to the aerial socket of the receiver. This lead should not be unnecessarily long, as this may cause losses, as well as picking up signals which cause second channel interference. If the lead is screened, it must be no longer than necessary. A 2.6mH short wave sectionalised radio frequency choke will be satisfactory for the frequencies mentioned.

Construction is best in a metal case, which can have a hinged lid if plug-in coils are to be fitted. No ganging difficulties can arise with VC1, which is adjusted for best volume.

Second channel interference is caused by signals which are 2 X IF frequency from the wanted signals. With a 470kHz intermediate frequency, these offending signals will be 940kHz from the wanted transmission. As a result, interference from this cause is unlikely at low frequencies, but very probable at high frequencies. Such second channel interference is considerably reduced, or completely avoided, by using a tuned RF stage of this kind, actual results in this direction depending on the receiver IF, and frequencies tuned.

A 9 V supply is adequate, and current may be drawn from the receiver if convenient. Only about 2mA to 3mA or will be wanted. The MEM618, 40602, and 40673 will be found satisfactory here.

144 MHz Converter

The reception of 2 metre signals is generally with a converter and short wave receiver, preferably of communications type. The latter will have sensitivity and selectivity better than average. With such an arrangement of equipment, the 144MHz or other VHF signal is changed in frequency so that the converter output falls within the tuning range of the receiver.

A converter of this type often has its own RF amplifier, and a relatively low frequency crystal controlled oscillator, followed by frequency multipliers. This allows high sensitivity and excellent frequency stability, but is a relatively complicated and expensive item. Bearing in mind that at this frequency the RF amplifier will not contribute very much gain, and that tunable VHF oscillators are used in many domestic VHF receivers, it is possible to use the much simpler circuit in Figure 3.

L1 is broadly tuned to the wanted frequency band by T1, and signal input is to gate 1 of Q1. Q2 is the local oscillator, and the operating frequency here is determined by L2 and T2. Oscillator injection is via C3 to gate 2 of Q1. The frequency of the output from the drain of the mixer Q1 is the difference between G1 and G2 frequencies. Thus if the signal at G1 is 144MHz, and Q2 is tuned to oscillate at 116MHz, output will be at 144 minus 116MHz, or 28MHz. Similarly, with the oscillator set at 116MHz, an input at 146MHz to G1 will give an output of 30MHz. Therefore 144-146MHz can be covered by tuning the receiver from 28MHz to 30MHz. L3 is broadly tuned to this band, and L4 couples the signal to the short wave receiver.

The oscillator can actually be tuned above or below the aerial circuit frequency of the converter, as it is the difference between converter signal input and oscillator frequencies which determines the converter output frequency. It is also possible to choose other reception and output frequencies, provided L1, L2 and L3 are chosen to suit.

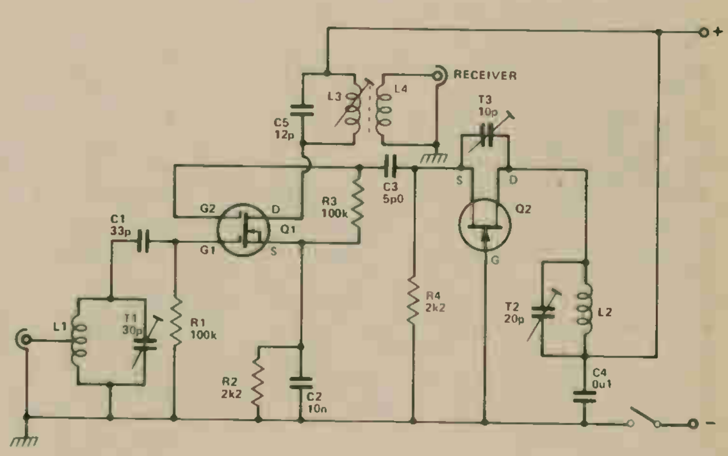

Fig. 3. Circuit for a 144 MHz converter for short wave receivers.

L1 and L2 are wound in the same way, except that L1 is tapped one turn from its grounded end. Each coil has five turns of 18 swg wire, self supporting, formed by winding the turns on an object 7mm in diameter. Space turns so that each coil is ½in or about 12mm long.

L3 is fifteen turns of 26swg enamelled wire, side by side on a 7mm former with adjustable core. L4 is four turns, overwound on the earthed (positive line) end of L3. Layout should allow very short connections in the VHF circuits. A co-axial aerial socket is fitted near L1. A screened co-axial lead is preferred from L4 to the receiver, to avoid unnecessary pick-up of signals in the

28-30MHz range. The converter will operate from a 9 V to 12 V supply.

L3 should first be peaked at about 29MHz. If a signal generator is available couple this to Q1 drain by placing the output lead near the drain circuit. Tune generator and receiver to 29MHz, and adjust the core of L3 for best results. Otherwise, couple an aerial by means of a small capacitor to the drain circuit, and tune in some signal in the 28-30MHz range, to allow adjustment of the core of L3.

It is now necessary to tune L1 to about 145MHz, and L2 to 116MHz, or 174MHz. If an absorption frequency indicator is available, this will permit an approximate setting of T2. A dip oscillator will also allow T1 to be adjusted. Subsequently adjust T2 to bring the wanted signals in at the required frequencies on the receiver, and peak these for best volume with T1, and check the setting of L3 core.

The converter is best assembled in a small aluminium box, completely closed, which can be placed behind the receiver. Note that if Q2 is not oscillating, no reception is possible through the converter. Q2 should be a VHF FET, such as the BF244, MPF102, and similar types, and if necessary T3 may be adjusted to secure oscillation here. The 40602, 40673, and similar VHF types will be satisfactory for Q1. If needed, frequencies can be brought within the swing of T1 and T2 by stretching or compressing L1 or L2.

The aerial may be about 38½in long, constructed as a simple self-supporting or wire dipole, with a feeder descending to the converter. Amateur activity is most likely to be greatest at weekends, and in many areas a whip or very short wire aerial will provide local reception.

Field Strength Meter

The device in Figure 4 will operate at any frequency up to 250MHz or even higher if necessary. A short whip, rod, telescopic or other aerial picks up radio frequency energy, and rectification by diode D1 provides a positive voltage for the FET gate, across R1. This FET is only operating as a DC amplifier, and the 2N3819 and other general purpose transistors will be satisfactory.

The "Set Zero" potentiometer may be 1k to 10k. With no RF signal present, it allows gate/source potential to be adjusted, so that the meter shows only a small current, which rises in accordance with the strength of the RF present. For high sensitivity, a 100 uA meter can

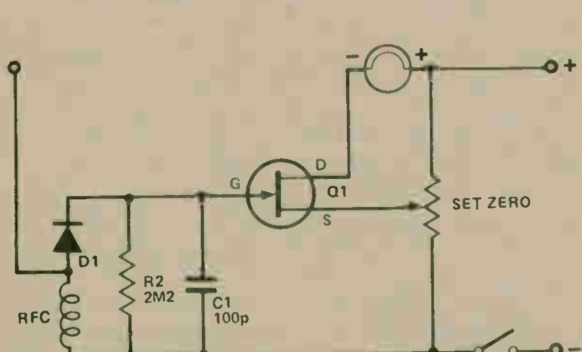

Fig. 4. Field strength meter, useful for determining the efficiency of RF equipment.

be fitted. Alternatively, a meter of lower sensitivity, such as 25 uA, 500 uA or 1 mA can be used, and will provide enough indication in most circumstances.

Should the field strength meter be wanted for VHF only, a VHF choke can be used, but for general usage over lower frequencies, a short wave choke is necessary. An inductance of about 2.5mH is satisfactory for 1.8MHz and higher frequencies.

The device can be constructed in a small insulated or metal box, with the aerial projecting vertically. In use, it allows tuning up a transmitter final amplifier and aerial circuits, or the adjustment of bias, drive and other factors, to secure maximum radiated output. The effect of adjustments will be shown by the rise or fall of the reading of the field strength meter.

FET TRF Receiver

Figure 5 is a circuit giving good headphone reception for persons listening, and it can if wished be contructed as a miniature receiver with a short throw-out aerial. Alternatively, it can be used with reduced range by relying on the ferrite rod alone for signal pick-up.

Q1 is the detector, and regeneration is obtained by tapping the source up the tuning coil. The use of regeneration greatly improves selectivity, and also sensitivity to weak signals. The potentiometer RV1 allows manual adjustment of the drain potential of Q1, and so acts as a regeneration control.

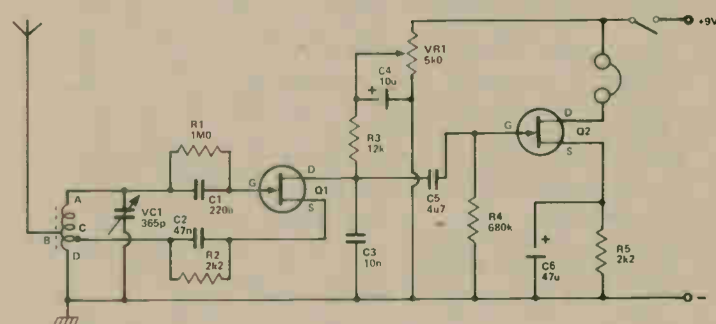

Fig. 5. FET TRF receiver.

Audio output from Q1 is coupled to Q2 by C5. This FET is an audio amplifier, operating the headphones. A complete headset is preferable for general listening, and phones of about 500 ohms DC resistance, or about 2k impedance, will give very good results here. If a miniature earpiece is wanted, this should be a medium or high impedance magnetic unit. A crystal earpiece will require resistance capacity coupling.

The tuning inductor is fifty turns of 26swg wire, on a ferrite rod about 5in × 3/8in. If the turns are wound on a thin card sleeve which can be moved on the rod, this will allow adjustment of band coverage. The winding begins at A, and aerial tapping B is at about twenty-five turns. D is the grounded end of the coil. The best position of the tapping C depends somewhat on the actual FET, on the battery voltage, and on whether the receiver is to be used with an external aerial wire or not. Should the tapping C be too near to end D, no regeneration will be obtained, or regeneration will be weak, even with RV1 rotated for maximum voltage. On the other hand, with too many turns between C and D, oscillation will begin with RV1 only slightly advanced, and signals will be weak. Best results are expected when regeneration begins smoothly, with RV1 about halfway through its rotation. It was found that only one to two turns were required between C and D. As changing the whole coil by a turn or so has little practical effect on frequency coverage, the best method is to make C two turns from D. Then if necessary unwind half a turn or more at D.

When regeneration is obtained, a heterodyne will be heard if the receiver is tuned through a transmission. RV1 should then be turned back very slightly. Maximum possible sensitivity is achieved when Q1 is almost in the oscillating condition. RV1 has to be set to suit the frequency tuned by VC1, so that final critical adjustment can be made. It is useless to regard RV1 as a gain control, and set it at maximum.

A metal case is suitable where an external aerial wire will be used. Where the ferrite rod only will be employed, for local signals, the box or case must be of plastic or other insulating material.

Timer

An adjustable timer, giving a delay of about 10 seconds to 1 minute, can be used for photographic and other purposes; or with various games where each competitor must make his move within the agreed period.

The circuit in Figure 6 can be employed in various ways, as will be explained. When the switch is moved to the "On" position timing begins, and C1 commences to charge through R1 and RV1. The two resistors R4 and R5 hold the source of Q1 at approximately a fixed potential. When the voltage across C1 has reached a high enough level Q1 gate is positive, so that drain current flows through R3. This causes a voltage drop in R3, so that the base of Q2 moves negative. Q2 is a PNP transistor, so conducts, and collector current flows in the relay coil, closing the relay contacts. When the switch is returned to the "Off" position, C1 is discharged through R2, so that the interval can be repeated.

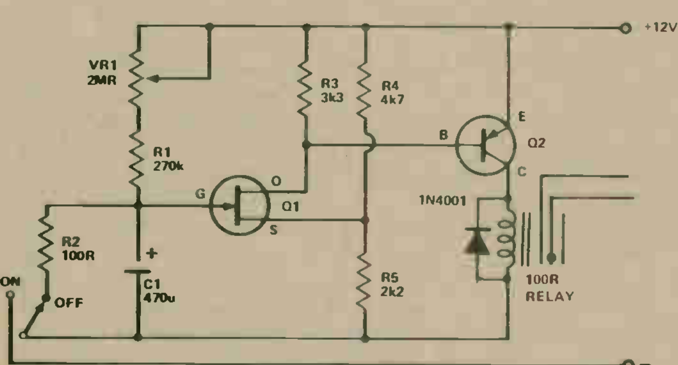

Fig. 6. A timer using a FET, the delay can be varied from about 10 seconds to 1 minute.

A 2N3819 is suggested for Q1, and 2N3906 for Q2. With C1 as shown (470uF) the interval was found to lie between 10 seconds with a total of 250k in the R1/RV1 position, up to 1 minute with 2 megohm. So the values in Figure 6 can be expected to allow any interval to be set from approximately 10 seconds to 60 seconds. Increasing C1, R1 or RV1 will lengthen the interval. Smaller values here will reduce it. This was with current rising to 40mA, with a 100 ohm relay.

It is not of course essential that these values or transistor types be followed exactly, and other relays would also be practicable, provided the circuit and Q2 allows a satisfactory current and voltage to suit the winding. Generally, a relay with a coil resistance of about 100 to 250 ohms will be most satisfactory.

The relay contacts can be so wired, that when the relay coil is energised, the circuit is completed, or interrupted. The former will most usually be wanted. Closure of the contacts can then light an indicator lamp, or sound a buzzer or bell. The use of opening contacts will be convenient for repeating a set interval when enlarging. A 2-pole 2-way switch is then required, so that switching the timer on lights the lamp to begin the exposure, which continues until the relay contacts open.

For games and similar purposes, a 12 volt 3 watt indicator lamp can be operated from the same 12 V supply. Should any kind of mains-voltage circuit be controlled, the relay must be a type intended for this purpose, and care must be taken to arrange mains circuit so that no danger can arise for the user.●

Type No.	Base	Maximum Ratings	Other Information
2N3819	1	200mW 25v	General purpose AF and RF. N-channel.
2N5457/ MPF103 2N5458/ MPF104	2 2	310mW 25v	General purpose AF. N-channel.
2N5459/ MPF105	2	200mW 25v	General purpose AF and RF. N-channel.
BF244	1	200mW 25v	VHF. N-channel.
7644/ BF244	5	200mW 25v	VHF. N-channel. (Sub. lead omitted)
MPF102	2	200mW 25v	VHF. N-channel.
2N5450/5	3	310mW 25v	General purpose AF. P-channel.
40602/ MEM618	4	330mW 20v	Dual-gate VHF amp. and mixer.
40673	4	330mW 20v	Dual-gate VHF amp. and mixer.
2N3823	5	300mW 30v	VHF amp./mixer. N-channel.
2N2497/ 500	6	500mW –	Low noise. P-channel.
80111	7	100mW 20v	RF amp. N-channel.

Table showing all the important parameters for the various FETs used in the circuits, the types used are all freely available and with only one or two exceptions are not very specialised.

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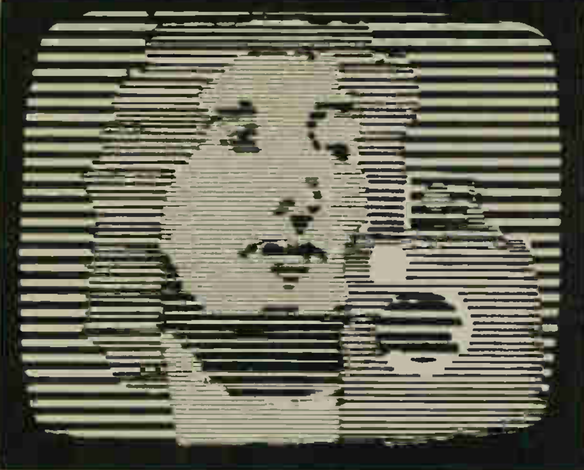
One substitution problem appears in this article, the Denco coils specified for the MF amplifier. The only substitutes we could immediately come up with were JW Miller devices. These are nos. B-5495-A (1.7 - 5.5 MHz), C-5495-A (5.5 - 15 MHz), and D-5495-A (12 - 36 MHz). You should be able to order these through a Miller distributor.



WHAT'S ON

group, exper. pros only please. Jo.
Medland 922-3617.
VIDEO tape your act for auditions or demos, reasonable, 364-5634.
WANTED bass, guitar, keyboard, for upcoming work within 424-4786

Steve Rimmer, ETI's Video Editor considers the problems in videotaping a rock band.

THIS MONTH'S column was distilled from the essence of a small three line bit in the "Dramatic & Musical" section of the classified ads. If it hasn't become lost or rolled up in a small ball during the printing process, it will no doubt be around here somewhere. It's truly amazing what you can squeeze out of a tiny bit of newsprint if you leave it in the still long enough and throw in a few vegetables.

If'n it don't eat through th' bottom o' th' jug it kin be mighty fine.

This month, we're going to look at a specific application for video, namely, the ins and outs of videotaping a rock band. In the past few years, with the emergence of the visually bizarre aspects of the new wave, this sort of thing has grown into quite a bulging little side industry. If, on the other hand, your scene is Glen Miller, and you break out in a fuming turquoise and chartreuse flaking pox just by being in the same room as an electric guitar, what is to follow will deal with some useful general video production techniques, which I promised to do several months ago.

You don't like Mondays either? Read on . . .

How Video Killed The Radio Star

If you are into nostalgia, and have the opportunity, try to check out a few rock movies of about fifteen years ago. Now, the music didn't sound quite the same back then, but, with so many new wave bands doing cover versions of dusty old songs at the moment, most of it will seem at least familiar, besides, everyone has heard "Teach Your Children" at least once on the golden oldies hour, so the style isn't completely alien. No, what is unique about these old flicks, in light of what is seething from the pot today, is the way the old bands, or "groups" (remember that?), looked on stage. Basically, they sang.

They stood around in perma-pressed hippy regalia and crooned into mikes. Sometimes they told jokes. The Who smashed instruments now and then, but, for the most part, visual dynamics wasn't really part of the scene. Everybody got into it this way, so it was fine . . . I think they expected the musicians to produce music. Silly audience.

Contemporary bands are, in a way, far more fortunate. The ability to play an instrument is of secondary importance in many realms of pop music. A good lighting man, on the other hand, is essential. Live rock is now extremely visual. In a way, it has become impressionistic theatre for people who don't like things with that kind of high brow name. However, more to the point, it's the shape of the industry at the moment. Guys who can play like their fingers are on fire are passé. . . guys who can play *while* their fingers are on fire are doing all right.

Back when those old rock movies were etched upon the celluloid of time, cutting a demo tape for a band meant going somewhere and singing a bunch of songs into a mike or two. However, with the bandwidth limitations inherent in audio recording, the visual impact of this kind of thing was limited to having the bass player play real, real low so that the speakers shook upon playback. Thus, the new style of performance has created a whole new realm of small scale recording. Rock and roll seems to have adopted television.

There are quite a number of reasons for setting a TV camera up in front of a rock band. If there is a spot of matter on the vidicon tube, the 120 decibels spewing from a wall of 200 watt Marshall amps will frequently dislodge it. This does the band no great benefit, but it will save having to replace the tube. On the other hand, if there is no spot on the camera tube, it could come to pass that the band itself might try to get you to set the camera up anyway. In fact, they might even pay you to do it.

Bands who are aiming at a very visual market will quite often get into video quite early in the game, just to be able to see what they look like while going through their respective gyrations and electronic dance routines. Eventually, they will get to the point where they will probably consider the world stable enough to receive their presence without halting its revolutions, at which moment, they will probably want to get a proper demo together, to flog around to agencies, and such like that there. Finally, when they have found true success, and a gig they have yet to bounced out of, they may want to really shoot the works and do a live, or studio, recording of the finished product.

It doesn't take much to tape a rock band that isn't used in any other video application. Just Aspirin and ear plugs.

The Works

First of all, when taping a band, money and equipment need be no great obstacle, because you can rent anything you need. In fact, it's usually best to rent everything you need; this way you can get studio quality machinery, plus it's insured. One of the advantages of using video in this sort of application is that it opens up quite a number of visual effects that are not possible live. This being the case, fairly versatile equipment is usually called for . . . generally, above and beyond the Betamax in your den, and the black and white camera you got for Christmas.

There are two ways to approach taping a band. One is to obtain a good recorder and camera, and shoot each piece through a number of times. The resulting raw tape is then edited onto a second machine, taking scenes out of each of the raw takes as required, and dubbing the soundtrack on at the end. This is extremely difficult in many

applications, because it requires extremely precise cutting and dubbing to maintain synchronization between the sound and the picture. Lip sync is all but impossible, so really tight closeups of a singer's face are not recommended. However, even if the shots are kept wide, one can run into situations wherein the drummer can go into a solo that isn't actually heard for five or ten seconds after he begins to play on screen and guitarists who sound like they're playing, even if their fingers do not move for a while. The solution to this might seem to be dubbing the sound with the video, but this creates even greater hassles. An edit misplaced by even a second or two will cause there to be a section of the soundtrack either removed or inserted again for the second time around. Glitches in the audio are considerably more noticeable and distracting than those in the image portion of the production.

On the other hand, this technique does have several advantages. It requires considerably less hardware than what we are about to get into, and it permits the use of animation effects. For instance suppose the lead guitarist is particularly ugly, and you feel that the artistic relevance of the work would be greatly enhanced if the vile brute were to be made to disappear at those times when he is not doing anything special. One simply films the whole mess through once in a normal manner, and then again, in exactly the same way, with the slimy troll off to one side. A cut from one take to the other will give the audience the illusion that the fellow has up and vanished. Reappearances are accomplished in the same way. If this technique is used in shots containing other bodies, i.e. those destined to remain post-disappearo, some pains should be taken to make sure they are looking about the same, in terms of position and facial expression (if any) in both takes. An exact match is usually impossible unless you glue the musicians to props, and sedate them, however, this is usually not necessary, unless they're extremely rowdy punkers, as the sudden reduction in the cast usually serves to distract the eye from small discrepancies in continuity.

This is the same technique used to get bottles of things to appear in peoples' hands in TV commercials.

The other approach to taping is to set up a genuine small studio. In this situation, multiple cameras are used, with a switcher to link them to a single recorder. The switcher is capable of selecting one of the several images being sent down the wire from the cameras, as well as doing wipes, dissolves, split screen and insert effects, and, in the more sophisticated systems, colour keys and various chroma manipulations. In this situation, there are really no edits to be made as such. When the last note has died away, the tape is complete, fully sync-ed sound and all. All cutting is done as things are going down. A number of the problems cursed silently at previously are thus eliminated.

Creatively, studio production of this sort offers a lot more variety in things like cutting from scene to scene, and vast, glittering heaps of special effect whizzbangs to play with. We'll go into more detail about these last presently. The only restriction, aside from the obvious proliferation of hardware, is that time distortions, like animation, are pretty well beyond the scope of the biscuit, as everything comes down in real time.

Of course, edit effects can be added afterwards, but at the expense of loosing the twelve eyed gulch lizard of sound mis-synchronization on humanity once again.

Knobs and Buttons

Whatever odd bits of paraphernalia you choose to begin the mighty enterprise with there are a few important techniques to install in the cerebral Write Only Memory chip of your mind. We'll have a few peeks at them herein.

The first thing to consider is lighting. You cannot shoot in available light. There probably will not be all that much of it available, and that which is will probably not be anywhere near where it should be. Colour temperature considerations also come into this. This kind of video is shot under very special quartz floodlights called Colourtrans. (This is actually a brand name, and several other manufacturers make equally suitable lights.) They are extremely powerful, running five hundred to a thousand watts each. Electrical concerns should begin biting upon your toes right about now.

The placement of lights is something of an art all to itself, and one which would take more space than I can occupy without having someone reaching for editing pencils. Fortunately, misplaced lights are not as much of a hassle when immortalizing a band as in other areas, as there is no real "normal" against which these characters can look "abnormal" in comparison.

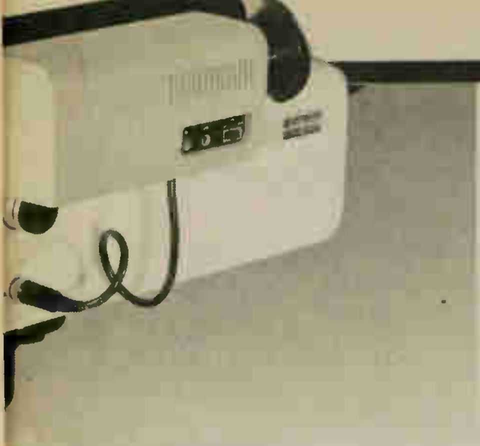
There are only a few precautions involved in using lights. First of all, they live up on marvelously rickety little stands that tower high in the air, and fall over at the slightest excuse. Thus, one must be very careful about the disposition of the power cords for the things lest they be tripped over, and an avalanche thus instigated. Yes, lights are good at knocking each other over.

Running, as they do, very bright, lights get very hot. The bulbs themselves would light up your Ginseng cigarettes, although this is not recommended. The glass is very, very sensitive, as are the innards. Even at the best of times, the bulbs are only good for twenty-five to thirty hours. They die if they are moved when hot. They die if they are re-ignited before they've cooled down. They also die if they are touched with the fingers during replacement; curious plastic contrivances are provided for this purpose. Needless to say, spare bulbs are essential.

Cameras come in all shapes and denominations, but all do pretty well the same things. Most of the types used in this type of application have two peculiarities in common; black and white picture tubes in the viewfinders, despite their colour pickup tubes further forward, and large, impressive zoom lenses that precede you everywhere you go.

The finders take a bit of getting used to, because they give one no idea how the colour is turning out. Since colour is affected by exposure, it is adviseable to get a feel for how the thing works alongside a colour monitor.

The big lenses are handy, for anyone who knows how to use them. They're a disaster for everyone else. It is important to realize, when shooting with video, that the poor soul watching the resultant blockbuster will be using the screen as an extension of his or her eyes. Now, for example, eyes don't really zoom much. Horrible sudden shrinkings in the field of view look



The Hitachi FP 3030A is an example of the high quality portable cameras available today.

A signal distributor. This unit, from Sony accepts up to 5 cameras and has intercom facilities.

extremely dramatic in the finder, but seem very mechanical on the tube, in the context of what is going on around them. With the lens on full telephoto, a three second pan across the stage would give the viewer the same image as if the camera was looking out of a car driving past the band at sixty miles an hour. This sort of thing only happens in surrealistic films, and then the camera is usually upside down.

Needless to say, all cameras must be mounted on a tripod, unless you've had a few years practice holding an Airiflex dead still on your shoulder.

The cameras are, as previously mentioned, usually dealt with by means of a switcher. And, also previously mentioned, the switcher does a great deal more than just switch. Just how much more depends upon what you are doing. However, most of the really interesting special effects available to the video producer are produced at this stage.

Most of the interesting things one can do with a switcher will require at least two cameras. Using simple superimposition, it is possible to create some really wild images using a technique called video feedback. The procedure is as follows. Camera one gets its beady little orb tuned into the subject, be it human or musical. The resulting image goes through the switcher to a monitor in the studio. Trained on the monitor is noble camera two, with its iris stopped down a shade to start with. The image from camera two gets mixed into that of camera one. The result is a video version acoustic feedback. The image seen by camera one is repeated in infinitely diminishing concentric reproductions on the monitor. Slight changes in camera two's zoom, position or aperture will cause all sorts of changes in the pattern, as will such things as light bounced off the monitor screen, and shapes (a hand, for instance), imposed between the lens and the screen.

Gary Numan-type robot bands were born for video feedback. The effect is extremely spacy if camera one is looking at a 'scope screen', on which is displayed the band's audio (or a portion thereof).

The other aspect of the switcher that does in most acolytes is the panel marked "colour key". You can do a lot with it without knowing the least bit about what it's for, because almost everything it turns up is interesting. However, in the interest of higher enlightenment and expanding awareness, there follows an explanation.

The colour key uses three images, one of which can be a solid one colour background generated by the switcher. We'll begin with the scene from camera one. It is used as the background. The key then takes the screen from camera two, and decides which areas are of a certain parameter. If it's a colour key, then the parameter will be a certain colour. Let us suppose that the knobs are set to make the colour shocking pink. The key will chop out of scene one all the areas in scene two that are shocking pink. It will fill them in with appropriately shaped areas of scene three.

A more useful variation of this technique is to assign the image from camera one so that the circuitry chops its holes in this scene based upon this scene, instead of another.

The potential of colour keying is pretty hard to describe using such primitive tools as a word processor and computerized typesetting. If the key is set to black, you could place an image of a guitarist in the soundhole of his own guitar, provided his guitar has a soundhole. This is kind of corny, but you get the idea. If it is turned to green, a scene can appear though the gradually defocused beam of an oscilloscope screen. Holes can be punched through eyes, teeth, hair, and such, through which one can look at other camera shots.

Some mention should be made of titles. Good ones can make a simple demo seem like micro movie. Mickey Mouse ones put to waste everything that follows. There are huge vast wastelands and prairies of room for experimentation in this area, but there is also a really quick way to get professional results, and that is the wonderful electronic video character generator. This can be bettered on if you have access to a microcomputer with some graphics capabilities. If you don't have any kind feelings for plain white letters, colour key them insensible.

Dubs

Chances are, all your production will be done on three-quarter inch cassette. Chances are also that the band will have no use for this format. Dubs may be required in VHS or Beta format, or the old EIAJ reel to reel style, and, if you expect to shoot another band in the future, you'll probably want a dub for yourself, to give you something to show your next victims — er, subjects. Now, you could rent a bunch of VTRs and do the deed yourself, but it's a lot easier, and cheaper to get it done at a dubbing house. Yes, these do exist, in rather copious numbers. The party from which you leased the hardware of which we have been speaking will likely know of several.

For mixing from several cameras, video monitors. These are 19" rack mountable colour units from Sony.

That All Folks

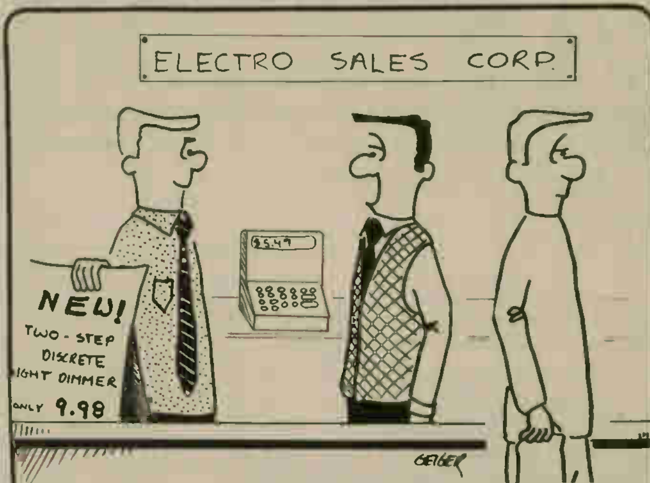
Yes, friends, once again, it's time to turn down the brightness, rip the wires off the speaker, pull the knob off the vertical hold pot, yank all the transistors out of the tuner, smash the horizontal output tube, short the B+ ground, unsolder all the capacitors from the chassis, put a brick through the picture tube, take an axe to the cabinet, and, in short, turn off the TV. What's On will be back next month, unless it isn't.

Until then, stay tuned.

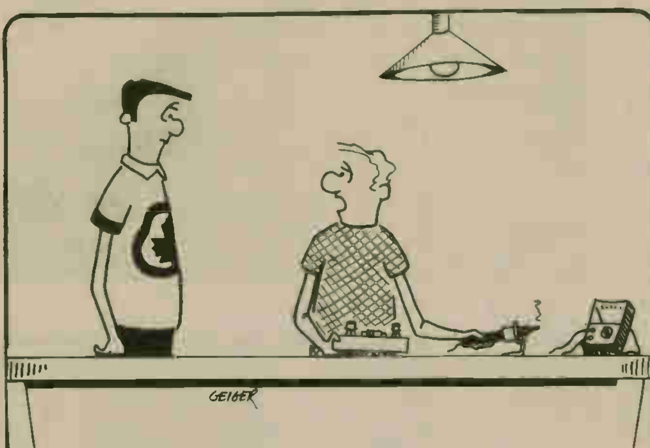
(A quiet but otherwise thundering show of appreciation, please, for Mark Salusbury of Tele Tech Electronics for the pictures and some assistance.) ●

The Fun of Electronics

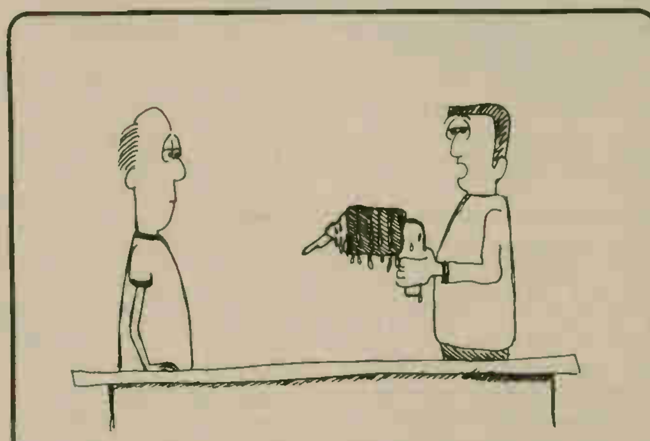
I appreciate how much work you've put into this, Mr. Johnson, but I just don't think there's much of a market for line-operated pacemakers.



I gotta hand it to you, Fred. Those light switches weren't selling at all until you came up with that sign.

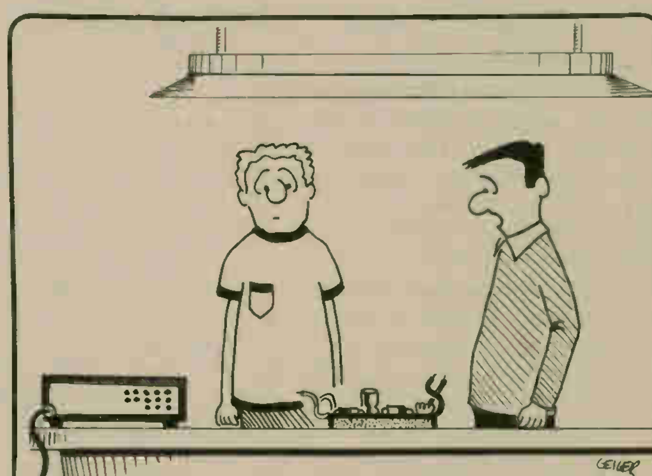


This circuit is going in a model racing car, so I had to use high-speed transistors.



My latest invention, a 2kW soldering iron that will melt everything . . . including itself.

Yes, perhaps you can help me. I've been thinking for weeks about buying one of those makers, but I can't make up my mind whether I need one.



I had to remove this headlight reminder circuit from — It kept draining the car battery.

PASSIONMETER

Do you have the hots for someone? Stick your hot finger (!) in our Passionmeter and find out.

MANY OF YOU have probably seen those small glass vessels, available from 'joke' and 'magic' novelty shops, sold as 'passionmeters'. They consist of a series of glass bulbs, one above the other, containing a red liquid at the lower end. At the touch of a hot palm the liquid bubbles its way toward the top — how high it bubbles depending on how hot the grasping palm happens to be!

Our passionmeter uses an electronic technique to measure the passionate user's level of excitement – or stress – indicating this on a 'ladder of LEDs.'

Now, a person in the throes of a passion (or under some stress, all the same thing for our purposes) undergoes certain physiological changes. Amongst such obvious and observable alterations as bulging eyes, flushed visage, foaming at the mouth and steam issuing from the auditory orifices . . . are more subtle phenomena. The one we are concerned with is skin resistance.

Skin resistance has a number of characteristics which make it a suitable variable for measuring the level of personal passion. The *lower* the skin resistance of a subject, the greater level of emotional stress. And vice versa.

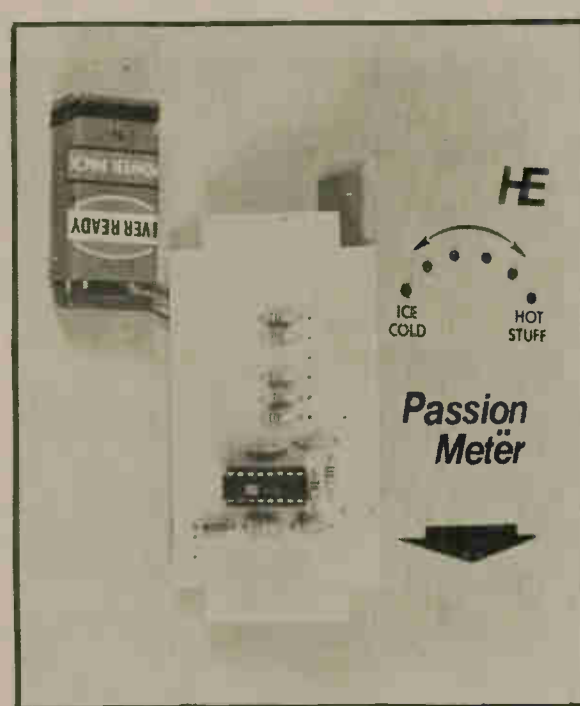
Skin resistance increases with age, decreases with perspiration (as from exertion) and varies according to the activity recently engaged in. A finger which has just finished the washing up will exhibit a lower skin resistance than one which has just assisted reading a newspaper.

With high skin resistance, few or none at all!, of the LEDs will light. With decreasing skin resistance more of the LEDs in the ladder will light, climbing all the way to the top with a subject at the height of passion — or one who has just finished the washing up.

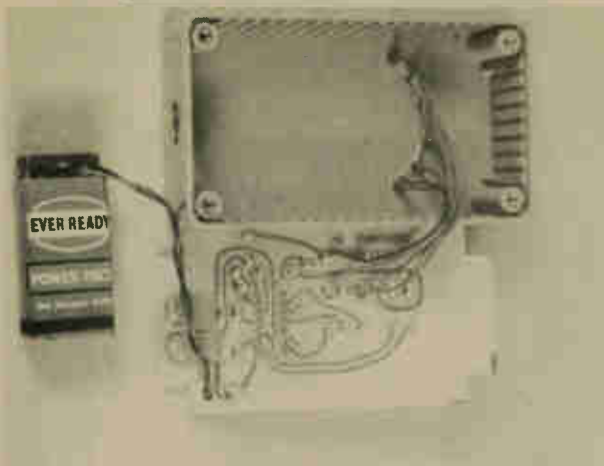
You will notice the lack of an on/off switch. As a CMOS IC is used in this project, the 'no-finger' (i.e. non-operating) current consumption is so low that battery drain is three-fifths of five-eights of half of 30% of the leakage across the battery terminals — negligible in fact. Hence, no switch.

We built the project into a small plastic and aluminum Verobox, with a hole in the side panel for the insertion of a finger. This size of box is very handy as the battery just fits in behind the printed circuit board and is neatly held with a little packing.

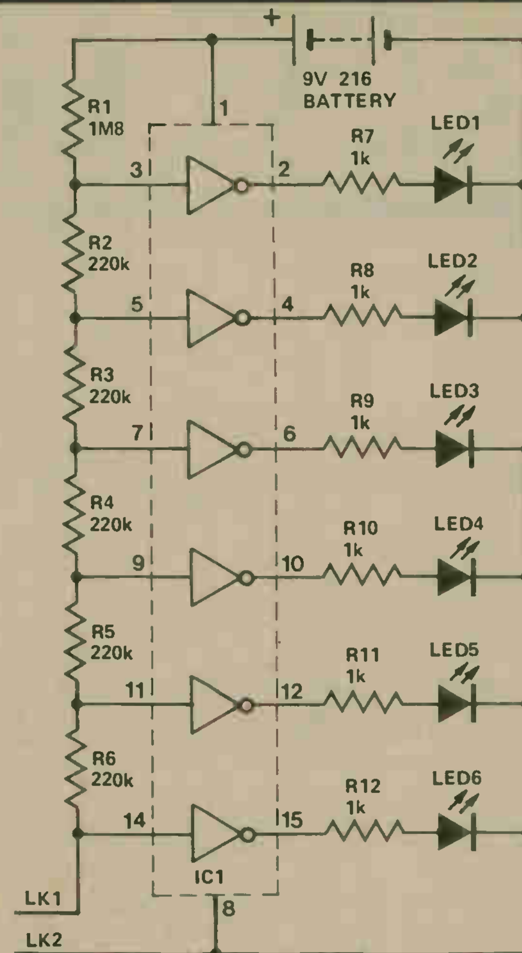
If you use ordinary copper foil PCB you will find after a while the areas of copper which are used for contacts will attract grease and oxidation which will affect the performance of the meter. The best way to stop this is to thoroughly clean and degrease the copper foil and then tin the areas which are used as skin contacts (the large black areas on the PCB track).



Above. Naked Passion (meter). Use of a PCB and straightforward design make this project a cinch to build. Only the LEDs need to be wired in to complete construction as no ON-OFF switch is required. The contact pads are underneath the PCB at the right.



Above A single 9V battery, which fits neatly in its case, powers the project.



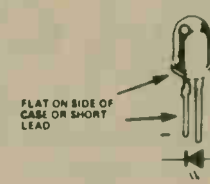


Fig. 1. Circuit diagram for Passionmeter.

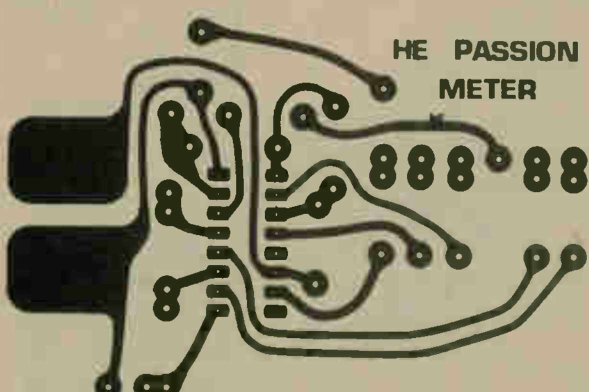


Fig. 2. PCB for Passionmeter.

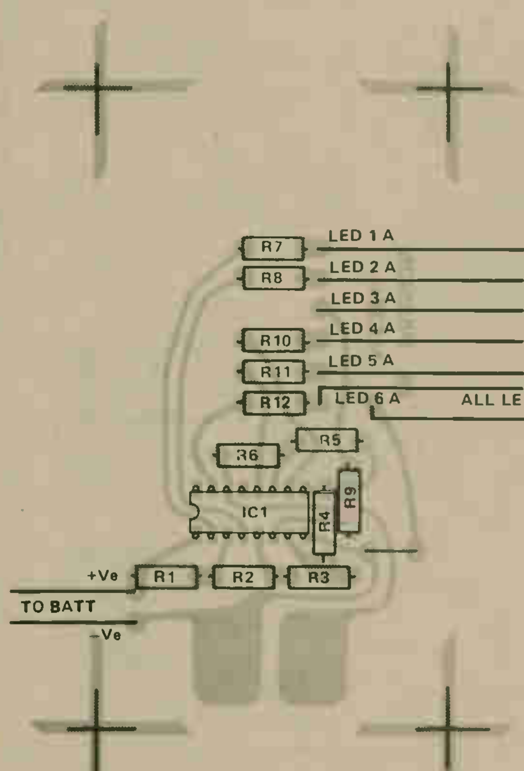


Fig. 3. Overlay for Passionmeter.

HOW IT WORKS

The operation of this circuit depends on the difference in skin resistance between different people. The lower the skin resistance, the more of the LEDs will light up.

This resistance is measured between the pads on the circuit board. As the finger of the person to be tested is pressed against the circuit board, it will cover both of these pads and the resistance between them will drop from its 'un-fingered' state in which the resistance across the pads is high) to a value less than 1M. This will cause the voltage on the resistor chain R1 to R6 to drop.

The 'gates' in the 4049 integrated circuit are inverters. This is, whatever happens on the inputs, the opposite will happen at the outputs. In this case, the inputs are being dragged to a low voltage. When the voltage on the input of any particular gate drops below about 4.5 V (half the supply voltage) the output will change from 0 V to 9 V. This will drive the current through the appropriate LED.

As the resistance across the contacts decreases, more of the gates will be turned on, causing LEDs in the line to light up.

When no finger is present, none of the LEDs are lit and the current drawn by the circuit is so small that an on/off switch is unnecessary.

PARTS LIST

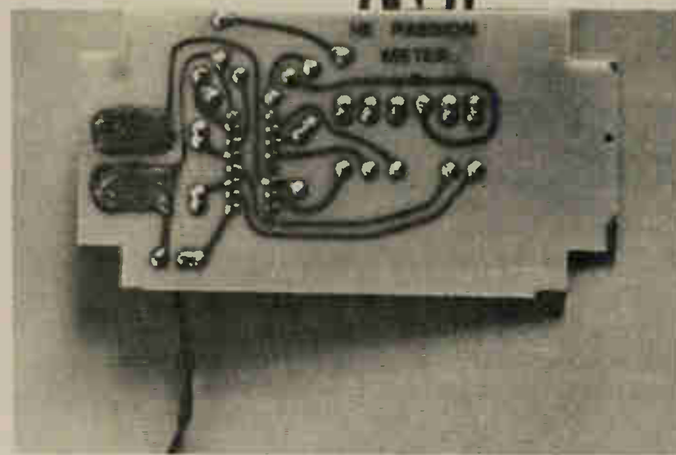
RESISTORS (All ½W. 5%)

R1	1M8
R2-R6	220k
R7-R12	1k

SEMICONDUCTORS

IC1	4049B
LED1-LED6	TIL220R Red LEDs or similar

MISCELLANEOUS
B1 9V battery, Battery clip, PCB. Box to suit.



Above: Simple PCB design makes an easy-to-build project.

Use an IC holder for IC1, it makes fault location so much easier plus the fact that the chip is less likely to be damaged by insertion. Make sure that it is the right way round.

Do not forget the wire link on the PCB. When soldering the components in, keep all of them as close to the board as possible with the exception of the LEDs, of course, which go on to the front panel of your case. Make sure that the LEDs are connected in circuit the right way round. Figure 1 shows how to tell the cathode from the anode. ●

LIFE OUT THERE?

Is there anybody there? Does anyone care? Yes to both. Read on . . .

ABOUT 20 YEARS AGO scientists, realised that their equipment might be able to detect suitably powerful radio emissions from intelligent beings on planets in other solar systems which may be many light years away from us. Attempts to detect Extra-Terrestrial Intelligence (appropriately abbreviated to ETI!) have already been made in the USA, Canada and the USSR without success, but much more work with larger aerials is required to provide workers in this field with a reasonable chance of success.

Apart from the Search for Extra-Terrestrial Intelligence (SETI), drawings and radio signals have been sent into space outside the solar system in the hope that they will eventually be detected and understood by intelligent beings many light years distant. Unfortunately the chances of two way communications with such beings are very remote, since the nearest star is a few light years away and most planetary systems are at much greater distances. Thus anyone sending a message from the earth to anywhere but one of the very nearest of the stars would be dead by the time any reply could be returned to the earth.

Attempts have also been made to detect signs of life within the solar system. In particular, the Viking spacecraft which landed on Mars conducted prolonged tests to try to detect life or the chemicals associated with life. Although no organic molecules that could be the past or present constituents of living things were found and the results were generally rather discouraging, they were certainly not conclusively negative as regards the possibility of life on Mars.

Communication Techniques

It seems likely that there are three possible ways in which we may be able to communicate with intelligent beings from outside the solar system. The first way involves a direct meeting of space vehicles or a landing by them on the earth. Unless the other beings have a longevity which far exceeds that of man, the journey time would make this method quite impossible. Many people do not fully appreciate how much vaster are the

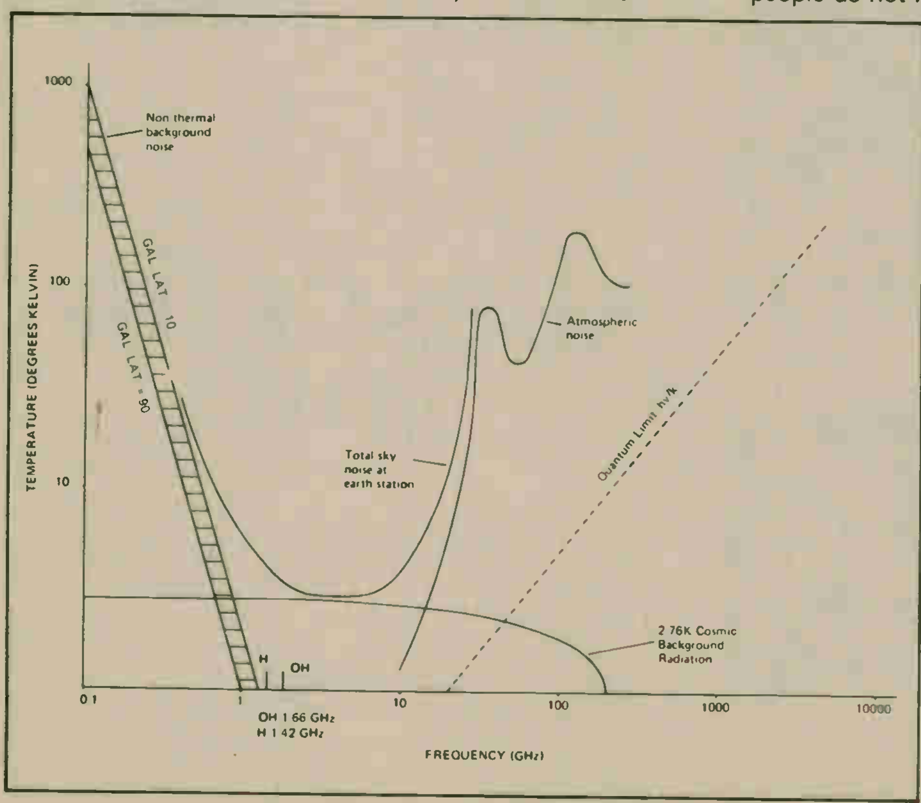


Fig. 1. Some of the most important factors which determine the choice of listening frequency. As signals from other stars would be very weak, it is important to choose a frequency where the natural background noise is relatively small. Most SETI work has been done in the relatively low total noise region of 0.5 to 10 GHz, christened the 'Water Hole', since it contains frequencies strongly associated with water. The favourite frequency is 1.42 GHz, emitted when the electron in a hydrogen atom flips over, reversing its direction of spin.

The noise contributions shown are — the 2.76 K cosmic background radiation (remnants of the big bang), atmospheric noise (as water and oxygen absorb and reradiate energy), quantum noise associated with the arrival of each photon in the atmosphere and synchrotron radiation emitted by particles spiralling round galactic magnetic fields (the level varies with galactic latitude. The extreme lines shown are for galactic latitudes of 10° and 90°).

distances involved in interstellar space than those within the solar system. Light takes about 8 minutes to reach us from the sun, but about 180 000 years to cross our galaxy and some thousands of millions of years to reach us from the farthest known objects.

As we require something which will convey information quickly, the obvious thing to use is electro-magnetic signals which travel at the speed of light. We can only send signals by this technique and not material objects, but generally it is far more sensible to send information on how to construct an object rather than to send the object itself over such vast distances. Should one use light, infra-red, radio waves or some other form of electromagnetic radiation? Radio-waves are to be preferred, since the energy required per transmitted photon is relatively low.

The third possible communicating technique involves the acceleration of sub-atomic particles to velocities very near to the speed of light, but as far as is known this technique has not yet been tried. If particles which can travel faster than light (known as 'tachyons') are ever discovered, one can only wonder whether they could be used in an extra-terrestrial communications system if they can be produced relatively easily; however, at the moment such a suggestion is nothing more than pure speculation.

It has been suggested that we should avoid transmitting any signals into space which would inform possibly hostile intelligent beings of our location. It is generally felt, however, that we can take comfort from the fact that any intelligent beings would be more interested in sharing information with us and co-operating with us as far as possible rather than in attacking us as in science fiction stories. In any event, it seems likely that it would take them so long to arrive here that our civilization would be in a very different state by the time they could reach us.

Basic Problems

Let us first consider the basic problems associated with receiving radio signals from outside the solar system, since any of our attempts to send messages are not likely to bring any result for an enormously long time. Any radio signals reaching the earth from outside the solar system are likely to be extremely weak owing to huge distances involved and it therefore follows that SETI projects require the use of the largest radio telescopes in the world.

One is left with decisions to make on the direction in which one should point the telescope, the frequency or frequencies which one should attempt to receive, the bandwidth one should use and perhaps even the time at which one should attempt to receive any transmissions. In the work on SETI which has been performed up to the present time, the telescopes have usually been pointed towards some star in our galaxy which is not excessively distant and which astronomers feel may possibly have a satellite system on which life could have evolved in some form or other.

In general astronomers have concentrated their searches in the regions of stars of the same or similar spectral classes as the sun. It has been felt that if a star has a luminosity much greater than that of the sun, then the lifetime of any planetary system associated with that star is probably too short to have enabled life to have developed to the point where intelligent civilizations have evolved. Stars of luminosity much smaller than that of the sun seem to have rather violent coronal activity which would probably result in any associated planetary system being rather inhospitable to most imaginable forms of life. Other stars have departed from the main sequence as a result of a super-nova or nova explosion and SETI workers have tended to disregard these because it seems doubtful whether any living species could survive the catastrophe event of such an explosion in the star.

Signal Types

What types of signal should we expect to receive from other planetary systems and how could we recognise such signals as originating from intelligent life? The SETI workers are basically searching for coherent signals, possibly modulated. For example, our own radio transmissions have a coherent carrier wave, although the modulation present inevitably involves a finite bandwidth. The presence of this type of signal would almost certainly indicate it is not of natural origin and hence would imply the existence of intelligent life elsewhere in the universe.

There are three basic types of signal from other planetary systems which we may be able to detect. The first type of signal is leakage of a signal into space in just the same way that our own radio and television signals leak away to a greater or lesser extent through our ionosphere. Indeed, a spherical wave of radio signals of a fairly wide range of frequencies has been travelling away from the earth over a period of rather over 50 years. In the case of more highly developed societies, it seems probable that they have been transmitting such signals for a far longer period (although one hopes they have not been stupid enough to destroy themselves by nuclear war).

A second type of signal we may possibly be able to receive is some form of inter-stellar or even inter-galactic communications between highly developed communities. Such reception would be by chance and it must be assumed that highly developed communities would employ very high gain antennae which are unlikely to be pointing towards our solar system. Thus the chances of intercepting such messages cannot be regarded as being very high.

The third type of signal we may hope to receive is an intentional one directed at our solar system by a society in a distant stellar system in order to notify us of their presence. It is also possible that such a society may send signals out isotropically (that is, all directions at equal intensities), but unless they have transmitters of extremely high power, such signals would be so weak at the earth that it is doubtful if we could detect them.

It is difficult to make an estimate of the optimum bandwidth one should select for SETI work. Narrow bandwidth receivers (possibly with a bandwidth of a few Hz) enable very weak signals to be detected, since the narrower the bandwidth of the channel used, the less the external noise which can penetrate into that channel. (Someone once said: "The wider you open the window, the more the amount of dirt that flies in," and this certainly applies to radio bandwidths). Unfortunately if one has a very narrow bandwidth channel, it takes a very long time to examine an appreciable range of frequencies. Modern plans are to use both narrow and wide band search techniques together with spectrum analysers for the simultaneous examination of numerous frequencies by computer techniques.

The Drake Equation

Before spending millions of dollars on SETI programmes, one would like to have some approximate estimate of the number of civilizations which are likely to possess the technology to be able to communicate with us. Such an estimate can be obtained by the use of the Drake equation. Professor Frank Drake is one of the leading SETI workers and is now Director of the National Astronomy and Ionosphere Centre of Cornell University. His equation reads:

$$N = R^* f_p n_e f_l f_i f_c L$$

where
- N is the number of existing civilizations possessing the interest and capability for inter-stellar communications
- R^* is the mean rate of star formation averaged over the lifetime of a galaxy
- f_p is the fraction of stars with planetary systems
- n_e is the mean number of planets in each system with an environment favourable for the origin of life
- f_l is the fraction of suitable planets on which life does develop
- fi is the fraction of life bearing planets on which intelligence together with manipulative abilities appears
- f_c is the fraction of the planets evolving advanced technical civilzation
- L is the lifetime of the technical civilization (perhaps very difficult to estimate!)

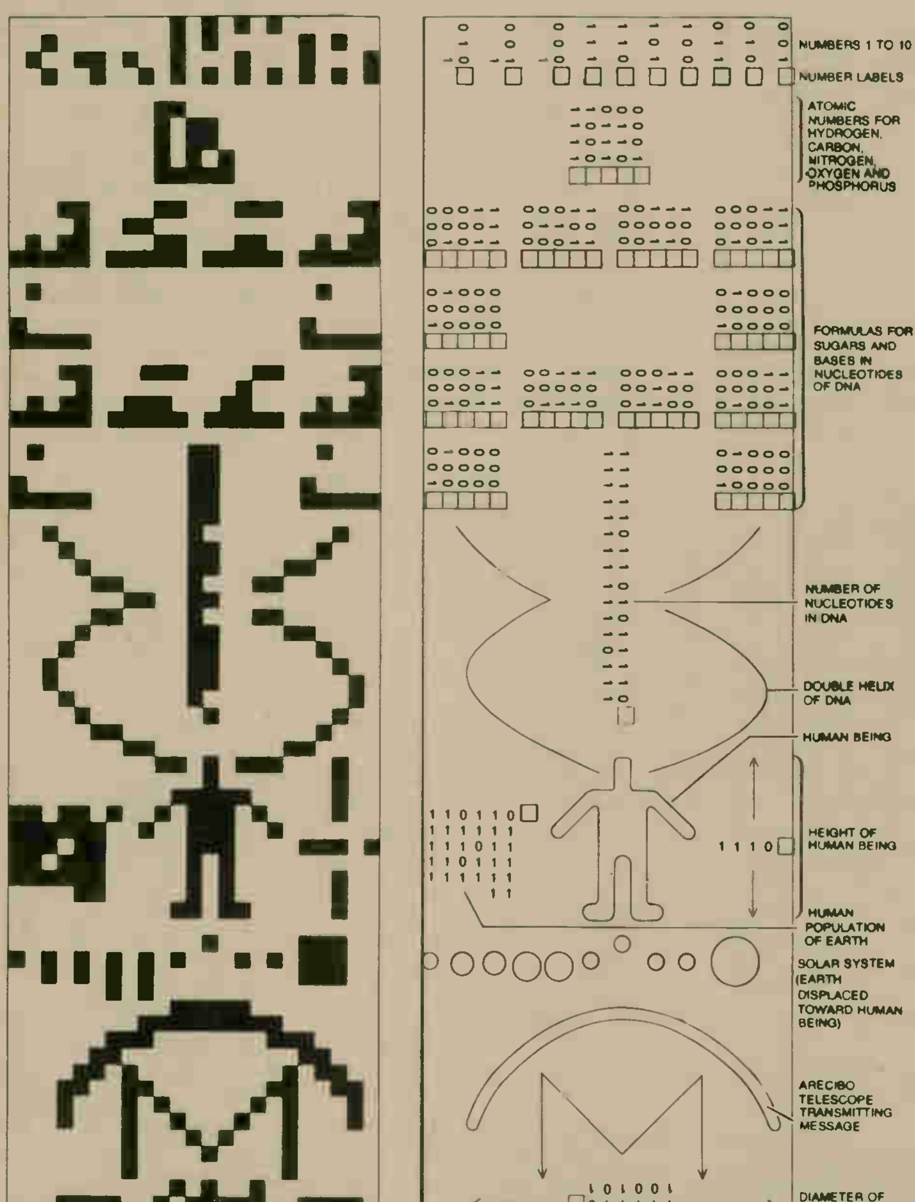


Fig. 2. On November 16th, 1974, the Arecibo telescope was used to transmit a message at 2380 MHz towards the Great Cluster in Hercules, Messier 13, some 25,000 light years away.

The message, 1679 bits long, can be decoded by breaking it into 73 consecutive groups of 23 characters and arranging these groups in sequence under one another as shown. The first piece of information consists of the first ten digits in binary form — the numbering system to be used. It continues with the atomic numbers of five common elements found in living things. Information on sugars and DNA follows, with a sketch of a human being and the solar system, ending with information about the Arecibo telescope.

Encoding information in various types of message poses some interesting problems in order that decoding can be carried out as easily as possible by intelligent remote beings.

The estimate obtained from the use of this equation will obviously vary widely according to the estimated values employed. However, most estimates now place the value of N around one million, these being distributed amongst approximately 500 million stars in our galaxy.

SETI History

Perhaps the first important paper on SETI work appears in *Nature* in 1959 under the title "Searching for Interstellar Communications" by Philip Morrison and Guiseppe Cocconi. It is interesting to note that they suggested the use of the 1.420 MHz hydrogen frequency, since it is a unique standard frequency which must be known to every observer in the universe.

Eight separate major efforts have been made by US, Canadian and Russian radio astronomers since 1960 to detect extra-terrestrial signals from intelligent beings. Although each search has concentrated on one or more specific frequencies in the range from 600 MHz to 22.2 GHz, the receivers used were those designed mainly for normal radio astronomical work which involves the detection of incoherent naturally produced radiation rather than the coherent radiation the SETI workers were seeking.

Although no confirmed sources of signals from intelligent beings outside the solar system have yet been detected, it has been estimated that the number of stars which have been examined is about 0.1% of the number which would have to be investigated if there is to be a reasonable statistical chance of detecting extraterrestrial intelligent signals.

Project Ozma

The first SETI work was led by Frank Drake using the 1420 MHz hydrogen frequency. It was named "Project Ozma" after the ruler of Oz — a far away place populated by exotic beings. Drake employed a bandwidth of 100 Hz and aimed his receiver at the two stars Tau Ceti and Epsilon Eridani which are both some 11 light years away from the earth. The observing time was some 150 hours using a 26 m (85 feet) diameter steerable antenna in 1960.

Project Ozma II is a much more extensive one which has also been carried out at the National Radio Astronomy Observatory, Green Bank, West Virginia. In this work some of the largest and most sophisticated radio telescopes in the world have been used; they include the 92 m (300 feet) diameter partially steerable antenna completed in 1962 at a cost of about 1 million dollars and the 43 m (140 feet) diameter equatorially mounted, fully steerable antenna which was completed in 1965 at a cost of some 14 million dollars.

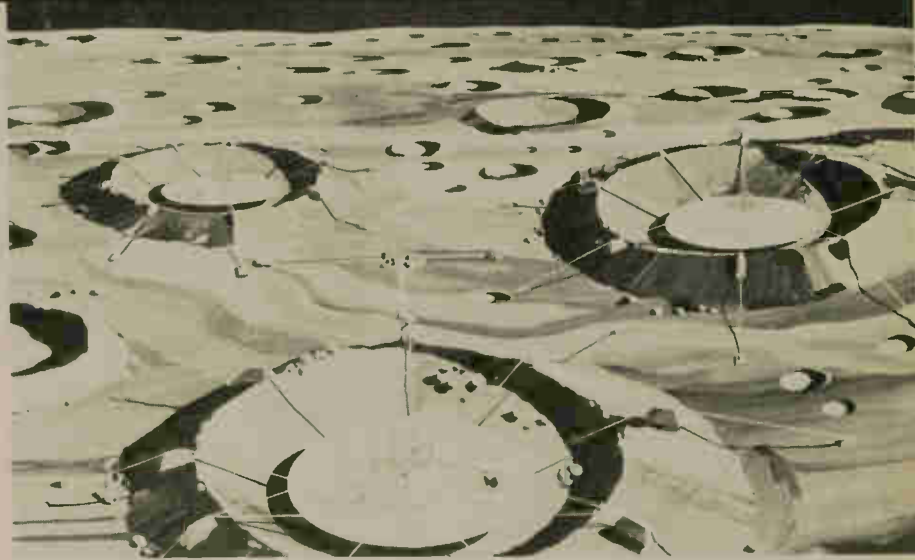
Project Ozma II was commenced in late 1972 under the leadership of Benjamin M. Zuckerman of the University of Maryland and Patrick Palmer, of the University of Chicago, the intention being to run the project for about two years. However, the Observatory made more time available and the project continued until December 1976 with an examination of about 700 stars at distances of up to some 65 light years. The prime targets were main sequence stars of the F5 to K5 class. The observations were carried out at 1420 MHz, each of 384 separate receivers being tuned to a slightly different frequency near to the 1420 MHz hydrogen line. A total bandwidth of 3 kHz was used.

At the end of the Project Ozma II work, about 12 stars showed some unexplained phenomena which were probably due to terrestrial radio interference, but which could have been due to faint signals from intelligent beings. These stars will doubtless be examined very carefullv at some later date.

Arecibo

Some SETI work has been carried out using the largest

The Goldstone 26 m Deep Space Network Antenna may be used in an all sky search. (Photo by courtesy of Jet Propulsion Laboratory)



An artists impression of a complex Cyclops array on the far side of the moon containing 216 large (200 m diam.) reflecting radio telescopes with a control building in the middle of the array. The lunar base is in the middle distance towards the left-hand side and is quite small.
(Photo by courtesy of NASA Ames Research Centre).

telescope in the world at the Arecibo Observatory in Puerto Rico which has a diameter of 305 m (500 feet) in the air. The reflector panels consist of 38,778 individual panels each a little over 1 m by 2 m in size; each pane must be positioned with an accuracy of better than 1 mm.

In 1967 a British post-graduate student noticed a mysterious regular pulsing signal from space and there was much speculation as to whether this was a signal from intelligent life beaming a message to earth. The Arecibo antenna was used to show that this signal was coming from the first pulsar to be discovered and that it was in the Crab Nebula.

Two of the best known SETI workers, Prof. Frank Drake and Prof. Carl Sagan, have used the Arecibo antenna to examine the radiation from whole galaxies for signs of signals from intelligent life. Although the use of this technique has enabled them to examine many millions of suitable types of stars simultaneously, it would require a signal of very great intensity to enable frequencies of 1420 MHz, 1654 MHz and 2380 MHz, but the time allocated to this work is relatively small.

Canadian Work

Dr. Bridle and Dr. Feldman commenced work at Canada's nationally owned Algonquin Radio Observatory in Algonquin Park, Ontario in 1974. They are using a 46 m (150 feet) diameter telescope to examine many of the nearest sun-like stars, but the frequency employed is 22.2 GHz — the emission frequency of the water molecule — which is much higher than that used by other workers.

Project Cyclops

One of the most ambitious SETI projects yet proposed is known as Project Cyclops. This is intended to be suitable for not merely detecting high power signals (such as those from our own Arecibo antenna), but also to allow eavesdropping on much lower intensity signals which other civilizations use for their own communications (like our radio and television transmitters). In order to be able to receive such signals from stellar systems at distances of a few hundred light years from the earth, enormous antenna systems are required.

It seems unlikely that it would be a practical possibility to construct a single reflecting dish of adequate size and therefore it has been suggested that the Cyclops project could employ an enormous array of radio telescopes, each of which may be about 100 m in diameter. For example, as many as 1500 such 100 m dishes could be spread out in lines over an area of perhaps 65 km^2 and connected together electrically to provide the same performance as a single dish of enormous dimensions.

Project Cyclops was initiated as a study by the NASA Ames Research Centre and Stanford University in 1971 under the leadership of Dr. John Billingham and Dr. Bernard Oliver. There have been vast improvements since then in solid state memories, microprocessors, wideband maser low-noise amplifiers, etc.

Conclusion

The Search for Extra-Terrestrial Intelligence has not yet been successful, but this is not particularly surprising in view of the small number of star systems which have been examined with high sensitivity equipment. Some people (including many of those who control scientific finance) may feel that the SETI project is rather frivolous and perhaps even a silly one. However, there are many scientists very strongly committed to work in this field — a point which can be demonstrated by the fact that a new journal, *Cosmic Search* devoted entirely to SETI work started publishing January 1979 under the editorship of Dr. Robert S. Dixon who is well-known for his SETI work at the Ohio State University Radio Observatory.

Dr. Frank Drake at times feels somewhat cynical about the cuts in the SETI budgets. Indeed, he has commented that the search for extra-terrestrial intelligence begins with the search for intelligence here on earth! He feels that at the present time there is a very well qualified group of people who are keen to carry out an extensive SETI project and, if no funds are forthcoming for a year or more, it is likely that many of these people will move to other work. If you were paying taxes in a country considering becoming involved in an extensive SETI project, how would you feel about paying an extra amount (far less in total than that to place a man on the moon) in order that the project could proceed? SETI work will doubtless continue, but more funds are required if it is to proceed at a rate which is likely to bring success within the lifetime of most people who are living today. ●

FEATURE

TEACHER'S TOPICS

A successful, properly working project is a thing of pride. Being prepared results in a crafted piece of equipment.

Ready to take the plunge into your first project? John Van Lierde has some useful hints.

YOU'VE BEEN READING ETI for a while now. You like the mag (we hope) and you really like the looks of the projects. Eventually you will want to build SOMETHING, just to show you can do it.

For many of us project construction is the most exciting part of electronics. It is probably the closest any of us will come to creating life in our lifetimes. Nothing compares to powering up a circuit and having it work first time (of course having it blow fuses regularly has an opposite if not equal effect).

For purposes of this discussion we will assume some knowledge of components and schematics. If you find that you are not at this stage of the game then it's time to hit your local library. While we could give you some quick descriptions, we don't have room to go into the whys and wherefores. If you're really unsure of yourself, start with something simple that will keep you out of trouble.

Power To The People

While on the subject of trouble, a word about line powered projects. Virtually all our line powered designs use transformers. Transformers effectively isolate the user from the power lines and reduce output to a somewhat safer level, typically 12 - 30V.

When constructing line powered projects insulate all terminals with either heatsink tubing, electrical tape or wire nuts. Protect connections from prying fingers and don't ever connect one side of the power cord to an exposed metal part (such as the chassis), even if you are using a polarized plug.

Additionally, always use a fuse, in most cases a .25 or .5A unit inserted in the primary circuit of the transformer will do the job. Fuses are cheap insurance.

Tooling Up

Needless to say attacking a project barehanded is nothing short of foolhardy (try soldering with your thumb). Every hobbyist needs tools, and a smart hobbyist buys good tools: they are cheaper in the long run.

The most basic requirements include longnose pliers, wire cutters, wire strippers, screw drivers, and a sharp knife. These will allow you to at least wire up a circuit. To put it in a case, you'll need a drill (with bits), metal nibbler, reamer, hacksaw, etc., etc., etc., ad nauseum.

You will also need a work area. This should be well lit, well powered and hopefully dedicated to your hobby. The latter, however, is not always possible and you may have to work on a kitchen table, desk or on your lap. If this is the case, organization is everything. Have separate containers for your project, its parts, tools etc.

Another word of caution, don't ever work over a shag carpet, you'll lose everything.

Soldering

The most important components in any project are the solder joints you make. A good joint will last the life of the equipment, a bad joint is a veritable Pandora's box of trouble.

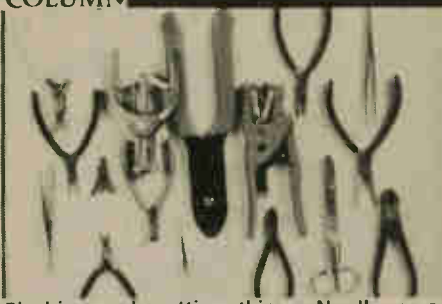
First you need a soldering iron. Look for something rated at 25 to 35 watts. Generally two types of tips are available, plain copper and iron clad. The copper ones are about 20% cheaper but the plated variety tin easier, wear better and effectively last forever.

Buying solder is easy enough. Get 'electrical' type solder. This is of 60% tin, 40% lead composition with resin (sometimes called rosin) core flux. Don't get acid core, it makes unreliable connections. Don't get the super heavy stuff either, a good thickness is 1.5 mm (.06 inch).

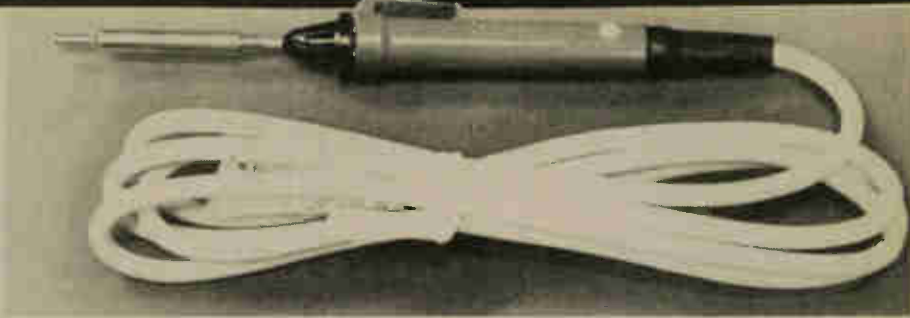
Before working with your iron, make sure the tip is well tinned, that is to say that there is an even layer of solder over the working surface. To tin your iron, first heat it up to operating temperature (3 - 5 minutes). If you're using a copper tip, you'll notice a black oxide forming. Quickly clean this off with steel wool or sandpaper and apply solder evenly over the surfaces. If you have an iron tip, omit the sandpaper bit.

Tip maintenance is vital to good solder joints. Wipe the tip clean of deposits and scale frequently with a damp sponge or rag. If you are cursed with a copper tip, you'll have to dress it up with a file from time to time, and retin it.

Screwdrivers are considerably higher on the Rockwell Hardness scale than fingernails and are generally recommended for assembling. Get yourself a good quality selection of miniature and standard Philips and slothead screwdrivers, they're a worthwhile investment.



Pinching and cutting things. Needle nose pliers are a good substitute for fingers. Get a pair with serrated tips that line up properly. Side cutters are also important. Make sure you only cut small wire with them. If you start using them on coathanger wire, they will quickly become useless.



The all purpose elbow and finger burner. A useful soldering iron should be rated at around 35 watts with a narrow chisel type tip.

The actual process of soldering is quite straightforward, consisting only of heating up the joint and applying solder (in that order). In spite of the apparent simplicity, bad soldering is a major cause of project failure. Let's look at these two steps more closely.

Heating the Joint. Make sure you apply heat directly to all parts to be soldered. For pc boards, the iron should touch both the leads and the foil. One way to ensure good heat conduction is to make sure that you're starting with a mechanically sound joint.

Applying Solder. This is the important part. The idea is to have the joint hot enough to melt the solder and let it flow. The best way is to heat the joint up on one side while touching it with the solder on the other.

Quick, careful work is the trick. The joint should be hot enough to melt solder, but not for long, or you might damage the component. In all, a solder joint shouldn't take longer than two seconds to make.

Buying Components

The most difficult part of project building is getting together the various bits you need. A good place to look is the Yellow Pages for your city. Look under 'Electronic Equipment & Supplies'.

Of course, this may not work out and you'll have to go to mail order for parts. In that case check the ads in ETI, after all that's what they are there for. Even if you don't see what you want, write to them and advise them of your needs. In fact, some companies will try to supply you with everything from your parts list, even if they have to go elsewhere.

Building It

How to build it is up to you, but it is a good idea to breadboard the circuit first. This will allow you to verify operation and make alterations to suit your needs.

Breadboards ('prototyping sockets') are an extremely worthwhile investment. The cost may seem a bit high (up to $15.00 and higher), but this is more than offset by their versatility.

Essentially, these sockets give you two paralled rows of common 'connections'. The spacing of these rows is 0.1", so DIP ICs will fit nicely.

The actual sockets will accomodate wire sizes of up to 22 ga. You can fit 20 ga. in a pinch, but this will deform the sockets and affect the reliability of the unit.

Another advantage of breadboard sockets is the capability to build test jigs. Need a logic probe? Sensitive Volt meter? A quick instrument amplifier? Wire 'em up and away you go.

After breadboarding you will be faced with a variety of methods: perfboard, wirewrap, veroboard, pc board and others.

Perfboard and Veroboard are the most flexible and inexpensive methods you can use. The results may not necessarily be aesthetically pleasing, but your circuit will work. (If you're interested in the Veroboard route, you might check Teachers Topics in ETI, March 1980).

Wirewrap is a variation of point-to-point wiring which frequently finds uses in prototyping computer circuit boards.

In our opinion, printed circuit boards are really the best route. A pc board has a more pleasing appearance, tends to be more reliable and also reduces the chance of wiring errors. If you don't feel up to making your own, check the classifieds in this issue or the list of pcb suppliers in the table of contents. These companies are more than willing to serve you.

Finally, fit the board in a suitable enclosure with its attached knick-knacks and switches and hopefully you'll have something you'll be proud to show your friends.

Finally

Having read this article, you may feel no closer to project construction than before.

Dive right in! You'll find it's largely a learn-as-you-do situation. Your first effort may not be dreadfully impressive, but you can only get better at it. ●

Breadboarding is an important step in project construction. Units such as these will set you back $10–$15.

Wirewrapping is extremely useful in computer applications. Wire-wrapped connnections are reliable for up to forty years (almost as good as solder) and are easily taken apart.

Babani Books From ETI

These books are specially imported from England by us. If someone has already used the card, write to ETI Magazine, Unit 6, 25 Overlea Blvd. Toronto. Ontario M4H 1B1.

IC 555 Projects — BP44

■ Every so often a device appears that is so useful than one wonders how life went on before without it. The 555 timer is such a device.
■ It was first manufactured by Signetics, but is now manufactured by almost every semiconductor manufacturer and is inexpensive and very easily obtainable.
■ Included in this book are Basic and General Circuits, Motor Car and Model Railway Circuits, Alarms and Noise Makers as well as a section on the 556,558 and 559 timers.
■ An invaluable addition to the library of all those interested in Electronics.

$7.25 plus 30c postage and handling.

52 Projects Using IC741 — BP24

■ IC741 is one of the most popular, inexpensive and easily obtainable devices available to the home constructor. It is also extremely versatile and can be used in a great number of various applications.
■ This unique book originally published in Germany, shows fifty-two different projects that can be simply constructed using only the IC741 and a few discrete components.
■ An invaluable addition to the library of all those interested in electronics.

$3.95 plus 30c postage and handling.

Mobile Discotheque Handbook — BP47

■ The vast majority of people who start up "Mobile Discos" know very little about their equipment or even what to buy. Many people have wasted a "small fortune" on poor, unnecessary or badly matched apparatus.
■ The aim of this book is to give you enough information to enable you to have a better understanding of many aspects of 'disco' gear.
■ The approach adopted is to assume the reader has no knowledge and starts with the fundamentals, hopefully the explanations given are simplified enough for almost anyone to understand but please not that this is by no means the full story.
■ The book is divided into six parts — Basic Electricity, Audio, Ancillary Equipment, Cables and Plugs, Loudspeakers, Lighting Equipment and the information has been considerably sub-divided for quick and easy reference.

$5.60 plus 30c postage and handling.

28 Tested Transistor Projects — No.221

■ Mr. Richard Torrins is a well experienced electronics development engineer and has designed, developed, built and tested the many useful and interesting circuits included in this book.
■ Some of the circuits are completely new and, to the best knowledge of the author, unlike anything previously published while others many bear similarity to more familiar designs.
■ The projects themselves can be split down into simpler building blocks which are shown separated by boxes in the circuits for ease of description, and also to enable any reader who wishes to combine boxes from different projects to realise ideas of his own.
■ Most of the circuits are very economical on the use of components and in many cases the semiconductors employed are non-critical, commonly available and inexpensive types.

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First Book of Transistor Equivalents and Substitutes — BP1

■ Shows alternatives and equivalents to many popular transistors made in Great Britain, U.S.A., Europe, Japan and Hong Kong etc.
■ Companion Volume to BP14 — SECOND BOOK OF TRANSISTOR EQUIVALENTS AND SUBSTITUTES.
■ An invaluable addition to the library of all those interested in Electronics be they amateur or professional.

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Second Book of Transistor Equivalents and Substitutes — BP14

■ Shows alternatives and equivalents to many popular transistors made in Gt. Britain, U.S.A., Europe, Japan and Hong Kong etc.
■ Companion Volume to BP1 — FIRST BOOK OF TRANSISTOR EQUIVALENTS AND SUBSTITUTES.
■ An invaluable addition to the library of all those interested in Electronics be they amateur or professional.

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Radio Circuits Using IC's — BP46

■ This book describes integrated circuits and how they can be employed in receivers for the reception of either amplitude or frequency modulated signals. The chapter on amplitude modulated (a.m.) receivers will be of most interest to those who wish to receive distant stations at only moderate audio quality, whilst the chapter on frequency modulation (f.m.) receivers will appeal to those who desire high fidelity reception of local v.h.f. stations possibly with stereo (and even quadrophony at some future date). Stereo decoder circuits and the devices available at present for quadrophonic circuits are discussed. Voltage regulator devices are also covered because they are so convenient in all varicap tuned receivers and because they have so many applications in all types of circuit.
■ Brian Dance is a highly experienced author who regularly contributes to many of the popular electronic magazines that are available both in the U.K. and overseas.
■ An extremely valuable addition to the library of all Electronics enthusiasts.

$5.60 plus 30c postage and handling.

50 (FET) Field Effect Transistor Projects — BP39

■ Field effect transistors (F.E.T.'s) find application in a wide variety of circuits. The projects described here include radio frequency amplifiers and converters, test equipment and receiver aids, tuners, receivers, mixers and tone controls, as well as various miscellaneous devices which are useful in the home.
■ It will be found that in general the actual F.E.T. used is not critical and many suitable types will perform satisfactorily. The F.E.T. is a low-noise, high gain device with many uses and the dual gate F.E.T. is of particular use for mixer and other applications.
■ This book contains something of particular interest for every class of enthusiast — shortwave listener, radio amateur, experimenter or audio devotee.
■ A valuable addition to the library of all electronic enthusiasts.

$5.20 plus 30c postage and handling.

Popular Electronic Projects — BP49

■ Included in this book are a collection of the most popular types of projects which, we feel sure, will provide many designs to interest all electronics enthusiasts.
■ All the circuits utilise modern, inexpensive and freely available components.
■ The 27 projects selected cover a very wide range and are divided into four basic areas: Radio Projects, Audio Projects, Household Projects and Test Instruments.
■ An interesting addition to the library of both the beginner and more advanced constructor.

$5.95 plus 30c postage and handling.

Electronic Music and Creative Tape Recording — BP51

■ Electronic Music is the new music of the 20th Century. It plays a large part in 'Pop' and 'Rock' music and, in fact, there is scarcely a group without some sort of electronic synthesiser or other effects generator.
It is possible with relatively simple apparatus to create complete compositions using electronic and sometimes non-electronic musical sources.
■ This book sets out to show how Electronic Music can be made at home with the simplest and most inexpensive equipment. It describes how the sounds are generated and how these may be recorded to build up the final composition.
■ With the constructor in mind, several ideas are given to enable a small studio to be built including a mixer and various sound effect units.
Circuits are included for VCOs, VCAs, Envelope Shapers, VCFs, Active and Passive Mixers, Fuzz, Noise Generators, Metronomes and a 10-Note Programmable Sequencer etc.
All the units shown have been successfully built and used by the author and most of the projects can be built by the beginner.
■ An unusual, fascinating and highly rewarding application of electronics.

$5.20 plus 30c postage and handling.

IC LM3900 Projects — BP50

■ The purpose of this book is to introduce the LM3900 to the Technician, Experimenter and Hobbyist. It provides the groundwork for both simple and more advanced uses and is considerable more than just a collection of simple circuits or projects.
■ The LM3900 is different from conventional 'Op. Amps.', it can be used for many of the usual applications as well as many new ones. It is one of the most versatile, inexpensive and freely available devices on the market today.
■ The book is divided into six basic sections —
Introduction
Audio Applications
Simple Linear Applications
Simple Digital Applications
Signal Generator Circuits
Special Applications
■ The LM3900 can do much more than is shown here — this is just an introduction. Imagination is the only limitation with this useful device, but first the reader must know the basics and that is what this book is all about.

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1st Book of Hi-Fi Loudspeaker Enclosures — No.205

■ Contains 26 practical designs and over 40 drawings to enable the enthusiast to construct his own Hi-Fi Loudspeaker enclosures.
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Corner Reflex, Bass Reflex, Exponential Horn, Folded Horn, Tuned Port, Klipschorn Labyrinth, Tuned Column, Loaded Port, Multispeaker Panoramic etc.
■ Also covers general construction hints and embellishing of cabinets as well as a considerable amount of other useful information.
■ A must for the library of all audio enthusiasts.

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50 Simple L.E.D. Circuits — BP42

■ The author of this book Mr. R.N. Soar, has compiled 50 interesting and useful circuits and applications, covering many different branches of electronics, using one of the most inexpensive and freely available components — the Light Emitting Diode (L.E.D.).
■ Also includes circuits for the 707 Common Anode Display.
■ A useful book for the library of both beginner and more advanced enthusiast alike.
■ Companion volume to book No. BP36 — 50 CIRCUITS USING GERMANIUM, SILICON & ZENER DIODES by the same author.

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Handbook of IC Audio Preamplifier & Power Amplifier Construction — BP35

■ Shows what audio IC's are, as well as how to use them.
■ Includes practical constructional details of various IC and Hybrid IC Transistor designs of about 250mW to 100W output.
■ This book is written by the very experienced and popular author Mr. F.G. Rayer who deals with the subject in four parts:
Part I Understanding Audio IC's
Part II Preamplifiers, Mixers and Tone Controls
Part III Power Amplifiers and Supplies
Part IV Hybrid Circuits
■ An ideal book for both beginner and advanced enthusiast alike.

$5.20 plus 30c postage and handling.

50 Projects Using Relays SCR's & Triacs — BP37

■ Relays, silicon controlled rectifiers (SCR's) and bi-directional triodes (TRIACs) have a wide range of applications in electronics today. These may extend over the whole field of motor control, dimming and heat control, delayed timing and light sensitive circuits and include warning devices, various novelties, light modulators, priority indicators, excess voltage breakers etc.
■ In this book the very experienced and popular author — Mr. F.G. Rayer — has given tried and practical working circuits which should present the minimum of difficulty for the enthusiast to construct.
■ In most circuits there is a wide latitude in component values and types allowing easy modification of circuits or ready adaption of them to individual needs.
■ An ideal book for both beginner and advanced enthusiast alike.

$5.20 plus 30c postage and handling.

50 Projects Using IC CA3130 — No.223

■ The CA3130 is currently one of the more advanced operational amplifiers that is available to the home constructor. This means that it is often capable of a higher level of performance than many other devices and that it often needs fewer ancillary components.
■ In this book Mr. R.A. Penfold has designed and developed a number of interesting and useful projects which are divided into five general categories:
I Audio Projects
II R.F. Projects
III Test Equipment
IV Household Projects
V Miscellaneous Projects
■ An ideal book for both the beginner and more advanced enthusiast alike.

$5.20 plus 30c postage and handling.

Electronic Projects for Beginners — BP48

■ In this book the newcomer to electronics will find a wide range of easily made projects, many complete with actual component and wiring layouts. Furthermore, a number of projects have been arranged so that they can be constructed without any need for soldering and, thus, avoid the need for a soldering iron.
■ This book which is written by the very experienced author Mr. F.G. Rayer is divided into four sections —
1. 'No Soldering' Projects
2. Miscellaneous Devices
3. Radio and Audio Frequency
4. Power Supplies
■ An absolute 'must' for all beginners in electronics.

$5.60 plus 30c postage and handling.

50 CMOS IC Projects — No.224

■ CMOS IC's are probably the most versatile range of digital devices for use by the amateur enthusiast. They are suitable for an extraordinarily wide range of applications and are now also some of the most inexpensive and easily available types of I.C.
■ In this book Mr. R.A. Penfold has designed and developed a number of interesting and useful projects which are divided into four general categories:
I Multivibrators
II Amplifiers and Oscillators
III Trigger Devices
IV Special Devices
■ An ideal book for both the beginner and more advanced enthusiasts alike.

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Electronic Calculator Users Handbook — BP33

■ An invaluable book for all calculator users whatever their age or occupation, or whether they have the simplest or most sophisticated of calculators.
■ Presents formulae, data, methods of calculation, conversion factors etc. with the calculator user especially in mind, often illustrated with simple examples.
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Hyperbolic functions (sinh, cosh, tanh)
Logarithms, square roots and powers
■ A comprehensive section of conversion factors covering such common conversions as length, area, volume and weight etc. through to more specialised conversions such as viscosity, illumination, and cargo shipping measures etc.
■ Formulae and data for VAT, discounts and mark up, currency conversion, interest, solutions of equations, binary and octal numbers, areas and volumes, statistics and mathematics etc.

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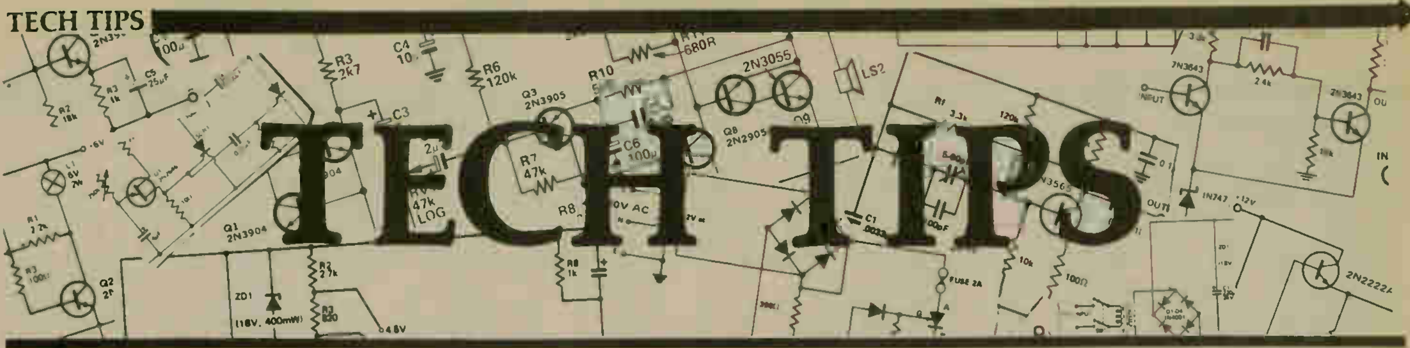
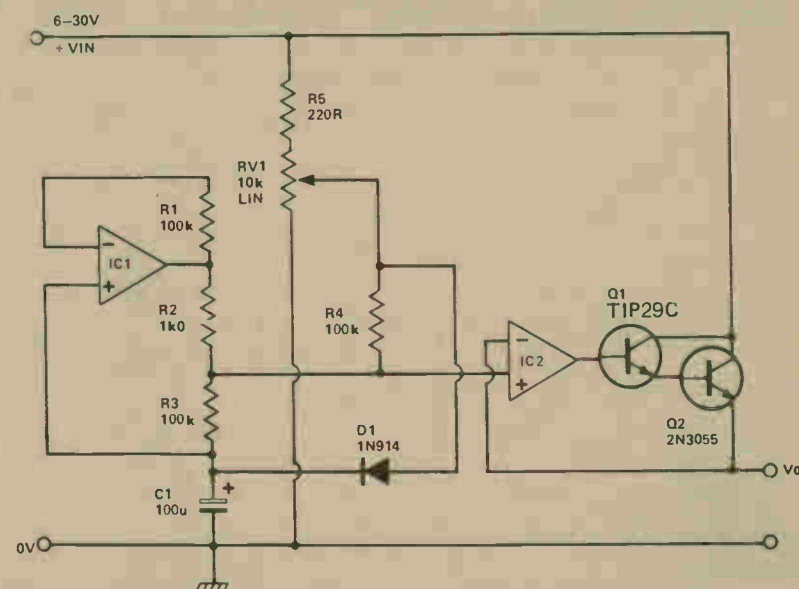


Gyrator Power Supply

J. P. Macaulay

Although this circuit was developed to supply a well smoothed supply to a stereo class A amplifier it is well suited to many other applications. The circuit is based on the dual op amp LM358. A1 is used as an gyrator, C1 being amplified by the ratio of R3 to R4, ie 1000X. The simulated capacitor thus formed between the output of A1 and ground is 100n.

R5 and RV1 set the output voltage while R4 in series with the 'capacitor' forms a smoothing network with a time constant of 10,000 seconds! In order to avoid protracted turn on times the diode, D1, rapidly charges C1 to within 0V6 of the nominal output voltage within two seconds. Ripple is not measurable with the prototype when supplying 3A into a load. IC2 and the Darlington output pair Q1 and Q2 form a voltage follower with an output current capacity in excess of 10A, if Q2 is mounted on a hefty heatsink.



Battery Charger Controller

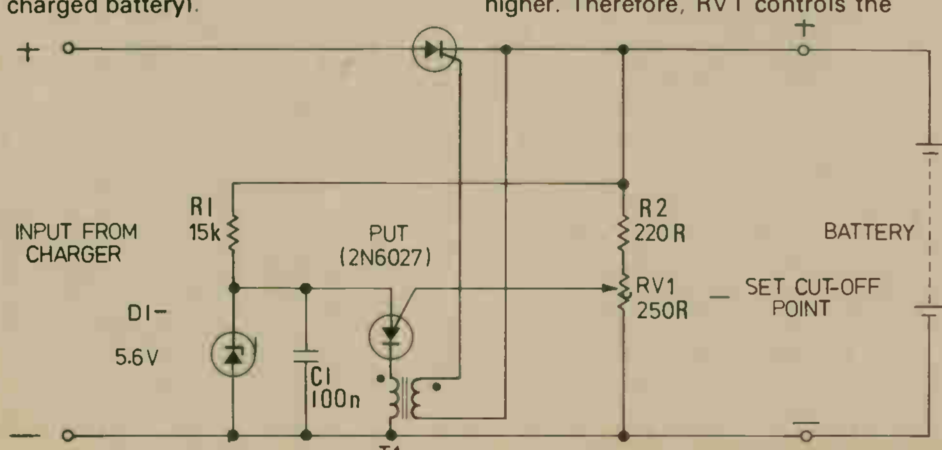
D. Wedlake

The battery charger circuit illustrated was designed to be incorporated in any conventional battery charger rated up to 10 amps, where the output is full-wave rectified and unsmoothed. It is fully protected as it cannot be damaged by short circuit or reverse battery connection. Furthermore, charging ceases when the battery voltage reaches a pre-set voltage (normally 13V8 for a fully charged battery).

The design is based on the Programmable Unijunction Transistor (PUT) oscillator which senses the battery voltage to determine when charging should cease. The battery being charged provides the power for the oscillator which, in turn, triggers the thyristor via the pulse transformer T1. As the anode of the PUT is clamped to 5V6 by the Zener Diode, ZD1, it follows that the circuit will not oscillate if the potential at the slider of RV1 is correspondingly higher. Therefore, RV1 controls the cut-off point which should be set to 13V8. This is best set under actual operating conditions and the charging current will gradually reduce as this voltage is approached.

The charger is fully protected as the circuit cannot oscillate under short circuit conditions or reverse battery connections. However, as the power for the oscillator is derived from the battery, the circuit will naturally not be self starting if the battery is completely flat or charged to less than about 7 volts. This problem could be overcome by providing a push-button shorting switch across the thyristor to initiate charging. In a short while the battery voltage should have risen sufficiently to maintain normal operation. However, one should bear in mind that the charger will not be protected when the start push button is pressed, so if included, one should provide a fuse as additional protection.

If used at full load current, the thyristor should be mounted on a suitable heat sink having a thermal dissipation of 4°C/W.



TABS AT ETI!

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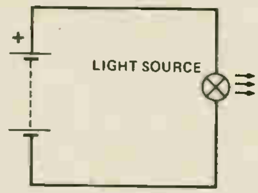
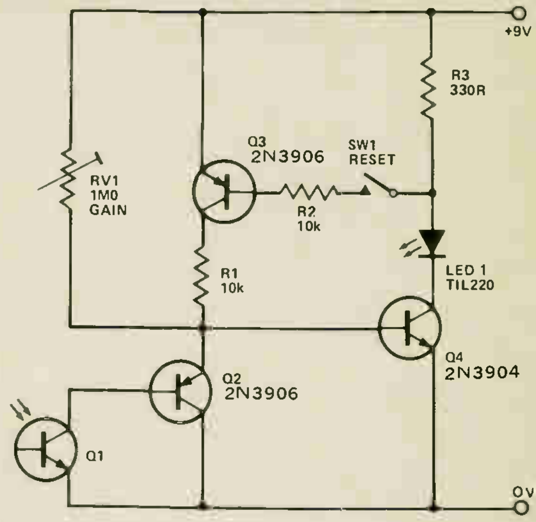
Silent Sentry

B. J. Lowery

The 'Silent Sentry' is a form of intrusion alarm. It will indicate the breaking of a light beam by means of lighting a Light Emitting Diode, which will remain lit until the RESET switch is activated. Q1 may be any suitable NPN photo-transistor available.



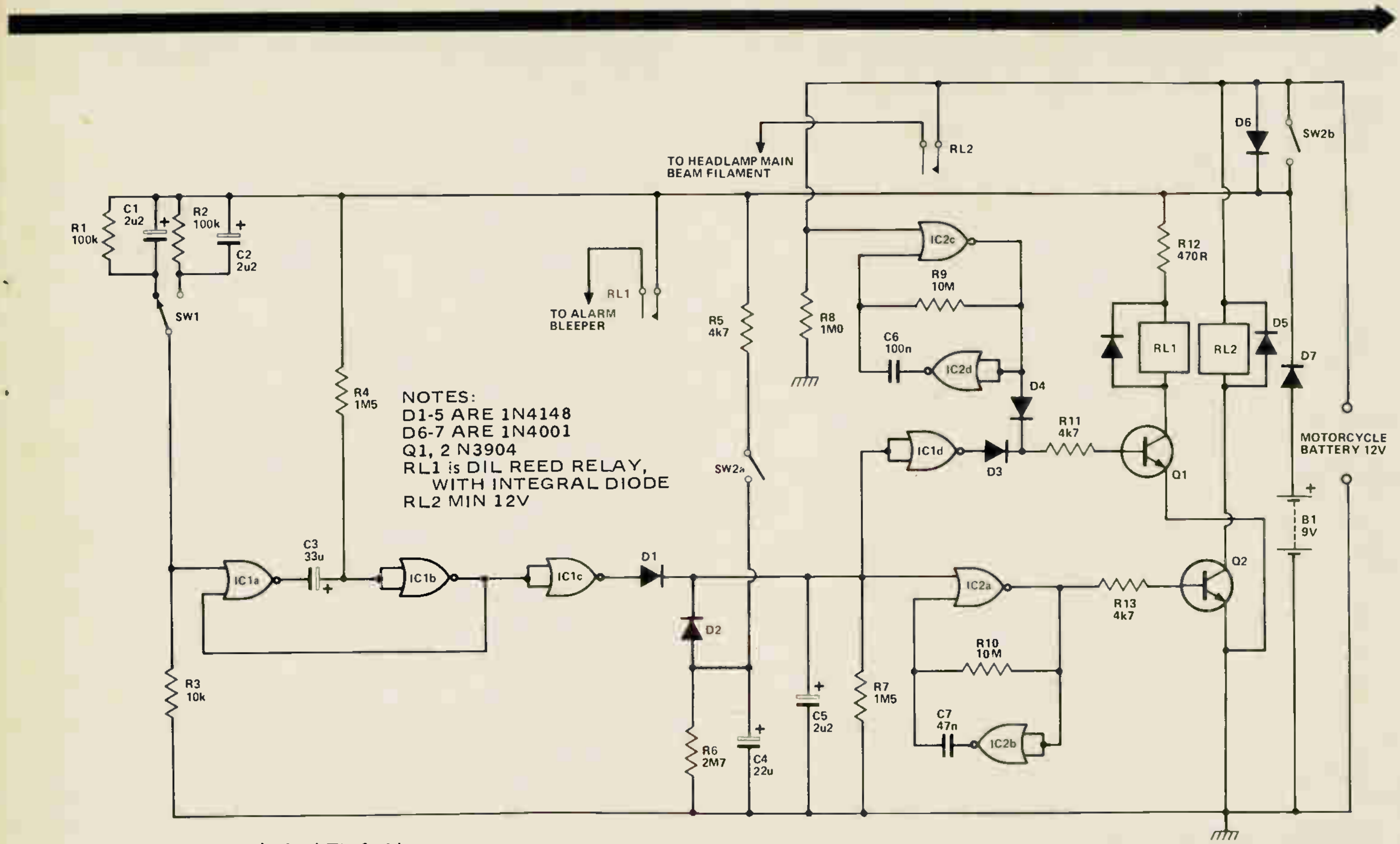


When light from the light source is falling on Q1, Q2 is turned on, causing both Q3 and Q4 to be turned off, therefore LED1 will not light. As soon as the light beam is broken Q2 is turned off, allowing Q4 to be turned on via RV1. LED 1 lights, Q3 is turned on via R2, SW1, LED 1 and Q4. Q3 forms a latching circuit for Q4 and this will keep LED 1 alight until the RESET switch is operated. The GAIN control is a sub-miniature preset and should be adjusted to give LED 1 a positive on/off action.

Motorcycle Anti-Theft Alarm

C. R. Goble

IC1a,b form a monostable triggered by mercury switch S1.IC1c then provides a low output, allowing the charge on C5 to decay over a couple of seconds through R7. After this short delay IC1d allows RL1 to sound the alarm bleeper and the astable around IC2a,b flashes the bike headlight via RL2. After a period the monostable resets and arms the circuit once more. If the battery leads are cut then another astable around IC2c,d will switch the bleeper on and off continuously, via RL1, until disarmed by lockswitch S2.C4 discharging prevents the alarm from sounding for about 20 seconds after initial arming. RL2 contacts should be suitably rated and, ideally, RL1 should take only a low current to help conserve standby power. Current drain when untriggered amounts to that through S1.6V operation is possible with 6V relays although values may need altering to preserve timing. Mercury switch S1 can be formed either from one double switch or from two single switches, mounted across the 'bike and wired to give a changeover action.



Motorcycle Anti-Theft Alarm

Circle No. 5 on Reader Service Card.

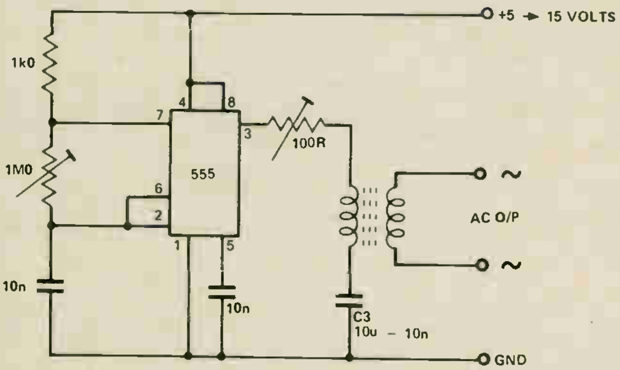
TECH TIPS

Milli-Power Inverter

J. S. B. Dick

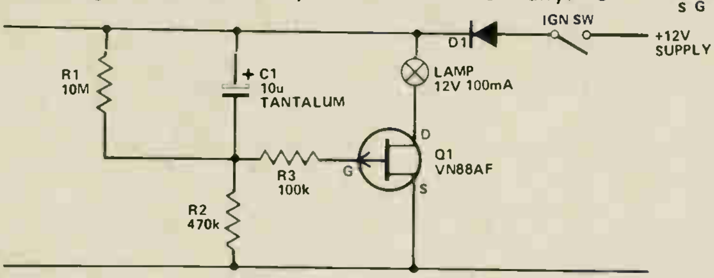
Many home-grown projects require a high voltage, low current source. The simplest and safest means of providing this is by an inverter. The circuit described here is versatile, efficient and easily capable of providing power for portable Geiger counters, dosimeter chargers, high resistance meters, etc.

The 555 timer IC is used in its multivibrator mode, the frequency being adjusted to optimise the transformer characteristics. When the output of the IC is high, current flows through the limiting resistor, the primary coil to charge C3. When the output goes low, the current is reversed. With a suitable choice of frequency and C3 a good symmetric output is obtained.



Seat Belt Indicator for Vehicles

As a reminder to put the seat belt on, a small opaque panel with the inscription "SEAT BELT" can be fitted to the dashboard with a lamp behind, which lights up for ten seconds after the ignition has been turned on. The new VMOS power FET can be used in a very simple circuit to achieve this. The current between source and drain is dependent upon the gate/source voltage. When the ignition key is turned to +12 volt supply is initially dropped across R2, since the voltage across a capacitor cannot change instantaneously (C1 is discharged by R1 when the supply is removed). As the capacitor charges up the gate potential of Q1 drops and the lamp extinguishes. The current drawn by the circuit falls to about 50 uA after a minute. The gate resistor R3 is provided to protect the zener diode which is between gate and source of Q1, the input resistance of Q1 is too high to be affected by this resistance normally. ●



Tech-Tips is an ideas forum and is not aimed at the beginner; we regret that we cannot answer queries on these items. We do not build up these circuits prior to publication.

ETI is happy to consider circuits or ideas submitted by readers; all items used will be paid for. Drawings should be as clear as possible and the text submitted should not be subject to copyright. Items for consideration should be sent to the Editor.

Electronics Today INTERNATIONAL

Summer 1980

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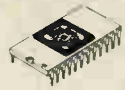

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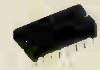

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TIP122	.74	NPN	5 AMP	100V
TIP125	.74	PNP	5 AMP	60V
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