

Electronics Today

INTERNATIONAL JULY 1981 \$1.95 MM70924

AUTO SOUND SURVEY



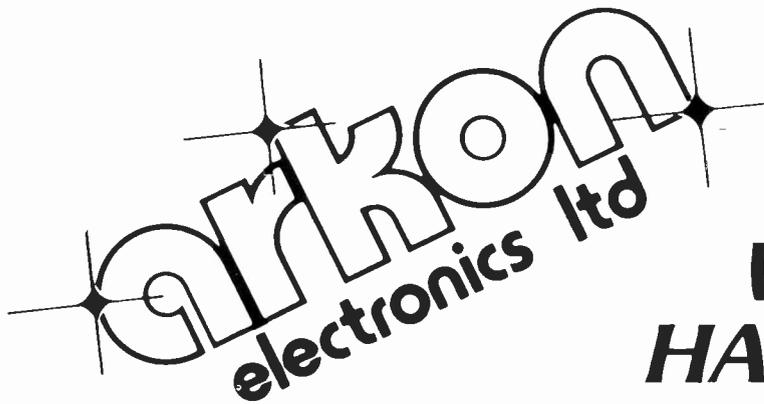
Bargraph Car Voltmeter
Electronic Stethoscope

Universal
LM3914
Life of Faraday

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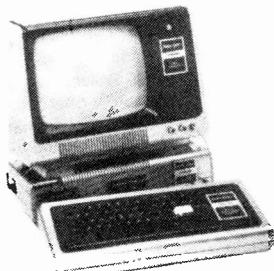


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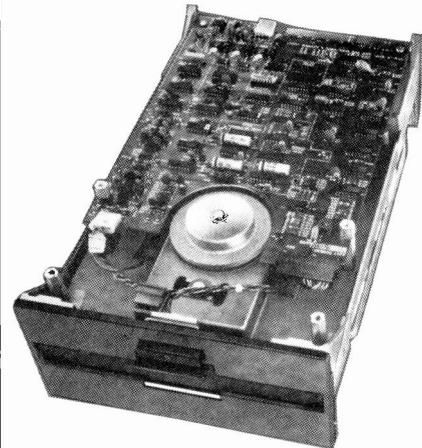
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MULTIFLEX Z80A COMPUTER



See page 67
for further details.

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assembled

THE Z80A IS DESCRIBED EXTENSIVELY IN AN INDEPENDENT PRODUCT REVIEW IN ETI MAY 1981. CONTACT EXCELTRONIX FOR COMPLETE INFORMATION. DEALER ENQUIRIES INVITED: MULTIFLEX PRODUCTS HAVE BEEN SELLING PHENOMENALLY WELL AND DEALERS ARE NOW REQUIRED ACROSS CANADA. A MINIMUM ORDER WILL BE NECESSARY BUT ALL DETAILS ARE NEGOTIABLE. SERIOUS PROSPECTIVE DEALERS SHOULD CONTACT EUGEN HUTKA AT EXCELTRONIX FOR MORE INFORMATION.

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74LS13	28	74LS95	.59	74LS163	.85	74LS249	1.25	74LS374	1.59
74LS14	25	74LS96	.69	74LS164	.75	74LS251	1.25	74LS375	1.95
74LS20	22	74LS109	.45	74LS165	1.35	74LS253	.95	74LS377	1.59
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 Editorial and Advertising Offices
 Unit 6, 25 Overlea Boulevard,
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 Telephone (416) 423-3262

Publisher and Editor
 HALVOR W. MOORSHEAD

Assistant Editor
 JOHN VAN LIERDE

Editorial Assistant
 STEVE RIMMER

Advertising Manager
 SENG HARRISON

Advertising Representative
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Contributing Editors
 WALLACE PARSONS
 DICK CARTRIGHT

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 Electronics Today International,
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Electronics Today

INTERNATIONAL

JULY 1981 Vol. 5, No. 7.

Features

LM3914 Circuits 14
 The LEDs go up, the LEDs go down . . . you could probably get them going around in a circle if you feed in cyclical voltages. This heavily useful chip is discussed by Ray Marston.

How To Solder 18
 If you can't solder, you're in big trouble. Ever tried building a micro-computer by twisting the ends of the wires together? Read this brief work by Keith Brindley and your life will again have meaning.

Michael Faraday 25
 I suppose this article comes a bit late as an obituary. On the other hand, it's probably too long, too. It deals with electronic pioneer Michael Faraday, without whom capacity would be measured in "micro-whatsits".

Current Affairs 29
 I'll bet you don't think holes and electrons aren't too exciting. Well, surprise! They're not. But this article will make you brilliant, so you won't care. At least, that's what A.S. Lipson said when he sold it to us.

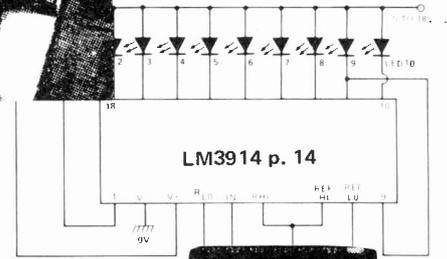
Auto Sound Survey 43
 Ah, the joys of tooling down the highway in the trusty family jeep with the Grateful Dead playing in the back seat. Don't think you can get the whole Grateful Dead in the back seat? Maybe you need Auto Stereo. Wally Parsons certainly thinks so.

Project Fault Finding 62
 If your newly constructed 2.5 megawatt per channel amplifier begins to blow out the three inch steel bars that serve as fuses, there is probably a fault in the project. Turn it off and read this article, by Keith Brindley.

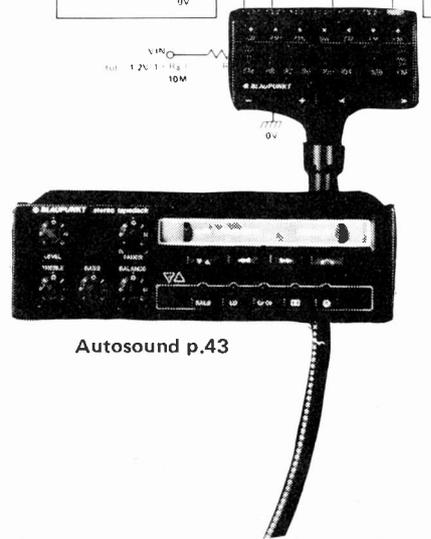
IC Master 65
 3400 pages of wild, sensuous data. . . The unspoken secrets of multiplex decoder chips. Passionate encounters with linear IC's. The dark, lustful truth about microprocessors. Steve Rimmer reviews this treasure trove of titillating spec sheets.



Michael Faraday p. 25



LM3914 p. 14



Autosound p.43

There's absolutely nothing to equal the splendor of meandering down a deserted country road in your chariot with trees as far as the eye can see, gurgling mountain streams, pure, unpolluted air, wildlife, peace, tranquillity and Deep Purple on the box at 120dB. Check out the box, on page 43.

ISSN 0703-8984

Projects



Universal Timer 10

Many applications call for a variable time delay. Sometimes a water clock isn't appropriate, and the atomic standard's out in the barn. You need this little creation.

Bargraph Car voltmeter 22

If you have mice in your motor, they will eat through your insulation by and by, and do the back stroke in your battery. All of this will do the electricals no great deal of good. Build this circuit, and put a cat in your carburator.

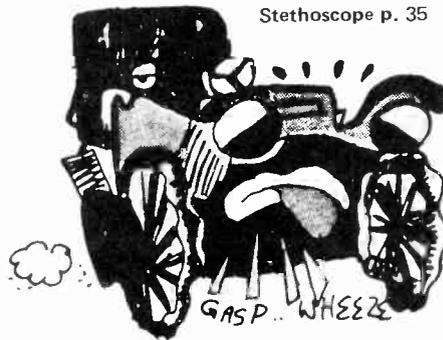
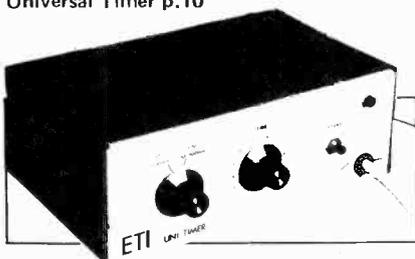
Engineer's Stethoscope ... 35

Useful for detecting which engineers are dead and which are merely talking slow.

Motherboard 49

As motherboards go it's about what you'd expect. It calls you every Wednesday and asks you to come over for meatloaf and spinach. After a while it announces it's getting a divorce, and flies off to Rio with the man from PCO. When its daughter boards turn up pregnant it sends back post cards asking "Where did we ever go wrong."

Universal Timer p.10



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ETI is available for resale by component stores. We can offer a good discount when the minimum order of 15 copies is placed. Readers having trouble in obtaining the magazine could ask their local electronics store 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 100nF, 5600pF is 5n6. Other examples are 5.6pF = 5p6 and 0.5pF = 0p5.

Resistors are treated similarly: 1.8Mohms is 1M8, 56kohms is the same, 4.7kohms is 4k7, 100ohms is 100R and 5.6ohms is 5R6.

PCB Suppliers

ETI Magazine does NOT supply PCBs or kits but we do issue manufacturing permits for companies to manufacture boards and kits to our designs. Contact the following companies when ordering boards.

Please note we do not keep track of what is available from who so please don't contact us for information on PCBs and kits. Similarly do not ask PCB suppliers for help with projects.

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.0015	.20	.047	.30	.0039	.20	.039
.0018	.20	.056	.30	.0047	.20	.12
.0022	.20	.068	.30	.0056	.20	.15
.0068	.20	.082	.30	.018	.25	.18
.0082	.20	.10	.30	.022	.25	.22
.010	.20					

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1			.25
2			.25
3			.25
4			.25
10	.25	.25	.30
22	.30	.30	.35
33	.30	.35	.35
47	.35	.35	.35
100	.35	.40	.50
220	.35	.40	.50
330	.40	.50	.65
470	.45	.55	.75
1000	.60	.70	1.00
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3300	1.05	1.35	
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	16 (20)	25 (32)	35 (40)
0.22			
0.33			
0.47			
0.68			
1.0			
1.5			
2.2			
3.3			
4.7	.35		
6.8	.35		
10	.45	.50	.55
15	.50	.55	.65
22	.55	.65	1.35
33	.65	1.20	2.25
47	1.95	2.75	
68	2.75		
100	3.50		

RADIAL LEAD

uF	WV(SV)	WV(SV)	WV(SV)
	16 (20)	25 (32)	50 (63)
2.2			.25
3.3			.25
4.7			.25
10	.25	.25	.30
22	.30	.30	.35
33	.30	.35	.35
47	.35	.35	.35
100	.35	.40	.50
220	.35	.40	.50
330	.40	.50	.60
470	.45	.50	.65
1000	.60	.75	
2200	1.00		

POWER SUPPLY

POWER SUPPLY

1400	16	.65	6800	Com 25	6.95
1600	16	.65	13000	RPE 10	4.50
2200	16	.75	12000	COM 40	6.95
2500	10	.65	14000	COM 40	7.50
1000	Can 16	1.50	15000	RPE 10	4.50
4700	Elec 40	1.75	15000	COM 25	5.50
4700	COM 100	6.95	15000	Com 50	11.95
6800	RPE 25	6.95	44000	Com 25	14.95
			80000	Com 20	14.95

7400	.45	7423	.55	7472	.55	74123	1.10
7401	.45	7425	.65	7473	.70	74125	.98
7402	.45	7426	.65	7474	.70	74141	1.15
7403	.40	7427	.55	7475	.98	74150	2.50
7405	.75	7430	.45	7476	.70	74151	.98
7406	.85	7440	.45	7485	1.40	74154	2.50
7407	.95	7441	1.35	7486	1.30	74164	1.75
7408	.75	7442	1.35	7490	1.15	74164	1.25
7409	.45	7446	1.45	7491	1.15	74177	1.45
7410	.39	7447	1.65	7492	.85	74190	1.65
7411	.55	7448	1.75	7493	.85	74191	1.60
7412	.55	7454	.65	74121	.65	74192	1.55
7413	.65	7460	.40	74122	.90	74193	2.95
7420	.45						

4000 SERIES

4000	.30	4015	1.50	4026	2.35	4064	1.05
4001	.45	4016	.50	4027	.65	4065	1.78
4002	.45	4017	1.50	4028	1.50	4067	1.09
4006	1.25	4018	.75	4029	1.25	4069	.45
4007	.20	4019	1.65	4030	.40	4094	1.50
4008	1.15	4020	1.25	4033	1.95	4099	.45
4010	.75	4021	1.95	4040	1.29	4510	1.95
4011	.65	4024	1.25	4041	2.05	4511	1.95
4013	.65	4025	.40	4043	1.30	4516	1.35
4014	.90						

MICRO PROCESSOR

LA SERIES	PRICE
74LS00	.85
74LS04	.60
74LS08	.65
74LS10	1.50
74LS11	.75
74LS20	.70
74LS30	.65
74LS32	.80
74LS33	.60
74LS37	.70
74LS50	1.10
74LS51	1.10
74LS52	.70
74LS53	.65
74LS109	.80
74LS123	1.00
74LS132	1.40
74LS151	1.60
74LS155	1.10
74LS244	1.18
74LS245	1.18
74LS247	1.49
8080	8.95
8212	3.00
8216	3.50
8224	8.95
8228	6.25
8253	8.95
4116	7.95

ZENERS

TYPE #	VOLTAGE	WATTAGE			
1M758A	10	1W	1M758A	10	1W
1M759A	12V	1W	1M759A	12V	1W
1M964B	13	.5	1M964B	13	.5
3E216D5	14	1W	3E216D5	14	1W
1M966	16	1W	1M966	16	1W
1M751A	18	1W	1M751A	18	1W
BZ61-C18	20	1W	BZ61-C18	20	1W
HZ20C	20	1W	HZ20C	20	1W
BZK61-C20	20	1W	BZK61-C20	20	1W
GE5028	20	.1W	GE5028	20	.1W
14-515-31	22	.5	14-515-31	22	.5
1M751A	30	1W	1M751A	30	1W
BZK61-C30	30	1W	BZK61-C30	30	1W
BZK79C36	36	1W	BZK79C36	36	1W
BZK61-C56	56	1W	BZK61-C56	56	1W
1M5045	56	5W	1M5045	56	5W
BZK61-C68	68	1W	BZK61-C68	68	1W
1M766A	100	1W	1M766A	100	1W
BZK79C36	36	1W	BZK79C36	36	1W
1M5593B	183	1W	1M5593B	183	1W

PART No	REPLACE	OLR PRICE			
ZN2906	- ECG - 159	1.79	ZSC1023	- ECG - 175	2.95
BF-245	- ECG - 133	1.99	ZSC1104	- ECG - 124	2.59
ZN3391	- ECG - 199	1.15	ZSC1104	- ECG - 124	2.59
BF-199	- ECG - 161	1.59	ZSD24Y	- ECG - 124	2.59
T15 92	- ECG - 128	2.40	A0162	- ECG - 133	3.99
B0136	- ECG - 189	2.99	A0139	- ECG - 106	1.89
B0135	- ECG - 184	2.99	ZSC1160	- ECG - 175	3.50
ZSC1505	- ECG - 198	2.95	ZK3614	- ECG - 121	3.95
ZSC1520	- ECG - 198	3.00	ZSC1106	- ECG - 162	9.95
ZSC1507	- ECG - 198	2.95	B0182	- ECG - 130	4.79
ZSC1446	- ECG - 198	2.95	B0205	- ECG - 165	9.95
HJZ370	- ECG - 242	3.59	B0108	- ECG - 165	9.95
ZSC940	- ECG - 283	11.95	ZSC919	- ECG - 163A	12.95
ZSC919	- ECG - 163A	12.95	BF245A	- ECG - 133	2.25
ZSC945	- ECG - 199	.89	ZSC945	- ECG - 199	.89
ZSC1685	- ECG - 199	.89	ZSC454	- ECG - 289	1.59
ZSC454	- ECG - 289	1.59	ZSC819	- ECG - 123A	1.59
ZSC819	- ECG - 123A	1.59	ZK5558	- ECG - 191	4.25
ZK5558	- ECG - 191	4.25	ZSC458	- ECG - 289	1.69
ZSC458	- ECG - 289	1.69	ZS877	- ECG - 102A	1.99
ZS877	- ECG - 102A	1.99	ZM1613	- ECG - 128	1.99
ZM1613	- ECG - 128	1.99	AC-187	- ECG - 103A	2.30

POTENTIOMETERS

A huge selection available. Slider controls from 99¢ to \$2.95; Single pots 49¢ (with switch 59¢) Dual pots 69¢ (with switch 79¢) See out catalogue for full range and other types.

MINIMUM ORDER

\$10.00. All merchandise subject to prior sale. Prices subject to change without notice.

SHIPPING

Add 5% extra to cover shipping, excess refunded. Orders over \$75 shipped pre-paid. Ontario residents add 7% P.S.T.

EduKit's

LOGIC TRAINER \$74.95
MODEL DLT01

A new development package for a BASIC DIGITAL LOGIC COURSE. Four gates and a counter. Circuit is included along with an in-depth manual. Protoboard included.

STEREO PHONO
PREAMP KIT \$11.25
MODEL EK80SP001

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

Specification: 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.

16 CHANNEL MULTI-MODE LED
CHASER KIT \$32.95
MODEL EK80L0C16

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: Up, Down, Skip, Pulse, Scramble, Single Pulse, Multi Pulse and many more. An optional 120 vac board is available. (Extra)

STROBE LITE KIT \$21.95
MODEL EK80SL001

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

CRYSTAL RADIO KIT \$8.95
MODEL EK80CR001

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

1.5 to 24v POWER
SUPPLY KIT \$24.95
MODEL EK80PS024

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.

0.28 VOLT POWER
SUPPLY KIT \$39.95
MODEL EK80PS028

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.

STEREO AUDIO
MIXER KIT \$49.95
MODEL EK80AM001

Inputs 2 phono, 1 aux. Master control. Expandable. Frequency response 20Hz-20kHz; 5v output, 0.01% distortion.

16 CHANNEL LED
CHASER KIT \$22.95
MODEL EK80LC016

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)

POWER SUPPORT 120 \$24.95
MODEL EK80PLC120

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.

5 WATT IC AUDIO
AMPLIFIER KIT \$19.95
MODEL EK80A005

A general purpose 5 watt amplifier with Thermal Overload and Short Circuit Protection. Because of its low operating voltage and high

DOMINION RADIO: The Home of Radio and Electronics Supply

RADIO

TRANSFORMERS

8801S	.....	\$8.95
Primary 110V. Secondaries 700V @ 150mA, 250V @ 50mA, 13.5V @ 1.5A (Specifically designed for the 7984 transmitting compactron tube.)		
2826500	.....	\$3.95
Primary 110V. Secondaries 28V @ 2A, 6V @ 500mA		
24-10182-1	.....	\$14.95
Primary 110V. Secondaries 56V (CT) @ 8A, 2V @ 2A, 6.3V @ 4A		
24-10182-2	.....	\$14.95
Primary 110V. Secondaries 58V (CT) @ 10A, 24V @ 2A, 6.3 @ 4A		
321 TK	.....	\$3.95
Primary 1 120V: Secondaries 10V (CT) 500mA, 14V @ 500mA		
Primary 2 120V: Secondaries 20V (CT) 500mA, 28V @ 500mA		

PHILIPS



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Woofers

AD4060WB/4	4" 30W	22.25
AD5060WB/4	5" 10W	20.55
AD70650WB	7"	31.20
AD70652WB/4	7"	28.50
AD08120WB	8"	8.62
AD80100WB/WBW	8" 40W	43.00
AD80601WB	8" 30W	25.95
AD80651WB/4	8" 50W	32.40
AD80652WB/4	8" 50W	30.00
AD80671WB/4	8" 50W	37.50
AD80672WB/4	8" 50W	36.00
AD1065WB*	30 W 10"	56.25
AD10100WB/4*	40 W 10"	75.00
AD10240WB/WBW	70 W 10"	67.50
AD10650WB	30 W 12"	54.00
AD12200WB	80 W 12"	78.00
AD12240WB/WBW	70 W 12"	69.00
AD12250WB	100W 12"	85.50
AD12600WB	40 W 12"	46.80
AD12650WB	60 W 12"	52.00
AD15240WB/WBW	80 W 15"	69.75

Tweeters — Dome

		Regular Prices
AD00400TB/4	18MM	15.40
AD00800TB/4	18MM	14.28
AD00900TB/4	18MM	18.00
AD140TB/4	Polycarbonate	15.40
AD141TB/4	Textile	15.40
AD01800TB/4/18	Exposed Textile	19.28
AD01803TB/4/18	Square Exposed	18.40
AD0182TB/4/18*	Polycarbonate	17.40
AD0183TB/4/18*	Textile	17.30
AD01830TB/4/18	Textile	18.00
AD01831TB	Textile Square	21.20
AD01832TB	Paper	18.00
AD01833TB/4/18	Paper Square	21.00
AD01833TB/15	Diamond Cut Ptt.	48.00

Tweeters — Dome — Ferro Fluid

AD01404TB/4	Available	17.30
AD01624TB/4	Early	18.00
AD01634TB/4	81	18.00

Tweeters — Cone

AD2273TB	2" Cone	5.45
AD2298TB	2" Cone	8.40

Squawkers (Mid Range) Dome

AD0211SQ8/4*	5" Textile	39.90
AD02110SQ8/4		37.75
AD02150SQ8/4		44.25
AD02180SQ8/4		46.50
AD02161SQ8/4	Deluxe Version	52.15

Squawkers — (Mid Range) Cone

AD5080SQ8/4*	5" Cone	28.00
AD5081SQ8/4	5" Cone	20.00
AD5062SQ8/4	5" Cone	28.65

Combi Plates (Squawker & Tweeter on Aluminum Plate)

AD21190ST8	Diamond Cut	Regular Price
AD21181ST8	Flat Back	85.00
		85.00

Full Range

AD5081M8	10 W 5"	20.75
AD7062M8	30 W 7"	28.25
9710MC	20 W 8"	48.00
AD12100M8	25 W 12"	80.00

Passive Radiators ("Drone Cones")

AD8000	Rubber Surround	14.28
AD8001	Rubber Surround	12.00
AD8002	Foam Surround	14.25
AD1000	Rubber Surround	34.50
AD10000W	Foam Surround	18.00
AD12000	Foam Surround	18.75
AD1201	Rubber Surround	35.90

Cross-Over

ADF1500/8/4	2 way	9.75
ADF1600/8/4	2 way	9.15
ADF2000/8	2 way	9.15
ADF2400/8	2 way	7.50
ADF3000/8/4	2 way	8.85
AD3WXSP	3 way hi-Power	37.50
ADF6/SSP	3 way hi-Power	32.00
ADF7/SSP	3 way hi-Power	41.10
ADF500/4500/8	3 way	17.40
ADF700/2600/8/4	3 way	22.50
ADF700/3000/8/4	3 way	22.50
AD1SUBW	Sub Woofer	37.50

NEWS



Pocket Typewriter

Sharp Electronics of Canada Ltd. has introduced its EL-7001 Memowriter which combines the functions of a calculator with those of a miniature typewriter that prints out messages, memos, bills or estimates.

Sharp's EL-7001 Memowriter is a pocket-sized alphanumeric calculator with a 10-digit liquid crystal display and 16-character-per-line impact printer. As many as 48 characters can be retained in the buffer memory.

The calculator provides basic functions plus constant, chain, reciprocal, power, percentage and round-off keys. It has a four-key memory plus a fixed or floating decimal.

The typewriter has 40 word-memories which hold seven letters and 10 numerals — or 15 letters — per memory. The printer automatically switches over to a second memory when the first is full.

The EL-7001 Memowriter comes packed in its own soft carrying case with an ink ribbon, paper roll and instruction booklet. It is powered by a rechargeable Ni-Cd battery and can be adapted to an AC outlet.

Suggested retail price is \$159.95, available at Sharp dealers and selected retailers across Canada.

Fast ADC

A new, low-cost flash (video-speed) analog-to-digital converter, the CA3300, available from RCA Solid State, uses CMOS technology to achieve sampling rates as high as 15 MHz (66 ns conversion time) with power consumptions below 200 milliwatts — the first CMOS flash ADC in the industry.

Operating from a single dc supply of 3 to 12 volts, the new CA3300 flash ADC develops a 6-bit latched 3-state output with an overflow bit and two "chip enables" at an accuracy to within ± 0.5 LSB (least significant bit). It is designed for accurate digitizing of high-speed video signals and transient events in applications that demand both high-speed conversions and low power consumption. The CA3300 operates over a wide dynamic input-voltage range of 2.5 volts up to the dc supply voltage with typical low CMOS power consumptions. When operated

from a 5-volt supply at a clock-generated sampling frequency of 11 MHz, the power dissipation of the CA3300 is less than 50 milliwatts. At a sampling frequency of 15 MHz, an 8-volt supply is required, and the amount of power consumed increases to about 180 mW.

The CA3300's overflow bit makes possible the connection of two or more CA3300's in series to increase the resolution of the conversion system. A series connection of two CA3300's in parallel doubles the conversion speed (i.e., increases the sampling rate from 15 MHz to 30 MHz). The feed-forward technique (CA3300's combined with a high-speed 6-bit D/A converter, a binary adder, control logic and op amp, resulting in a 12-bit sub-microsecond A/D converter.

Further information on the CA3300 flash ADC may be obtained from RCA Solid State Division, Box 3200, Somerville, NJ 08876.

Introducing **JET STOCK**

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SHIPMENT**

● **OVERNIGHT
DELIVERY
ACROSS
CANADA**



Introducing "Jet Stock", a high priority service from ACA Electronic Centres that doesn't cost you anything extra. With "Jet Stock" you get next day shipment of all orders and prepaid delivery across Canada, all at ACA's highly competitive prices.

This exciting new service is yours automatically, when you order products designated as "Jet Stock" inventory, including the following popular equipment:

- *Fluke hand-held digital multimeters*
- *Fluke bench digital multimeters*
- *Fluke current, HV, RF, and temperature probes*
- *Fluke multifunction counters*
- *Anatek laboratory power supplies*
- *Gould 15 and 25 MHz dual-trace scopes*
- *Wavetek waveform and function generators*
- *Shimpo digital tachometers*

Accessories and other products are also included. Additional items will be added as market demand and inventory quantities permit.

ON-LINE COMPUTER

This new service has been made possible through an on-line computer system which links all seven ACA offices and which automatically processes all documentation, right down to shipping instructions and inventory replacement orders.

NEXT-DAY SHIPMENT

ACA's extensive inventory program and accelerated shipping procedures ensure that your order is on its way to you not later than the next day after receipt of order.

DOOR-TO-DOOR DELIVERY

Highly efficient door-to-door delivery service now permits overnight delivery to most centres across Canada. Next day shipment followed by overnight door-to-door delivery gets your order to you faster than ever before.

COMPETITIVE PRICES

Automated order processing has permitted us to dramatically improve our service to you while maintaining our highly competitive prices. Now, we even ship prepaid at no extra cost to you.

HOW TO ORDER JET STOCK

Just place "Jet Stock" items on a separate order from other ACA products. That's all. We'll look after the rest.

To find out which products are "Jet Stock" call your local ACA office. And remember, the sooner we receive your order the faster you'll receive delivery.



Allan Crawford Associates Ltd.

Toronto: 6503 Northam Drive, Mississauga, Ontario L4V 1J2 Telephone: (416) 678-1500

Montreal: 7018 Côte de Liesse, St. Laurent, P.Q. H4T 1E7 Telephone: (514) 731-8564

Ottawa: 881 Lady Ellen Place, Ottawa, Ontario K1Z 5L3 Telephone: (613) 722-7982

Halifax: 192 Joseph Zatzman Drive, Dartmouth, Nova Scotia B3B 1N4

In area codes 902 and 506 phone toll free: 1-800-267-6131

In area code 709 phone toll free: Zenith 01720

Vancouver: 3795 William Street, Burnaby, B.C. V5C 3H3 Telephone: (604) 294-1326

Calgary: 1935-30th Ave. N.E., Calgary, Alberta T2E 6Z5 Telephone: (403) 230-1341

Edmonton: 15043A - 118th Avenue, Edmonton, Alberta T5V 1H9 Telephone: (403) 451-4893

In area code 403 phone toll free: 1-800-332-1092



EPROM Programmer

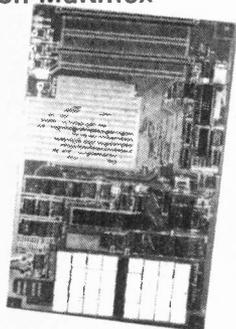
Designed and manufactured in Canada, the Z.800 is a small, portable, low-cost unit capable of programming single 5 volt NMOS EPROMS without the use of personality modules or additional hardware. It is currently programmed for use with the following EPROM types: 2758, 2508, 2716, 2816, 48016, 2732, 2732A, 2532, 2764, 2564 and 68764.

A particular EPROM type is selected by making a simple key-stroke entry. The Z.800 then accommodates the device pin-out and algorithm, all under software control. Software up-dates will be available to accommodate future EPROMS (if necessary, up to 512k in density).

The two 28 pin sockets allow two different EPROM types to be used at the same time for direct duplication and verification without any intermediate steps. The master socket is 'cold' (no programming voltages applied) to ensure protection of the MASTER against accidental programming or damage.

Quantec Systems Ltd. P.O. Box 832 Station "A" Scarborough Ontario M1K 5C8 Tel (416) 291-8761

More on Multiflex



The response to our cover feature in May on the Multiflex Z80 computer from Exceltronix is said to be amazing. We believe it, too, 'cause when you go down to the Exceltronix store you see the people behind the counter looking very pleased with themselves, and walking around a foot off the floor.

As a result of the huge number of cards, letters, telephone calls, telegrams, emissaries from Arabic sheikdoms and one peculiar

Tiny TV Transmitter

A complete, single-chip miniature precision transmitter capable of generating a high quality television signal for transmission on a 75-ohm cable has been introduced by Motorola. This 14-pin plastic integrated circuit, the MC1374, is aimed at applications in video tape and disc players, home TV cameras, and subscription TV decoders, where a professional quality RF signal is required. While primarily characterized for the FCC guarded channel 3 and channel 4 operation, its balanced design and high frequency processing make special applications feasible. For example, the RF oscillator and modulator can be operated at over 100 MHz, a requirement for the Japanese market.

The package contains the RF oscillator, balanced RF modulator, sound carrier oscillator, and FM modulator, thoughtfully arranged to permit "clean" printed circuit board layout and good isolation of sound and video circuits. The RF modulator closely resembles the highly regarded earlier MC1496 modulator, complete with dual inputs and adjustable gain. The RF oscillator is internally connected to the modulator, and has only 2 external pins, which can be used for LC tuning or crystal control. The modulator provides the means to generate a standard signal from video of either polarity, and levels of from 0.5 to 2.5 V p-p. The dual inputs also permit insertion of video and modulated 4.5 MHz sound carrier separately, thereby reducing the possibility of cross talk and unwanted mixing products.

The sound oscillator and FM modulator are actually one inseparable circuit within the IC. Two pins are brought out for the IC tuning components which establish the nominal carrier frequency. A third pin is used for audio input and, if desired, DC frequency control (AFC) of the sound oscillator. Also the sound oscillator power supply pin is brought out separately, permitting the sound section to be disabled. Price in 100 up quantities, is \$2.88.

fellow who showed up late the other night in a big silver thing marked 'UFO', all of which followed this report, Exceltronix have put a special ad in this issue to describe the functions, facilities and other highly useful whizzbangs of the computer in profound detail.

Check out page 67 and become illuminated.

Solid State Emitter Guide



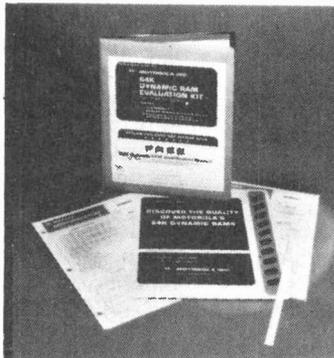
A twenty-four page product guide providing tabulated data and outline configurations for RCA's line of Solid State Emitters has been released by RCA Electro-Optics and Devices.

The line includes the following types of IR emitters and injection lasers: infrared emitting diodes, pulse and CW operated injection lasers, stacked diode lasers, and laser systems.

The product guide, SSE-100 features an applications section depicting schematics of typical drive circuits for IR emitting diodes and injection lasers. Selection guides are also included.

Copies of the SSE-100 product guide may be obtained by writing to RCA, Box 3200, Somerville, NJ 08876.

64K Dynamic RAM Evaluation Kit



Motorola IC Division has introduced a 64K Dynamic RAM Evaluation Kit, priced at \$150.00 each. Motorola offers this kit to aid in the designer's evaluation of the MCM6665 64K Dynamic RAM. This Dynamic RAM is fabricated using HMOS high performance N-channel silicon gate technology. The Evaluation Kit contains: Ten (10) MCM6665L20 (200 nanoseconds), 64K Dynamic RAMs (usually \$49.00 each / 1-24), a Qualification Manual request coupon, two data sheets (MCM6664, MCM6665), A Motorola Memory Selector Guide, and a notebook for use in your evaluation. Kits are available now, limited to one per customer location. This kit provides an effective way of evaluating Motorola's Dynamic RAMs. For further information contact your local Motorola sales office or Motorola distributor.

Independent Videotext System

A Canadian-owned and managed videotext company, TeleMart International Ltd. of Toronto, is launching its independent videotext systems for immediate commercial use in North America and Europe.

The TeleMart "Series 50" systems are designed and manufactured for immediate use in business, government and education, rather than in the home. Because its systems are independent, TeleMart International has overcome the inherent disadvantages of dependent systems for private applications. Dependent systems require outside communications links, off-site data bases and computers which provide severe constraints on system effectiveness.

An important added advantage of independent systems is their inherent privacy and confidentiality. Users can be sure no one else has access to the type, scope and sequence of information sought. Security of the data is also guaranteed because access terminals cannot be used to modify data pages.

In terms of graphics, the Series 50 systems allow eight programmable graphic fonts to be used, on any page, in combination with eight basic colors and 14 shades. Of the eight fonts, four can be displayed in four different sizes and four are high resolution. Because the fonts are user-programmable, the range of graphics and languages is unlimited.

The TeleMart search technique allows any page to be coded using up to one hundred million descriptors. Users can locate and call up any page in as few as three search steps. In combination with computer-generated indices, TeleMart's approach dramatically reduces the number of costly index pages otherwise required.

Manufactured in Canada, the new independent videotext systems can be used immediately without concern for the different videotext standards still being developed throughout the world. In addition, because they are independent, each system can communicate with its own data base. By using a popular international computer communications standard, the Series 50 terminals are also able to talk to other computers.

For more information, contact TeleMart International Ltd, at 361 Steelcase Rd. West Unit 1, Markham, Ontario.

UNIVERSAL TIMER



Our two-range (1-10 and 10-100 min) timer has excellent stability and produces a 30 second pulsed alarm sound at the end of each timing period. The unit is line powered, can switch 15 A loads and can give either make or break timing operation.



MOST analogue (pot controlled) long-period timers published in electronics magazines use a 555 one-shot IC and a large electrolytic capacitor as their main timing elements. Unfortunately, conventional electrolytic capacitors have very wide tolerances (typically -50% to +100%) and suffer from relatively large and unpredictable leakage currents. Consequently, these simple circuits cannot be relied upon to give accurate or repeatable timing periods or to give periods significantly exceeding 15 minutes or so.

Our ETI Universal Timer gets away from the conventional design approach, with its inherent disadvantages, by using an astable clock generator and a divide-by-8192 CMOS counter as its main timing elements, the astable period being controlled by a pot and a highly stable polyester capacitor. Consequently, our timer has excellent accuracy and stability and can fully span the 1 min to 100 mins timing range in two switch-selected decade ranges.

Our timer has a few other unusual features. It is line powered and has a relay-switched power output socket that can be used to feed juice to external loads (heaters, lamps, etc.); the relay can switch currents of up to 15A and a mode switch enables the timer to give either make or break timing operations of the external loads.

Timing operations are initiated by a push-button start switch and a pulsed-tone alarm sounds for 30 seconds to give an audible warning on the completion of each timing cycle. The unit has a variety of practical uses in the home, workshop, darkroom, etc.

Construction

Most of the circuitry (with the exception of T1, the relay, the switches and pot) is mounted on a single PCB, the construction of which should present few

problems. Note that IC1-3 (CMOS types) should be mounted in suitable sockets and voltage regulator IC4 needs to be fitted with a small heat-sink.

When construction is complete, fit the PCB in a suitable case, together with the power transformer and the heavy-duty relay (which MUST be fitted in the specified socket) and proceed with the interwiring. Take special care over the interwiring of the relay contacts and SW2 and the 120V connections. Finally, drill a small hole (roughly 4 mm) in the top of the case, bond the acoustic transducer below it and connect it to the rest of the circuitry.

Testing

When the unit is complete, give it a functional test as follows. First, plug the unit in and check that its neon indicator illuminates when SW2 is set to TIMED BREAK position and turns off when SW2 is set to TIMED MAKE. Now set RV1 to its minimum position, set SW1 to the '1-10 min' range and firmly operate PB1. Check that the neon immediately changes state, indicating that the relay has turned on and the timing period has begun; also check that the relay turns off again at the end of the timing period (roughly one minute) and that the acoustic alarm operates and generates a pulsed-tone signal for roughly 30 seconds when the timing period is complete.

Calibration

Once the unit is functioning correctly, you can proceed with the scale calibration. The obvious (and very time consuming) way to do this is to check the timing periods obtained by varying RV1 against a stop watch, by trial and error, until suitable RV1 calibration points are found.

PARTS LIST

Resistors all ¼ W 5%

R1	2k2
R2,10	39k
R3,9	1M0
R4	6k8
R5	4k7
R6	470R
R7	27k
R8	2M2
R11	47k

Potentiometer

RV1	470k Linear
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Capacitors

C1,3,9	100n polycarbonate
C2	1u0 polycarbonate
C4	47u 25 V axial electrolytic
C5	10u 63 V electrolytic PCB type
C6	220n polycarbonate
C7	10n polycarbonate
C8	1000u 25 V axial electrolytic

Semiconductors

IC1	1CM7555
IC2	CD4020B
IC3	CD4011B
IC4	78M12 or 7812
Q1	2N5087
BR1	50 V, 1 A bridge rectifier
D1	1N4148
D2,3	1N4001

Miscellaneous

SW1	1 pole rotary switch
SW2	DPDT toggle 15 A 240 V
PB1	momentary push button
Tx1	transducer
RLA	12 V coil resistance > 100R, 3 pole changeover, contacts rated at 120 V, 20 A and 11 pin relay base 25 A rated
T1	12 V, 6 VA

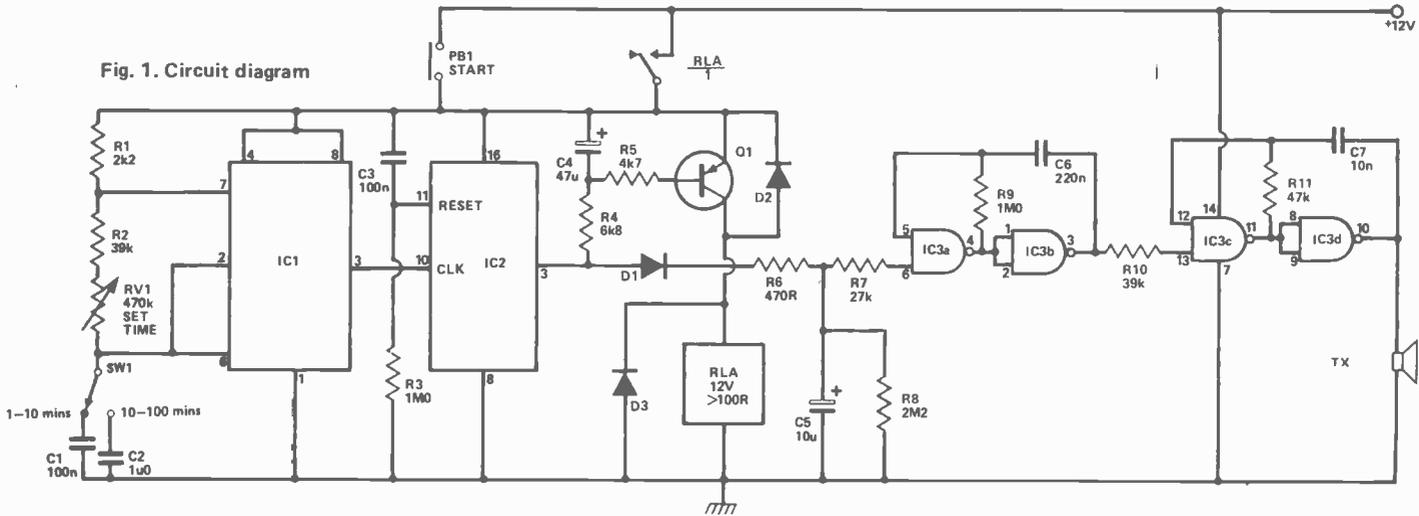
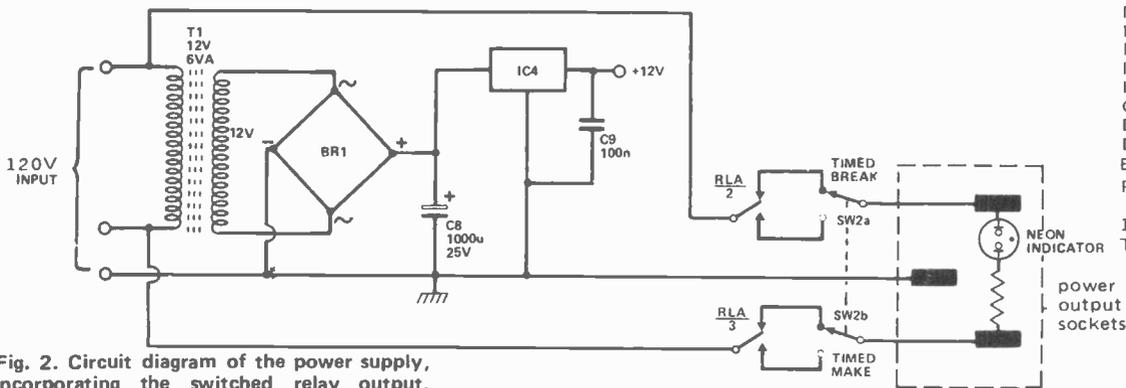


Fig. 1. Circuit diagram



Note:
 IC1 is ICM7555
 IC2 is CD4020B
 IC3 is CD4011B
 IC4 is 78M12
 Q1 is 2N5087
 D1 is 1N4148
 D2, D3 are 1N4001
 BR1 is 50B, 1A BRIDGE
 RLA is 12V relay, coil resistance 100R min.: 3 set of heavy — duty 120V, 20A changeover contacts
 Tx acoustic transducer

Fig. 2. Circuit diagram of the power supply, incorporating the switched relay output.

Alternatively

If you have access to a reasonably accurate scope, a far easier way to calibrate the timing scale is to directly measure the period of the IC1 clock waveform, noting that a period of 7.32 mS corresponds to a timing period of precisely one minute. Thus, 1 min = 7.32 mS, 5 mins = 36.6 mS, 10 mins = 73.2 mS, etc.

The upper timing range of SW1 is approximately a decade up on the lower range, so a single calibration scale can

serve for both ranges. The tracking accuracy of the two ranges depends on the relative accuracies of C1 and C2 and will typically be within 10% if good polyester components are used. If you want precise tracking you can achieve it by replacing C2 with a 820nF polyester capacitor and then padding its value up by trial and error, until precise coincidence of the '5 min' and '50 min' points is obtained on the two range scales.

PROBLEMS? NEED PCBs? Before you write to us, please refer to 'Component Notations' and 'PCB Suppliers' in the Table Of Contents. If you still have problems, please address your letters to 'ETI Query', care of this magazine. A stamped, self addressed envelope will ensure fastest reply. Sorry, we cannot answer queries by telephone.

Construction is fairly straightforward. IC4 needs a small heatsink and CMOS ICs 1-3 should be mounted in sockets.

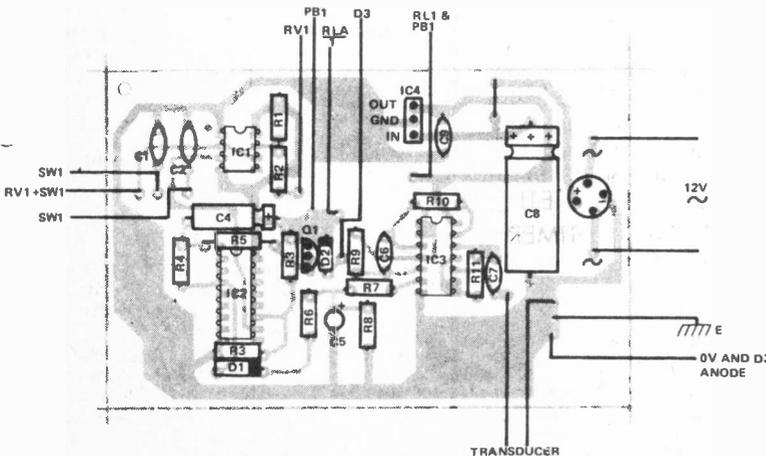
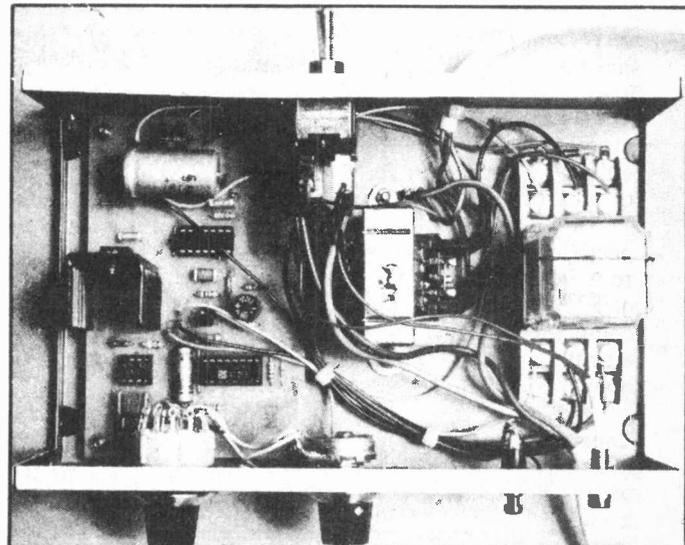


Fig. 3. Component overlay



The circuit comprises four main blocks, these being an astable clock generator (IC1), a multi-stage binary divider (IC2), a relay driver (Q1) and a gated alarm-call generator (IC3), all powered from a 12 V regulated line provided by IC4.

The clock generator is designed around IC1, a CMOS version of the 555 timer. The chip is wired in the astable mode and generates clock signals with periods variable over the 7.3 mS to 732 mS range via RV1 and SW1. The output of IC1 is used to clock the multi-stage CMOS binary counter designed around IC2, which is effectively wired in the 'divide-by-8192' mode; the output (pin 3) of this counter is normally low but goes high on the arrival of the 8192nd clock pulse.

The output of IC2 is used to drive relay RLA on via Q1 and to gate on the alarm-call generator (IC3) via the D1-R6-C5-R8-R7 network. This generator comprises a fast astable (IC3c-IC3d) and a slow

astable (IC3a-IC3b). The slow astable is gated on by a momentary high output from IC2 and then gates the fast astable on and off at a rate of about 2 Hz.

The alarm-call generator part of the circuit is permanently connected to the 12 V supply lines, but the IC1-IC2-Q1 parts of the circuit are only connected to the supply rails when PB1 or relay contacts RLA/1 are closed. The complete circuit functions as follows.

Timing operations are initiated by momentarily closing PB1, thereby connecting the supply to the IC1-IC2-Q1 circuitry. As PB1 is closed, a reset pulse is fed to pin 11 of IC2 via C3 and causes the counter's registers to set to zero, driving the output of IC2 low. As IC2's output goes low it drives Q1 and the relay on via R4-R5, thereby causing contacts RLA/1 to close and maintain the supply to the circuitry once PB1 is released.

As soon as PB1 is closed, IC1 starts to

oscillate and generate clock pulses, which are then counted by IC2. On the arrival of the 8192nd clock pulse the output of IC2 switches high, turning Q1 and the relay off and causing contacts RLA/1 to open and break the supply connections to IC1-IC2-Q1. The timing sequence is then complete.

C4 imposes a slight turn-off delay on Q1, so that the output of IC2 remains high for 100 mS or so before the relay turns off. This brief high period is sufficient for the IC2 output to fully charge C5 via D1 and R6, thereby activating the IC3 alarm-call generator, which produces an audible pulsed-tone signal in the PB-2720 transducer. Once the relay has turned off, the charge on C5 slowly leaks away via R8 until, after about 30 seconds insufficient charge remains to gate IC3a on, at which point the alarm-call generator turns off. The entire operating sequence is then complete.

Designer Circuits

SIGNAL INJECTOR - TRACER

There are two extremely useful pieces of test gear for both the serviceman and the amateur constructor. These are a signal source and a signal tracer.

Faced with a transistor radio that doesn't work, what do you do? It is important that a logical approach is taken and although this may sound obvious, it is very, very easy to become diverted.

First check that the battery is not flat (for this accounts for about 50% of so called faults) and then check that a good contact is being made on the cut-out switch of the earpiece socket if one is fitted. Always check these first but assuming there is still no joy what do you do?

The volume control is easily located, contacts can generally be made to it quickly and it is an excellent place to start.

If you inject a signal of the slider of the volume control and it is heard at a decent level from the loudspeaker you can be fairly sure that nothing is wrong with the amplifier. If nothing is heard there is obviously something wrong and the field is immediately narrowed.

Assuming that the audio stage is working you can then inject and IF signal at the collector of the mixer stage — the same rules apply as before.

Alternatively you can take the 'signal detect' approach. If instead of injecting a signal at the volume control you can listen at the same point to establish that the radio is working satisfactorily up to a certain point.

The above is a super concise lesson in fault finding but it does illustrate the tremendous use that a signal injector and a signal tracer can be put to.

The project described here is for a combined device — it can inject signals at RF IF and audio and can detect signals at the same frequencies assuming that they are high enough in level. The simplicity of circuit may lead you to doubt this claim but it does do all this.

The function switch, SW1, has

- No. 1 Off position
- No. 2 Trace Position
- No. 3 Inject Position

Position 1 merely disconnects the supply and the device is of course inoperative. As shown the function switch is in position 2 and in the trace mode.

One of the contacts is the common line and should be wired using a crocodile clip to the chassis of the equipment being investigated. The other connection is the probe.

This goes via DC blocking capacitor C1 whose working vol-

tage should be high — if a 500 V working component is used the circuit can be used on valved equipment working at high voltages.

The signal is fed to Q1 which is arranged as a common emitter amplifier but which is biased nearly to cut-off which creates deliberate distortion at the same time as amplifying the signal. Distortion in such a manner leads to the detection of RF signals and so whatever the frequency fed in, assuming it is modulated, and audio output will be heard. The collector load of Q1 is R2 and the output of this stage is fed to a further one of similar design, but the collector load here is represented by a high impedance magnetic earpiece in which the signals are heard.

On inject, SW1 is in position 3 and the output of Q2 is coupled to R4, acting as the collector load and also to C3 which feeds back to the base of Q1. The circuit, which was previously an amplifier, now becomes a multivibrator producing a square wave signal at approximately 1kHz and this is fed, again via C1, to the probe.

A square wave can be described as a fundamental frequency plus all its harmonics and so in addition to 1kHz there is an output at 2kHz, 3kHz etc., going right up into the

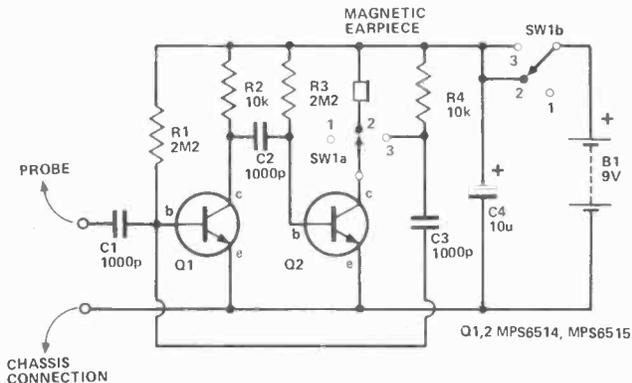
RF range. In fact, these are still a useable output at 30MHz.

Holding the probe near the aerial will produce an output from a working radio as the injector is working as a very low power transmitter and an output at 1kHz will be heard from the loudspeaker.

High gain transistors are needed in order to hear really low signal sources and high frequency types are needed to handle the upper harmonics.

Note that only high impedance magnetic earpieces are suitable, though 2000 ohms headphones can be used instead.

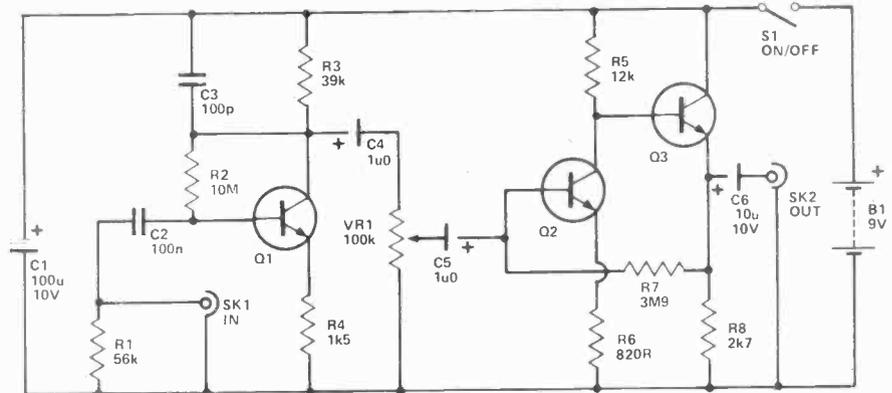
Once completed and used the signal injector/tracer will be found to be almost indispensable and for this reason it is worthwhile building the circuit carefully and neatly into a small chassis.



Designer Circuits

TWO MICROPHONE PREAMPLIFIERS

Q1, Q2 2N3904
Q3 TIS97, MP5A18



Microphones provide only a minute output signal and cannot be used successfully with many items of equipment unless their output is augmented by a suitable preamplifier. For example, few stereo Hi-Fi amplifiers have an input that is an acceptable match for a microphone (a magnetic pickup input is unsuitable as it has RIAA equalisation with consequent bass boost and treble cut). Many simple makers have only high level inputs and require separate preamplifiers for use with low level sources.

The first preamplifier circuit shown here is for use with low impedance (200 or 600 ohms) dynamic microphones. Most electret type microphones have an integral source follower JFET buffer stage which gives a low output impedance, and these should also work well with this circuit. Low impedance microphones have an extremely small output voltage

which in normal use is unlikely to ever exceed 1 mV. RMS. This means that the preamplifier must have a high level of voltage gain and a very low noise input stage as well if a high signal to noise ratio is to be achieved. This circuit requires only about 200 uV. RMS at the input for an output level of 1 V. RMS, and the unweighted signal to noise ratio (input open circuit) is a little under -66 dB.

A common base input stage is used, and it is based on Q1 which is an ultra low noise — high gain device. Although the common base configuration is not often encountered in audio circuits it is ideal for this application as it gives the required low input impedance and high voltage gain. In order to obtain a really low noise level Q1 is operated at a collector current of only about 180 uA. C4 is an RF filter capacitor, and this reduces the risk of radio signals picked up

by the input wiring breaking through to the output. With high gain circuits such as this RF breakthrough is not an uncommon problem, and ideally the unit should be built into a metal case so that the circuit is screened from RF signal sources.

The output from Q1 collector is fed by way of gain control VR1 and coupling capacitors C5 and C6 to a two stage amplifier circuit. Q2 is a common emitter amplifier and it provides the additional voltage gain that is required. Q3 is used as an emitter follower output stage and gives the circuit a low output impedance. Power is obtained from a 9 volt battery supply and the current consumption is only about 3 mA.

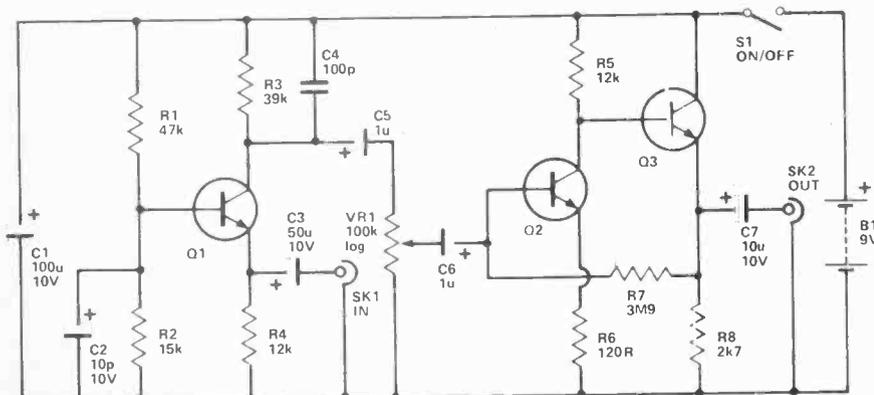
Many dynamic and electret microphones have an integral step up transformer which gives increased output voltage, but the available output current is of

course decreased and so a preamplifier having a higher input impedance (usually 50k) is required. Although on the face of it there may seem to be no point in incurring the additional expense of the transformer plus the small loss of performance it inevitably gives, indirectly it gives improved performance. This is simply because a preamplifier designed to match the higher voltage, higher impedance signal tends to have superior performance to an equivalent circuit designed to match the direct output of the microphone.

The high impedance microphone preamplifier shown here requires an input level of approximately 5 mV. RMS for an output of 1 V RMS, and the unweighted signal to noise ratio (input short circuited) is well over -70dB. With reference to this output level. Apart from the input stage the circuit is virtually identical to the previous design, the only difference being that the emitter resistor for Q2 has been increased in value. This has been done because the circuit only needs to have a moderate amount of voltage gain, and the increased negative feedback produced by raising the value of the resistor gives the necessary reduction in voltage gain.

The input stage is again run at a fairly low collector current (about 250 uA.) in order to give a low noise level. Only a moderate voltage gain and medium input impedance are required from this stage, and so Q1 is employed in the common emitter mode with non-bypassed emitter resistor R4 being used to introduce negative feedback to give increased input impedance and reduced voltage gain. The input impedance to Q1 is actually somewhat higher than is required, and so R1 is used to shunt the input and reduce the input impedance to approximately the required figure of 50k.

Q1, Q2 2N3904
Q3 TIS97, MP5A18



LM3914 CIRCUITS

This month Ray Marston takes an in-depth look at the LM3914 IC and shows a variety of ways of using it as an indicating instrument in the car and the workshop.

IF YOU LOOK at this month's 'Car Voltmeter' project you'll notice that it is based on the LM3914 Dot/Bar Display Driver IC from National Semiconductors. We've used this IC in several projects in ETI over the last few months and are greatly impressed with the device. We regard it as a very important new tool in the field of amateur and professional electronics.

The LM3914 is a highly versatile IC that is designed to sense an analogue input voltage and drive a line of 10 LEDs to give a visual analogue display of that voltage. The unit can give either a 'Dot' or 'Bar' display of the voltage. Figure 1 illustrates the appearance of the two alternative display modes when used to indicate 5 volts on a 10 volt scale. The unit acts as an inexpensive and superior alternative to the conventional analogue-indicating moving-coil meter. It does not suffer from 'sticking' problems, is unaffected by vibration and can be used in any attitude.



Fig. 1a. 'Dot' indication of 5 volts on a 10 volt LED scale.

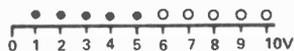


Fig. 1b. 'Bar' indication of 5 volts on a 10 volt LED scale.

The LM3914 can readily be used as the basis of a wide variety of 'indicator' and instrumentation projects in the home, the car, the workshop and in miscellaneous audio and musical projects. One of the great attractions of the device is that it is very easy to understand and use. You don't need to be a BA or MSc to be able to fully comprehend its operating principle and learn to adapt it to suit your own particular circuit requirement. We explain the essential details of the device and show several practical ways of using it in the next few pages.

The LM3914: Basic Principles

Figure 2 shows the equivalent internal circuit of the LM3914 IC, together with the connections for making it act as a 10-LED voltmeter with a full-scale sensitivity of 1.2 volts.

The first point to note about the IC is that it contains a 10-resistor potential divider, wired between pins 4 and 6. The IC also contains ten voltage comparator circuits, each with its non-inverting (+) terminal taken to its own particular tap on the potential divider, but with all inverting (-) terminals of the comparators joined together and taken to the output of an input buffer amplifier. This buffer amplifier gives an output that is, for all practical purposes, identical to the voltage applied to input terminal 5 of the IC. The output of each one of the ten

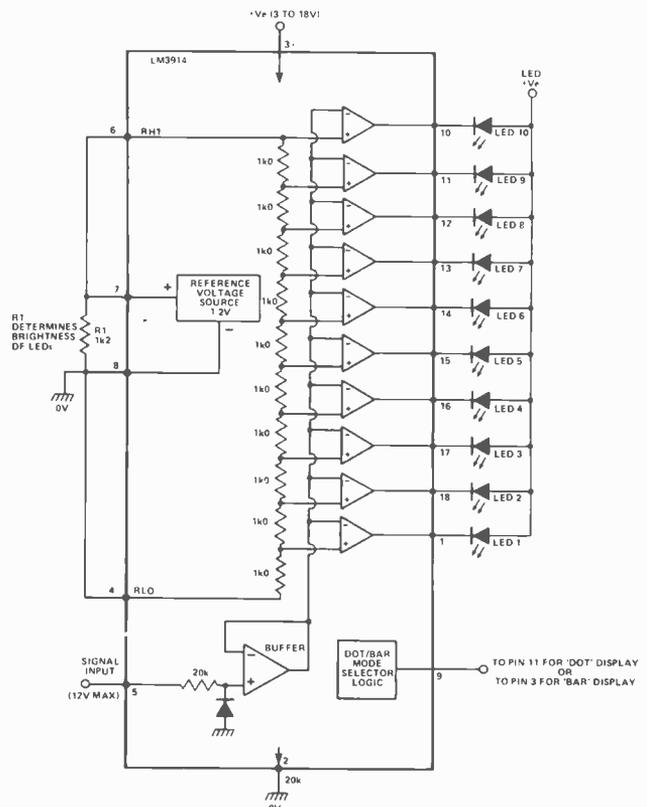


Fig. 2. Equivalent internal circuit of the LM3914 with connections for making a 0-12 volt dot or bar meter.

voltage comparators is individually available on one of the pins of the IC (pin 1 and pins 10 to 18) and is capable of 'sinking' a current of up to 30 mA.

The next point to notice is that the IC contains a built-in reference voltage source that provides a highly stable potential of 1.2 volts between pins 7 and 8. This source is of the 'floating' type, so that 1.2 volts is developed between pins 7 and 8 irrespective of whether pin 8 is tied to ground or is held at some voltage above ground. In the diagram of Fig 2 we've shown pins 7 and 8 externally connected to potential divider pins 6 and 4 respectively, so in this particular case 1.2 volts is developed across the 10-resistor potential divider network of the IC.

The final point to notice about the IC is that it contains an internal logic network that can be externally programmed to give either a 'dot' or a 'bar' display or action from the outputs of the ten voltage comparators. In the 'dot' mode, only one of the ten outputs is enabled at any one time. In the 'bar' mode all outputs below and including the highest 'energised' output are enabled at any one time.

At this point, let's put together the basic information that we have already learned about the LM3914 and the circuit of Fig 2, and see how the entire circuit functions. Let's assume that the logic is set for 'bar' mode operation.

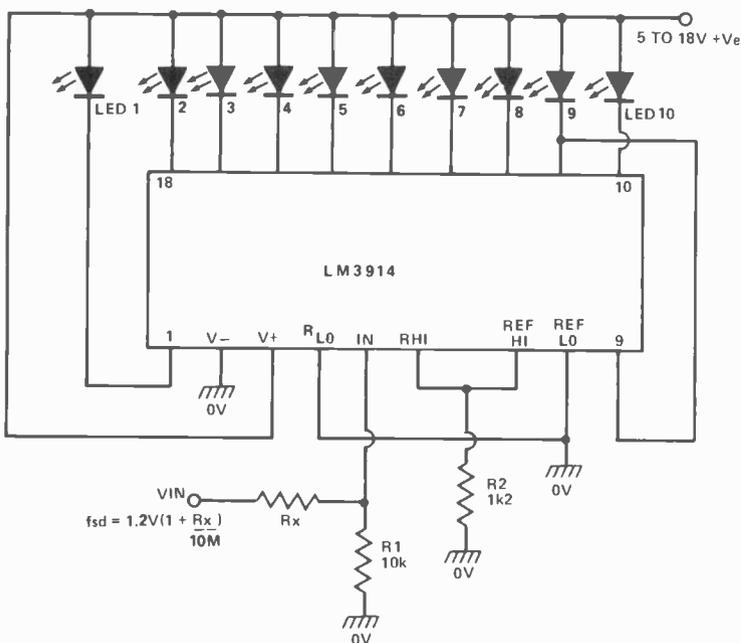


Fig. 3. 1.2 V to 1000 V FSD 'Dot' mode voltmeter.

We already know that a reference of 1.2 volts has been set up across the 10-resistor divider, with the low (pin 4) end of the divider tied to ground (zero) volts. Consequently, 0.12 V is applied to the '+' input of the lowest voltage comparator, 0.24 V to the next, 0.36 V to the next and so on. If we now apply a slowly rising voltage to input pin 5 of the IC, the following sequence of events takes place:

When the input voltage is zero, the outputs of all ten voltage comparators are high and none of the external LEDs are turned on. As the input voltage is slowly increased it eventually reaches and then rises above the 'reference' 0.12 volts value of the first comparator, which then turns on (it's output conducts) and energises LED 1. As the input is further increased it eventually reaches the 0.24 V of the second comparator, which then also turns on and energises LED 2. At this stage both LED 1 and LED 2 are on. As the input voltage is further increased progressively more and more comparators and LEDs are turned on, until eventually, when the input rises to and then exceeds 1.2 volts, the last comparator and LED 10 turn on, at which stage all ten LEDs are illuminated.

A similar kind of action is obtained when the LM3914 logic is set for 'dot' mode operation, except that only one LED turns on at any given time. At zero volts, none of the LEDs are on. At voltages above 1.2 (or whatever reference value is applied to the last comparator) only LED 10 is turned on.

At this stage, then, you can see that the LM3914 is a reasonably easy device to understand. Let's move on, then, and look at some of the finer details of its operation.

The LM3914: A Closer Look

There is one component in Fig 2 that we have not yet mentioned and that is R1. This resistor is wired between the pin 7 and pin 8 output terminals of the reference voltage source and determines or 'programmes' the ON currents of the LEDs. The on current of each LED in fact approximates ten times the output current of the

reference voltage source. The reference can supply up to 3 mA of current, so the LEDs can be programmed to pass currents up to 30 mA.

Remembering that the reference develops 1.2 V, you can see that if a total resistance of 1k Ω is placed across the pin 7 — pin 8 terminals the reference will pass 1 mA and each LED will pass 10 mA in the ON mode. In Fig 2 the total resistance across the reference terminals is equal to the 1k Ω of R1 shunted by the 10k Ω of the IC's internal potential divider, so the reference actually passes about 1.1 mA and the LEDs conduct 11 mA. If R1 were removed from the circuit the LEDs would still pass 1.2 mA due to the resistance loading of the internal potential divider on pins 7 and 8.

You'll notice from the above description that the IC can pass total currents up to 300 mA when it is used in the 'bar' mode with all ten LEDs on. The IC has a maximum power rating of only 660 mW, so there is a danger of exceeding this rating when the IC is used in the 'bar' mode. We'll return to this point later.

The LM3914 IC can be powered from any d.c. supply in the range 3 to 25 volts. The LEDs can use the same supply as the IC or can be independently powered from supplies with voltages up to a maximum of 25 V. The voltage across the internal potential divider can have any value up to 25 volts maximum.

The internal reference amplifier produces a basic nominal output of 1.28 volts (limits are 1.2 V to 1.32 V), but can be externally 'programmed' to produce effective reference values up to 12 V (we'll show how later).

The input buffer of the IC has integral overload protection and can withstand inputs of up to plus or minus 35 V without damage.

The IC can be made to give either a 'dot' display by wiring pin 9 to pin 11, or a 'bar' display by wiring pin 9 to positive-supply pin 3.

Practical Circuits: Simple 'DOT' Mode Voltmeters

The basic circuit of Fig 2 acts as a voltmeter that reads full-scale at an input of 1.2 volts. The range of the circuit can be changed in a variety of ways. The sensitivity can be increased, for example, by either interposing a d.c. amplifier between the input signal and pin 5 of the IC, or by reducing the reference voltage that is applied to the pin 4 — pin 6 terminals of the IC: in this latter case the IC will operate quite well with a reference voltage down to a couple of hundred mV.

The easiest and best way to reduce the sensitivity of the meter is to use the connections shown in Fig 3. Here, the basic circuit is that of a 1.2 V meter, but the input signal is applied to the IC via a potential divider formed by Rx and R1. Thus, the circuit can be made to read 12 volts full scale by giving Rx a value of 90k Ω , so that Rx-R1 act as a 10:1 divider. This circuit can be used to read full scale voltages from 1.2 V up to about 1000V.

An alternative connection is shown in Fig 4. In this case the input voltage is applied directly to pin 5 of the IC, but the reference voltage on the internal divider is made variable from 1.2 V to 10 V via RV1. You'll remember that the 'reference voltage' develops 1.2V between pins 7 and 8, but this voltage is fully floating. By wiring RV1 between pin 8 and ground we can ensure that the output current of the reference flows to ground via RV1, thus providing a voltage that raises the pin 8 (and also pin 7) value considerably above zero volts. This increased voltage is applied to the top (pin 6) end of the internal potential divider, which has its low end (pin 4)

grounded, and determines the full scale sensitivity of the circuit. This circuit has a useful voltage range of only 1.2 V to 10V. The IC supply voltage must be greater than the required full scale voltage.

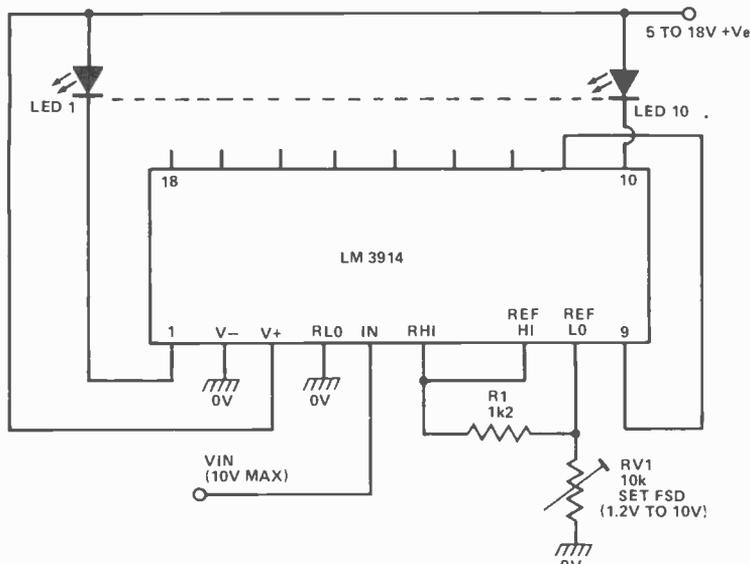


Fig. 4. An alternative 1.2 to 10 V FSD 'Dot' mode voltmeter.

Figure 5 shows how the LM3914 can be used as an expanded scale voltmeter that reads (say) 10V at minimum scale but 15 V at full scale. The secret of this circuit is that both the top and bottom ends of the internal potential divider (pins 6 and 4) of the IC are externally available, so the top and bottom limits of the scale can be individually set. In the diagram the top of the divider is fed from the 1.2 V reference, but the bottom is fed from

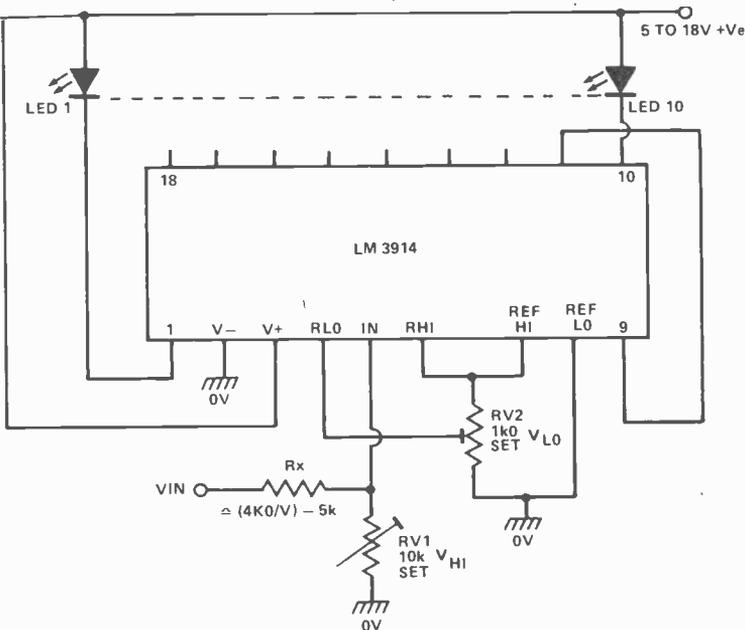


Fig. 5. Expanded scale (10 V - 15 V etc) 'Dot mode' voltmeter.

the slider of RV2. The external input signal is applied to the IC via the Rx-RV1 potential divider. Thus, if 1.2V is set to the top of the divider and 0.8 V is set to the bottom and the input divider has a ratio of 20:1, the circuit will read 24 V at full scale and 16 V at minimum scale.

Practical Circuits: 'BAR' Mode Operation

The three basic voltmeter circuits of Figs 3 to 5 can be used with the IC connected in either the 'dot' or the 'bar' mode. When using the bar mode, however, it must be remembered that the power rating of the IC can easily be exceeded when all ten LEDs are on if an excessive voltage is allowed to develop across the output terminals

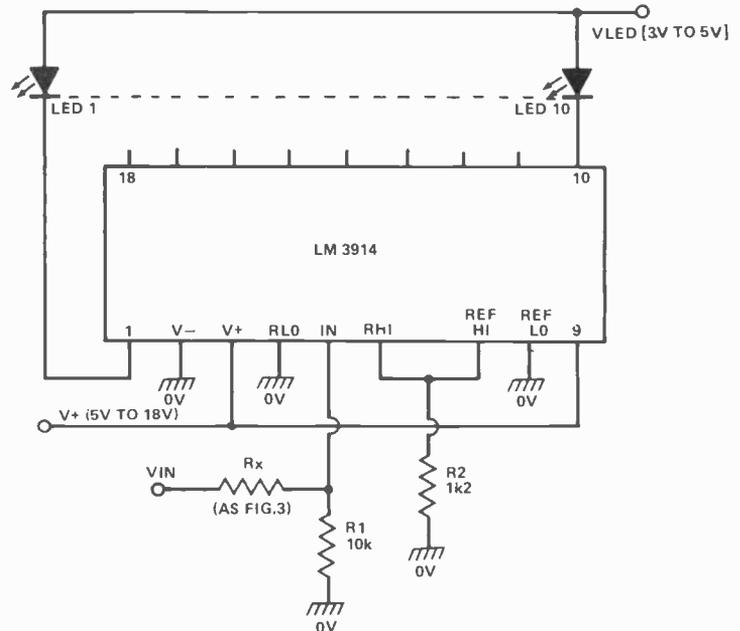


Fig. 6. Bar-display voltmeter with separate LED supply.

of the IC. LEDs normally drop about 2 volts when they are conducting, so one way around this problem is to power the LEDs from their own low-voltage (3 to 5 V) supply, as shown in Fig 6.

An alternative solution is to power the IC and the LEDs from the same source but to wire a current-limiting resistor in series with each LED, as shown in Fig 7, so that the output terminals of the IC saturate when the LEDs are on.

Practical Circuits: 20-LED Voltmeters

Figure 8 shows how two LM3914s can be interconnected to make a 20-LED dot mode voltmeter. Here, the input terminals of the two ICs are wired in parallel, but IC1 is configured so that it reads 0 to 1.2 volts and IC2 is configured so that it reads 1.2 volts to 2.4 volts. In the latter case, the low end of the IC2 internal potential divider is coupled to the 1.2 V reference of IC1 and the top of the divider is taken to the 'top' of the 1.2 V reference of IC2, which is raised 1.2 V above that of IC1.

The Fig 8 circuit is wired for 'dot' mode operation. In this case pin 9 of IC1 is wired to pin 1 of IC2 and pin 9 of IC2 is wired to pin 11 of IC2. Note that a 22k resistor is wired in parallel with LED 9 of IC1 in this mode.

Fig 9 shows the connections for making a 20-LED 'bar' mode voltmeter. The connections are similar to those of Fig 8, except that pin 9 is taken to pin 3 on each IC, and a 470R current limiting resistor is wired in series with each LED to reduce the power dissipation of the ICs.

Practical Circuits: A 20-LED Car Tachometer

The LM3914 can be made to act as a car tachometer by simply wiring a frequency-to-voltage converter between

the vehicles contact breaker points and the input pin of the IC. Fig 10 shows the practical circuit of such a converter, designed to interface with either of the

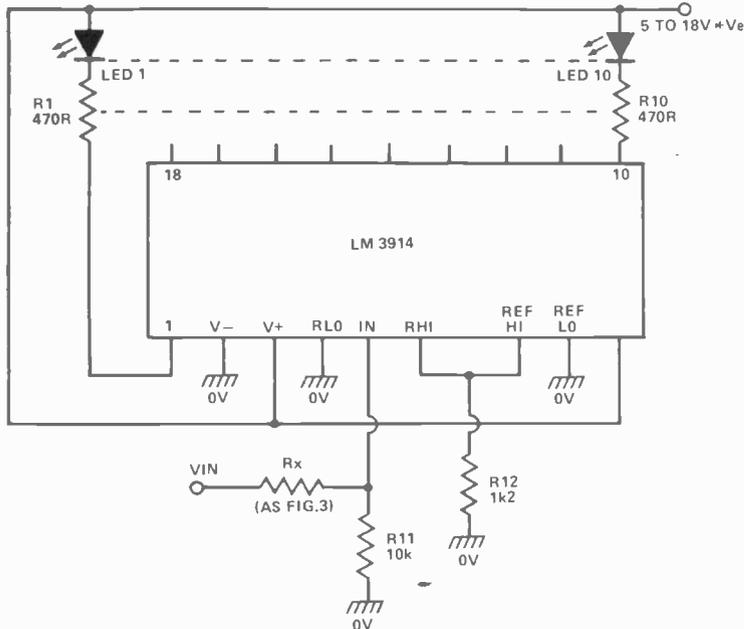


Fig. 7. Bar-display voltmeter with common LED supply.

20-LED voltmeter circuits of Figs 8 or 9. Note the LM2917 IC used in this circuit is a 14-pin device. The C2 value of 22n is the 'optimum' value for a full scale range of approximately 10 000 RPM on a 4-cylinder 4-stroke engine. For substantially lower full scale RPM values, the value of C2 may have to be increased. The value may have to be reduced on vehicles with 6 or more cylinders.●

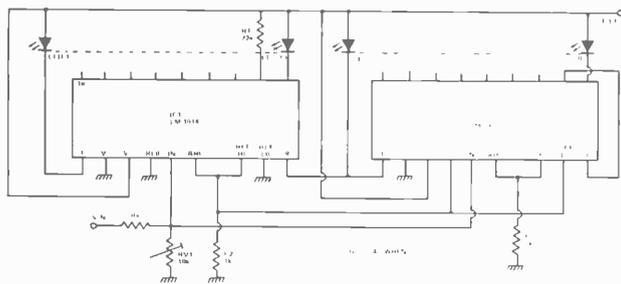


Fig. 8. Dot-mode 20 LED voltmeter. (FSD = 2.4V when Rx=1)

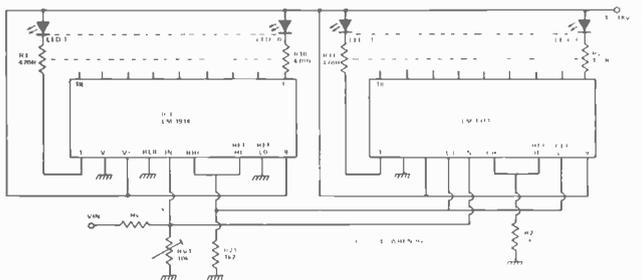


Fig. 9. Bar-mode 20-LED voltmeter. (FSD=2.4 V when Rx=0).

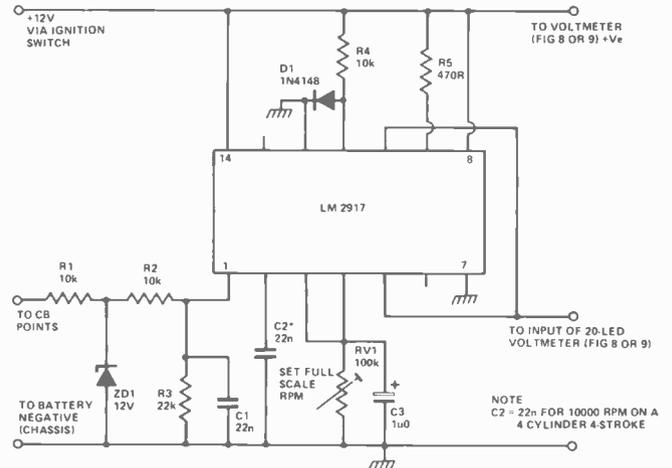


Fig. 10. Car tachometer conversion circuit for use with a 20 LED voltmeter. (Fig. 8 or 9).

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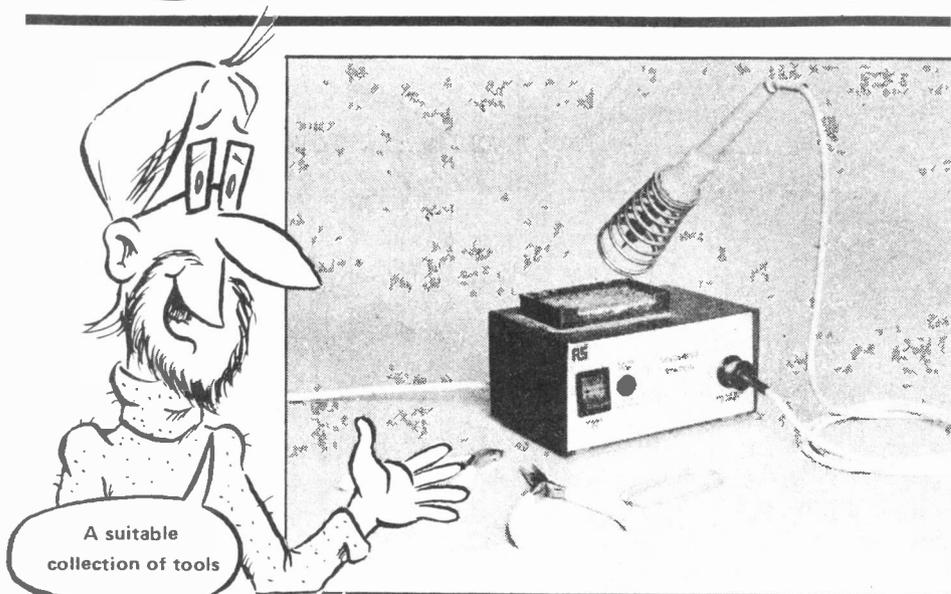
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SOLDERING

After the Prof's cartoon last month on incorrect soldering techniques, Keith Brindley puts things straight with a few down-to-earth hints



DON'T LET ANYBODY kid you into believing that soldering is difficult — it's not! There's no art to soldering, it's simply just a matter of applying the right rules at the right time. Nothing else! Once you know the rules, soldering is an easy as falling off a log, backwards.

First things first, you must have the equipment for the job: a soldering iron with a good tip; cored solder (not plumbers' stuff); and a good quality pair of long-nosed pliers and side-cutters. Irons are rated by their electrical power and any within the range 15-40W is normally adequate for PCB work.

What's it all about?

Now, just before we jump into soldering technique it might be a good idea to take a brief look at why we use solder at all. Well, the answer is simple — correct use of solder along with a PCB gives us a method of connecting the components of a circuit together in a permanent fashion which is the toughest, most resilient and neatest method available. The idea is that the joint is heated and solder is applied to 'alloy' the component to the copper track of the PCB.

Solder for electronic components consists of a mixture of tin and lead in about a 60/40 ratio and as such has quite a low melting-point (about 190°C) compared with the other metals in the joint. This low temperature melting-point of solder is the key to understanding the process — it means that the joint does not have to be heated up so much that component damage occurs, but

nevertheless, a strong joint between the metals can still be obtained. Included in the solder are a number of thin veins of flux, which promote the fusion of the metals by preventing any rapid oxide build-up which would otherwise occur when the metals are heated.

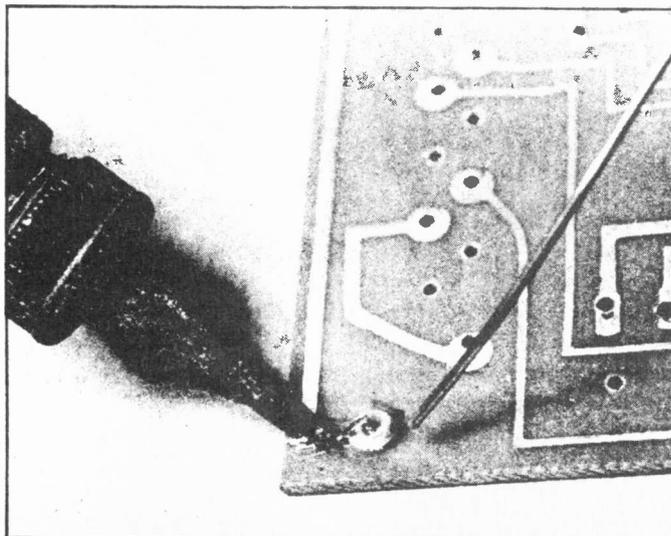
Everything to be soldered must be clean and greasfree, otherwise the solder cannot make a good joint. This is the area where most problems lie — any grease on the copper track or component leads may remain between the solder and metal, preventing a good electrical contact. Even if a total open circuit (ie no connection) doesn't occur, the joint may still possess an electrical resistance which could prevent your circuit from working. Methylated spirits,

wire-wool, fine emery paper or simple detergent powder can be used to clean the two metals of the joint. The surface of copper in particular should be shiny clean — remember that copper oxidises in contact with air and the oxide layer needs to be removed before soldering. If your board has been left for more than just a few hours without being completed, you may have to clean it again.

One way of avoiding having to re-clean the PCB is to make use of the fact that solder doesn't oxidise easily, because of its high percentage of tin. By heating the copper at each joint to be made and melting a thin layer of solder around the hole, the copper is protected against dirt and grease. This process is called 'tinning' and can be used successfully to keep the soldering iron tip clean too! Wipe the hot tip of the iron on a damp sponge to get rid of any gunge and simply melt some solder on it — letting the solder flow over the end ¼" or so. The tip should now have a silvery, shiny appearance and you should keep it so. In use, every time the tip loses the shiny appearance clean it on the sponge and tin it.

Technique

Well, that's got the equipment and its upkeep out of the way — we can move on now to the actual soldering process. The simple knack here is to remember



'Tinning' a hole on a PCB to ease future soldering

that the joint needs to be heated up to a temperature which exceeds that of the melting-point of solder. BUT, you must not heat the joint up so hot that you damage the component through excess heat!

So, how do you know when the temperature is correct? Short of a thermocouple and a meter, you don't – it's a matter of guesswork! However, there is a simple way to keep the amount of uncertainty to a minimum and this relies on the fact that heat should only be applied to the component itself at the very last minute. The copper, because of its large surface area compared with the component lead, needs far more heat and thus the tinned iron tip can be held steady on the surface of the copper so that maximum heat transfer takes place. At no time yet should the component lead be heated. Holding the iron tip at one side of the component hole, as in Fig. 1, you can now apply the solder – to the other side of the hole. When the copper is hot enough (which shouldn't take more than five or six seconds, depending on the power of the iron and the surface area of the copper), the solder will begin to flow onto the metal. You then know that the copper is just at the correct temperature! At this point, the iron can be moved up to the component lead (still touching the copper, as in Fig. 2) so that it also can be heated. In a couple of seconds the lead will be hot enough, and solder can be applied there.

As soon as the joint has been made, remove the soldering iron completely, to prevent heat damage to components. The large area of copper (a good heat conductor) will dissipate the excess heat rapidly. Let the joint cool naturally in air – don't blow on it, because this may make the solder brittle and it may break. If all goes well and you make a 'good' joint, the solder will flow into a smooth, arc-shaped form as pictured in Fig. 3, and have a shiny, bright appearance. Alternatively, if you make a mess of the joint, you will have a dreaded 'blob' – a more or less round ball of solder which doesn't make good soldered contact with either copper track or component lead.

Finally, all that remains is to cut off the excess component leads close to the board with your side-cutters, to avoid short-circuits between individual leads or between leads and printed tracks. After all that, it's just practice – you will soon reach a stage when soldering is second nature to you and it becomes difficult to solder a bad joint. ●

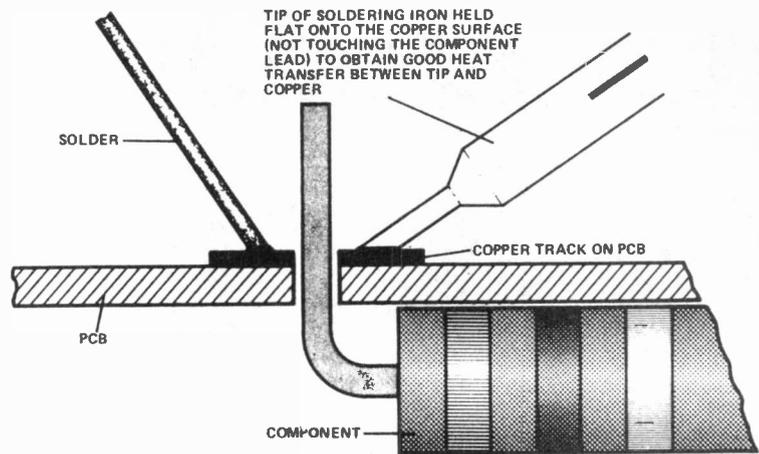


Figure 1. Heat one side of the component hole (not the component lead!) whilst holding the solder at the far side of the hole

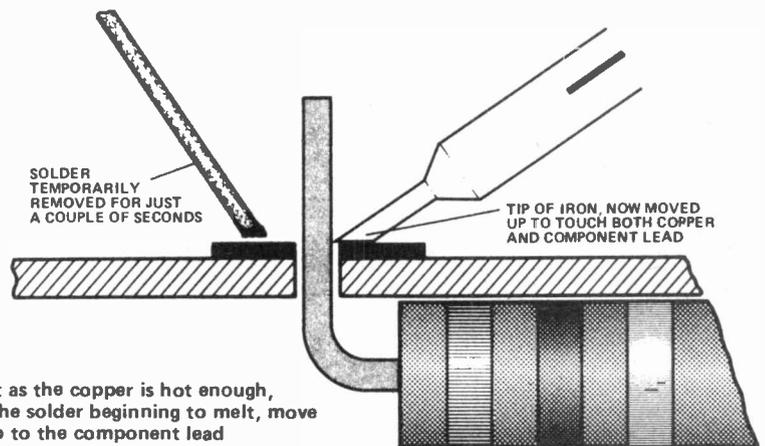


Figure 2. Just as the copper is hot enough, indicated by the solder beginning to melt, move the iron tip up to the component lead

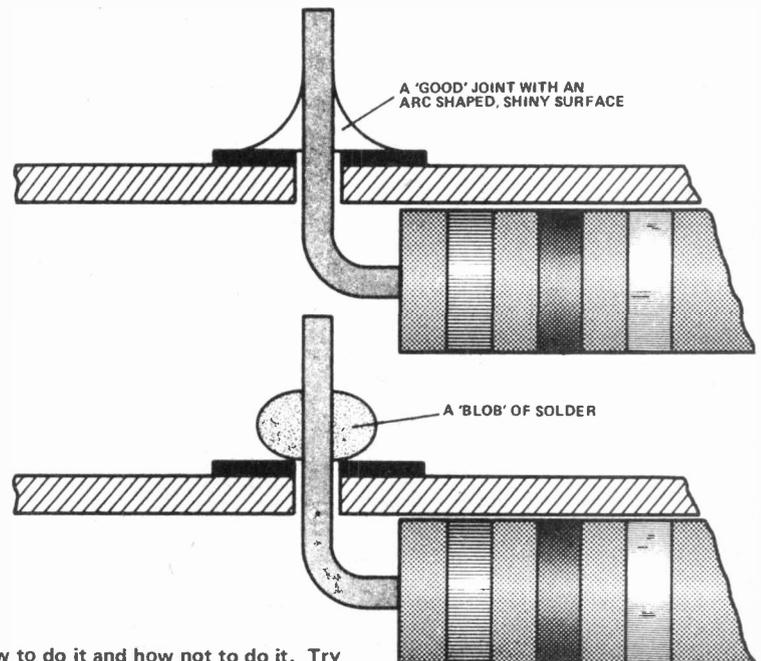
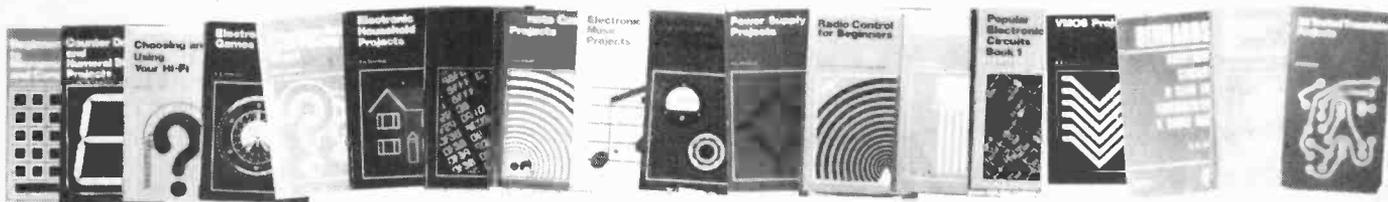


Figure 3. How to do it and how not to do it. Try not to get the 'blob'!

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BP66: Beginners Guide To Microprocessors & Computing \$7.55

This book is intended as an introduction to the basic theory and concepts of binary arithmetic, microprocessor operation and machine language programming. The only prior knowledge which has been assumed is very basic arithmetic and an understanding of indices. A helpful Glossary is included. A most useful book for students of electronics, technicians, engineers and hobbyists.

BP67: Counter Driver & Numeral Display Projects \$7.55

The author discusses and features many applications and projects using various types of numeral displays, popular counter and driver IC's, etc.

BP68: Choosing & Using Your Hi-Fi \$7.25

The reader is provided with the fundamental information necessary to enable him to make a satisfactory choice from the extensive range of stereo equipment currently on the market. This should aid him in understanding the technical specifications of the equipment he is interested in buying. Full of helpful advice on how to use your stereo system properly so as to realise its potential to the fullest and also on buying your equipment. A Glossary of terms is included.

BP69: Electronic Games \$7.55

The author has designed and developed a number of interesting electronic game projects using modern integrated circuits. The book is divided into two sections, one dealing with simple games and the latter dealing with more complex circuits. Ideal for both beginner and enthusiast.

BP70: Transistor Radio Fault-Finding Chart \$2.40

Author Mr. Chas. Miller has drawn on extensive experience in repairing transistor radios to design this book. The reader should be able to trace most of the common faults quickly using the concise chart.

BP71: Electronic Household Projects \$7.70

Some of the most useful and popular electronic construction projects are those that can be used in or around the home. These circuits range from such things as "2 Tone Door Buzzer" and Intercom through Smoke or Gas Detectors to Baby and Freezer Alarms.

BP72: A Microprocessor Primer \$7.70

A newcomer tends to be overwhelmed when first confronted with articles or books on microprocessors. In an attempt to give a painless approach to computing, this small book will start by designing a simple computer that is easy to learn and understand. Such ideas as Relative Addressing, Index Registers, etc. will be developed and will be seen as logical progressions rather than arbitrary things to be accepted but not understood.

BP73: Remote Control Projects \$8.58

This book is aimed primarily at the electronics enthusiast who wishes to experiment with remote control and many of the designs are suitable for adaptation to the control of other circuits published elsewhere. Full explanations have been given so that the reader can fully understand how the circuits work and see how to modify them. Not only are Radio control systems considered but also Infra-red, visible light and Ultrasonic systems as are the use of Logic ICs and Pulse position modulation etc.

BP74: Electronic Music Projects \$7.70

Although one of the more recent branches of amateur electronics, electronic music has now become extremely popular and there are many projects which fall into this category, ranging in complexity from a simple guitar effects unit to a sophisticated organ or synthesiser.

The purpose of this book is to provide the constructor with a number of practical circuits for the less complex items of electronic music equipment, including such things as Fuzz Box, Waa-Waa Pedal, Sustain Unit, Reverberation and Phaser-Units, Tremolo Generator etc.

BP75: Electronic Test Equipment Construction \$7.30

This book covers in detail the construction of a wide range of test equipment for both the hobbyist and radio amateurs. Included are projects ranging from a FET Amplified Voltmeter and Resistance Bridge to a Field Strength Meter and Heterodyne Frequency Meter.

Not only can the home constructor enjoy building the equipment but the finished project can also be usefully utilised in the furtherance of his hobby.

An ideal book for both beginner and advanced enthusiast alike.

BP76: Power Supply Projects \$7.30

Power supplies are an essential part of any electronic project.

The purpose of this book is to give a number of power supply designs, including simple unregulated types, fixed voltage regulated types, and variable voltage stabilised types, the latter being primarily intended for use as bench supplies for the electronic workshop. The designs are all low voltage types for use with semiconductor circuits.

There are other types of power supplies and a number are dealt with in the final chapter, including a cassette supply, Nicad battery charger, voltage step up circuit and a simple inverter.

BP78: Practical Computer Experiments \$7.30

This book aims to fill in the background to microprocessors by describing typical computer circuits in discrete logic and it is hoped that this will form a useful introduction to devices such as adders, memories, etc. as well as a general source book of logic circuits.

An essential edition to the library of any computer and electronic enthusiast.

BP79: Radio Control For Beginners \$7.30

The aim of this book is to act as an Introduction to Radio Control for beginners to the hobby. The book will commence by dealing with the conditions that are allowable for such things as frequency and power of transmission. This is followed by a "block" explanation of how control-device and transmitter operate and receiver and actuator(s) produce motion in a model.

Details are then given of actual solid state transmitting equipment that the reader can build. Plain and loaded aerials are then discussed and so is the field-strength meter to help with proper setting up.

The radio receiving equipment is then dealt with, this includes a simple receiver and a crystal controlled superhet. The book ends with electro-mechanical means of obtaining movement of the controls of the model.

No.223: 50 Projects Using IC CA3130 \$5.50

In this book, the author has designed and developed a number of interesting and useful projects using the CA3130, one of the more operational amplifiers that is available to the home constructor. Five general categories are covered: Audio Projects, Test Equipment, Household Projects and Miscellaneous Projects.

BP80: Popular Electronic Circuits-BOOK 1 \$8.25

Another book by the very popular author, R.A. Penfold, who has designed and developed a large number of circuits which are accompanied by a short text giving a brief introduction, circuit description and any special notes on construction and setting up that may be necessary.

The circuits are grouped under the following headings; Audio Circuits, Radio Circuits, Test Gear Circuits, Music Project Circuits, Household Projects, and Miscellaneous Circuits.

An extremely useful book for all electronic hobbyists, offering remarkable value for the number of designs it contains.

BP83: VMOS Projects \$8.20

Although modern bipolar power transistors give excellent results in a wide range of applications, they are not without their drawbacks or limitation. With the advent of field effect devices it seemed that it would only be a matter of time before improved power transistors became available, this has happened and a number of different power FETs are now available to the hobbyist.

This book will primarily be concerned with VMOS power FETs although power MOSFETs will be dealt with in the chapter on audio circuits.

A number of varied and interesting projects are covered under the main heading of: Audio Circuits, Sound Generator Circuits, DC Control Circuits and Signal Control Circuits.

No.213: Electronic Circuits For Model Railways \$4.50

The reader is given constructional details of how to build a simple model train controller; controller with simulated inertia and a high power controller. A signal system and lighting for model trains is discussed as is the suppression of RF interference from model railways. The construction of an electronic steam whistle and a model train chuffer is also covered.

No.215: Shortwave Circuits & Gear For Experimenters & Radio Hams \$3.70

Covers constructional details of a number of projects for the shortwave enthusiast and radio "Ham". Included are: an add-in crystal filter, adding an "S" meter in your receiver; crystal locked H.F. Receiver; AM tuner using phase locked loop; converter for 2MHz, 40 to 800MHz RF amplifier, Aerials for the 52, 144MHz bands, Solid State Crystal Frequency Calibrator, etc.

No.221: Tested Transistor Projects \$5.50

Author Mr. Ricahrd Torrens has used his experience as an electronics development engineer to design, develop, build and test the many useful and interesting circuits in this book. Contains new and innovative circuits as well as some which may bear resemblance to familiar designs.

No.224: 50 CMOS IC Projects \$4.25

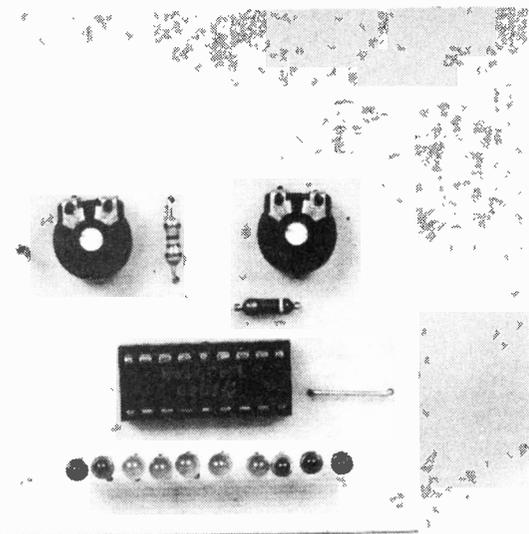
CMOS IC's are suitable for an extraordinary wide range of applications and are now also some of the most inexpensive and easily available types of ICs. The author has designed and developed a number of interesting and useful projects. The four general categories discussed in the book are: Multivibrators, Amplifiers and Oscillators, Trigger Devices and Special Devices.

Babani Books are now available from Arkon, CESCO, Dominion Radio and General Electronics.

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With the engine turned off and all lights switched on, the battery reading should fall to 11 to 12 volts. Again, any reading lower than this indicates a faulty battery.

With the engine running at a fast idle and the electrical system lightly loaded, the battery reading should rise to between 13 and 14 volts. A reading below the lower value indicates a faulty dynamo/alternator or a defective regulator. A reading above the upper value indicates a defective regulator.

You'll notice from the above statement that the range of voltmeter readings that are of interest span only a very limited range, from say 10.5 volts minimum to 15 volts maximum, so a special type of 'suppressed zero' voltmeter should ideally be used in the car.

Our car voltmeter is very special. It is an all solid-state design that gives a readout on a two-coloured line of ten

LEDs (light emitting diodes). The unit has excellent long-term and thermal accuracy once it has been initially calibrated to span the range 10.5 to 15 volts. The unit is very easy to install in the vehicle and has a total building cost of only 10 dollars or so. The unit gives a 'dot' display in which only one of the ten LEDs is illuminated at any one time.

Construction And Use

The entire circuit, including the ten LEDs, is built up on a small PCB and construction should present very few problems. Note that IC1 is an 18-pin device and also that it should be fitted to the PCB via a suitable holder. We advise testing each one of the LEDs, to confirm its functioning and polarity, before fitting it to the PCB.

To check each LED, connect it in series with a 470R resistor and then connect the combination across a 12-volt supply. If necessary switch the LED connections until the LED illuminates, under which condition the lead closest to the positive supply rail is the anode.

When construction is complete, double-check the circuit wiring and connect the unit to a variable voltage DC supply that can span the 10-15 volt range. Monitor the supply voltage with a reasonably accurate meter and calibrate the unit as follows.

Set the supply to 15 volts and adjust RV1 so that LED 10 just turns on. Reduce the supply to 10 volts and adjust RV2 so that LED 1 just turns on. Recheck the settings of RV1 and RV2. The calibration is then complete and the unit can be installed in the vehicle by taking the '0' volt lead to chassis and the '+12 volt' lead to the vehicle's battery via the ignition switch. ●

PROBLEMS? NEED PCBs? Before you write to us, please refer to 'Component Notations' and 'PCB Suppliers' in Table of Contents. If you still have problems, please address your letters to 'ETI Query' care of this magazine. A stamped, self addressed envelope will ensure fastest reply. Sorry, we cannot answer queries by telephone.

HOW IT WORKS

There is little we can say other than the IC1 acts as a LED-driving voltmeter that has its basic maximum and minimum readings determined by the values of R2 and RV2. When correctly adjusted, the unit actually spans the approximate range 2.5 volts to 3.6 volts, but is made to read a supply voltage span of 10-10.5 volts to 15 volts by interposing potential divider R1-RV1 between the supply line and the pin-5 input terminal of the IC.

The IC is configured to give a 'dot' display, in which only one of the ten LEDs is illuminated at any given time. If the supply voltage is below 10.5 volts none of the LEDs illuminate. If the supply equals or exceeds 15 volts, LED 10 illuminates.

A comprehensive description of the functioning of the LM3914 IC is given elsewhere in this issue.

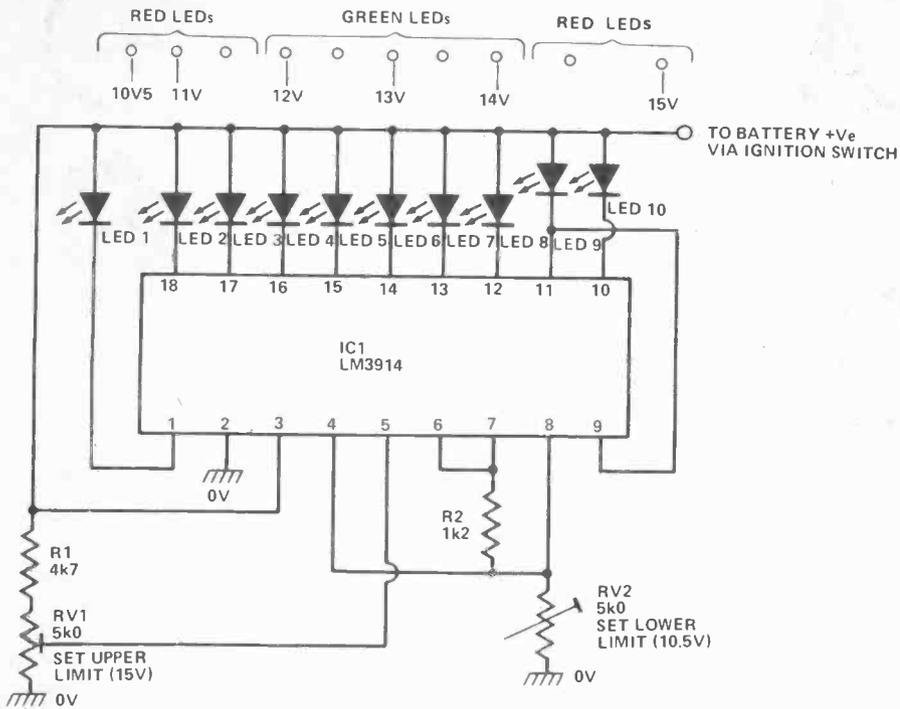
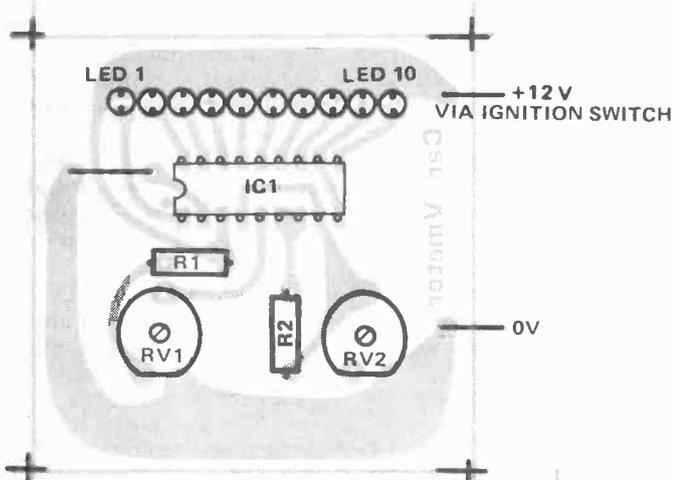
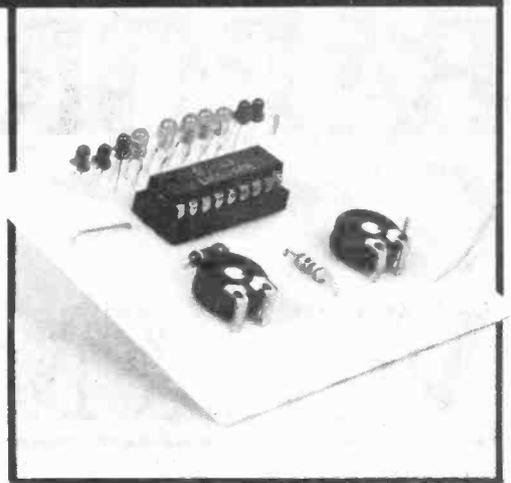
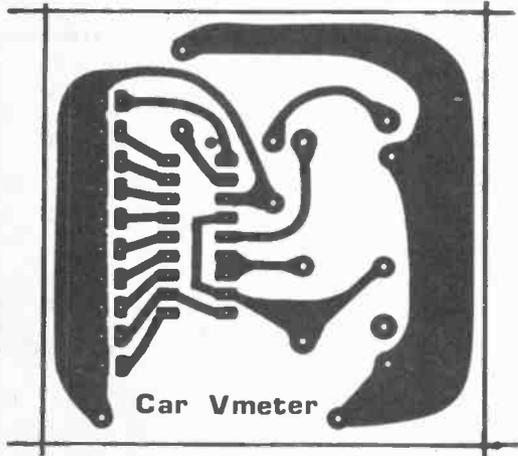


Fig. 1. Circuit diagram of the ETI Bargraph Car Voltmeter.
The choice of a box is decided by the type of installation required.



PCB overlay for the Voltmeter, note the position of IC1.
(lower) PCB foil pattern, take care to avoid solder splashes.



The ETI LED Voltmeter.
See text for the setting-up procedure.

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 R2 1k2
- POTENTIOMETERS
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MICHAEL FARADAY

No, Michael Faraday did not invent electrolytic capacitors. This month, we'll have a look at the life of this brilliant pioneer of electrical engineering.

EVER FELT TOTALLY baffled by a bit of theory? Ever found that you could learn more with a hot soldering iron in your hand than using a book? Take heart, for your condition is in some respects like that of Michael Faraday, who did more for the progress of electricity than almost anyone else in the history of this subject.

Faraday was born in 1791, at Newington, Surrey, the son of a local blacksmith, who must have taught him much about the machines of the day. These, remember, were times of considerable and violent change. The Americans had successfully declared unilateral independence, the French were having a revolution, and machines had been invented to do the work of three men and a boy! The results were that there was a huge expansion of trade, a demand for machine-made goods, and jobs for anyone who wanted them. There's nothing new under the sun — the Luddites broke machines because they thought there would be less employment, yet within a few years there was such a scarcity of people to do the jobs that children were working in factories.

In Faraday's youth, the blacksmith was the man who was the machine repairer, because his skills were well fitted to this job. The family moved to North London, to take advantage of this new and lucrative source of income but Michael, at the age of 14, decided that he would not be a blacksmith, and was apprenticed instead to a bookbinder who also had a bookselling business. As he bound the books, Faraday read them and was fascinated by the many books dealing with physical science. Determined to increase his knowledge, he went to hear Humphry Davy lecture at the Royal Institute. This experience convinced him that he should make his career in scientific research, and he wrote to Davy asking for a job, enclosing a complete transcript which he had prepared of the lecture he had attended. Davy was impressed and appointed Faraday, now aged 21, as his assistant at the Royal Institute.



Davy did not regret this step — Faraday proved to be an extraordinarily astute experimenter, able to devise apparatus to prove or disprove any theory which might be put to him.

One early opportunity occurred when the Danish scientist, Oersted, reported that a magnetic field existed around any wire which was carrying an electric current. Faraday at once repeated Oersted's experiments to confirm the principle, and then went on to construct an ingenious piece of apparatus, shown in Fig. 1, which demonstrated the shape of the magnetic field. By passing current through the wire and the mercury, Faraday showed that the magnet moved in a circular path around the wire — a path which he concluded must be the shape of the magnetic field round the wire. Davy and Faraday also saw that this device converted electric current into mechanical movement, and so the electric motor was born.

The two men worked as a team, touring Europe with lecture-demonstrations concerned with discoveries which they had jointly made. These tours put them in touch with many of the most famous names in electrical science, in particular Biot and Savart, who were working on a theory of magnetism, and these subjects were to remain the most fascinating of all for

Faraday. In 1825, aged 34, he was appointed as Director of Laboratories at the Royal Institute and one of his first actions was to start a series of formal lectures, to be held each Friday, describing new advances in some branch of Science. These Friday lectures have continued ever since. Faraday had a gift for clear and simple language, and his lectures were invariably crowded out. This is one aspect of Faraday's work which is often overlooked, and we may probably never know how many students were set an excellent example both by Faraday's meticulous practical work and by his clear and concise lectures.

In 1831, Faraday published the results of work which was to mark a huge step in our understanding and application of electricity. The experiment was the 'induction ring' — an iron ring (Fig. 2) with two separate windings. One winding was connected through an on/off switch to battery, and the other winding was connected to a sensitive galvanometer (micro-ammeter). Faraday was looking for a way to convert magnetism to electric current, and his was the first of many such attempts to succeed. There were two reasons for this. One was that Faraday had built his own apparatus in his usual meticulous way, and the galvanometer in particular was very much more sensitive than

most. The other was that Faraday observed and noted everything. On this occasion he observed and noted something which earlier researchers might not have bothered about: that the galvanometer needle flicked each time the switch was made or broken. Everyone expected that the galvanometer would read continually while current was flowing from the battery, and disregarded these transient effects. To Faraday, these were the important results, and he concluded that a current flowed to the galvanometer *only* when

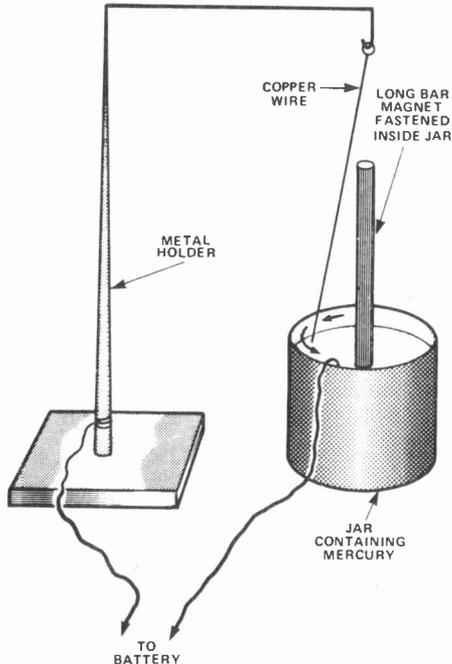


Fig. 1. Faraday's motor experiment. A magnet was fastened inside a pot containing mercury. When a wire was dipped into the mercury, and current was allowed to flow through the wire, the wire rotated around the magnet.

the current from the battery was changing. He had, of course, discovered the transformer principle and by doing so, laid the foundation for all our use of electricity. It was only a small step onwards to disconnect the battery and show that a magnet pushed into or out of the ironring would also cause the galvanometer to deflect. The essential point, which no-one else had grasped, was that *change* was the key, change of current when the arrangement was used as a transformer, or change of position when the arrangement was used with a magnet.

The next step was to produce a continuous current from continuous motion. Faraday realised that a practical generator must use circular motion, and devised the disc dynamo (Fig.3), which we now call a homopolar generator. As shown it consisted of a

copper disc rotated between the poles of a strong magnet. Rubbing connections were made to the shaft and also to the rim of the disc, and a small voltage could be detected when the disc was spun round. Oddly enough, this arrangement, which has only ever been a curiosity in the past, is now coming under investigation again. The reason is that though the voltage is very low, the current can be very large, and low-voltage high-current supplies are just what we need for modern semiconductor circuits. Since the output of the homopolar generator is DC, not just a full-wave rectified output such as we get from most dynamos, the homopolar generator is ideal for providing an emergency supply for electronic equipment.

Faraday was content to move on to other topics, and leave the development of the dynamo to others, later, notably Siemens and Edison. His interest was still in the understanding of the mysterious relationship between electricity and magnetism, and he was fascinated by the representation of magnetism in terms of lines of force, an idea which he could express as a drawing. His intuitive feeling was that electrostatics, current electricity, and magnetism must be part of the same thing, but he lacked the mathematical facility to prove what he was sure must be true. The complete proof was left to Clark Maxwell just after Faraday's death.

By 1844, Faraday was busy tying up other aspects of electricity, still pursuing his hunch that electricity was the key to all science. In his early years with Davy, he had made many chemical investigations, some of which had been concerned with glass. Now glass is not a single chemical compound but a mixture, and so thousands of different types of glass can be made. One which Faraday had made and christened

Fig. 3. The homopolar generator. The disc revolving between the poles of the magnet generates a small voltage between the contacts, it's magnitude depending on the speed of the disc and the strength and size of the magnet.



'heavy glass' turned out to be quite remarkable. This particular glass polarised any light which passed through it, acting in the way we all know now from Polaroid sunglasses. What was extraordinary about Faraday's 'heavy glass' was that the polarisation varied when a magnetic field was applied to the glass. To be precise, the plane of polarisation was rotated when a magnetic field was applied. This was a clear indication of a link between light and magnetism, and the 'Faraday rotation' as it is called is an effect which is used nowadays to control laser beams, enabling us to modulate a laser beam directly by an electric current.

Faraday retired in 1858, after a career which had touched on and improved practically every branch of science. We've concentrated here on just a few of his major discoveries, leaving out all his chemical and electrochemical work, which included the discovery of electroplating. He died in 1867, an experimenter of genius with a teacher's gift of clear explanation. He left behind him an extraordinary number of discoveries which still bear his name, an organisation which still delivers lectures in his name, and a new branch of engineering — electrical engineering. Few men have made such an overwhelming contribution to our present century.

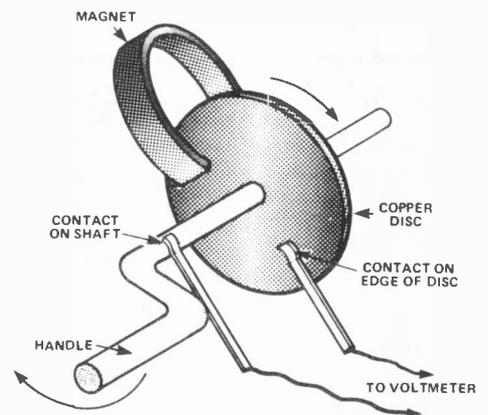


Fig. 2. The iron ring experiment. Faraday found that the arrangement, the first transformer, produced a pulse of current indicated on the galvanometer, at the instants when the switch was opened or closed.

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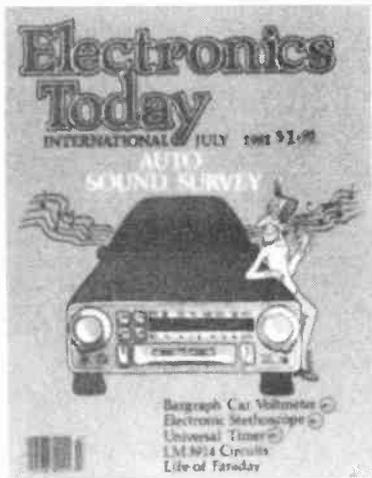
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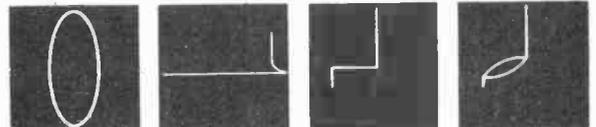
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CURRENT AFFAIRS

We seem to take for granted that circuits work, but why is it that conductors, semi-conductors and insulators do just what their names imply? A.S. Lipson takes us step by step through the whys and wherefores of atomic structure.

MOST OF US ARE reasonably familiar with what electricity is — the movement of electrons through a conductor. But there are some things that we tend to take for granted. For instance, why is it that some materials, like metals, conduct easily, whereas others — insulators — don't, and still others — semiconductors — seem to be somewhere in the middle; conducting, but not as well as metals? In order to find out why, we'll first have to learn something about atomic structure. . . .

First Theory

Essentially, the atom consists of a central, very small positively-charged lump called the nucleus, surrounded by negatively charged electrons. Many books — particularly old ones — tend to give the impression that the electrons are just like little planets orbiting a sun (the nucleus) and that the atom is like a miniature solar system. This is wrong. Electrons do not behave just like little billiard balls, or little solid lumps. It is in fact more accurate (although not quite so simple) to visualise the electrons in an atom as being spread out 'charge clouds' around the nucleus, with most of this charge being concentrated at specific distances from the nucleus. The comparison between the two points of view is made in Fig. 1.

The electrons within an atom can have different energies. If they obtain more than a specified amount of energy (for any particular type of atom), then they can actually break free from the atom. It is clear that the more energy a particular electron has within an atom, the less energy that electron will need to have added to it in order for it to break away from the atom; in other words, the easier it will be for that electron to escape.

Conduction and Insulation

But what has all this to do with conduction of electricity? In metals, some of the outer electrons present have

quite high energies within their atoms and, in a solid lump of metal, one or two electrons from each atom are more or less free of their own atoms, although they are held into the metal as a whole. The positively charged ions left when electrons are removed from atoms are packed closely together and, in between them, the free electrons move about at random, (acting as a sort of 'atom glue'). This negative charge attracts the remaining positive charge on the ions, and holds the whole thing together.

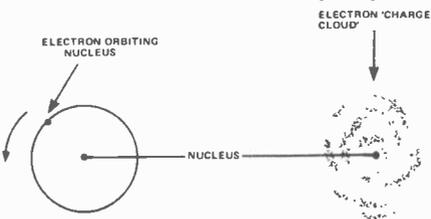


Fig. 1. A hydrogen atom according to (a) The 'Solar System' model (b) The 'Charge Cloud' model.

(See Fig. 2.) The charge-clouds of all the free electrons join together, and form what is often known as an 'electron sea'. Because of this structure — the way that they are held together — metals can conduct electricity. Why? Because of all those free electrons, which aren't held by any particular atom, only by the metal as a whole. They are so loosely attached that if you apply a potential difference across the metal, they can drift along under its influence, and so cause a current to flow. In insulators, on the other hand, the electrons are held much more tightly by the atoms, there is no 'electron sea', and the atoms are bonded together by other means. Consequently, if a potential difference is applied, the electrons are unable to break free from their atoms, and so no current can flow. Our problem is thus solved — we now know how electrical current is conducted in metals, and why it isn't in insulators. Or do we? This theory was widely

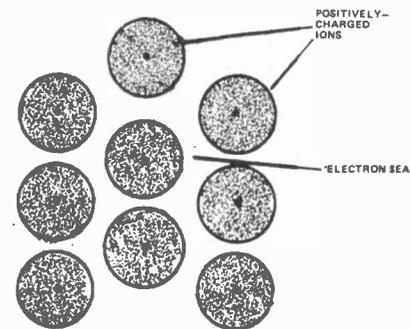


Fig. 2. The structure of a metal. Positively charged ions are surrounded by an electron 'Charge Cloud'.

accepted for some time, and in fact it's still accepted as being broadly true, but there are just one or two things it doesn't explain. Semiconductors, for instance? And why should metals hold their electrons less tightly than non-metals? Our theory is obviously incomplete.

The New Approach

It was the physicists to the rescue. We return to the atom. . . .

In the first decades of this century, a startling new branch of physics — Quantum Mechanics — made its debut. This was the work of several men, including Einstein, Heisenberg and Schrodinger. One of the first results Quantum Mechanics produced was embodied in a conclusion that Niels Bohr published in 1913. This was that, contrary to what had previously been assumed, the electrons within an atom could not have just any energy level, but could only exist at certain set energy levels. (See Fig. 3a.) This was a radical departure from what had been believed up until then, but it has been proved and is now unquestioned by physicists.

So electrons in atoms can only exist at certain set energy levels. But if you get more than one atom together, the situation changes again — energy levels are split. If, for example, you put two atoms close together, and then look at what has happened to a particular energy level in each atom, you will find that, in one atom, it has shifted up fractionally, in the other atom, it has shifted down slightly. The two atoms act as though the single energy level has

been split into two (See Fig. 3b), one very slightly higher than the other. In a solid, where there are millions of atoms all together, the energy levels are split into so many 'sub-levels', all very close in energy, that they act like continuous

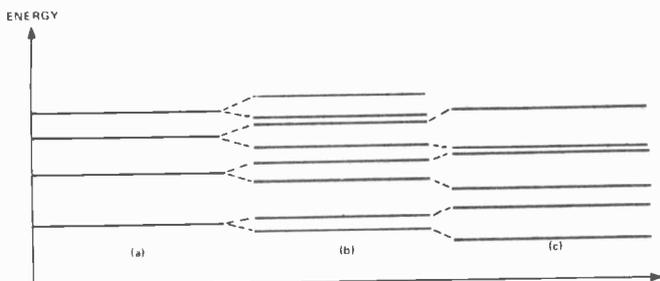


Fig. 3a. The electrons within atoms can exist only at set levels. b) When two atoms interact with each other, their energy levels are split. c) In a solid, millions of atoms all interact with each other, and the energy levels are split into so many 'sub-levels' that they behave like continuous bands.

band, (Fig. 3c). In a solid, instead of there being several separate energy levels at which the electrons can exist there are, instead, several energy 'bands', within which electrons can have a whole range of energy levels. Between these bands however — and this is the important bit — there are still 'forbidden gaps'; energy ranges in which electrons cannot exist because there are no allowable energy levels present. So how does all this help us to understand electrical conduction? Patience, we're just coming to that.

Electron Distribution

The way a material behaves electrically, whether it acts as a conductor or an insulator or whatever, depends on the arrangements of its energy bands, and the way that the electrons are distributed within them. The energy bands of a) a conductor, b) an insulator and c) a semiconductor are shown in Fig. 4. Firstly we will deal with the conductor. The energy bands shown in Fig. 4a are fairly typical of a material like copper. As in any material, the lower energy bands tend to fill up with electrons more easily than the higher energy bands, and consequently, they contain all the electrons that they can possibly hold. There is then a 'forbidden gap' of energies, and above this is another band — known as the conduction band. This band, unlike those below it, is not full, but is capable of holding more electrons than it in fact does. An electron in this band is relatively loosely

held by this atom and so it requires only a very small amount of energy, which can be obtained from an applied potential difference to raise it to a higher-energy but still within the conduction band.

It can now drift along within the metal under the influence of the potential difference. Thus, in a metal, which has either a partially-filled conduction band (eg. copper) or an empty conduction band which overlaps a full energy band, (as in magnesium) it is possible for current to flow quite easily. So far, so good. What about insulators? The energy-band theory can also explain the behaviour of non-conducting materials (Fig. 4b). In such substances, there are still full energy bands at the lower energy levels, but the conduction band is empty. In other words in insulators, electrons do not normally exist with enough energy to be in the conduction band. And it is only in this conduction band that electrons are free enough to take part in a flow of electrical current. If it were possible to get the electrons out of the lower energy bands into the conduction band then these materials could conduct electricity, but in order for that to happen electrons would have to cross the forbidden gap, and the energy required to make them do this is much more than can be supplied by a normal potential difference. In terms of eV (the eV, or 'electron-volt', is a measure of energy which atomic physicists find it convenient to work with, 1 eV being the energy picked up by an electron in passing through a potential difference of 1 volt), the forbidden gap in insulators is normally about 5 eV, hence, under normal circumstances, insulators do not carry electricity.

What About Semiconductors?

Semiconductors are really an 'in-between' case. Like insulators, very pure semiconductors such as silicon or germanium have empty conduction bands when the temperature is 'absolute zero' (about minus 273°C), separated

From the other energy bands by forbidden gap. At normal temperatures the conduction bands are not completely empty. Why? Because in semiconductors the forbidden gap is much smaller than insulators — about

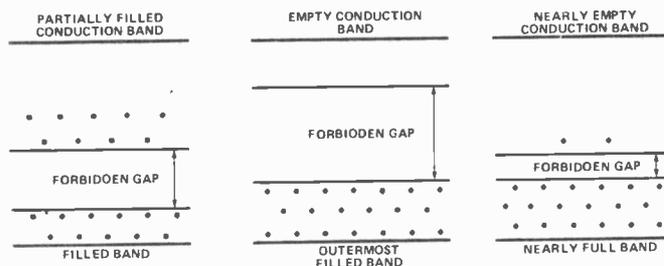


Fig. 4. Comparison of the forbidden gap position and magnitude in the three basic types of material. Far left: a conducting substance. The lower energy bands are full of electrons and the forbidden gap is easily bridged by sufficiently energetic electrons which then enter the conduction band. Center: insulators. Note the empty conduction band and the wide forbidden gap in which there are no permissible energy levels. On the right: semiconductor materials in which the energy gap is around 1 eV and at room temperature sufficient energy is imparted by heat action to allow some electrons to cross the gap into the conduction band.

1 eV. It is so much smaller, in fact, that at normal temperatures, the vibration of the atoms in the semiconductor is sufficient to give enough energy to a few electrons to reach the conduction band. Eventually they fall back to the lower energy bands — but more electrons are entering the conduction band all the time, so eventually a balance is struck, with the number of electrons entering the conduction band in any period of time being equal to the number falling back. At normal temperatures, therefore, there are always just a few electrons in the conduction band of a semiconductor, and so it is able to conduct electricity, though it conducts less well than a metal, since there are far fewer electrons in the conduction band.

But That's Not All. . . .

There is, however, another means by which a semiconductor can carry electricity. Every time an electron leaves a lower energy band for the conduction band, it leaves an electrically neutral space where there was previously some negative charge. These neutral spaces, surrounded by negatively-charged electrons, can behave almost like a positively charged particle, and when a potential difference is applied, this 'hole' as it is called travels in the opposite direction to that of the electrons. To understand how

this happens, imagine a row of chairs, with someone sitting in each of them except the one at the end. (Fig. 5) If the first person in the row moves into the empty chair, the next person moves into the chair left empty by the first person, and so on, the 'space' where no one was sitting appears to move in the opposite direction to the people, and that's exactly how it works with 'holes' in semiconductors. While it appears that the hole is moving in one direction, carrying positive charge, what is really happening is that the electrons in the lower energy bands are travelling in the other direction, carrying negative charge, and are moving into the spaces left by electrons which have gone into the conduction band.

Conclusion

Therefore, in a semiconductor, there are two types of charge carriers involved in the conduction of electricity; electrons and 'holes'. Various experiments indicate that in germanium, for example, about one third of all the current is carried by the 'holes'!

You will remember that, in semiconductors, electrons reach the conduction band because of the vibration of the atoms. This fact is quite important. At higher temperatures the atoms vibrate more, and so more electrons (and 'holes') are available for conduction purposes. To the extent that above about 100°C for germanium, and 150°C for silicon, the conduction is no longer really under control, and so devices like transistors, which use semiconductors, have to be kept below these temperatures, if they are to remain reliable during operation. The fact that silicon is useful as a semiconductor at high temperatures than germanium was the major reason for the increased use of silicon rather than germanium devices. ●

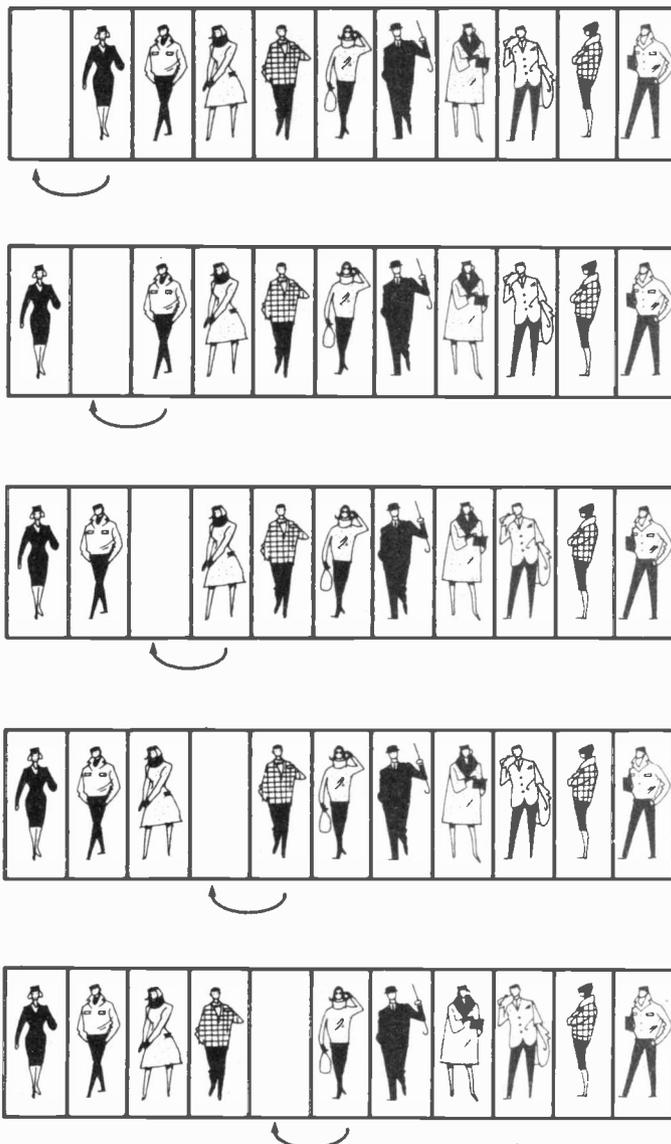


Fig. 5. As each person moves into the space next to them, it appears that the gap moves in the other direction. In the conduction band this is an electrically neutral space where there was previously a negative charge. These

'holes' can behave almost like a positively charged particle. When a potential difference is applied this 'hole' moves in the opposite direction to the electrons.



Excuse me M'lady, could you pass me a pear?

Yes, this woman has just been noticed by her dinner companions to be somewhat naked. This is due in no small part to her having no clothes on to speak of. Sometimes you can get away with this sort of thing, but it is something of an embarrassment if someone catches on during the

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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 100 nA to 10 mA. 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 immunity to stray pick-up. The non-inverting input of the IC1 is biased to the 0V rail by whichever of the range res-

istors (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.

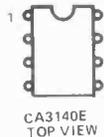
If an input current is connected to the unit, a voltage will be developed across the selected range resistor, this voltage being amplified to produce a positive meter deflection. With R2 switched into circuit, 10mA is needed to give full scale deflection of

M1, since 10mA will cause 10mV to be developed across R2 ($E = I \times R$, $= 0.01 \text{ A} \times 1 \text{ ohm} = 0.01 \text{ V}$ or 10 mV), and this will be amplified one hundred 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 10mV and give full scale deflection of M1.

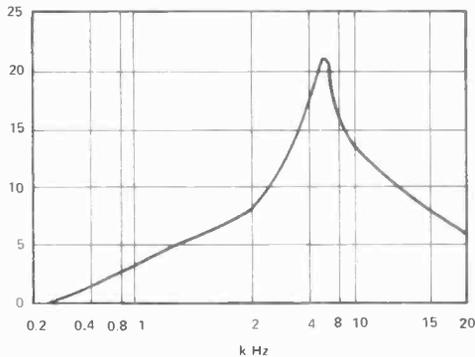
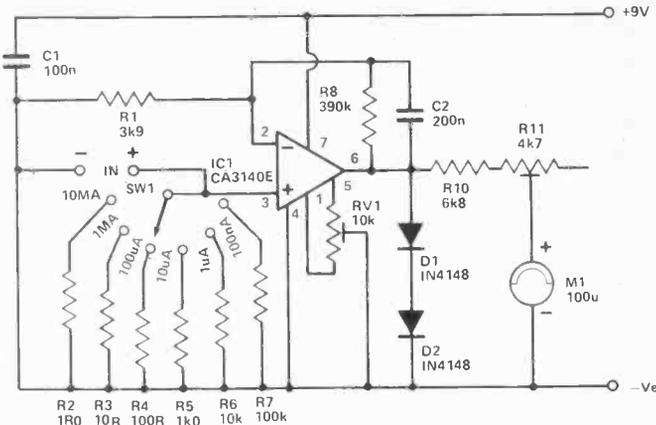
This arrangement relies on the amplifier having a very high input impedance so that it does not drop

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.



R1 TO R7 ARE CLOSE TOLERANCE TYPES



THE FREQUENCY RESPONSE OF THE TREBLE BOOSTER

TREBLE BOOSTER

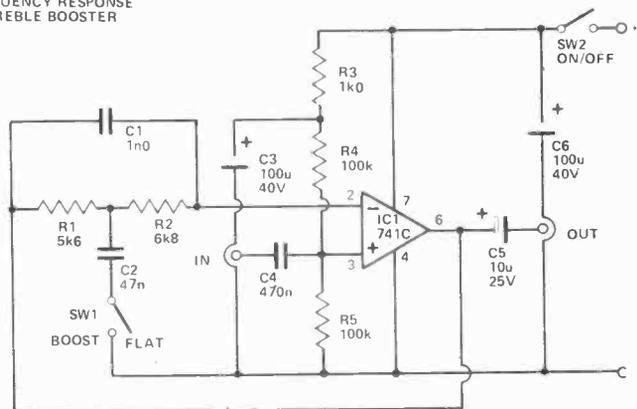
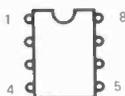
A treble booster circuit can be used with an electric guitar (and also electronic instruments) to boost the higher order harmonics and give a more "brilliant" sound. A circuit of this type gives a fairly flat response at bass and most middle audio frequencies, with the upper-middle and lower treble frequencies being given a substantial amount of boost. It is normal to

give only a modest amount of emphasis to the upper-treble in order to give good stability and a low noise level, and this also prevents the output from sounding too harsh. The frequency response of this treble booster is shown in the accompanying graph.

The circuit is basically just an op. amp. (IC1) used in the non-inverting amplifier mode. The non-inverting input is biased by R4 and R5 via a decoupling network which is comprised of R3 and C3. C4 and C5 give DC blocking at the input and output respectively. With SW1 open there is virtually 100% negative feedback through R1, R2, and C1, giving the circuit unity gain and a flat response. Closing SW1 brings C2 into circuit, and this decouples some of the feedback through R1 and R2 at frequencies of more than a few hundred Hz, giving the required rising response. Feedback through C1 at high treble frequencies causes the response to fall away about 5.5kHz, and prevents the very high frequency harmonics from being excessively emphasised.

As the unit has unity gain at frequencies where boost is not applied it can simply be connected between the instrument and the amplifier.

741C TOP VIEW



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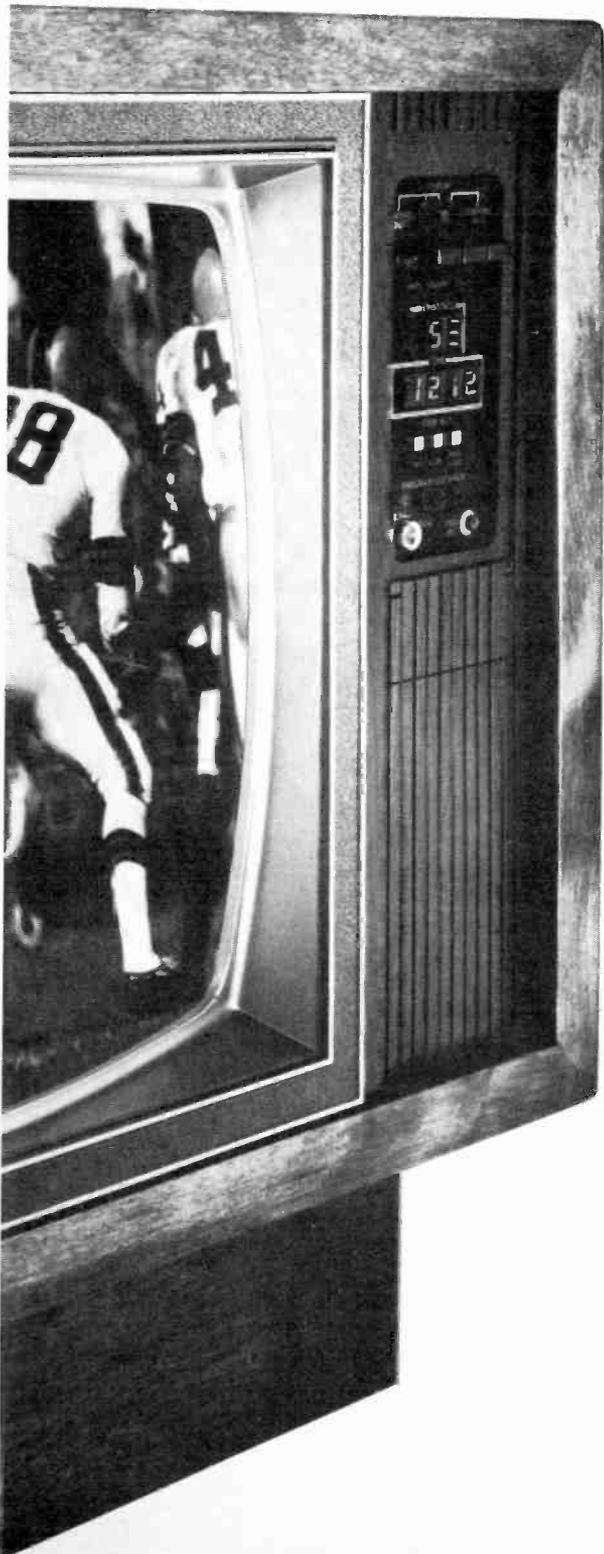
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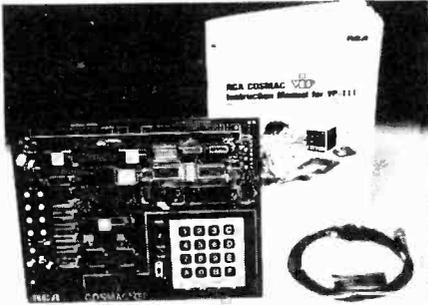
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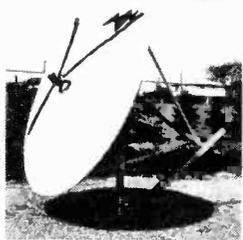
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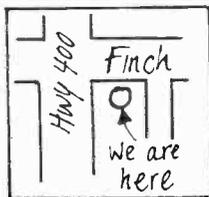
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ENGINEER'S STETHOSCOPE



This unusual device lets you locate or listen to internal engine sounds, such as the rumble of bearings or the rattle of valves. An essential project for the DIY nut.

THIS VERY UNUSUAL project enables you to effectively and effortlessly get right inside an engine and listen to, or locate, all of its internally-generated sounds, such as the noises of bearings, pistons, valves, etc. The device is fitted with a double filter network that can be used to pick out one set of sounds (such as those of the bearings or the valves, etc.) from all others, thus facilitating fault-finding on engines.

The Stethoscope project comprises an acoustic probe unit, a 'box-of-tricks' and a pair of conventional headphones. The headphones help muffle ambient sounds, so that you can concentrate on the sounds of the stethoscope even in a very noisy environment. The probe unit is used to make mechanical contact with the engine or mechanism under test and is coupled to the 'box-of-tricks' by flexible leads.

The probe unit relies on mechanical coupling or contact between itself and the engine (or

whatever) for acoustic pick-up. The coupling can be achieved either directly or by a metal rod. The rod can take any one of a variety of forms e.g. a screwdriver or a needle. If a needle probe is used, the stethoscope can even be used to listen to the sounds of individual jewelled bearings in a watch mechanism.

Operating Principles

The stethoscope operation relies on the simple fact that what is commonly called sound is a series of mechanical vibrations transmitted through a medium of some sort — air, water, metal etc. Thus, all the internally-generated sounds of a gasoline (or any other) engine, such as the sounds of valves, pistons, bearings, etc., are transmitted throughout the engine block and can readily be further transmitted down a metal rod (or screwdriver, etc) to the body of an acoustic pick-up device such as a microphone.

Our stethoscope relies on this mechanical coupling principle. We use a crystal mike as the pick-up device, with all of its air holes blocked off (to exclude dirt) and with the coupling made to its body either directly or by some kind of metal rod. The use of rod coupling enables the source of a given sound to be precise-

ly located within (say) an engine block, by simply probing to find the position of maximum noise. If a needle probe is used, the sound source can be located with pin-point accuracy.

Construction

The Stethoscope circuit is fairly simple and construction should present very few problems. Wire up the PCB first, noting the use of 20 Veropins to facilitate interwiring, as shown in the component overlay. When wiring up RV1 and RV2 take special care to connect the two halves of each component in the same phase, so that the resistances increase or decrease together.

On our prototype we've fitted the two 9V batteries into the top half of the case, secured by double-sided tape. We've fitted a small jack socket to the case top to facilitate connection to the external low-impedance headphones and have used a 3-pin socket for connecting the probe unit.

Finally, to complete construction, wire up the probe circuit as shown in the circuit diagram, taking care to fit Q1 and R1 as near as possible to the crystal mike terminals and connect the assembly to a suitable plug and lead.

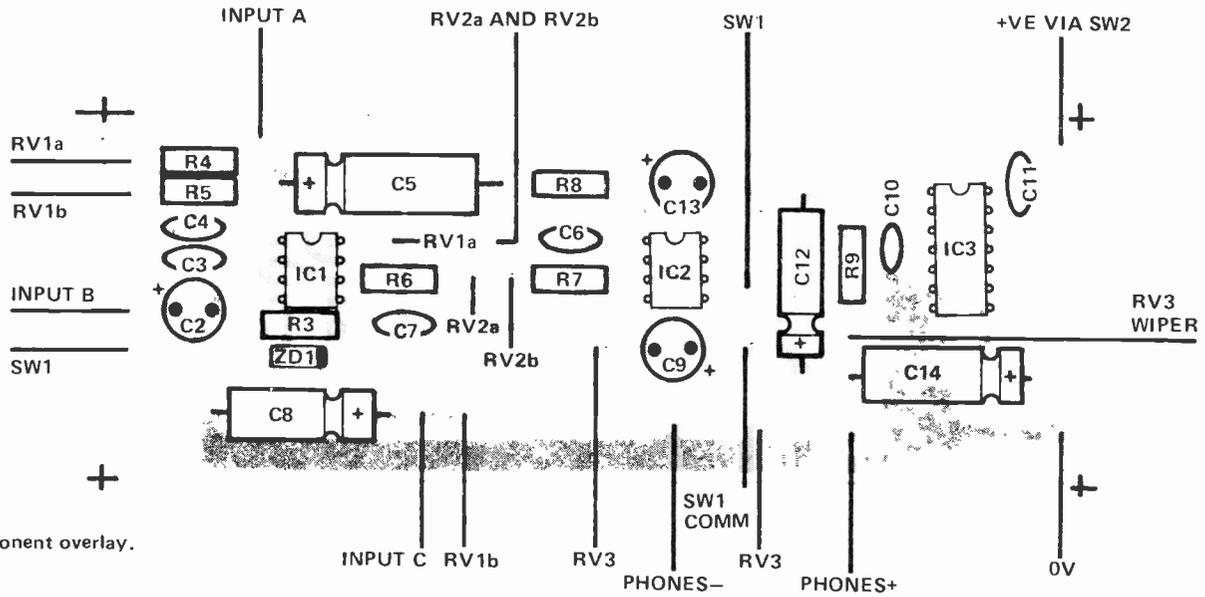


Fig. 1. Component overlay.

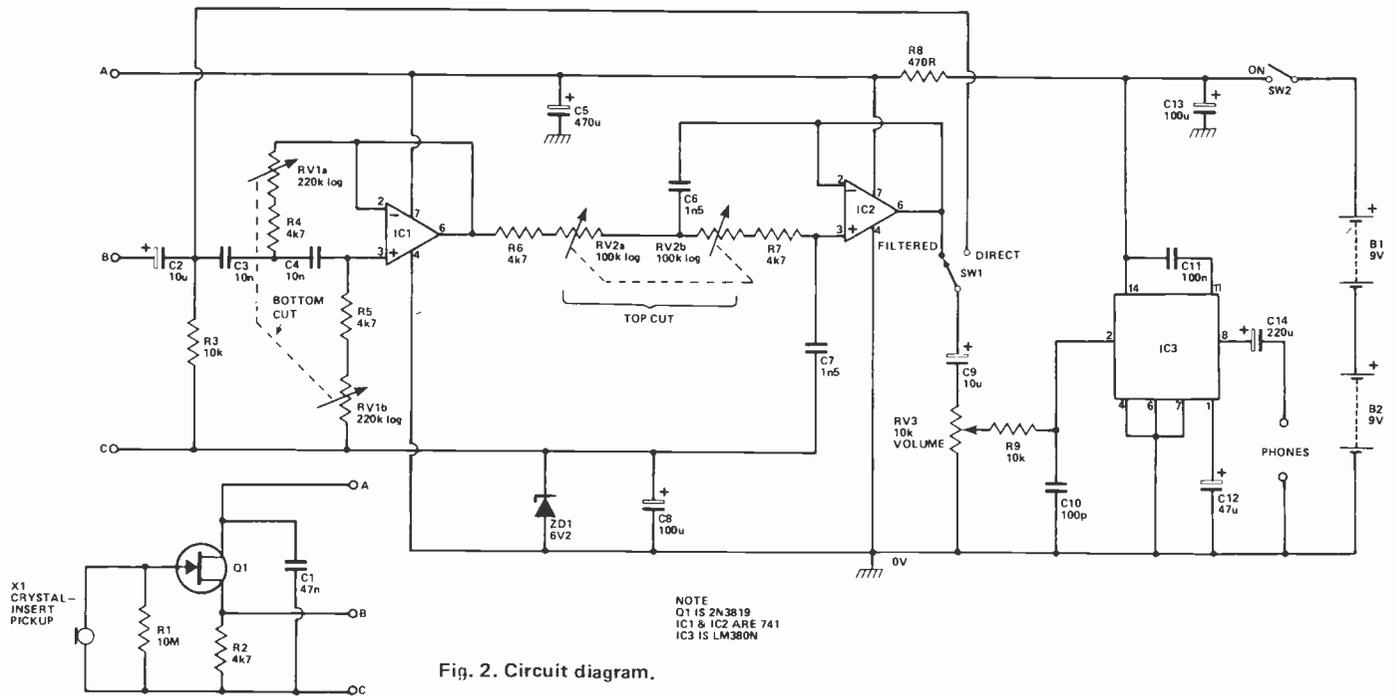


Fig. 2. Circuit diagram.

At this stage, give the unit a simple functional test by placing the head against the speaker of a small radio. Check that tone quality and volume can be varied with the three controls. When the above test is satisfactory, complete the probe construction by blanking off (with tape) any airholes in the mike (to exclude dirt and oil) and encapsulate the electronics in wax or resin. On the completed circuit the probe can be used as it stands or can be epoxied to a screw terminal or clip (or both) that can be used to make connections to a variety of probe types (metal rods, a screwdriver, etc). The Stethoscope is intended for use with a pair of headphones of not less than 8R0 impedance.

PARTS LIST

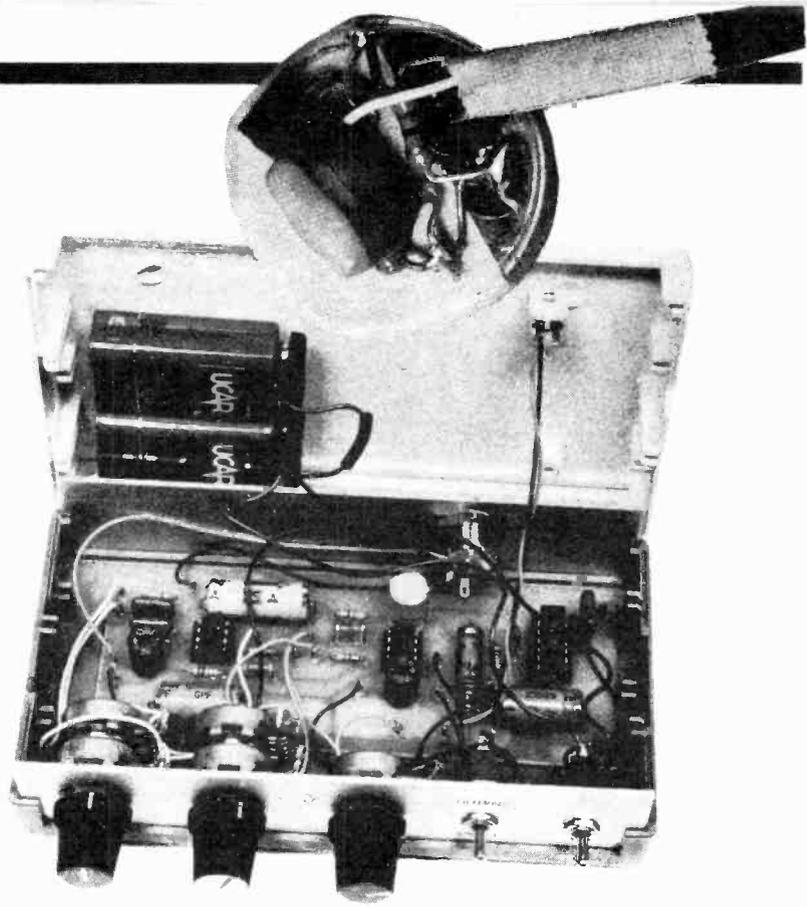
Resistors All 1/4 W 10%		C10	100p ceramic
R1	10M	C11	100n polyester
R2,4,5,6,7	4k7	C12	47u 25 V axial electrolytic
R3,9	10k	C14	220u 25 V axial electrolytic
R8	470R	Semiconductors	
Potentiometers		IC1,2	741
RV1a,b	220k dual logarithmic	IC3	LM380
RV2a,b	100k dual logarithmic	Q1	2N3819
RV3	10k logarithmic	Miscellaneous	
Capacitors		SW1,2	DPST miniature toggle
C1	47n polycarbonate	SK1	3-pin socket
C2,9	10u 63 V electrolytic, PCB type	SK2	3.5mm jack socket
C3,4	10n polyester	Case	Vero No. 202-21040
C5	470u 25 V axial electrolytic	3 off knobs to suit	
C6,7	1n5 polycarbonate	Crystal mike	
C8,13	100u 25 V axial electrolytic		

HOW IT WORKS

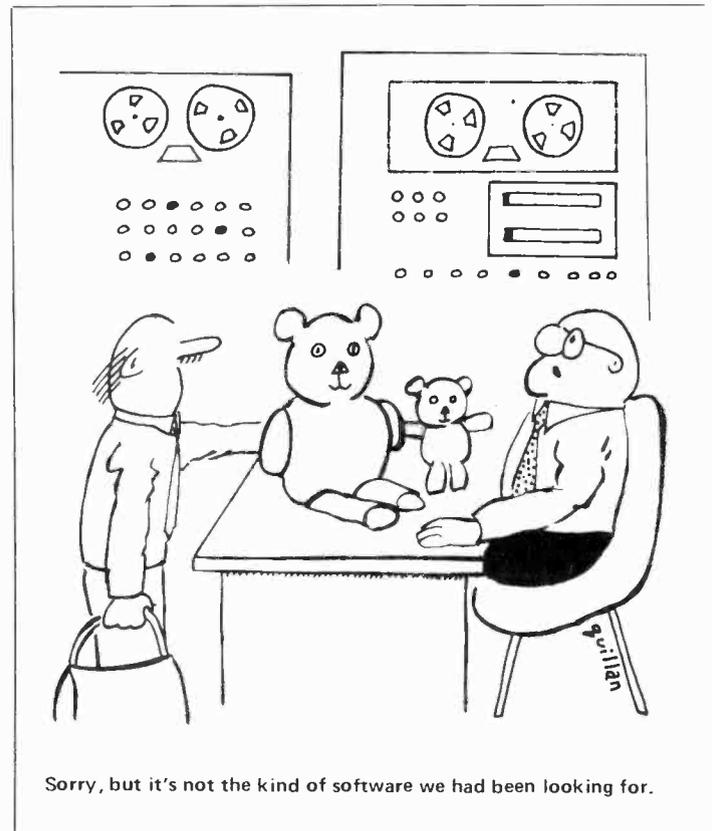
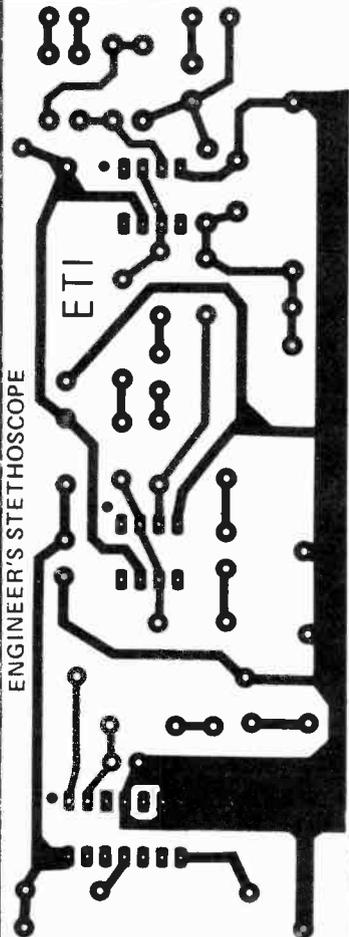
A common crystal mike is used as the pick-up device, with the external mechanical sound vibrations being fed to its body either directly or by a metal rod from the engine (or whatever) under test. FET source follower Q1 is wired directly to the output of the pick-up device, to give a low-impedance output from the resulting probe. The output of the probe circuit is then fed, either directly or through a double filter network, to a power amplifier stage (IC3) and then on to a pair of headphones.

When the stethoscope is used in the filtered mode, the output of the probe circuit is first passed through high-pass (bottom-cut) filter IC1 and then on to the power amplifier via low-pass (top cut) filter IC2. Both of these filters are second-order variable types. The IC1 filter can be used to reject signals below roll-off frequencies that are variable from 80 Hz to 3 kHz via RV1 and the IC2 filter can be used to reject signals above roll-off frequencies that are variable from 700 Hz to 15 kHz via RV2. These two filters can be used to pick out specific sounds, such as the low-frequency rumble of bearings or the high-frequency rattle of valves, from the broad spectrum of sounds that are generated by an engine.

The complete stethoscope is powered by a pair of 9 V batteries and typically consumes about 15 mA when driving a pair of 8R0 headphones. The split power supplies to the IC1-IC2 op-amp filters are generated with the aid of ZD1 and C8.



R1, R2, C1, and Q1 are wired directly across the mic. insert. We fixed our batteries to the top half of the case.



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AC VOLTS (5 RANGES): 200mV to 1000V full scale. RESOLUTION: 0.1mV. ACCURACY: ±1% + 2 digits. 45 Hz to 1kHz. ±5% + 5 digits to 5 kHz. INPUT IMPEDANCE: 10mΩ. OVERLOAD PROTECTION: 1000V DC/1750 RMS
RESISTANCE (7 RANGES): 20Ω to 20MΩ full scale except no 20Ω range on MX331. RESOLUTION: 0.01Ω on MX333, 0.1Ω on MX331. ACCURACY: 0.1% + 1 digit except 0.2% on 200Ω, 1% on 20MΩ, and 3% on 20Ω ranges. OVERLOAD PROTECTION: 500V DC on RMS all ranges plus 2A fuse on 20Ω range. TEST VOLTAGE: Low power. 0.25V max of full scale.
DIODE TEST (1 RANGE): Measures forward voltage drop across diode and transistor junctions at 2mA nominal current.
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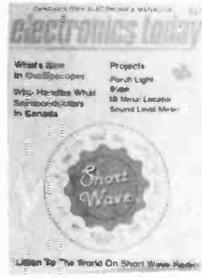
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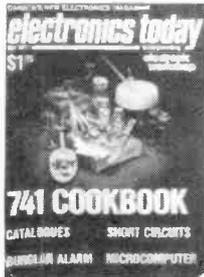
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Features: Personal Computing Commentary, CMOS Quickies, SSB by Phasing, History of Electronics in Medicine.
Projects: UFO Detector, CCD Phaser, Strobe.



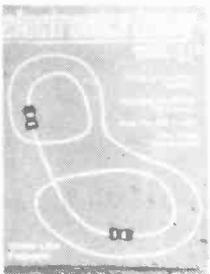
July 1977

Features: A Generation Away, I²L Explained, CB Supplement, Intro to Computers.
Projects: Mastermind, DVM, Overled, Turn Indicator Cancellor.



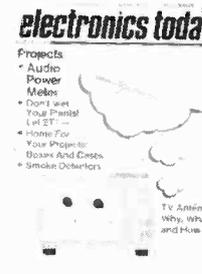
June 1979

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



May 1978

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



August 1979

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



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.



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 handy order form, which lists other back issues available, or just send to:

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

Help Us To Help You

Dear Reader,
In January 1978 we ran a reader survey to find out just where we stood with respect to the market in Canada. Since that time, however, ETI has undergone many changes and we would like to know if we are doing as good a job as we hope we are.

You may have been with us since the beginning, you may have just started subscribing or this may be the first copy you've ever seen. Whatever the circumstances, we want to hear from you. ETI is your magazine, and only you can ensure its continuing success.

Please take some time to complete this questionnaire and send it in to us. We promise to faithfully read every one, even the rude ones. Furthermore, we promise that all information will be used solely to improve the magazine.

A-The Magazine

1-Please rate this month's articles on a scale of 1 (pathetic) to 10 (excellent). If you did not read the article, please do not give it a score.

	Score	Comments
Autosound Survey		
Project Fault Finding		
LM3914 Circuits		
IC Master		
Michael Faraday		
Current Affairs		
How To Solder		
Engineer's Stethoscope		
Bargraph Car Voltmeter		
Universal Timer		
Motherboard		

2-Please rate our regular features, also on a scale of 1 to 10.

	Score	Always Read	Sometimes Read	Never Read
Audio Today				
What's New				
News Digest				
Fun Of Electronics				
Tech Tips				
Designer Circuits				

3-Have you constructed any of our projects? Yes No

4-How many projects have you built in the last year (from ETI or other sources) _____

5-Do you make your own printed circuit boards? Yes No

6-When building up a circuit, do you usually use:
Printed Circuit Veroboard Perfboard Wire Wrap Other _____

7-Please indicate (in order of preference) the types of projects you would prefer to see. Assign the projects you would like to see most a 1, the least an 8. DO NOT use the same number twice.

- ___-test equipment
- ___-games and novelty
- ___-audio
- ___-automotive
- ___-musical
- ___-alarms and switches
- ___-computing
- ___-photography
- Others (please specify) _____

8-Articles in the magazine come under various general categories. Please indicate your interest in each of the following:

Interest	High	Fair	Low
Complex Projects			
Simple Projects			
Circuit Features (including Tech Tips)			
News			
Computing			
Applications of Electronics			
HiFi/Audio			
Educational			
Historical			
Photography			

B-Buying Habits

1-When buying components or equipment, do you use:

- Mostly mail order
- Mostly over the counter
- A mixture of both mail order and over the counter
- Other (please specify) _____

2-Do you find that advertisements in ETI are useful when buying components or equipment?

- Yes, definitely
- Usually, but not always
- Sometimes but rarely
- No, not at all

3-Do you own:	Yes	No	Plan To Buy
A multimeter (not electronic)			
An electronic meter (VTVM)			
A digital multimeter			
An oscilloscope			
A function generator			

4-How much a) did you spend on yourself b) do you intend to spend in the coming year and c) how much of your employer's money do you spend each year on these products (where applicable).

	A				B				C				
	up to \$50	up to \$150	up to \$500	up to \$5000	up to \$50	up to \$150	up to \$500	up to \$5000	up to \$500	up to \$1000	up to \$2500	up to \$5000	up to \$10000
Audio equipment													
Test equipment													
Video equipment													
Electronic components													
Tools													
Computers													
Computer Peripherals													
Books on Electronics													

C-Distribution Information

- 1-Do you read ETI each month? Yes No
- 2-How long do you keep your copies of ETI?
 1 month
 2 months
 3 months
 6 months
 1 year
 Indefinitely
- 3-How did you obtain your copy of ETI?
 From a newsstand
 From a component store
 Subscription
- 4-If you subscribe to ETI, does your issue arrive:
 Early (before the cover date)
 On time
 One week late
 More than one week late
 If it does NOT arrive early, please give the first letter of your postal code (eg, for M4H 1B1, enter M) _____
- 5-If you bought your ETI from a newsstand:
 i) Was it available at the beginning of the month?
 Yes No Don't know
 ii) Do you find it hard to find a newsstand that sells ETI?
 Yes No
- 6-How many people read your copy of ETI?
 Nobody else
 1 other person
 2 other people
 3 other people
 4 other people
 more than 5 other people
 (please specify) _____
- 7-How did you find out about ETI?
 From a friend
 Saw it on a newsstand
 Through promotional literature in the mail
 Other (please specify) _____

D-Reader Profile Information

The following is for statistical use only and will be handled in confidence. Do not answer questions that you feel are objectionable or none of our business.

- 1-How old are you? _____ years
- 2-Sex Male Female
- 3-To what level were you in full time education?
 i) High school (grade 12 or 13)
 ii) Community college
 iii) University (Arts)
 iv) University (BSc)
- 4-Do you hold any credit cards, and if so which ones?
 Visa
 Mastercharge
 American Express
 Other (please specify) _____
- 5-What is your annual income? \$ _____
- 6-How do you rate ETI against other magazines? Use a scale from 1 to 100 with ETI scoring an arbitrary 50.

read	regularly	often	Used to	never	rating
ETI	X				50
Popular Electronics					
Radio Electronics					
Science and Electronics					
Byte					
Kilobaud					

- 7-Are you employed or otherwise occupied in electronics?
 Yes No

If yes, in what capacity?

- Management
 R & D
 Production
 Maintenance and servicing
 Buying
 Sales
 Clerical
 Technical
 Other _____
- 8-Are you a student studying full time? Yes No
 If so, are you currently in
 University
 Community College
 Correspondence course
 High school
 CEGEP
- 9-Are you considering further education in electronics?
 Yes No
- 10-What suggestions do you have for improving ETI?

- 11-What do you like about ETI?

- 12-What do you dislike about ETI?

Please address completed forms to:
 The Editor
 Electronics Today International,
 Unit 6, 25 Overlea Blvd., Toronto
 Ontario M4H 1B1

AUTO SOUND

There has yet to emerge a car stereo with a built in 16-track recording studio. Just about every other feature is available, as Wally Parsons explains.

AUTOSOUND HAS COME A LONG WAY from the days when it referred to "super" car radios and speakers for teen-agers with hot-rods, and sported brand names which seemed aptly to describe an acid-head. Although it is still possible to buy enough power to blow the windows out of your car (a documented fact) and holes between your ears, things have calmed down and the hucksters with the electric ties have gone out of business, leaving the field to saner heads.

Herewith, then, we present a summary of equipment available to the audiophile desirous of sane, high quality sound in his home on wheels. No claim is made to be all-inclusive; we have concentrated on the best of the serious manufacturers, rather than toymakers.

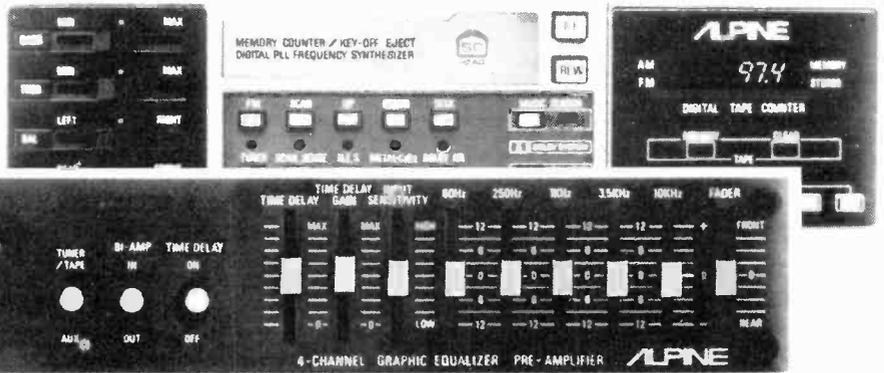
A brief summary of each line is followed by a tabulation of the products.

Standards In Transition

I should mention here that no official standards have yet been adopted as applicable to autosound equipment, unlike the IHF standards used with home gear. At the time of writing this state of affairs is in the process of correction. Consequently, there is some inconsistency from one manufacturer to another and even between different products of the same manufacturer. Frequency response, for example, is taken from the manufacturer's claims, and usually refers to cassette response, under worst conditions. Use of Dolby, high quality tapes, etc, may well result in better performance. Likewise with regard to power output and distortion. Generally the most conservative set of figures is quoted.

There is simply no room to list all special features. Therefore, one or two are singled out for each product, but may well be included in others of the same line.

And if there are any mistakes, they are probably those of Ye Olde Audio Editor who had to wade through mountains of data.



Alpine

Now there's a name to conjure up dreams of Gran Turismo as you tool about the slopes in an open top Alfa Romeo or a muscular Lamborghini. In fact, the line has a very European feel to it, although fully at home in North American machines, it would even be comfortable in the boss's Ford wagon, or my own T-Bird.

Here's a true specialist, who even makes available a variety of accessories, including noise suppressors. This is definitely a high end line which even features digital time delay unit, but prices are surprisingly modest.

Tastefully sporty.

Blaupunkt

The image here is that of Mercedes and the Autobahn, and movies and TV shows starring people like Roger Moore and Patrick McGooan.

Blaupunkt will not offer you a selection of umpteen gazillion different models, but the six receiver models cover the range in perfor-

mance from the simplest to the most elaborate. In addition, the line covers suppression kits, automotive burglar alarms which go off if anyone even contemplates theft, and manual and automatic antennas.

You're no more likely to find Blaupunkt in your local discount tire shop than you are to find Pirelli tires. Contact Robert Bosch, or try a Mercedes or Volkswagen dealer. And check out the original remote control on a flexible stalk, part of the Berlin 8000 model.

Stylish and businesslike.

Craig

What can we say; I understand the name is unknown on Gilligan's Island, but that's the only place.

Craig specializes in autosound aimed at the vast middle market, people who want sensible equipment at reasonable prices. That they've succeeded is attested to by the widespread popularity of their products. The line includes a couple of 8-track units, and possibly the only bass reflex autosound speaker on the market.



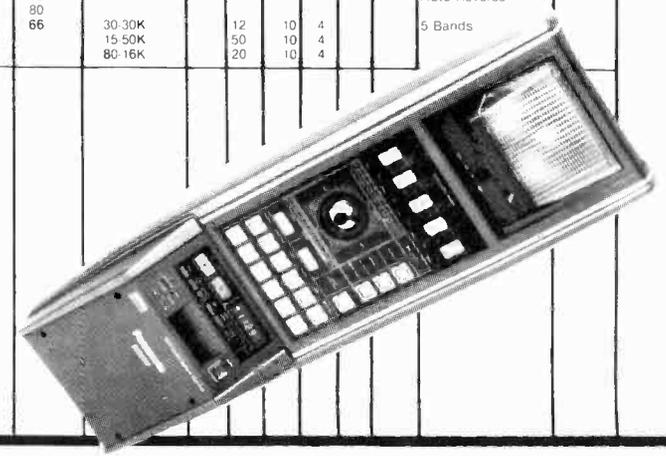
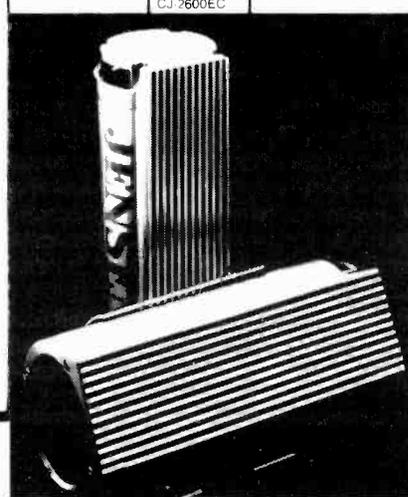
The Craig R3 and Blaupunkt Berlin 8000.



BRAND	MODEL	PRODUCT TYPE	AM?	FM?	STEREO?	DOLBY?	CASSETTE?	S/N RATIO, dB	FREQUENCY RESPONSE	WOW, FLUTTER, %	PWR, IN OR OUT	DISTORTION %	IMPEDANCE, OHMS	NUMBER OF SPEAKERS	WOOFER SIZE (Inches)	SPECIAL FEATURES	M.S.L.
Alpine (Alpine Electronics 101 Amber st. Units 18,19,20 Markham, Ont L3R 3B2)	7124	Receiver	X	X	X		X	55	40-12K	1	2.2	8	4			Auto Reverse	349 99
	7327		X	X	X		X									Music Sensor	599 99
	7100		X	X	X	X	X									5 Presets	299 99
	7111		X	X	X		X									Cassette Glide	299 99
	7114	Cassette Player														Auto Replay	279 99
	7120	Receiver	X	X	X		X	55	40-12K	1	2.2	8	4			Locking FF	369 99
	7121	(Expandable system)	X	X	X	X	X	55	40-12K	.1	2.2	8	4			Key of eject	499 99
	7123		X	X	X	X	X									5 Presets	569 99
	7128		X	X	X		X									PLL Digital Tuning	569 99
	7201	Receiver	X	X	X	X	X	50	40-12K	.1	2.2	8	4			Auto Replay	499 99
	7203		X	X	X		X									Noise Elimination	669 99
	7204		X	X	X	X	X									5 Presets	549 99
	7205		X	X	X	X	X									Tone Controls	629 99
	7206		X	X	X	X	X									Permalloy Head	729 99
	7212		X	X	X	X	X									Direction Ind	629 99
7213		X	X	X	X	X									Metal Tape	699 99	
7217		X	X	X	X	X									Locking FF	389 99	
7307		X	X	X	X	X									Music Sensor	699 99	
7308		X	X	X	X	X									4 Pwr Amps	1199 99	
Alpine	3000	Graphic Eq									20					5 Bands, 4 CH	299 99
	3001	Digital Time Del														2 IC's	149 99
	3002	Pwr amp									65	.2				Auto Rem. Pwr Sw	399 99
	3003	Graphic Eq														Bi-Amp Sw	219 99
	3004										20					LED Ind.	179 99
	3005	Pwr Amp/Preamp									20					Electronic Rhythm	469 99
	3006	Pwr Amp							20-20K		18	8	4			Micro Size	99 99
	3007	Amp/Eq									18					Bi-Amp	259 99
	3008	Pwr Amp									40	8	4			Micro Size	259 99
	3011	Graphic Eq							30-30K							LED Level Ind.	249 99
	6000	Speaker							20-20K					3	6 1/2	Piezo Tweeter	109 99
	6001										20			3	6x9		149 99
	6002										20			3	4		149 99
	6003										20			3	x10		149 99
	6004										20			3	5x7		149 99
6104										25			3			149 99	
6204										40			3			149 99	
6302								100-17K		20			3		Titanium Dome Tw.	259 99	
6302								40-20K		65			2	7	Dual Cone	69 99	
6302										50			3	6 1/2	Detachable Tweeter	299 99	
6202	Full range of accessories are available for use with all models									20			2	4	Dynamic Tweeter	159 99	
6202								100-17K					2	4		69 99	
Blaupunkt	CR2000	Receiver	X	X	X	X	X	53	35-10K	15	5	10				ASU Noise Sup	389 95
	CR4000		X	X	X	X	X	53								4 Amplifiers, ASU	489 95
	CR2001		X	X	X	X	X	53	40 14K	15	7					ASU, 5 Presets	519 95
	CR5001		X	X	X	X	X	54	35 14K	15	5	10				Sep. 4 Ch Pwr Amp	679 95
	CR3001		X	X	X	X	X	53	40-14K	15	15					4 Ch Rem Control	879 95
	Berlin 8000		X	X	X	X	X	56	63 14K	15	16	10				4 Ch 4 sep units	1795 00
	Bea 50	Graphic Eq							30 15K		20					5 Bands	124 95
	Bea 100	Eq/Amp							30-40K		15	10	4			4 Ch 5 Bands	219 95
	Bea 200	Amplifier							30 40K		15	10	4			4 Ch, Reverb	349 95
	7 444 230-119										7.5					4 ch	89.95
	7 444 230-120	Speaker (rear)									15					4 ch	149 95
	LA6687								80 16K		15		4	2	142 mm	2 way co-ax	
	LA6688								40 16K		20		4	2	240 x	co-ax	
	LA6725								80 18K		15		4		170 x	Dual Cone, Round Frame	
	LA6728								80-18K		15		4	3	160	Triax round frame	
LA6721								50 15K		10		4	1	160	Closed Box		
LA6729								70-20K		15		4	2	140	Closed		
LA6731								70-20K		15		4	2	205	Closed		
LA6526								125-14K		5		4	1	150	Closed, Swivel mt		
LA6640								100-12 5K		5		4	1	170	Limited Space		
LA6545								100-12 5K		5		4		118	Slant box		
LA6665								140 14K		4		4	1	115	Closed box		
LA6668								115-14K		5		4	1	130	Closed, Limited Space		
LA6668														129			
Blaupunkt	LA6723	Door/Rear Spkr							70 15K		8		4	1	121	Small Size	
	LA6724								70-15K		10		4	1	133	Large Magnet	
	LA6726								80-15K		8		4	1	134	Square Grill	
LA6727	Also Available, Antennas, Suppression Kits, Alarm Systems, Accessories							70-15K		10		4	1	134	Useable near window crank		
Craig (Withers-Evans 5925 Ambler Dr. Mississauga, Ont L4W 2K2)	V451	Speaker							60-20K		40		4	4	6x9	Separates Mesh/Chrome Grill	
	V350								65-16K		25		6	3	6x9		
	V362								60-20K		25		6	2	6x9		
	V360								70-18K		25		8	2	4x1C		
	V240								80-15K		25		4	1	4x10	Twin Cone	
	V341								90-20K		15		6	1	4x6	Late GM Dash Mt	
	V321								70-20K		25		6	2	5 1/4		
	V304								70-16K		25		8		5		
	V103								80-17K		10		6	1	5 1/4		
	V102								90-16K		8		6	1	5 1/4		
	V300								130 13K		15		8	1	3	Dash Use	
	V101								120-14K		8		6	1	4		
	V301								120-20K		15		6	1	4		
	V480								120-20K		12		4		4	Twin Surface Mount	
	V180								140-15K		7		4	1	3x5	Padded Grill	
V380								80-10K		20		8			Horn Dome		
V190								100-15K		10		6			Convertible Mount		
V732								50-17K		50		6	1	5 1/4	Trans-Ribbed Cone		
V731								60 17K		50		6	1	5 1/4			
V771								50-17K		50		6	1	6x9			
V772								45-17K		50		6	1	6x9	Bas Reflex		

BRAND	MODEL	PRODUCT TYPE	AM?	FMT?	STEREO?	DOLBY?	CASSETTE?	S/N RATIO, dB	FREQUENCY RESPONSE	WOW, FLUTTER, %	PWR, IN OR OUT	DISTORTION %	IMPEDANCE, OHMS	NUMBER OF SPEAKERS	WOOFER SIZE (Inches)	SPECIAL FEATURES	M.S.L.	
Craig	T687	Receivers	X	X	X	X	X			2	12.5	1	4			4 ch 5 presets elec tronic tuning		
	T690		X	X	X	X	X			.15	12	5	4			5 Presets		
	T689		X	X	X	X	X			.09	14	5	4			Power Loading		
	T681A		X	X	X	X	X			.12	12	5	4			Tape End Eject		
	T619		X	X	X	X	X			.18	8	5	4			Tape Search & Play		
	T634		X	X	X	X	X			.15	4	5	4			Preamp Output		
	T638		X	X	X	X	X			.12	4	5	4			Auto Pwr Ant Sw		
	T618		X	X	X	X	X			.1	4	5	4			Dial Dimming		
	T614		X	X	X	X	X			.12	4	5	4			Locking F F		
	T639		X	X	X	X	X			.12	4	5	4			Compact Chassis		
	T640		X	X	X	X	X			.15	4	5	4			Auto-Reverse		
	T617		X	X	X	X	X			.12	4	5	4			Power Loading		
	T610		X	X	X	X	X			.15	4	5	4			Stereo/Matrix P.B.		
	S632		X	X	X	X	X			.2	4	5	4			8 Trk Auto/Man P6M		
	S699		X	X	X	X	X			.15	4	5	4			10 Stn. Preset		
V930		X	X	X	X	X									Auto Rev			
T103	Cassette Player										4	5	4		7 Band Graphic Tr.			
R551	Equalizer					X		75	20-20K		4	5	4		B-Amp 4 Ch Time Delay			
R550	Pwr Amp							75	20-20K			.03			B-Amp			
R511									30-20K		50	1	4	2ch	4 Independent Amps			
R510									30-20K		25	1	4	4ch	Bridge Output			
R501									20-60K		30	1	4	4ch				
R502									30-20K		15	3	4		Switchable Sens			
									30-20K		15	3	4		Auto Pwr Switching			
									30-20K		25	1	4					
Concord Paco Electronics Ltd 20 Steelcase Rd.W Unit 10 Markham Ont L3R 1B2	HPL-101	Receiver	X	X	X	X	X		30-20K	.08	5	8	4			Line output jacks	349 95	
	HPL-112		X	X	X	X	X	58	30-20K	.08	5	8	4		Sim chassis	449 95		
	HPL-115		X	X	X	X	X	58	30-20K	.08	12	8	4		3-Band bass eq	549 95		
	HPL-120		X	X	X	X	X	58	30-20K	.08	12	8	4		Quartz clock	649 95		
	HPL-506		X	X	X	X	X	58	30-20K	.08			8	4	No amp 3 band eq	579 95		
	HPL-512		X	X	X	X	X	58	30-20K	.08	12	8	4		DC servo	649 95		
	HPL-515		X	X	X	X	X	58	30-20K	.08	12	8	4		Bi-amp crossover	749 95		
	HPA-41	Power Amp	X	X	X	X	X	58	30-20K	.08	20	06	4		Dual line outputs	199 95		
	HPA-45		X	X	X	X	X	58	20-20K		20	06	4		Output protected	199 95		
	HPA-70		X	X	X	X	X	58	20-20K		20	06	4		Dynamic com pliance	259 95		
HPS-150	Speaker							20-20K		50	05	4		Dynamic com pliance	539 95			
HPS-201	Powered Spkr							50-20K		12		4	1	5	Thin design self powered with mounted dynamic compliance amp	74 95		
								50-20K		24		4	2	6x9		249 95		
FUJITSU Ten INORESCO Canada Inc. 50 Wingold Ave Toronto Ont M6B 1P7	SP 600S4	Under-Dash Cassette					X		65-12.5K		4	10	4			Auto Eject	179 50	
							X		65-12.5K		4	10	4			Slide Controls	159 50	
	SP 770						X		65-12.5K		4	10	4			Auto Reverse	199 95	
	SP 780						X		65-12.5K		16	10	4			Hall Effect I C	249 50	
	SP-785						X		30-15K		4	10				Dial in door	229 50	
	DP-1000	Receiver (in-dash)	X	X	X	X	X		30-15K		4	10				Short Chassis	259 50	
	DP-1006		X	X	X	X	X		30-15K		4	10				5 Presets	299 50	
	GP-1010		X	X	X	X	X		30-15K		16	10				MOSFET Front End	389 50	
	CR-1030		X	X	X	X	X		30-15K		4	10				Soft Muting	479 50	
	CR-1130	Preamp-deck-tuner	X	X	X	X	X		60-15K		5	10	4			5 Band Graphic Eq	799 50	
	EP-820	Receiver	X	X	X	X	X		30-15K		5	10	4			Adjustable Shafts	299 50	
	DP 7872	(in-dash universal)	X	X	X	X	X		30-14K		5	10	4			No Pwr Amps	329 50	
	DP 7874		X	X	X	X	X		40-12K		4	10	4			4 Pwr Amps	399 50	
	DP 7881	(DIN STD)	X	X	X	X	X		30-15K		10	10	4			Pwr Ant Lead	299 50	
	DP-640		X	X	X	X	X		30-15K		4	10	4			Auto Reverse	389 50	
	DP-644		X	X	X	X	X		30-15K		4	10	4			Noise Blanker	299 50	
	GP 1010	Graphic Eq/Preamp	X	X	X	X	X		20-20K							Visual Curve	199 50	
	CA 200Q	Pre-Amp Graphic														500-2500 mSec	279 50	
	RV 130-Ex-1	Trme Delay														Visual Display	299 50	
	AT-7831	Receiver/Preamp	X	X	X	X	X		65-12.5K							PLL I.C	289 50	
SP-711	Remote Controller														Anti-rolling System	139 50		
CA-100	Power Amp														For component systems	119 50		
PA-130								70	60-20K		12	5	4		Power Ind	169 50		
PA-150								70	30-20K		40	3	4		4 Ch	249 50		
PA-200									30-20K		40	3	4		Die Cast Heat Sink	449 50		
PA-160									30-20K		40	3	4		4 Ch	449 50		
Fujitsu Ten	SSB-864	Speaker							60-15K		20		8	1	6	Double Cone	54 95 pn	
	SSB-4G57								60-15K		20		4	1	5	Wide Harness	74 95	
	SSB-4G64								50-20K		20		4	2	6	Wire Mesh Grill	99 95	
	SG-1602	Door Mount Spkr							50-20K		30		4	1	6	Wire Harness	79 50	
	SG-103								90-16K		30		4	1	4	Simline	59 95	
	SG-1002	Enclosure Spkr							90-16K		70		4	1	4	Simline	89 95	
	SSB-4B37								70-22K		40		4	2	4	Dome Tweeter	199 95	
SSB-4B39	Wide Range of Ac- cessories For Above							70-22K		60		4	2	4	Aluminum Encl	249 95		
Grundig (Interpal 1055 Yonge St Suite 303 Toronto, Ont M4W 2L2)	GEM5000	Receiver	X	X	X		X					4	2			8 Track	229 00	
	GCM4650	Receiver	X	X	X		X					4	2			Bias switch	299 00	
	GCM8100	Receiver	X	X	X		X					4	4			Motorglide	379 00	
	GCM8200	Receiver	X	X	X		X					4	4			Flatnoze Motors	399 00	
	GCM9200	Receiver	X	X	X		X					4	4			Flatnoze Motors	629 00	
	GCV2700	Receiver	X	X	X		X					4	2			Electr Tuning	639 00	
	GC9300	Receiver	X	X	X		X					4	2			Metal Tape	489 00	
	WKC2035	Receiver	X	X	X		X					4	2			Din Hi-Fi tuner	409 00	
	GAA7500	Eq											4			4 x 15 W	159 00	
GAA7700	Eq											4			4 x 20 W LED peak	229 00		
Hepner (Paco)	6930-4	Speaker							35-20K		100		4	3	6x9	Available in 8ohms	239 95PR	
	6928-4								35-20K		75		4	2	6x9		189 95	
	6924								40-4K		100		8	1	6x9	Sub-woofer	144 95	
	6910								35-18K		25		8	2	6x9		109 95	
	4128								70-20K		50		8	2	4x10		129 95	
	5216								60-20K		50		8	2	5 1/4		139 95	
Jensen Series II	E2000	Enclosure Spkr							43-40K		55	2	4	2	4 1/2	Passive radiator	289 95	
	E1001	Speaker system							35-20K		50	1	4	3	6x9	Separate drivers	259 95	
	E1033	Speaker kit							38-40K		100	4	3	6x9	Triax	219 95		
	E1130								43-40K		50	2	4	3	4x10		219 95	
	E1124								58-40K		75	1	4	3	5 1/4	Separate bass unit co ax	219 95	
	E1037								38-20K		90	8	4	2	6x9		159 95	
	E1201								55-20K		50	1	4	2	6 1/2		149 95	
	E1041								58-40K		75	1	4	2	5 1/4		132 00	
	E1126								63-40K		50	1	2	4	2	4 1/2		125

BRAND	MODEL	PRODUCT TYPE	AM?	FM?	STEREO?	DOLBY?	CASSETTE?	S/N RATIO, dB	FREQUENCY RESPONSE	WOW, FLUTTER, %	PWR. IN OR OUT	DISTORTION %	IMPEDANCE	SPEAKERS	WOOFER SIZE (Inches)	SPECIAL FEATURES	M.S.L.		
Jensen Series II	E1242	Speaker Kit (All include Mounting Hardware And Grills For 1 Pr.)							40-20K				55	4	4	6 x 9 4 Way 6 x 9 3 Way Triay 4x10 5 1/2 6 x 9 2-Way Coax 4x10 6 1/2 5 1/2 4 1/2 6 1/2 Dual Cone 4 1/2 Piezo Tweeter 4 1/2 4 1/2 4 1/2 3 1/2 Same 6 x 9 Dual Cone 5 1/2 Same 4 1/2 Same	219.00		
	E1065		169.95																
	E1101		169.95																
	E1174		175.00																
	E1069		109.95																
	E1105		109.95																
	E1188		109.95																
	E1077		109.95																
	E1093		95.00																
	E1245		59.95																
	E1186		99.95																
	E1263		64.95																
	E1134		49.95																
	E1117		39.95																
E1073	79.95																		
E1069	67.95																		
1097	59.95																		
Jensen (Len Finkler Ltd.) 80 Alexander Rd Downsview, Ont. M3J 2B4	R430	Receiver	X	X	X	X	X	50	50-10K	15	2	1	8	(Front Rear)	Bi-amp c/w separate Amps 4 pwr. amps 5 AM, 5 FM presets synthesized tuning digital readout Memory Switches 5 Presets Solenoid Tape Eject LED Function Ind	799.95			
	R420		X	X	X	X	X	50	50-10K	12	1	1	8			649.95			
	RE518		X	X	X	X	X	50	50-10K	2	1	1	8			649.95			
	RE512		X	X	X	X	X	50	50-10K	4	2.5	4	4			599.95			
	R410		X	X	X	X	X	50	50-10K	4	2.5	4	4			519.95			
	R406		X	X	X	X	X	50	50-10K	2	1	1	8			499.95			
	R401		X	X	X	X	X	55	50-10K	2	1	1	8			489.95			
	R402		X	X	X	X	X	50	50-10K	2	1	1	8			399.95			
	R400		X	X	X	X	X	50	50-10K	3.5	2.5	4	4			359.95			
	R210		X	X	X	X	X	50	50-10K	2	1	1	8			359.95			
	R200		X	X	X	X	X	50	50-10K	2	1	1	8			359.95			
	A124		X	X	X	X	X	80	50-10K	2.5	2.5	4	4			259.95			
				Power Amp							50-12K	2.5	2.5	4		4		259.95	
											20-20K	50	6	4		4		499.95	
									20-20K	25	6	4	4		349.95				
									20-20K	15	3	4	4		179.95				
									60-20K	17	3	4	4		229.95				
																329.95			
MetroSound (Paco)	MS 531-3X	Speaker							60-22K				35	3	5 1/2	Grills available separately 4 or 8 ohms convertible mount enclosed	89.95		
	MS 69-2024X		50						50				4	6x9	79.95				
Paco	MS 69-2023	Receiver	X	X	X	X	X	50	30-20K	25	50		3	3	6x9	Auto reverse PLL circuitry ABS Cabinet	69.95		
	MS 410-2023X		X	X	X	X	X	50	30-20K	25	50		3	3	4x10		64.95		
Panasonic (Panasonic Canada) 5770 Ambler Dr. Mississauga, Ont L4W 2T3	EAB-920	Rear deck spkr							30-25K		50		4	6x9	Piezo mid/high Dome tweeter	79.95			
	EAB-940								40-20K		50		2	6x9					
	EAB-752	Door panel spkr							80-20K		10		2	6x9	Dual cone Titanium dome tweeter	64.95			
	EAB-772								70-18K		10		1	6x9					
	EAB-930	Front dash spkr. Door panel spkr.							50-20K		50		2	5 1/2	Waterproof C/W fitting plates Thin grill	64.95			
	EAB-910								300-15K		50		1	5					
	EAB-030								80-16K		10		1	5					
	EAB-911								100-20K		10		1	3					
	EAB-909	Enclosed rear deck spkr. Rear deck spkr							70-15K		10		1	5	Co-axial Dual cone Wood case	369.95			
	EAB-753								70-20K		10		1	5 1/2					
	EAB-773								45-25K		10		2	5 1/2					
	EAB-800								100-20K		10		2	5 1/2					
	EAB-814								100-20K		10		2	4x10	159.95				
	Panasonic	CQ 5780EC	Receiver	X	X	X	X	X	50	30-15K	18	4	10				Preamp out, Pwr. ant. Cont. 5 Presets Repeatrack Graphic Eq. Bi-Amp Capability Graphic Eq. No Amp Digital Clock AM Ant. Trim 8-Track Digital Clock Pwr. Ant. Cont. Pre-Selects Overhead Console Led Meter High Filter 4-Way Balance Preamp Out Tone Control Auto Reverse 5 Bands		
CQ 5710EC		X		X	X	X	X	50	30-15K	18	4	10							
CQ 5740EC		X		X	X	X	X	50	30-15K	18	4	10							
CQ 5700EC		X		X	X	X	X	50	30-15K	18	4	10							
CQ 5680EC		X		X	X	X	X	50	30-15K	18	4	10							
CQ 7600EC		X		X	X	X	X	50	30-15K	18	4	10							
CQ 7400EC		X		X	X	X	X	53	30-15K	18	4	10							
CQ 8530EC		X		X	X	X	X	45	30-15K	18									
CQ 6800EC		X		X	X	X	X	53	40-12K	3	10	10							
CQ 2800EC		X		X	X	X	X	45	40-12K	3	5	10							
CQ 5900		X		X	X	X	X	50	50-10K	3	7	10							
CQ 5900		X		X	X	X	X	50	40-12.5K	18	4	1							
CQ 5820		X		X	X	X	X	50	50-12.5K	18	4	1							
CQ 5646		X		X	X	X	X	50	80-10K	18	4	1							
CQ 5756		X		X	X	X	X	50	80-10K	13	2	3							
RM-710		X		X	X	X	X	50	80-10K	13	2	3							
CQ 5700		X		X	X	X	X	50	30-14K	13	10	5	4						
CQ 5710		X		X	X	X	X	50		20		5	4						
CQ 5740		X		X	X	X	X	50	80-10K	18	4	1	4						
CQ 5780		X		X	X	X	X	50	80-10K	18	4	1	4						
CX 5200EC				Cassette Player							80-10K		18	4	1	4			
CX 7200EC											80-10K		18	4	1	4			
CX 1200EC											80-10K		18	4	1	4			
CA 9600EC											80-10K		18	4	1	4			
CJ 3600EC				8 Track Player Tuner Graphic EQ Pwr Amp	X	X	X			68	40-12K								
CJ 5000EC										80	30-30K	12	10	4					
CJ 2600EC										66	15-50K	50	10	4					
											80-16K	20	10	4					



Concord

Here is another name which may not be well known to audiophiles, but is quickly making a reputation in the field of autosound. Like many component quality specialists, the line does not offer more models than the GM lineup, and their idea of a simple basic car radio would make many home systems look like fancy portables.

The emphasis is on performance specifications, especially low distortion with relatively high power output. This is the only line to my knowledge which uses a form of motional feedback which they claim acts as an automatic all band equalizer to smooth out response of the speaker and its acoustical environment. Trade named "Dynamic Compliance" it is also featured on the HPS-201 self-powered speaker.

There is an extensive applications guide, to assist in matching car and sound system.

Fujitsu Ten

Like most of the manufacturers presented here, Fujitsu Ten specializes in autosound products. Many of the receivers have memory functions in their tape facilities, and Dual Gate MOS FET front ends for improved FM performance under the unpredictable reception conditions encountered on the road.

In addition to universal in-dash and under-dash models, the line includes mini models for use in compact cars and a series meeting European DIN specifications for European vehicles. There is also a cassette player, Model SP-600S4 designed specifically for the Datsun 280ZX.

The Graphic Time Delay incorporates a unique display consisting of a window which changes colour from green to red as reverb increases. Most intriguing to watch.

Jensen' RE 518 and the Roadstar.



Grundig

Grundig is the name which appeared on the best portable short wave receiver ever made. It appeared on this side of the big pond in the form of Hi Fi consoles which never claimed to be hi fi but kicked the bejabbers out of all the big department store coffins sold at the time. This was our first taste of German technology, and we liked it. You can still get it in their autosound line, high quality products with a definite understated European look.

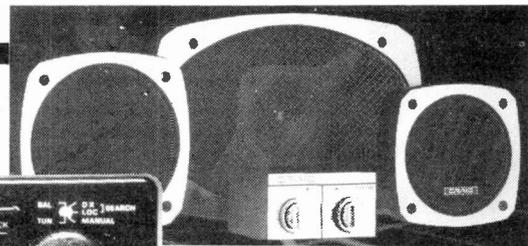
Their best units feature "Motorglide", which is not exactly an automatic transmission, but a system which automatically takes the cassette from your hand as you begin to insert it, then finishes the job. Very handy when driving along the Queen Elizabeth Way surrounded by maniacs playing "chicken" with their tractor trailers.

Jensen

One of the oldest and most experienced manufacturers in the field, Jensen can trace its lineage all the way back to Danish audio pioneers. It's reputation was built on high performance professional speakers, the best known of which was the original Triaxial. Jensen entered the auto sound arena when everyone else thought it was a big joke, and became best known for its Triaxial automotive speaker.

Besides expanding its speaker line, Jensen now produces a full range of electronics, including such unusual products as the EQ400, a 15 band graphic parametric equalizer, and the J2000 Mini Speaker.

Jensen's product application guide is one of the most extensive, and covers just about any combination of car and sound system imaginable.



Grundig's GCV 2700 a/b and Jensen Speaker.

Panasonic

Most autosound manufacturers are specialists, but Panasonic is one of the few broad line manufacturers who is also represented.

Best known to audiophiles for the Technics line, Panasonic autosound features the variety of models and the design innovation which as we've come to expect. To the best of my knowledge, their RM-710 is the only complete system designed for use as an overhead console. Dubbed "The Cockpit", it even includes a dome light, low distortion high power amplifiers and separate front and rear channel amplification. Must be seen to be appreciated.

Roadstar

With a name like that you expect an autosound specialist, and that's exactly what you get. Design emphasis is on solving the kinds of problems peculiar to the automotive environment, such as power supply fluctuations. Roadstar includes a regulated power supply on most models as a matter of routine.

The line includes the "Cobra Head", a remote control unit mounted on a flexible stalk. Unusual, and most practical.

Sound Barrier

This is a relatively new name, which first appeared with a miniature loudspeaker, one of the first of the super compacts boasting very high performance for the size. Since then they've branched out into a full line of speakers and electronics, but perhaps their most interesting products are their self-powered speakers.

A major problem with any high powered autosound system is the placement of a separate power amplifier. Usually it winds up in the trunk, often exposed to some danger if the owner often carries a lot of stuff in the trunk. Self-powering integrates the amplifier chassis into the speaker frame, for more efficient use of space.

Con't on page 78



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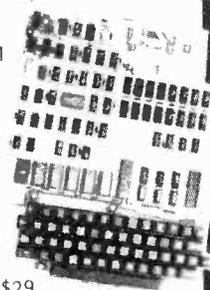
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MOTHERBOARD

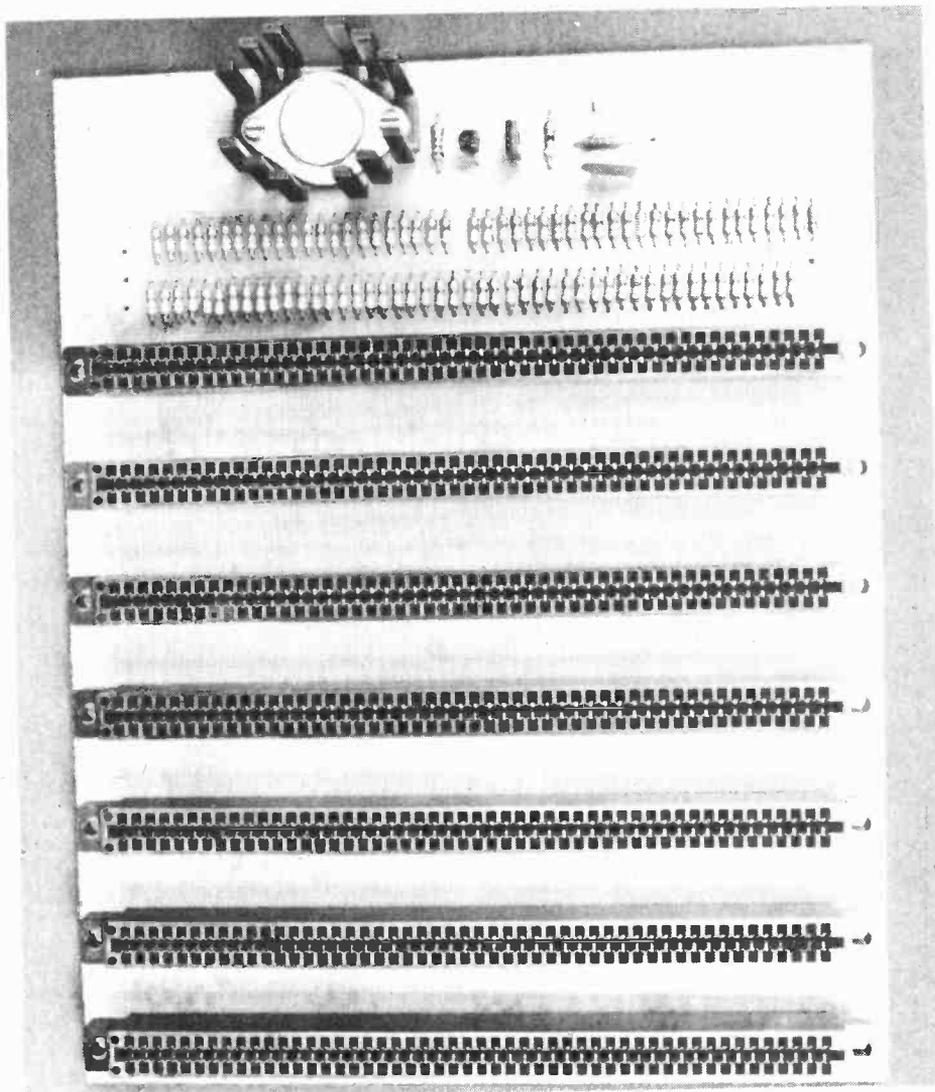
THE MOTHERBOARD described here is a low-cost 'starter' for the hobbyist who has blown all his cash on more important things, like the CPU and a speech synthesizer. Mounted in a cheap case, or even standing alone, the board will connect and support up to seven S-100 cards, and can be expanded.

Construction of this board is very simple. Once the pcb has been made, it's a good idea to check for continuity along the length of the tracks. After this has been done, the sockets should be soldered in, and a second check done, this time looking for shorts between adjacent tracks. Keep in mind that adjacent tracks don't go to adjacent pins on the sockets, but to opposing ones.

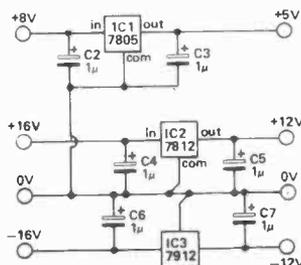
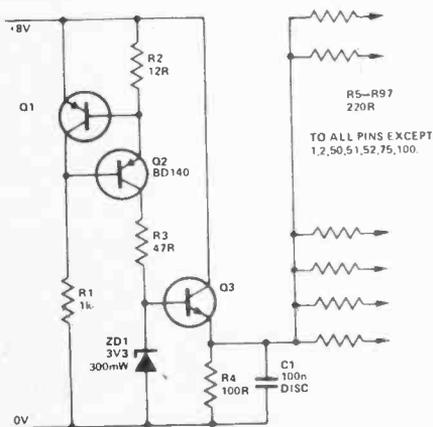
Next, the active termination resistors can be soldered into place, if required, and the regulator assembled. After a final eyeballing, the board should be ready to use.

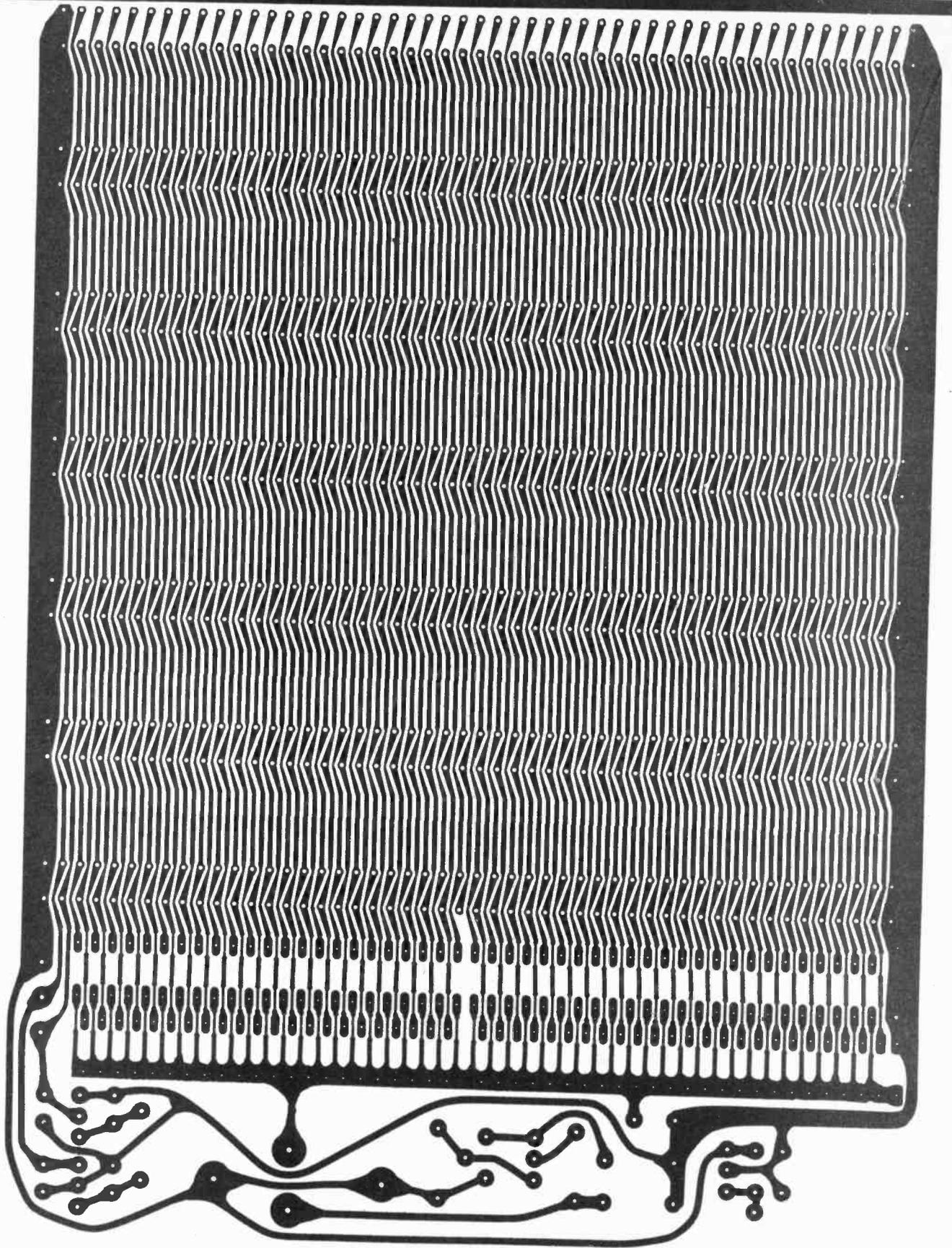
The capacitance between the tracks of the board is fairly high, which will limit things slightly. One could extend the artwork for the pcb out to hold, say, fourteen sockets, but this would add to it still more. For instance, 4 MHz Z-80 cards may experience problems with the motherboard, in which case they should be switched to 2 MHz if possible.

Ideally, the motherboard should come to live in a case, with plastic card guides to support the cards and reduce the stress on the board. If you're really bent on doing it 'on the cheap', two pieces of hardwood with slots cut to accept the S-100 boards will serve almost as well as commercial card holders.

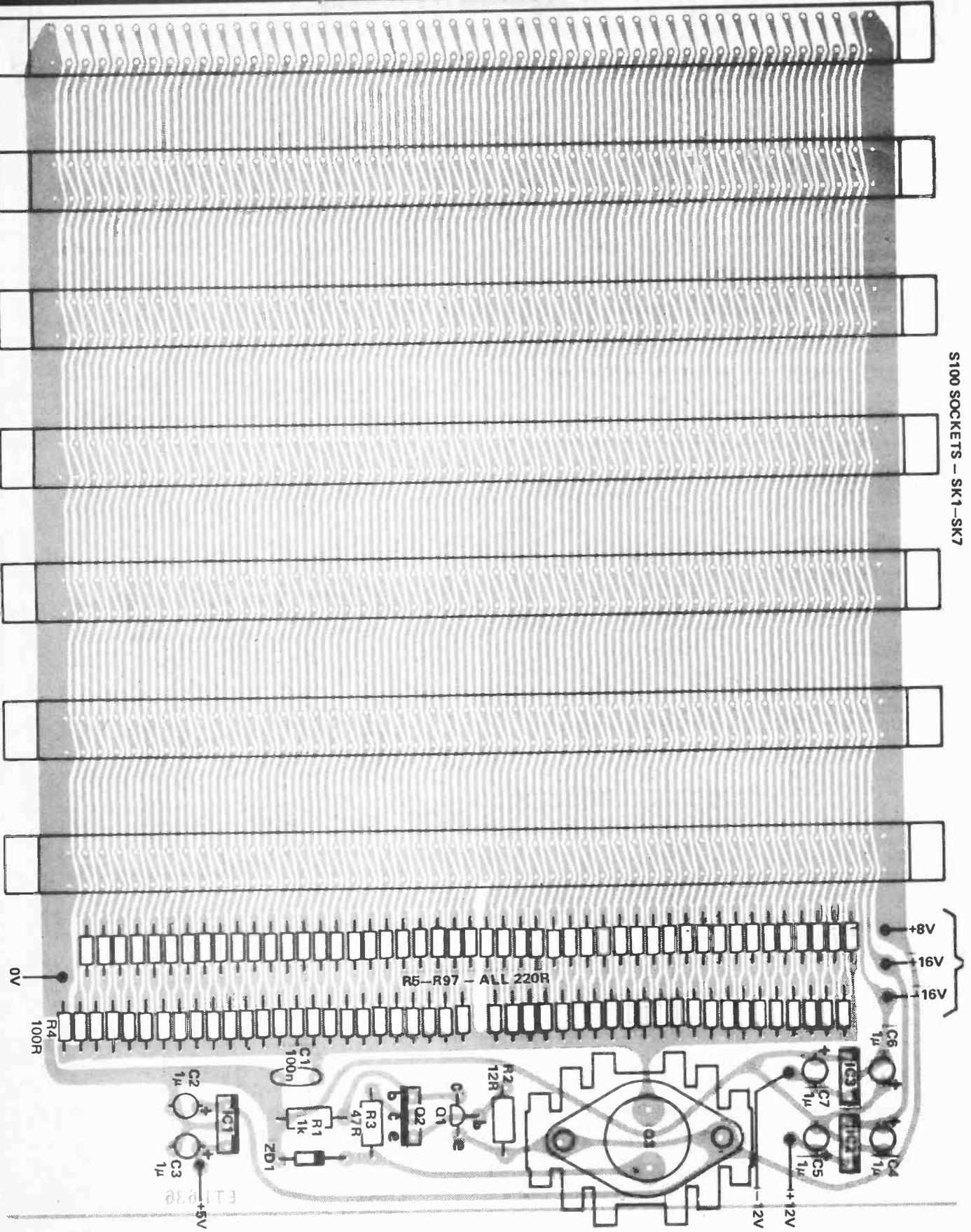


Overall view of the S-100 Motherboard. We have not mounted the extra power supply regulators and components on the board.

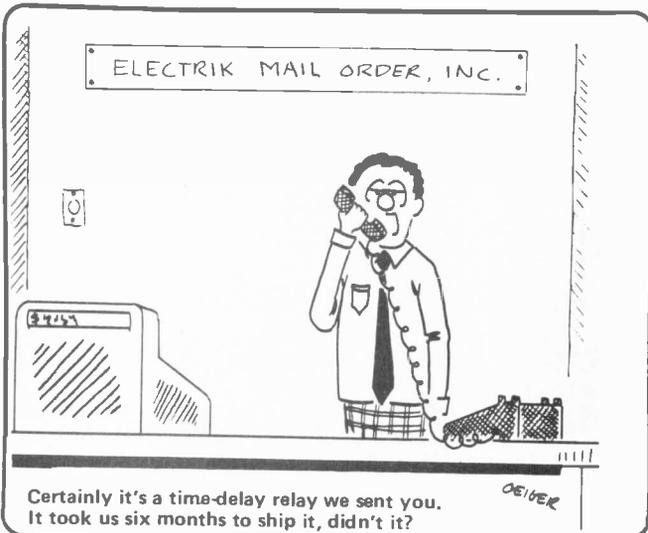
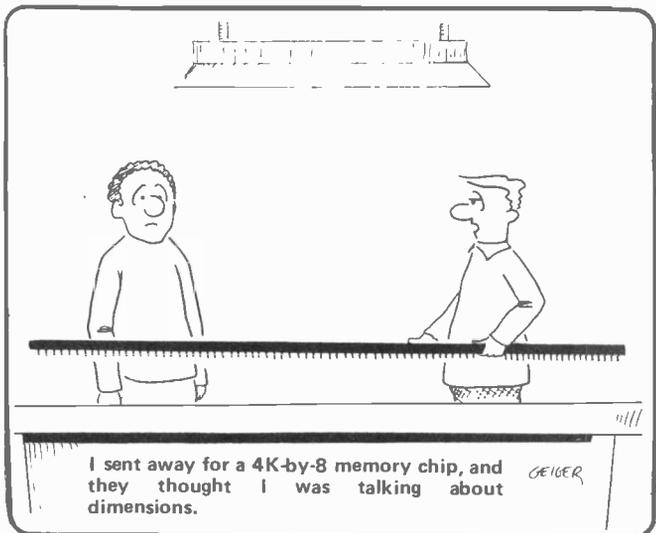
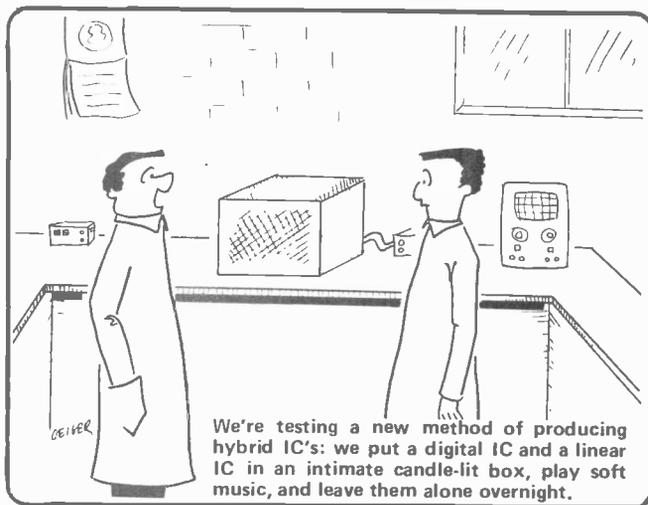
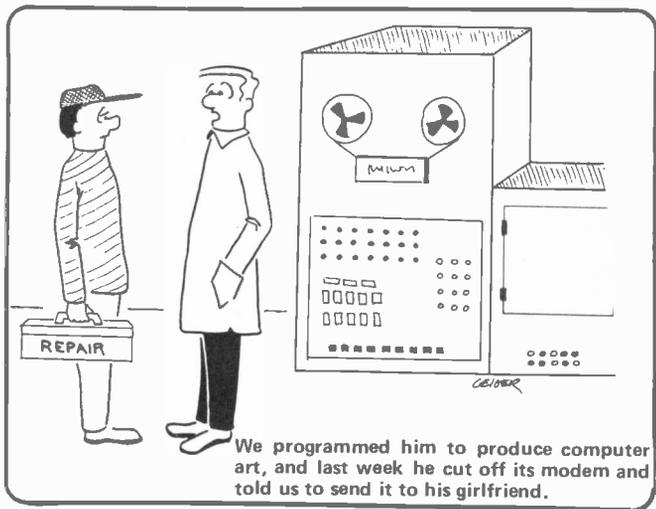
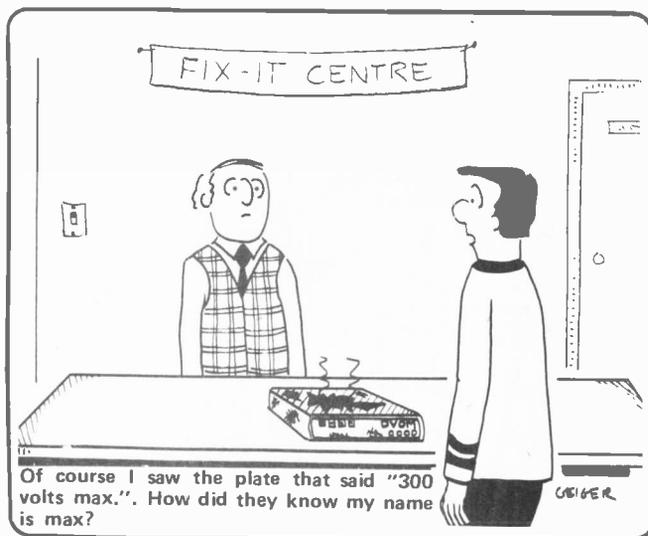
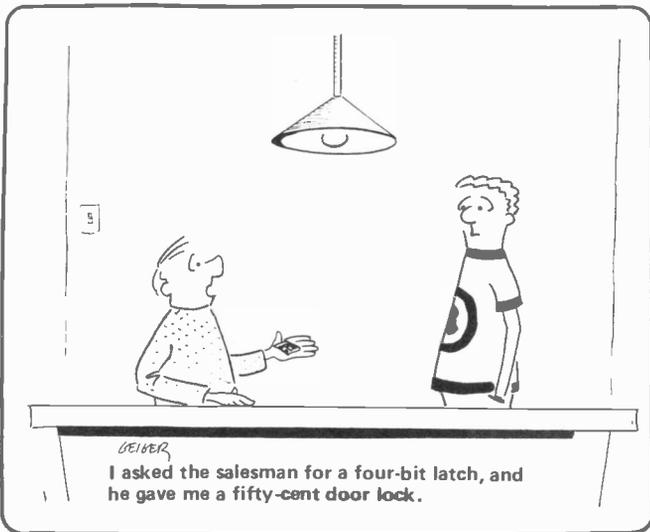




S100 SOCKETS - SK1-SK7



Continued on page 64





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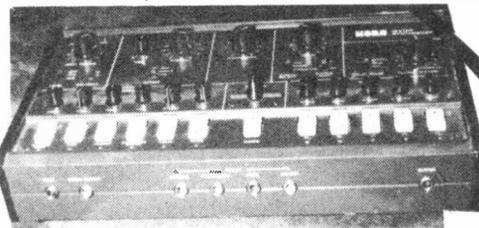
The Tale of the Wombat and the Aardvark

THERE ONCE WAS AN AARDVARK, and a very fine aardvark he was, as aardvarks go. He lived on a slime island in a beautiful festering swamp, where he ate bugs that would have grossed out most other creatures, and caught diseases at a rate of one a month. However, he was happy, because pretty well everyone in the swamp was coated with slime, so it was pretty difficult to tell that he was actually an aardvark . . . he looked like an ambulatory landfill sight, just like everyone else.

One day, a big truck backed up to the swamp and heaved a whole pile of agent orange into the swamp, because they couldn't figure out what else to do with it. Almost immediately, the bull-rushes started turning brown, the slime dried up, and the bugs started mutating 'till they were too gross, even for the aardvark. After a while the neurons in the aardvark's brain started misfiring, and he went a little crazy. He began running as fast as he could, until he came to the highway, where he started trying to suck in bugs off the asphalt. He shortly had an unpleasant experience with a '65 Ford Fairmont. He wandered up and down the soft shoulder until he was discovered by a middle aged lady from a local wildlife group, who had never seen so wretched a creature as he, and felt he might be endangered. She put him in the back of her pick-up, and took him back to headquarters.

At headquarters, the lady put the aardvark into a cage, which, by chance, was right beside that of a furry brown wombat, who had recently escaped from a research lab, where he had been eating acne cream for science. There had been a few good headlines' about him being the last living wombat in North America. That was until someone found out that wombats came from Australia.

The wildlife society was determined to save the wombat at all costs. He had, to date, had eighteen operations. He had had an artificial liver installed, a genetically cloned right lung, an electric heart with an atomic power cell to run it, one bionic leg, a synthetic eye capable of rendering thirty two shades of grey, a micro-miniature subcutaneous implanted dialysis unit in place of his kidneys, a micro-computer to control the epilepsy caused by the lesions in his brain inadvertently created when his hypothalamus was replaced with that of a monkey, and a Dow-Corning stomach made of materials invented for use in space.



The wombat had, to date, cost \$1,137,985.89 to keep alive . . . He was 78% synthetic. A regular, natural wombat could have been flown in from Australia for \$235.00. In fact, the Australian consulate had offered to do it for free if the wildlife society would just let the thing die in peace.

Needless to say, they had too much invested. The middle aged lady tapped on the bars of the wombat's cage. "Wommy wommy wombat", she cooed. This was a mistake. For some reason, it caused the wombat's computer to malfunction. It triggered a seizure, which overloaded the atomic power pack, which in turn switched out the dialysis machine, and sent a reflex nerve pulse to the bionic leg, which drove itself right through the bars of the cage, finishing off the aardvark. The atomic pile went critical, and the state had a new glow in the dark landmark for light aircraft.

This is a story about synthesis, and the hazards involved in going too far. This month, we're going to look at guitar synthesizers.

Guitar Synth.

A synthesizer isn't actually played . . . it's controlled. This relationship can be thought of as being very much like that of Tory politicians. It is a very important distinction, no matter which side you voted for, as a synthesizer is not, by definition, an instrument in the same way as a guitar or a harpsichord. Like a "real" instrument, it has bits to produce sounds and bits to effect their control by the musician, but, unlike in an acoustic noisemaker, these two aspects are wholly separate, in a comfortable, modular sort of way. The sound producing parts do not specify the nature of the sound controlling parts. This is kind of useful, because it means that if you don't like the controller you are presently working with, you could possibly have it done away with, and replace it with something . . . new and improved.

Now then, there are all sorts of controllers. Most are pretty ginchy. Some, like Moog's ribbon controller, were devised so as to make the synthesizer most accessible, but without much regard for what was going to be done on it . . . hopefully, to play something similar to music. As the evolution of the instrument progressed, its designers began to realize that contemporary instruments, which operated by essentially acoustic and mechanical means, had gone through no end of tedious development to get to where they were, and represented fairly nice optimized trade-offs in versatility verses manipulability. Thus, it has come to pass from up on high, or wherever it is that things come to pass from in Southern California, that synthesizers usually come equipped with something that looks like a familiar traditional instrument.

This has, in the past, usually been a keyboard, because keyboards operate very much like switches, and switches are fairly easy dealt with by engineers. They can be encoded, matrixed, pulsed, keyed, overheated, fused, burned out and replaced by updated versions having 18.925 more operations if used in atmospheres of liquified nitrogen. Not altogether a bad scene, either, because keyboards are played, to some degree, by quite a number of musicians. Lot of piano lessons when they were six, one might suppose. However, this left out a whole lot of other heads, with caluses and short fingernails on one hand, yes, my brothers, I speak to you today of the most noble, most elegant, most splendid . . . electrical guitarist.

You see, the keyboard of your average synthesizer produces not notes, but voltages, which then go on to produce notes somewhere else. Not so with a guitar, which actually churns out notes right from the start. Your basic synth doesn't have the first thought about what to do with pitches; it wants DC levels and that's, like, it. Period. Mojo uptight that way.

The electric guitar, however, is a superbly playable instrument, and, if it were, in fact, usable as a controller, a lot of rather nice things would come down. There are things easily done on guitar that aren't pleasant at all to have to try on keys. (The same is, of course, also quite true in reverse). However, the problem of getting those strings interfaced with a Moog type synthesizer is quite a hassle.

Look, Ma, No Strings.

The first approaches along this line were the touch sensitive guitars . . . eez seemple, no; wee yust tek off ahl dee streengs, hokay? This was, in effect, a guitar shaped bit of wood with ribbon controllers in the neck representing strings. The idea was that you touched the ribbons instead of fretting the strings, and, in some incarnations, tapped little short strings or bars down where the pickups would have been to provide triggers. Quite a novel approach to the problem, and, boy, was it awful.

As any good calculator manufacturer known, when you gots yer fingers coming in contact with mechanical objects and/or devices, you've gotta have tactile feedback, or your digits won't know that they've done anything. It takes significantly longer for one to do something,

witness the result through another sense, such as hearing, even if it is instantaneous . . . it frequently is not with a synthesizer . . . and then affirm that one's fingers are cool and wonderful, as opposed to getting that information directly through the skin. Thus, whereas a stringless guitar is, in theory, faster to play, it isn't really all that cool because you have to wait a lot longer to make sure you're actually playing what you had in mind.

Would have been great if it had worked.

The problem in using a guitar as a controller still remained one of interfacing a real guitar. The next approach to this got into something a little closer to practicality . . . the pitch to voltage converter. This is, in fact, the heart of a usable guitar oriented synthesizer system . . . something to take notes and derive control voltages from them. However, it isn't as easy as just ordering up a pitch to voltage converter chip and applying power. Nothing worth doing is ever that easy.

Something to take notes and derive control voltages from them

This sort of circuit has a number of conflicting demands made on it. Chief among these is that it have a wide range and a fast settling time. Your average guitar has better than three octaves of sound from the low E to beyond the twelfth fret of the high E. At the same time, it has a very fast attack. The converter has to take any incoming pitch in this range and churn out a DC voltage linearly proportional to it. It has to do so very quickly, and without slewing from one level to the next for a period long enough so as to be audible. It has to be accurate to within about a twelfth of a semi-tone, so the thing doesn't sound like a washtub bass. All this isn't easy . . . in fact, until quite recently, it wasn't even really possible.

The earliest attempts to do this compromised on the range, in a rather clever fashion. Guitars, as we all know, have six, count 'em, strings, of which each is responsible for a portion of the range. Thus, the early guitar synth systems came with special pickups to be installed in the guitars to be used with them. Instead of having all the coils essentially tied together, they were each run out separately, with the result that the

signal was neatly divided into several bands of somewhat more restricted range. It wasn't quite so difficult getting converters to handle these. More recently, multiple pole, ultra-steep filters have been used to arrive at much the same sort of result. There are designs, however, for contemporary converters, that can actually handle the range.

Like the more common keyboard type synthesizers, guitar synths have gradually metamorphosed into two types; the pure studio machine, in the classical Moog configuration, and the normalized stage model. The differences between these two are largely dictated by the requirements of where they're played. In the studio, it's not really important how long it takes to set up a patch, just so long as the maximum capability of the instrument is taken advantage of. The patching system can be as clumsy as one likes, right down to the venerable old patchcords of the first synthesis designs. On the other hand, when you're up on stage in front of nineteen screaming fans and a cocker spaniel, you don't want to be stopping the show after every song to change the knobs and wires, now, do you? You also probably won't want to be synthesizing crump horns or East Indian nose harps, so those sorts of capabilities can be done away with. Stage machines, then, make use of a finite number of presets and fixed, switch operated patch matrixes, so as to be operable real quick like.

Most of the current crop of guitar boxes are of the stage oriented design. The reason for this is rather nebulous . . . it has more or less just happened that guitarists don't seem to want to fool around with knobs as much as keyboard players. Unlike keys, which have been responsible for creating a lot of the "new wave" sounds and other suchlike abominations, the roll of the guitar synthesisist seems to have become more of the provider of other acoustic instruments. With a presettable synthesizer, the lead player can do horns, violin, bass, and so on. This hasn't really had much appeal for studio work, as it is quite simple, in this context, to drag in real horns, violins, basses and etceteras . . . not economical, mind you. Etceteras command a pretty high price these days.

The Works

The accompanying block diagram should give some insight into the innards of a typical guitar synthesizer.

Some systems include other things not shown here, like artificial reverberation or some sort of chorusing, but these are not, strictly speaking, part of the synthesizer. They represent the fine art of guiding the lily . . . necessary, actually, because of the inherent simplicity and "dryness" of purely electronic sound.

The guitarist . . . or whatever he is . . . plugs the output of his instrument into a preamp. This is usually more than just a bit of gain. It can be adjusted, usually with the assistance of some sort of level detection circuitry, to get the range of the incoming signal into the neighbourhood of activating the trigger circuitry, but not to the point where upon it clips out and gets distorted . . . the high frequency harmonics produced by distortion can confuse the workings. This gets sent on to the envelope detector, which detects the changing amplitude of the signal. When it reaches a given level, the Schmitt trigger gets Schmitted and possibly triggered, firing off several soon to be mentioned bits.

At the same time as all this is happening, the pitch to voltage converter is doing its scene, as previously discussed. Because the guitar signal dies off shortly after it is initiated, the pitch to voltage converter's output is fed into a sample and hold. This is a circuit which charges a capacitor to a given value . . . the output of the converter . . . and, upon command (a pulse from the Schmitt trigger), remembers it. It gets buffered through a very high impedance amplifier, so the charge on the capacitor will remain effectively constant for the foreseeable future; a few minutes, anyway. Thus, the guitarist can pack up and go home, and the synthesizer can still hold its note. Neat, huh. . .

The sample and hold churns out what is, in essence, the main control voltage, the one that's proportional to the incoming pitch. This may be fed into an octave divider, which would chop it by a half or amplify it by two. One could also have the same effect by putting a frequency divider either between the pre-amp and the converter, or between the VCO's and the VCF's.

The control voltage meanders along to the VCO(s) to get them to the same pitch as the guitar, and to the VCF(s) to get them to track the VCO(s). As you may have gathered, the number of these modules is indeterminate . . . one will suffice, but two or more, even if they're on the



Fig. 1. The Korg, a typical guitar synth.

same frequency, will sound much richer due to phase errors. The oscillators and filters are also modulated by a low frequency oscillator, to effect vibrato, such as in a violin sound, and by envelope generators, to effect dynamic timbral

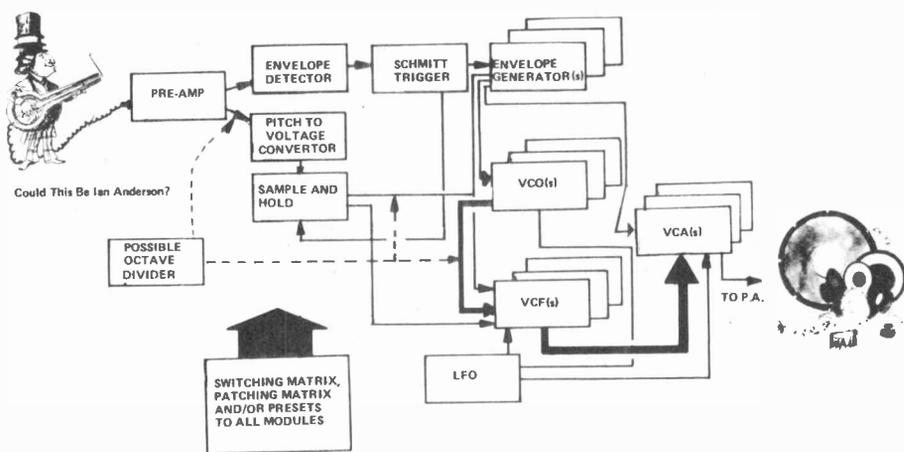


Fig. 2. The interior decorating of a synthesizer

changes, as in a horn.

After all this, the amplitudes of the various signals are set and controlled by the VCA(s), which are also fed by the low frequency oscillator, which produces tremolo, as in a flute sound, and by still more envelope generators, which impose the characteristic amplitude dynamics of whatever instrument is being synthesized.

Lastly, we have that big box marked "Switching Matrix . . .". This can be any one of a number of things, determined by the of synthesizer in question. As can be seen in the accompanying photographs, the little Korg box uses quite a sophisticated system of presets,

such that one switch might adjust almost every module in the instrument in one shot. The miracle of voltage control.

Whether or not guitar synthesizers are a real genuine advance in instruments, or just a nifty new effect, destined to go the way of the flanger and the fuzz box, remains to be seen. Probably more important is whether they actually do something creatively useful, or are they just an expedient to permit hiring fewer musicians. Great toys, though.

Hail and Farewell

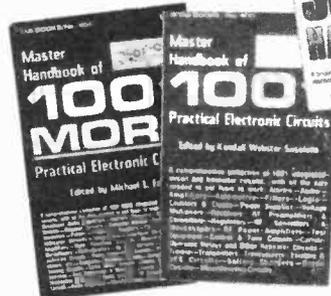
How many wombats are needlessly sent into critical mass and atomic self destruct each year by middle aged ladies with good intentions?! More than you might think, but certainly fewer than you need worry about, unless you live due North of Nebraska in a three story split level light house backing onto a stream. Can an aardvark that's stoned on industrial waste and defoliants reasonably be expected to make a liv-

ing ingesting insects while people are starving in South America? Finally, if a chicken and a half can lay an egg and a half in a day and a half, how long would it take a monkey with a wooden leg to kick all the seeds out of a dill pickle?

Very heady stuff, this. Something to meditate on while picking away on your guitar synthesizer. Next month, we'll be back . . . or, at least, I will be, with a brand new topic, and many of your favourite words. Now, be a good head. Turn down the volume on the magazine so you don't keep the folks next door awake.

And do stay tuned. ●

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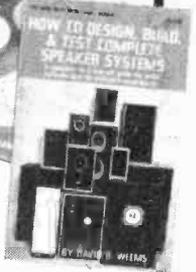
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But that isn't all — once you've learned what makes a synthesizer work and how to produce all kinds of music and sound effects, Horn includes a full section on how to build your own. There's even a list of universal patch diagrams to assist you in your tinkering and experimenting. If you'd like a book that gives you solid, practical help in choosing and using — or building — a synthesizer, this informative manual is your best choice.

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INTO ELECTRONICS (Part 10)

Having spent the last nine chapters at the basics of electronics, Ian Sinclair now turns his attention to bigger things. This month, AM & FM radio.

WE'VE COVERED A LOT of ground in these past nine chapters, looking at the components and the circuits that make up the building-blocks of electronics systems. Now it's time to look at what we build with these circuits, the electronics systems which we make so much use of these days. We'll start with one of the oldest of electronics systems, radio.

The history of radio started when Heinrich Hertz in 1888 showed that electromagnetic waves, which had been predicted by Maxwell some twenty years earlier, actually existed, and could be transmitted from one place to another. The waves that his apparatus generated had quite a short wavelength, and the distance of his first transmission was comically short, a few metres, but he had demonstrated the first principles of radio, that a high-frequency (short wavelength) signal will leave a wire and travel through space. Another wire placed in the path of this signal will have signal voltages induced by the wave, so that the signals can be received.

Old Spark

The early transmitters generated radio waves by making use of the oscillations caused by sparks. These spark transmitters worked, but they generated a huge mixture of waves of different frequencies — fine when only a few transmitters existed, but useless now. Nowadays we need to generate a high-frequency radio wave which is of a single selected frequency, and to avoid interference with the thousands of other transmissions, we need to be able to keep the frequency constant to within a few Hertz (Hz). Every radio transmitter, then, apart from some low-power or mobile types, starts with a crystal-controlled oscillator.

This is only a starting point, though. The frequency which is to be used for transmission may be much higher than the frequency of the crystal. To obtain the higher carrier frequency from the lower crystal oscillator frequency, distorting amplifiers called frequency multipliers are used. A frequency multiplier stage is simply an amplifier with deliberate under- or over-biasing. The input is tuned to the (low) frequency of the crystal oscillator, which then switches the current in the multiplier on and off at the crystal frequency. This causes pulses of current in the collector circuit, whose load is a tuned circuit, tuned, that is, to an exact multiple of the oscillator frequency (such as twice, three times, etc). Each pulse of current through this load sets the tuned circuit into oscillation, and the oscillation will not have died away too much before the next pulse of current sets it off again. The point about having the load

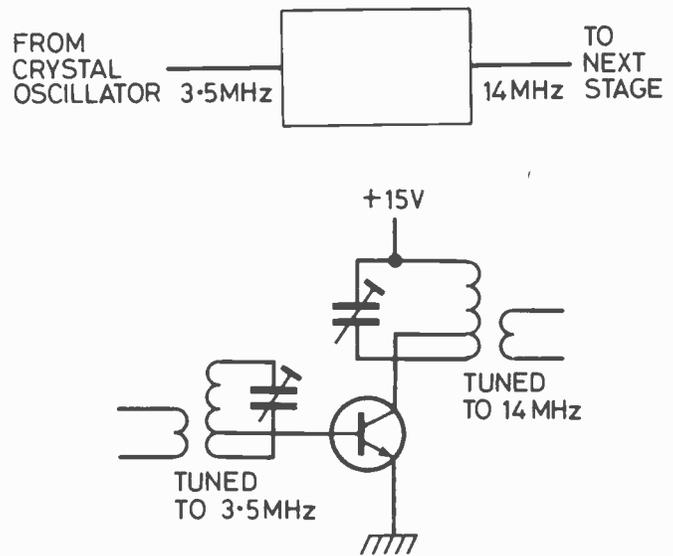


Fig. 1. Frequency multiplication using tuned circuits.

tuned to an exact multiple of the oscillator frequency is that each pulse of current will then arrive in just the right phase to keep the oscillation going in the tuned load. If the load is not correctly tuned, there will not be a continuous steady signal at the collector. The output from this lot is therefore a high frequency signal which is a sinewave, whose frequency is controlled by the crystal oscillator.

Dah, Dah Dit. . .

So far, so good. We have a high frequency signal which will radiate from a wire, an antenna (or aerial). How do we use it? In the early days, the only way we

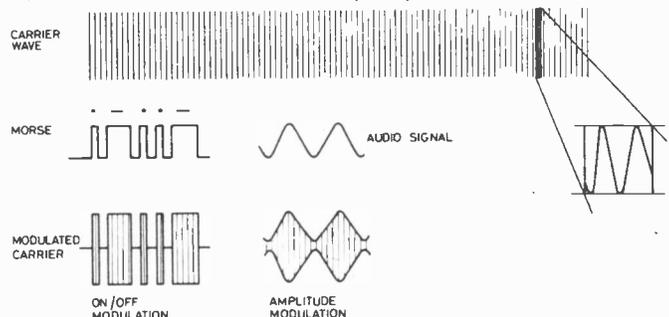


Fig. 2. Amplitude modulation of a carrier wave.

knew to use a radio wave was the way we used the current in a telegraph wire — we started and stopped it in the pattern called Morse code. Now the Morse code is a fairly simple code, but the idea behind it is important. You can't convey much of a message with a steady signal of any kind, telegraph or radio. To make your radio signal useful, you have to change it, modulate it, either in the form of a stop-start code like Morse code, or in some other way.

A Morse message takes a long time to send, even when automatic transmitters and receivers are used. What was needed was a way of coding an audio signal on to the radio wave, and one of the most frequently used methods is called amplitude modulation. Remember what we mean by amplitude. It's the size of the wave, measured to the peak, in volts. Amplitude modulation means changing the amplitude of the high frequency carrier wave, the one that can be transmitted from an aerial, in a way which allows the carrier to take the information of a low frequency signal along it.

Take a look at Fig. 2. This shows a high frequency wave; the frequency is so high that individual cycles cannot be distinguished in this scale. Along with this carrier wave is shown an audio wave, the type of signal we get, after amplification, from a microphone. Amplitude modulation means making the amplitude of the carrier wave vary at the same rate and with the same voltage changes as the signal wave, and the result of such amplitude modulation is shown in Fig. 2. This modulated wave is still a high frequency wave, it can still be radiated from an aerial, but its amplitude now varies in a way that carries all the information on the amplitude and frequency of the audio signal that we want to transmit.

The final stages of an AM transmitter therefore consist of amplitude modulation and power amplification, very often carried out together. One well-established method of amplitude modulation consists of feeding the carrier signal to a power amplifying stage whose collector voltage is then modulated by another transistor (Fig. 3.). Large transmitters, of course, use vacuum tubes rather than transistors, but the types of circuits that are used are similar. Fig. 4. shows a block diagram for a complete fixed-frequency AM transmitter.

So far, so good, but there's not much point in having transmitters sending out modulated carrier waves unless we can receive them. Receiving the carrier wave is one thing, a piece of wire will do that, though some design work and cunning is needed if we want to make the best use of the modulated wave. The problem now is what to do with the modulated carrier. The trouble is that it's still a radio frequency wave, even though it's modulated. No matter how much we amplify this wave, no loud-speaker or earphone will vibrate at the frequency of the carrier wave, large amplitude or small. The modulation cannot do anything because the modulation waveform of the opposite peaks of the carrier is in antiphase — one part of the modulation cancels out the other. What we need is some method of recovering the original audio signal from the modulated carrier wave.

Detective Work

The process of recovery, called detection or demodulation, is practically always carried out by a diode, making use of the principle that a diode conducts in one

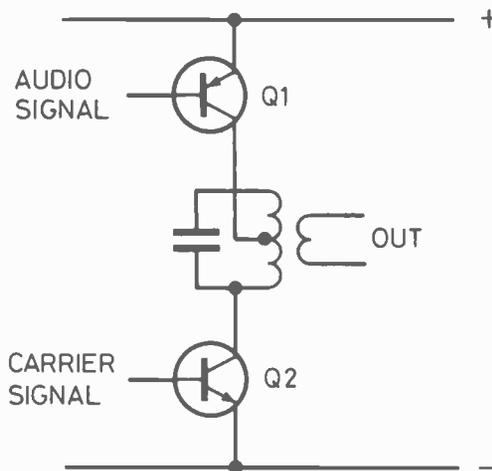


Fig. 3. AM by means of an emitter follower.

direction only. A modulated carrier fed to a diode will cause the diode to conduct for only half of each cycle of the carrier wave, and so the waveform at the other side of the diode looks very different (Fig. 5.). We can then use this waveform to charge a capacitor which is allowed to discharge through a resistor. If we choose the time constant of the capacitor and resistor well, the capacitor will not discharge noticeably during the time from one carrier peak to the next, but will discharge fast enough to follow the changes in the audio waveform. The effect of the capacitor also ensures that there's hardly any carrier wave left, and the small amount that remains can be filtered off, leaving the audio signal.

Wait a minute, though. We've been assuming that we have a signal of large enough amplitude to pass through a diode. We don't in fact get that much signal from an aerial unless the transmitter is very close or very powerful, and we still need to make sure that we have selected the correct carrier wave from the thousands that are around. How do we do that?

Tuning In

Selecting a frequency, of course, is the job of a tuned circuit, and the obvious way to construct a radio is to have several stages of amplification each using a tuned circuit as load. Obvious, yes, and this was the method that was once used. It's called TRF — tuned radio frequency (Fig. 6.), but it isn't suited to modern needs, and here's why. To start with we need to be able to

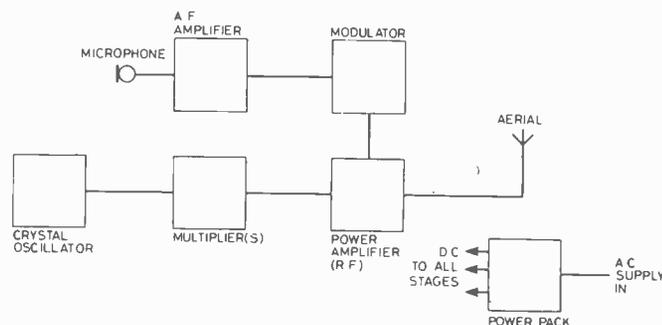


Fig. 4. Block diagram of a complete fixed frequency AM transmitter

change the tuning of each tuned circuit if we want to be able to tune from one carrier frequency to another.

At the same time, if we want the radio to be selective enough to pick out one carrier wave from others whose

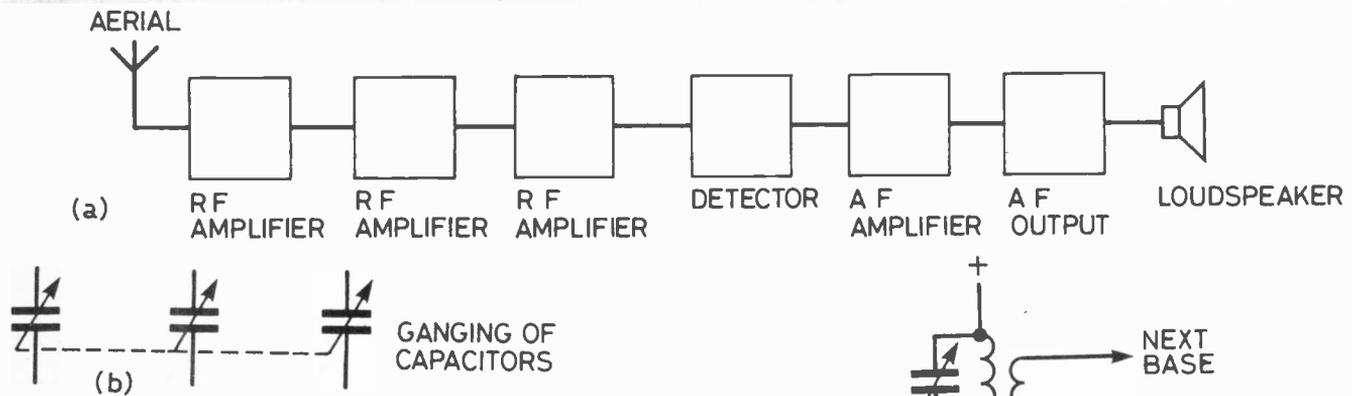


Fig. 6b. Using ganged capacitors to tune several stages simultaneously.

frequencies are very close, we need a lot of tuned circuits. It's not entirely impossible, because we can make *ganged* tuning capacitors, variable capacitors with one shaft operating several capacitors, but it's difficult. In addition, and just to make a difficult job almost impossible, we have our old friend positive feedback lurking around. We may have to amplify the radio signal by quite a bit using perhaps a gain of one thousand or so. With so much amplification of a carrier that can launch itself off a piece of wire so easily, it's very hard to stop some of the amplified signal from getting back to the input. Working on the 'butter-side-down' principle, such feedback is always positive at some frequency or other, so that the whole amplifier oscillates.

The fact that an oscillating receiver is useless as a receiver is bad enough, what makes it worse is that it radiates the oscillating signal back into the aerial and so to any other receivers that are around. When your receiver oscillates, no one listens to the show. We don't like TRF receivers, folks.

Supersonic Changes

All is not lost, though, because a brilliant invention of more than fifty years ago lets us have lots of tuned circuits, along with easy changes of frequency and less chance of feedback. It started with the name of super-sonic heterodyne but not surprisingly lost a few letters and ended up being called the superhet receiver. How does it work? Pin your eyelids up and read on.

At the input of a superhet receiver, the signal is tuned in the usual way, using a variable capacitor which is part of a two-gang capacitor set. Instead of amplifying this tuned signal, though, its frequency is changed in a mixer stage. Two frequencies are fed into the mixer stage — the carrier signal that has been selected by the tuning, and a sinewave generated by an oscillator (called the *local oscillator*) which is part of the receiver. Most small receivers do not use a separate oscillator stage; the mixer is connected so that it will oscillate. Now we've mentioned the idea of signal mixing before (beat-frequency oscillator, remember?) but let's run over it again. When we feed two radio signals into an amplifier which is not biased for linear amplification, the output signal will consist of the sum and difference frequencies as well as the frequencies we put into the mixer. More remarkable and useful is the fact that if one of the input frequencies is modulated, then the sum and difference frequencies will also carry the identical modulation. We choose the difference frequency, called the intermediate frequency (IF) and use as the load of the mixer a tuned circuit which will resonate at this intermediate frequency.

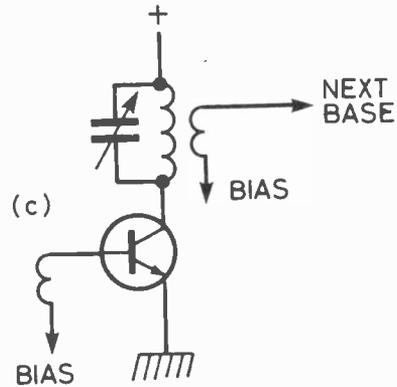


Fig. 6c. A single RF stage and connections to the next stage.

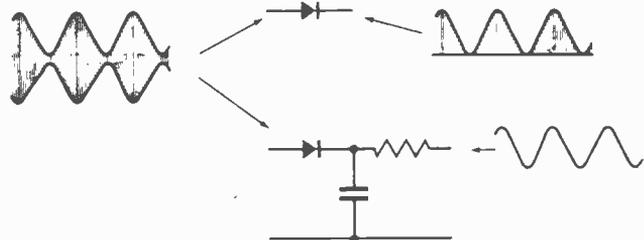


Fig. 5. Using a diode and CR network for detection and demodulation.

Tracking Down the IF

What's so smart about changing the frequency? Well, it's not just that we change the frequency, but that we change *any* input carrier frequency into the same IF frequency. The frequency of the local oscillator is controlled by a variable capacitor, the other half of the ganged pair whose first half is used to tune the carrier. Now with a bit of cunning we can arrange it so that these two tuned circuits, the input and the oscillator, will 'track' together, meaning that when we change the tuning of the carrier by 50 kHz, then the tuning of the

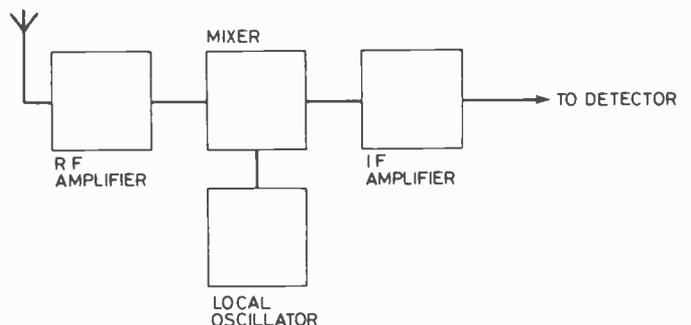


Fig. 7. Block diagram of a superhet receiver up to the detection stage.

oscillator will also change by 50 kHz. If this tracking is accurate, then the difference between oscillator frequency and carrier frequency stays constant, so that when we tune from one carrier to another the frequency at the output of the mixer, the IF, stays constant.

We now have the easy job of amplifying a signal which is at a fixed frequency. The tuned circuits for this lot can be kept inside metal cans to reduce radiation of IF signal, so that positive feedback can almost be eliminated. Any feedback to the input of the mixer is not particularly important, because it's at a different frequency from the carrier frequency and will be rejected by the tuned circuit at the input. A few high-class receivers use an additional IF trap at the input, just to make sure. Very cunning, very useful.

Automation

Summing it all up so far, Fig. 7. shows a block diagram of a superhet receiver up to the detector stage, and Fig. 8. shows the actual circuit diagram of a typical pocket transistor radio. There's one little bit of cunning that we haven't mentioned yet — it's called the AGC circuit, meaning Automatic Gain Control. This AGC is needed because of the way in which radio waves reach us. Radio waves are electromagnetic waves, like light, and they travel through space in the same way, at the same speed of 300 million metres per second, obeying the same laws. Apart from the effects of diffraction, the only way a radio wave can reach us from a distant transmitter (because of the curvature of the Earth) is by reflecting from the Heaviside or Appleton layers. These are belts of ionised gas that surround the atmosphere, with lots of loose electrons floating about, and they reflect radio waves at most of the lower frequencies. Any radio signal of up to around 30 MHz can then reach us by several paths, a direct path if the transmitter is not too far away, and various reflected paths (Fig. 9.) depending on the height of the reflecting layers, which is generally around 30 to 50 miles.

To Be Or Not To Be. . In Phase

At the receiver, then, signals arrive from several different directions having travelled by different path lengths, and there is no chance that they will always arrive perfectly in step. At 1 MHz for example, the wavelength of a carrier

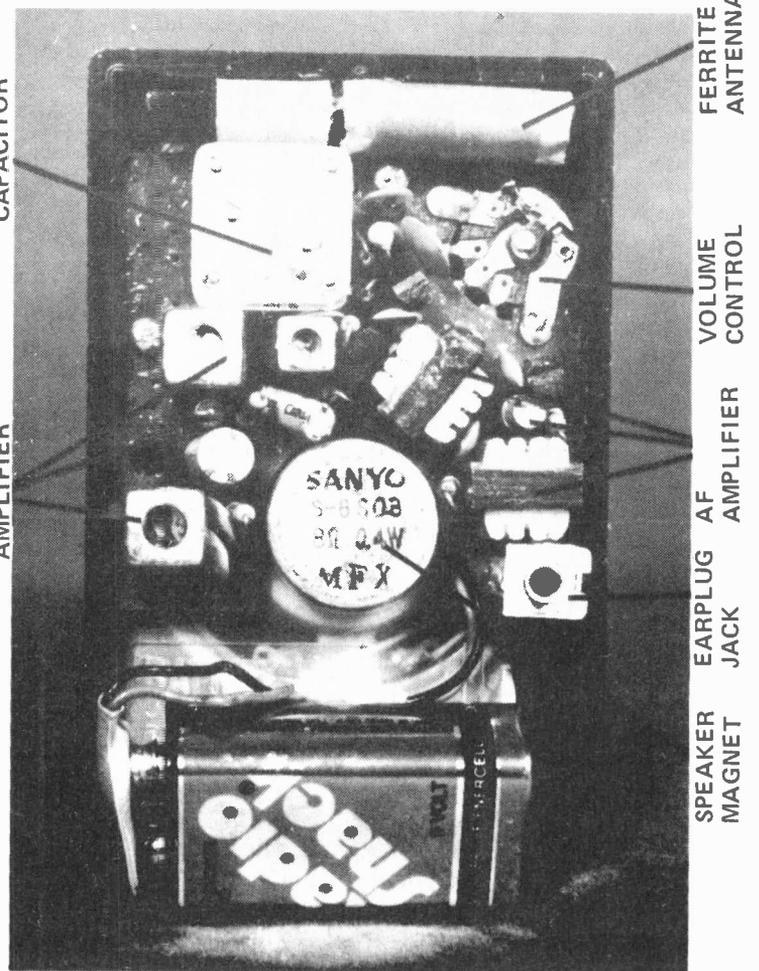


Fig. 8a The various parts of a pocket A.M. radio.

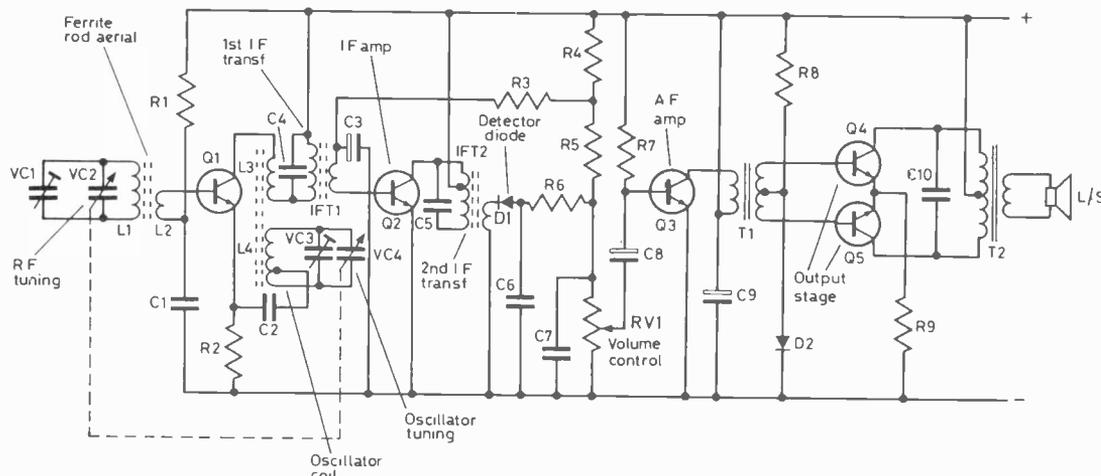


Fig. 8b Circuit diagram of a typical pocket transistor radio.

is 300 metres. A path difference of only 150 m at this frequency will cause one wave to be inverted relative to the other, and any odd multiple of 150 m difference in path length will also cause the waves to be in antiphase.

The reflecting layers are constantly on the move, so that reflected waves have to cover different distances from one minute to the next. At one instant, the waves reaching the receiver may reinforce each other, at the next instant they are just as likely to cancel. The result is

that the signal received at the aerial varies greatly in amplitude from one moment to the next.

We could, of course, sit with one hand on the receiver volume control turning up the gain each time the signal became faint and turning it down again when the signals were strong, but it's easier to use a form of negative feedback to do the job. AGC makes use of the fact that the detector diode rectifies the carrier signal, so that there's a steady (DC) voltage at the detector. The

PROJECT FAULT FINDING

Keith Brindley comes up front to discuss a largely ignored topic in the art of project building and gives a few hints how to go about fault finding.

IN THE BEGINNING there's the first project — a fuzz box, a light chaser or a photographic timer — and it doesn't work!! You spend hours going through the circuit, checking that you have got all the components in as the diagram says and you *still* can't figure out what the fault is. Blast — throw it in the bin. But wait a minute, it cost you \$30.00. Well maybe you can re-use the components in your next project. Let's see, what's in this month's copy of ETI?

Bang — and before you know it, you have caught the bug (No, not 'flu' you fool — the electronics bug). And if you are like countless thousands of others you'll never get rid of it. Every time you go into a newsagent's your eyes will wander to the magazine section looking for the new edition of ETI. You may even sink low enough to look at some of our competitors — not buy, just look (of course, you will *only* buy ETI).

Be that as it may, your first project doesn't work and what is more your second probably won't either. But don't let me put you off or depress you. After all, YOU are our livelihood. In fact, figures would probably show that a beginner only stands about a one in 10 chance of first time success. However, looking on the brighter side, the chances are that the reasons for your circuit not working are only minor.

The trick is to be able to detect a fault, because unfortunately they don't jump up and shout to be found. Normally this knack will only be acquired with practice of building circuits, but that is not to say that it can't be learned!

Troublesome Twosome

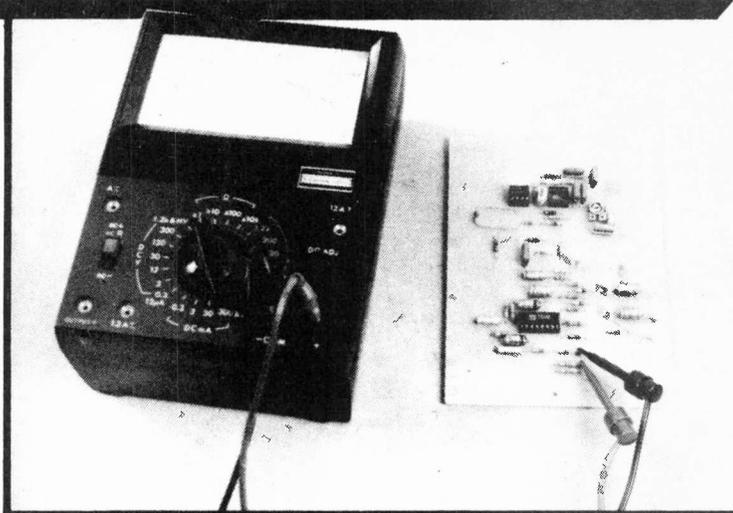
Faults can broadly be classified into two groups:

- 1) user induced
- 2) component fault

Of the two groups, the most likely to cause a fault would be group one — user induced faults. This is mainly to do with the fact that the beginner, not knowing the right techniques, can make unintentional mistakes to his or her disadvantage. The obvious example of a fault in this category is a dry soldered joint.

Components, if bought from reliable dealers are not normally prone to faults if handled correctly, but it has been known.

Sometimes the two groups overlap — the reason being that the user has somehow induced a component fault. An example of this might be damage of a transistor by overheating when soldering.



Every home should have one. The multimeter is the first and probably most useful piece of test-gear you can buy.

A Fault Is A Fault Is A Fault

Anyway, however caused, once the fault is there, it is not going to remove itself! It has to be located and repaired and the aim of this article is to suggest a few hints and clues how to go about this.

The best technique is to adopt a system of logical progression, eventually isolating the cause, or causes of non-function. There should be no guesswork involved.

First check the printed circuit board, making sure that all components are in their correct place. What about electrolytic capacitors — are they the right way round? Are all semiconductors ie diodes, transistors, integrated circuits in the correct way? Remember that there is a possibility that a semiconductor which had previously been inserted incorrectly, could be damaged by this, and reinsertion in the correct manner may not repair the fault. A new component may be necessary.

As a matter of good practice it is better to undertake all of these suggested checks before even the first switch on — it may save the expense of a replaced component.

Look for dry joints (they have a knurled, grey appearance). Later in this article we look at a simple procedure for isolation of dry joints, which a visual check might not find.

Next, get a good idea of how the circuit works. This is done by reading the "How It Works" section which we publish with every project in ETI. You may even have to read it a few times before it sinks in. As a general rule we try to describe a circuit in as simple a fashion as space allows, to help the amateur constructor. Try to picture what is going on in there eg in an audio amplifier bear in mind that a small input produces a large output. The input signal may be about 200 mv, but the output signal could be 10 volts. The popular integrated circuit amplifier, the LM 380 provides a useful case-study. Figure 1 shows the IC in a typical circuit, a two watt audio amplifier.

All Boxed Up

It can, however, be visualised in a much simpler fashion, the "black box". This term probably arises from the work of H. S. Black, who designated boxes into his circuit diagrams to represent complete amplifiers. In fact the modern representation of an operational amplifier in a circuit, as in figure 4, is really only a "Black Box". The area in broken lines in figure 1 can be termed a black box and can be redrawn as in figure 2. In order for the black box amplifier to function correctly, certain con-

nections obviously have to be made — power supply, volume control, i/p and o/p capacitors, etc, as shown in figure 1, although they are not shown in figure 2. But as

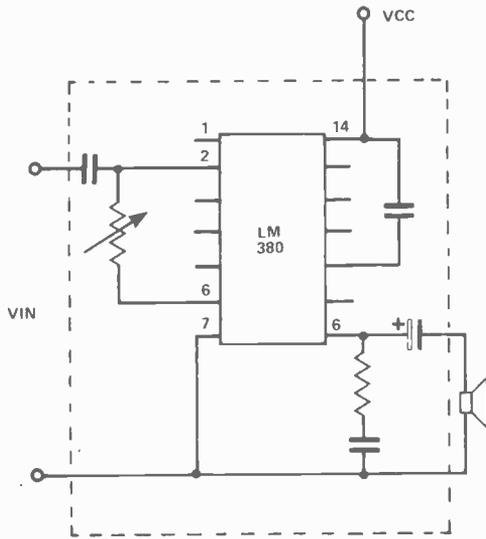


Fig. 1. The area inside the broken lines can be regarded as a 'Black Box' amplifier.

long as we appreciate this then there is no reason why we can't think of an amplifier as a box. The same logic can be applied to literally any electronic circuit. As an aside, it is well worth remembering that a fault in a circuit using ICs, is much more likely to arise from these peripheral connections and components than from the main IC.



Fig. 2. A 'Black Box' amplifier. Note the complete lack of external circuitry.

Let Your Mind Do The Work

Try to reduce the whole circuit in your own mind to a number of black boxes, (as many as you need) say 2 or 3. Let us take for an example a typical mains to low voltage D.C. power supply as in figure 3.

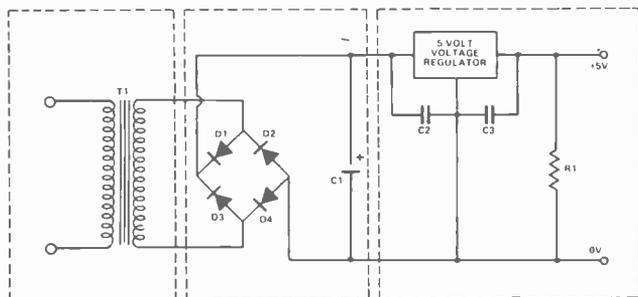


Fig. 3. Circuit diagram of a simple 5Vdc power supply.



Fig. 4. Black box representation of mains power supply.

Reducing the circuit diagram, which consists of ten components to black box symbols gives us something as in figure 4. The supply can be seen to have three main stages; a method of reducing the high voltage A.C. to low voltage, an A.C. to D.C. converter and a method of regulating the voltage. This is a much simpler representation of the supply than its corresponding circuit diagram but if we remember that there are certain peripherals to connect then it is every bit as accurate.

If the supply is malfunctioning then we should begin to check each individual black box in turn. It is wise to start at the first box and work to the last, because if the first box is not working then any following it won't either. In the example, therefore, we would look at the input to the transformer first (be careful — mains voltage can be lethal!). An A.C. voltmeter should give a reading of 120 V. If not, the fault is prior to this — perhaps a blown fuse?

Next, measure the output voltage of the transformer, which will depend on the transformer itself. In our theoretical example it should be about 6 volts. If all is correct so far we can move on to the next black box, the A.C. and D.C. converter, whose output voltage should be approximately $\sqrt{2}$ x transformer output voltage = 8 volts D.C. After verifying the second black box is operational then we move to the final one and check this.

If you obtain any results at all from your project, for instance the power supply output might be 8 volts, then knowing this may help you to reduce the fault. In this example the problem is probably the IC voltage regulator itself, not functioning.

Remember, there may be more than one fault, in which case you will have to repair one at a time until the project fully works. The idea at this stage is to be as methodical as possible, isolating the area in which the fault lies and then finally pin-pointing the fault itself.

The worst faults of all to find are intermittents. There one minute — gone the next. These were often caused in old tube circuits by rising temperature as the tubes warmed up. Happily, a disappearing problem with the almost universal use of solid-state electronics.

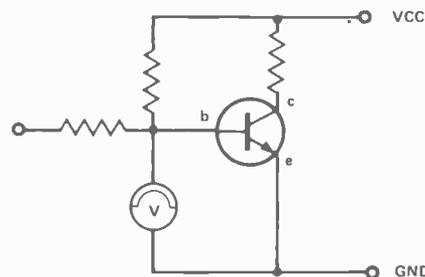
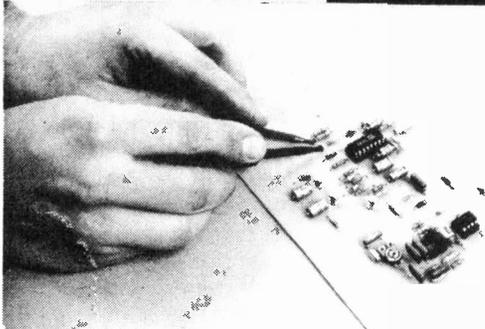


Fig. 5. The voltage from base to emitter for a silicon transistor should be 0.6 volts.

To (V)Be Or Not To (V)Be

In transistor circuits the voltage from base to emitter (V_{be}) can be measured, giving a clue as to whether it works or not. In a silicon transistor this should be about 0.6 volts (see figure 5).

You can estimate unknown voltages, as in figure 6 and measure them to see if they correspond. Of course this is only an approximate method because the voltage depends on the resistance of the next stage after point A (which should if possible be taken into account in the voltage calculation).



Take care not to short any components with the test clips when probing your circuit.

With the use of a resistance meter, soldered joints can be checked in the vicinity of the fault by touching the probes onto component leads, which should be connected underneath the board by joints and copper track (see figure 7). If the meter shows zero resistance then all well and good, but if it shows a high resistance or even one of just a few ohms (probably due to dirt on the copper underneath the solder) then you have located a faulty joint.

If the fault still remains stubbornly hidden, the next step is to sub-divide the black boxes into smaller and smaller sections, checking each in turn, until finally you

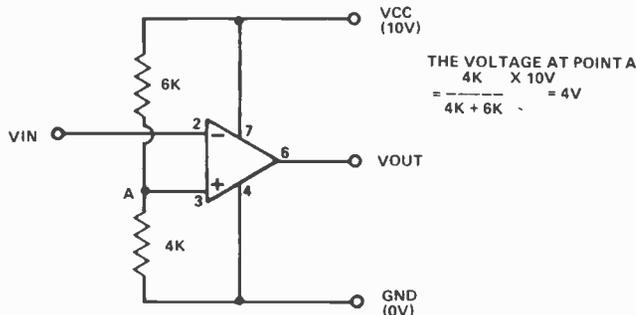


Fig. 6. Estimation of the voltage at point A. (With respect to 0 V.)

are considering individual components. These can be unsoldered and tested out of the printed circuit board if necessary.

Non electrolytic capacitors; can be checked out of circuit with a resistance meter, they should have a high (almost infinite), resistance. Electrolytics, when measured, should normally appear to have a lower resistance then slowly increase to a high one. Lower values, 1-10uF will change considerably faster. This is because they charge up using the current available from the meter. Again, the ideal procedure is to check all of this before construction, in an attempt to reduce possible causes of faults. However, a component which seems perfect on insertion, can be damaged if there is a fault nearby, by high current, temperature etc. So testing of a component before use only reduces risks of faults and doesn't eliminate it.

The Last Straw

Finding faults in a project can be a very difficult task, but one which every aspiring electronics genius will have to go through! There are no easy methods — although a logical approach to the symptoms is advisable. Remember also that fault finding can be very rewarding and great pride can be taken in the finished article.

However, if after all this time, energy and strenuous brain activity you still haven't got a working project — the alternative is still the bin!

PARTS LIST

Resistors ALL ¼W, 5%

R1	1k
R2	12R
R3	47R
R4	100R
R5-R6	220R

Capacitors

C1	100n disc ceramic
C2-C7	1u, 25V tantalum

Semiconductors

Q1	2N3905
Q2	TIP30C
Q3	2N3055
IC1	7805
IC2	7812
IC3	7912
ZD1	3V3, 300 mW zener

Miscellaneous

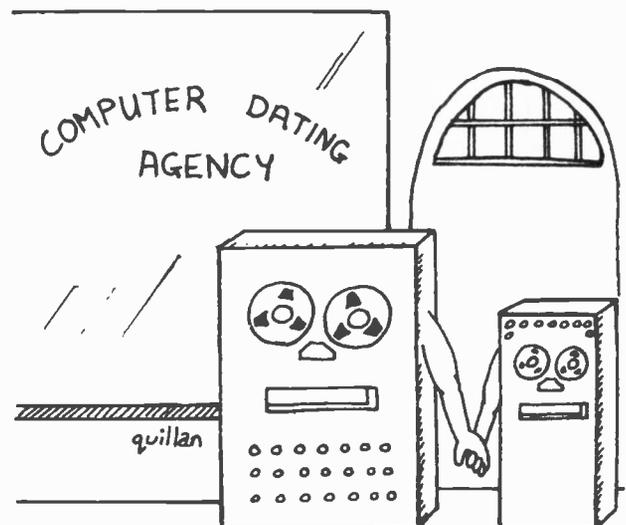
ETI-636 pc board, seven S-100 solder-in sockets (SK1 to SK7), finger-type heat-sink for Q3, nuts, bolts and about half a kilogram of solder!

HOW IT WORKS

Transistors Q1 to Q3 are the active termination circuitry. Q1 and Q2 provide a constant current source for ZD1, clamping the base of Q3 at 3.3 volts. Q3 is a series regulator, producing about 2.7 volts across R4. Resistors R5 to R97 (there are a lot of them, aren't there) terminate the bus lines to a common bus, connected to the emitter of Q3. R4 is bypassed by C1. Open lines will be held at 2.7 volts, by terminated by a resistive impedance at RF. High clock speeds shouldn't produce any reflections back down the bus.

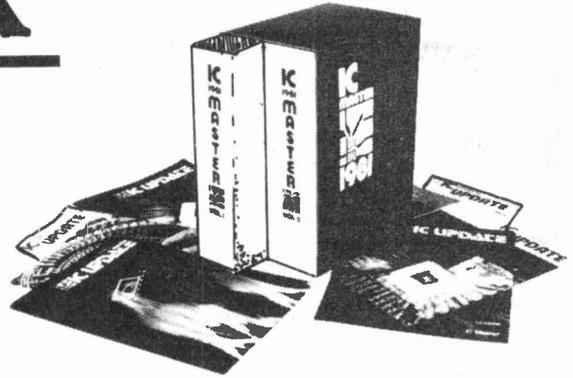
Most processors running at up to 4 MHz will have no problems with the board...it has been used on 2 MHz systems even without the termination.

The three additional regulators are not, strictly speaking, necessary for an S-100 system...although they're nice for peripherals...and can be omitted if they aren't needed.



IC MASTER

The gods do not smile upon those who do not have data sheets. Bring good fate and healthy children unto your house with an IC Master. By Steve Rimmer.



The IC Master

Spec sheet for an LM301, huh? Oh ya, right, that's filed under the pile of surplus vacuum tube computer circuit modules, which I seem to recall seeing on top of the broken dish washer, right out behind the work bench with the three 1958 Edsel carbs on it. Or is that where I put the manual for the power fingernail clipper? Well, if it is where the thing's stuck, it's near the bottom of the pile. You'll know it cause that's the one Mrs. Furnshredder's rabbit started chewing up to make a nest.

A large hassle, this spec sheet business. First of all, you've got to talk them out of the component store guy, who will, after several minutes of heated innuendo, usually only produce Xerox's anyway, usually with the edge of the page blurred beyond recognition. Then you've got to find the nasty scraps when it actually comes time to do whatever you got them for in the first place. And if the inspiration for a new and improved digital mousetrap hits you at two AM on Sunday morning, forget about scarfing up data for that sixteen channel binary rodent detector chip. If you use integrated circuitry to build anything more complex than a one chip phono pre-amp, you might need an IC master.

The IC Master is a two volume, boxed collection of manufacturers data sheets. It's quite a wonderful little library. The entries are divided into nine categories; digital, microprocessor, military, MPU Development systems, Microcomputer boards, interface, linear, and memory. On top of that, there are several sections of ancillary indexing systems to help you wade through the 3400 pages of information.

Index Fingers

The first of these is, actually, the index of indexes, so you can quickly locate the index you're after. Beginning to get

an idea of the size of the work? Following this, we have the master selection guide, which takes specific device functions and translates them into generic sorts of device nomenclature. For instance, if you needed a Bidirectional transceiver chip, it would send you scrambling for "Interface-Line circuits, Line Transceivers". This is particularly useful if you find yourself in an area of electronics with which you aren't terribly familiar.

Next, we have the part number index, which is a prize all in itself. Let us suppose that one has a circuit diagram drawn crudely by a baboon on a lunch bag, listing a chip designated as, say, a 339. Now, who makes a 339? Usually there's a letter prefix that tells one this. Well, the part number index takes the base number and lists all the manufacturers who source it. It also supplies the number with its proper prefixes, LM for National, uA for Fairchild, and so on. Did you know there are fourteen sources for a 741? Hmmm.

Then, there's the part number guide, which explains the codes imbedded in the part number. These are peculiar to each manufacturer, in most cases. For example, TMS4027-15JL means: TMS (MOS Memory/Microprocessor,) -15 (150ns Maximum access time), J (Ceramic DIP package), L (0°C temperature range). Betcha didn't know all that stuff. It's actually quite interesting the amount of data actually available from many manufacturers' part numbers . . . if you know the code.

There's also an advertiser's index, which lists the abbreviations used to refer to IC manufacturers. A list of logos is also provided which often helps in identifying otherwise orphan parts.

There's a list and source guide for a library of application notes, a list of the ICs for which data is given in the guide, along with page references, a list of

alternate sources for each chip, along with the alternate part numbers, and, finally, a list of the names and addresses of the manufacturers and their dealers and distributors.

The selection of data sheets in the master is pretty good . . . naturally, it doesn't list everything in the master index, but it has a fairly good crop. It is, however, heavily weighted toward digital, and particularly toward microprocessors. This isn't wholly unreasonable . . . most of the ICs made have something to do with this area. There's even a batch of stuff on built up boards for micros and their associated whizzbangs.

Lastly, there is a fairly good introductory bit on custom IC's. Naturally, it doesn't even begin to completely cover this very complex subject. However, it provides a comprehensive grounding on who can supply what, and who to contact for more information.

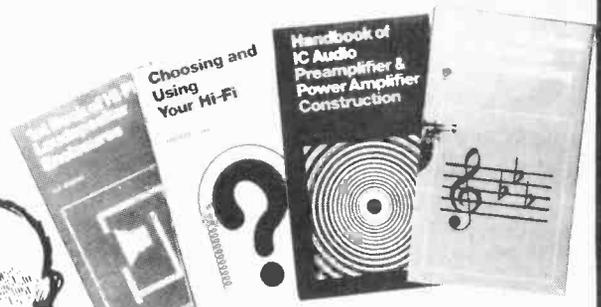
Do You Need One?

First off, one should be aware of the price of this wonderful, highly useful book. \$100.00 buys you the whole shooting match, boxed, with a year of quarterly updates. This is, admittedly, fairly steep, probably too much so for any but the most grimly serious, or affluent, of hobbyists. However, if you're doing any sort of development, circuit design or suchlike, it's about as indispensable as your soldering iron.

The IC Master represents a single source listing for virtually all the ICs one could normally expect to encounter in any typical applications. If you use reference data a lot, it can be expected to pay for itself in time saved alone.

The IC Master is available from Active Component Sales, . . . there are several locations, too numerous to mention . . . about five, actually, which are listed on the back cover of this very magazine. The actual price is \$99.99. ●

His Master's Vice



ETI Book Service
Unit 6, 25 Overlea Blvd.
Toronto, Ontario
M4H 1B1

If it happened to be streaking through the local mall, shoplifting bamboo toe picks out of Nigerian novelty boutiques, hunting sparrows with a howitzer or even running around town spray painting nuns, Nipper here wouldn't mind a bit. However, bad luck for the unfortunate mutt, the old guy's into audio reproduction. Just last week, the poor beast came home to find two hundred watt speakers in his dog house playing a demonstration record of the U.S. Air Force on manoeuvres. Nothing worse than an amp that goes up to thirty five thousand hertz if you're a dog.

We here at ETI feel sorry for dogs with masters that have loud cheap

stereos. Dogs usually aren't tall enough to reach the medicine cabinet to get the ear plugs, and if they manage to chew through the line cord to shut the thing off, the shock usually blows out their teeth and the other dogs laugh at them. Thus, they are forced to endure lifetimes of Pat Benatar at 11% distortion... a truly lamentable fate.

For those of you who feel like doing something kind for your dog, we have a few books here to help you out. The *1st Book of Loudspeaker Enclosures* (BP205, \$3.55) will provide all sorts of alternatives to suspending a 6 x 9 in a milk crate. *Choosing And Using Your Hi-Fi* (BP68, \$7.25) explains all sorts of useful things,

like why your neighbour's Mac amps sound better than you Close'n Play. *Handbook of IC Audio Preamplifier & Power Amplifier Construction* (BP35, \$5.50) is just the tome for those interested in blowing out their eardrums with something home made. And *Electronic Music And Creative Tape Recording* (BP51, \$5.50) will help you go clear off the deep end drown in a sea of really peculiar sounds.

Buy these books. They will make you really smart, and if you learn lots from them... your dog will probably clear out for good within the week.

MORE CIRCUITS

\$4.50 Useful design ideas



Circuits to get you thinking how to solve your special tasks, or just for fun. From power controls to special effects to alarms, test circuits, and so on. Plus detailed sections on crystal oscillators, speaker crossovers and more. For ordering details see below.

Obtain yours now from us directly by using the order card in this issue, or by mailing \$4.50 + 45c for postage and handling to MORE CIRCUITS, Electronics Today Magazine, Unit 6, 25 Overlea Blvd, Toronto, Ontario, M4H 1B1.

What you should know about the Multiflex Z80A computer

MULTIFLEX is a young, fast-growing Canadian computer company. Most people have only just heard of us within the past year, because previous to that we were involved in intensive, low-profile research and development.

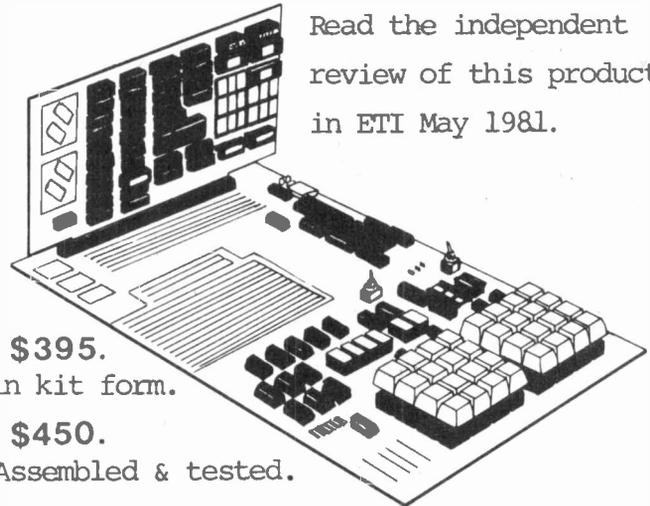
THE Z80A SYSTEM was developed over a two-year period. The company's intent was to produce a computer suitable for both hobbyists and industry, capable of functioning as a stand-alone trainer yet infinitely expandable. That goal has been attained, with the added benefit of a very low price.

STAND-ALONE FEATURES

of the system include the following:

of the system, selected for maximum usefulness and lowest cost, include the following:

- Separate motherboard and CPU card, which communicate over the industry-standard S-100 bus. The motherboard can accommodate up to four S-100 cards.
- Space on the CPU card for up to 4K of RAM and up to 16K of EPROM. The RAM is organized as two blocks of 2K bytes each, (200 nS 2114 devices are used) which can be located within any 2K block in the address-space by hardware jumpers. An 8K or 16K block size may be selected for the EPROMs and this, too, may be located at any address. 2708 and 2716 devices may be used exclusively or in combinations.
- A resident 3.5K Monitor which facilitates machine-language program entry, execution and debugging, and controls all input/output hardware on the motherboard. The Monitor is in two 2716 EPROMs which may be removed and re-used if the user wishes to implement a more powerful operating system.
- A hex keyboard, fourteen Monitor function keys, and two unassigned keys for user routines.
- A six-digit hex LED display organized as a four-digit address field and a two-digit data field.
- An interface to a conventional cassette recorder, which sends and receives data at 2000 bits per second with exceptional reliability. The Monitor includes a special routine which simplifies precise calibration of the recorder and interface.
- An EPROM programmer for 2708 and 2716 devices. The contents of any block of system memory may be written out to EPROM, and programmed EPROMs may also be read into RAM through the programming socket for duplication. Many industrial buyers have used Multiflex Z80A systems just to download data from larger computers, to be programmed into EPROMs.
- A parallel interface based on the 8255 PPI chip. Twenty-four I/O lines are available, which can be programmed in several configurations.
- An optional RS-232C serial interface, already wired on the motherboard. The components for this may be purchased and installed at any time, allowing communication with a modem, printer, or other device using the RS-232C standard. Eight jumper-selectable baud rates are available, from 110 to 9600 baud.
- A 40-chip wire-wrap area on the motherboard for custom hardware development or modifications. The wire-wrap plane is centrally located for easy access to bus signals and all I/O hardware.



Read the independent review of this product in ETI May 1981.

\$395.
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EXPANDABILITY is assured by the use of the S-100 bus system. Almost any product, made by any manufacturer for use with S-100 computer systems, may be used with the Multiflex Z80A. Also, all bus signals are heavily buffered in the Multiflex computer, to facilitate expansion to many extra boards. Multiflex is now developing an entire line of support products designed specifically for the Z80A. These include:

- A 64K dynamic memory board with automatic refresh, based on the Intel 8202 Dynamic Memory Controller chip. Each board may be loaded with 16K, 32K, 48K or 64K of 4116 RAM devices, and up to eight full boards may be used on the same bus because of the bank-select feature.
- A low-cost video board for displaying text on an ordinary black-and-white television set, with an interface to a standard ASCII keyboard.
- A high-resolution colour text/graphics board and I/O subsystem, based on the Motorola 6847 Video Display Controller. The video circuitry offers eight display modes and can be interfaced to a standard ASCII keyboard. The I/O section includes two 8255 PPI chips for up to 48 bits of parallel I/O, an 8253 programmable real-time clock, a fully handshaked RS-232C interface with baud rate programmable through the 8253, and up to 6K of static RAM. The board may be used with any colour television set, because a complete RF modulator is provided on-board.
- An EPROM emulator for use in the development of stand-alone microprocessor systems. This board appears to a host computer as ordinary RAM on the S-100 bus, but to an external device connected to it by a 24-pin DIP jumper, it completely simulates a 2716 or 2732 EPROM.
- A bipolar PROM programmer which connects directly to the EPROM programming socket of the Z80A system. This board and the software package sold with it, are capable of programming all of the popular Schottky PROMs.

All of the above-mentioned products except the PROM programmer may be interfaced to any S-100 computer, regardless of manufacturer.

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AUDIO TODAY

AT THE LAST audio show I attended, I encountered a display which included a separate turntable, arm and pickup assembly, and although all three components came from the same manufacturer, they required assembly by the user.

When I first met him, the gentleman demonstrating the equipment was complaining about inexplicable distortions.

Even the most casual observer would quickly have noticed that the pickup/arm assembly had been improperly installed, with a large amount of lateral tracking error built into the system. To my amazement, when I pointed this out, I was treated to the information that tracking error wasn't really important.

I don't think we need dwell on the patent absurdity of this last assertion. But it really is quite remarkable how often a pickup and arm are fitted together then mounted on a turntable incorrectly, and I've even observed this with integrated units where you would think there was no opportunity for installer error.

There's really little excuse for it, outside of inebriation or excessive blowing of smoke out of the ears. The appropriate arm geometries have been well known since the acoustical days, and the only real question is how much error is to be permitted, and over what parts of the record surface is tracking accuracy most important.

Finding the Right Track

First we had best define what we mean by "Tracking". Generally, to track means to following step, so as to maintain some fixed relationship between the tracker and the trackee, so to speak. The function of a pickup arm, then, is to support the pickup in such a way as to allow it to follow a

path across the record surface which tracks the movement of the cutting head which made the original master. More precisely, the stylus orientation, and its vibrational axis should be maintained identical to those of the cutting stylus.

Standard practice in modern recording dictates that lateral modulation occurs at right angles to a line tangent to the groove arc. Since such an angle also parallels a radius line intersecting the tangent, modern lathes achieve this modulation angle by carrying the cutter in a straight line parallel to the radius, with the cutting stylus coincident to the radius. This is illustrated in Fig 1.

The obvious way to ensure perfect tracking by the playback pickup is to arrange a straight line tracking carrier, with the pickup stylus following the radius, and indeed, this is the principle of the new straight line tracking systems currently on the market.

Throwing a Curve

However, for a variety of reasons, the earliest of arms, and most of the better units in current production mount a pickup at the end of an arm which is pivoted at the opposite end. This is where life becomes complicated, because, as Fig 2 shows, the pickup cannot follow a straight line; consequently, the pickup orientation is never parallel to the groove tangent if the arc of travel crosses the centre of the record and the amount of error, that is, the angle between groove tangent and pivot/stylus axis, increases with the radius of groove spiral. The amount of error can be calculated using the following equation:

$$\theta = 57.3((r/2L) + (D/r)) \text{ degrees}$$

Eq.1

where θ is the tracking angle, or error,

L = stylus-to-pivot length, r = groove radius, and D = shortest distance between record centre and stylus, or overhang.

It is, of course, quite possible to arrange for tangential orientation at one radius only, by underhanging the stylus, that is, arranging for its arc to pass between the record centre and the arm pivot.

Solving Eq 1 for various negative values of D shows that for a given arm length, it is possible for a straight arm to have less deviation from either side of tangence, even though the total angular deviation range is greater than for zero underhang.

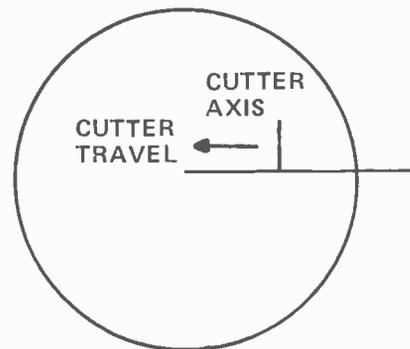


Fig. 1. Cutting geometry

However, look what happens if we *overhang* the stylus, that is have its arc pass beyond the centre of the record. The amount of tracking error at *all* radii is greater than with no overhang, and at no radius is it possible to achieve zero error. This can be visualized from Fig 2, and verified using Eq 1 for various values of overhang, D .

The Deviate Track

What may be less obvious, but more interesting, is the fact that, although tracking error is greater it varies less

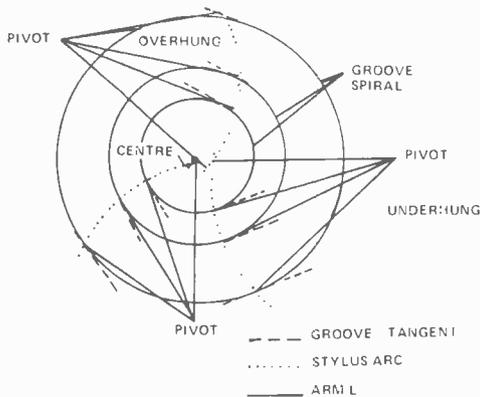


Fig. 2. Effect of under and overhang

from inner to outer radius, and, in fact, for any radius, another can be located at which the error is identical, except for one radius.

All of the above are illustrated in Fig 3.

Further examination of Eq 1 and Fig 3 will disclose two other useful features. First, there is a correct amount of overhang for a given length; any other value will give a greater range of error.

The second point is that the longer the arm, the less variation in angle.

The significance of this is about to become clear.

Getting Bent

Suppose we have an arm whose pivot-to-stylus length, L , is 10.75". If it is mounted with an overhang of 0.6", at groove radii of 2.25" and 5.75" the error will be about 21°, while at 3.75" it will be 19°. These represent minimum and maximum radii on a long play record, as well as a median point. At 2.5" and 5.0" the error will be 20°, the mean value of the two extremes.

Now, if we rotate the pickup so as to provide an offset angle of 20°, then at 2.5" and 5" radii the error will be zero, while at 2.25" and 5.75" the error will be +1° and at 3.75" it will be -1°.

These figures are calculated using Eq 1 and rounding the answers.

Despite the simple math involved, this is still a cumbersome trial and error method, and, in fact, there are two equations, the famous Bauer equations, which are useable to calculate overhang and offset when length and minimum and maximum radii are known.

Optimum arm geometry is obtained when the overhang D is

$$D = \frac{r_2^2}{L[\frac{1}{4}(1 + r_1/r_2)^2 + r_1/r_2]}$$

and offset angle B is

$$B = \frac{57.3r_1(1 + r_1/r_2)}{L[\frac{1}{4}(1 + r_1/r_2)^2 + r_1/r_2]} \text{ degrees}$$

where r_1 and r_2 are minimum and maximum groove radii of interest, respectively.

Notice that the expressions $(1 + r_1/r_2)$ and r_1/r_2 appear in several places and in both equations the denominator is the same, which greatly simplifies calculations, especially if your calculator has several memories.

It should be remembered that the effect of tracking error is more severe at high frequencies in the inner grooves. It is possible, then, to optimize D and B for inner and middle radii and allow some increase in the outer grooves, but we are talking about very small values, small enough that they are likely to be far less than errors introduced due to mounting inaccuracies.

In setting up a commercially manufactured arm, it is a relatively simple matter to measure the values of L and B and calculate D . It's also instructive to calculate the errors which result. In most arms it is possible to vary L and B slightly by altering the pickup mounting, shifting it fore and aft, and rotating it in the mounting.

I should also point out, in the interests of accuracy, that Eq 1 incorporates some simplifications, and is derived from $\phi = \arcsin((r_2 + 2LD - D^2)/2rL)$. Under conditions normally

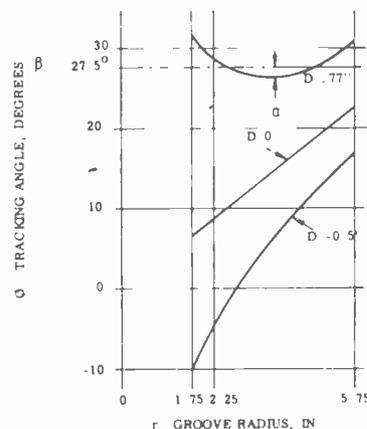
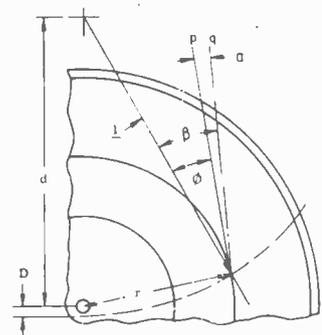


Fig. 3. Tracking angle relationships for 7½-inch arm.

encountered it is satisfactory to assume that the sine of the angle is equal to the angle and to neglect D^2 within the parenthesis. The equation then becomes $\phi = (r/2L) + (D/r)$ radians, which can be converted to degrees, or use Eq 1.

The resulting error is around 0.02%.

That's certainly less than the inflation rate.

AUDIO TODAY LETTERS



I am building the 300 W amplifier from your August issue, and I have a few questions that I believe would be of general interest to builders of this project.

- 1) Would it be possible to, and how to, limit the output of this amplifier? Not with a volume control but in preset increments of, say, 50-100-150 watts, etc, with a

switch. My point is that some builders may only have 100 or 150 watt speakers and they will surely go up in smoke!

- 2) Is there a way to switch R19 (10 K/8 Ohm load) to 6k8/4 Ohm load? Or is the bias to be reset whenever this resistor is changed. In this way the amplifier could be matched easily to different loads.

- 3) You mentioned where the power transistors could be had. Can the 2500 uF/80 VRTP Elna capacitors be obtained from the

AUDIO TODAY LETTERS

same place. I've tried the big dealers here in Montreal, and they look at me like I'm stupid asking for such a thing.

G.H. Montreal.

1) A volume control does not limit the output of the amplifier; it merely sets the level input, or input gain. Output level is often limited by adjusting output protection circuitry so that it will cut in at some specified value of output voltage/current, but I don't recommend this method unless the amplifier is specifically designed for it.

Since output power into a given load is determined by the supply voltage, you can reduce maximum output by reducing supply voltage in proportion to the square root of the desired output change.

The best method, though, would be to use a peak limiting amplifier at the input, set to limit at an input level corresponding to the desired output. This is the only method which allows convenient switch selection.

I question your reasons for wanting to do this. 300 Watts is a lot of power, only likely to be used on peaks. Most decent speakers can handle this without trouble even though they may be rated much lower. If your average level is 10 Watts, it doesn't matter how much above this the amplifier is capable of, you'll still be using only ten watts, with the remainder providing headroom.

In any case, if you do have good reason for limiting output to, say, 50 Watts, why not build a 50 Watt amplifier and save a buck.

2) R19 is a feedback resistor and sets the gain, as well as feedback factor. There is a way to switch it: with a switch. You shouldn't have any bias problems, but you might want to check it for yourself.

3) You don't have to use Elna capacitors. As a matter of fact, you might consider using computer grade units mounted on the chassis, with small mylar units of around 50 nanofarads in place of the Elnas. Use the largest capacitors you can get, but don't skimp on the rectifier. The latter should be selected for very high surge current.

Using about 15000 uF capacitance will really make it sound like the high power amplifier it is, and tighten up bass response considerably.

Don't worry about the salesman, They get that expression from looking in the mirror too much.

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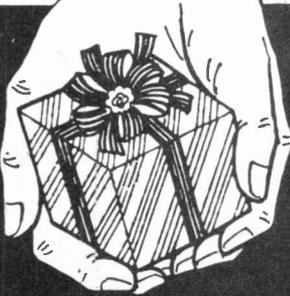
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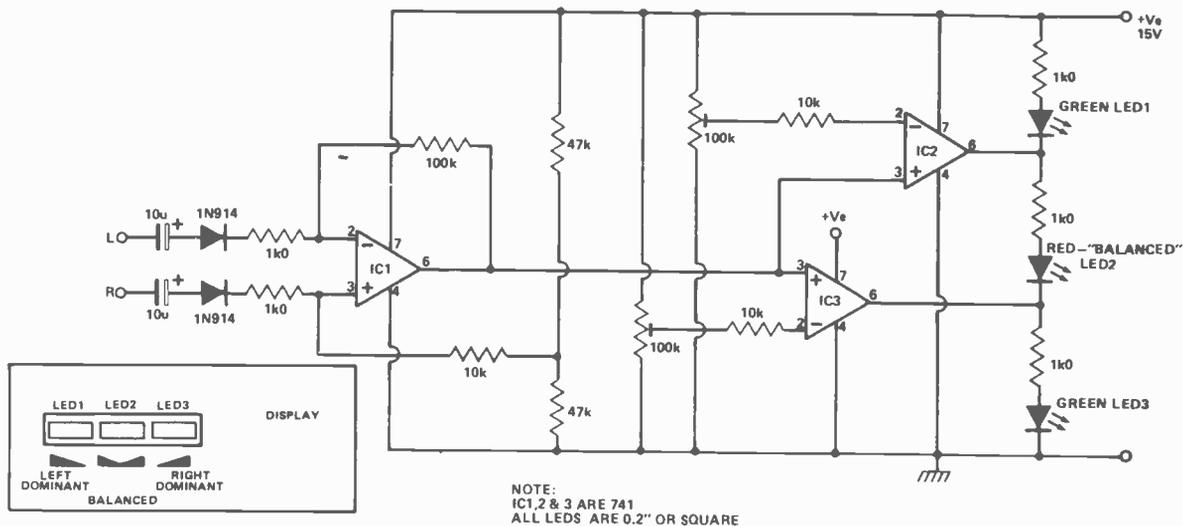
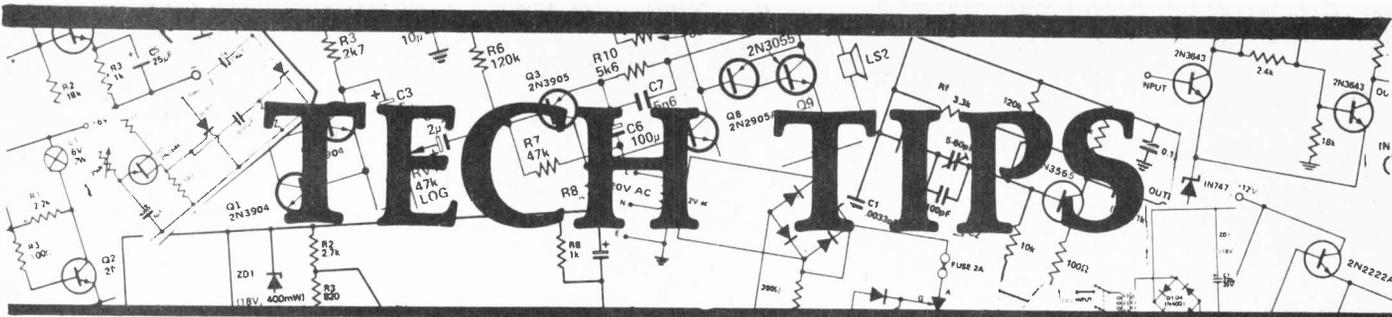
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Stereo Balance Meter G. Durant

Balance on a stereo amplifier is usually set by ear, but this of course can be very difficult to judge. If an amplifier has a balance meter at all, it is usually of the centre-zero moving coil type — bulky, old-fashioned looking and expensive. This circuit is designed to overcome all of these problems.

The outputs from each channel are fed to the two inputs of IC1, this being connected as a differential amplifier. If the left and right channels are of equal levels, the output of IC1 will have its output at about halfway between the supply rails. If

the left channel gets above the level of the right channel, the output of IC1 will approach the 0 V rail. If the right channel is loudest, the output becomes positive.

IC2 and 3 are also differential amplifiers, but in this case they are driven by the output of IC1. LEDs form a display at the outputs of the two ICs. Pin 2 of ICs 2 and 3 each go to a preset across the supply. In practice, the preset in conjunction with IC2 is set to hold pin 2 slightly above 0 V and the preset connected to IC3 is set to hold pin 2 just below supply voltage. These settings, however, must be set by trial and error so that the circuit works accurately.

The output of IC1 is connected to

the non-inverting inputs of IC2 and 3. If the output of IC1 approaches the supply rail, the outputs of ICs 2 and 3 will also go high, thus illuminating LED 3. This would happen if the right channel were dominating. If the left channel were dominant, the outputs of ICs 2 and 3 would be low, thus illuminating LED 1. If the two channels were equal in amplitude, the outputs of ICs 2 and 3 would be high and low respectively, lighting up LED 2.

The circuit can easily be added on to a ready constructed unit without using up large amounts of panel space, or used as an add-on unit for a hi-fi system. The unit draws about 20 mA, so battery operation is practical.

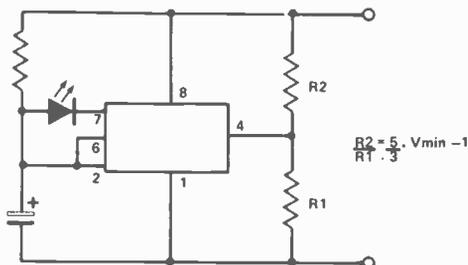
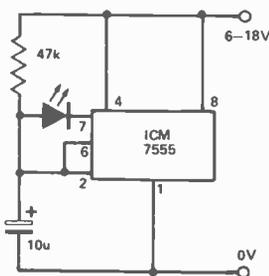
Micropower LED Flasher D. Stewart

The circuit will brightly flash an LED, yet has a supply current of only 150 uA. In a normal 555 astable, the timing capacitor is discharged straight to ground. Here, the charge is made use of by discharging it through the LED. A suggested use is for an on-off indicator in a battery-powered circuit.

With slight modification the circuit can be used as a good battery indicator. A potential divider is connected to pin 4 (reset) from the supply rail of the circuit whose battery is being monitored, so that when the supply

drops below a predetermined voltage, then the voltage on pin 4 drops below 0V7. Thus the LED will only flash if the supply is higher than

the predetermined voltage. Keep the value of the resistors high to reduce current consumption (eg 1M0 for R1).



DYNAMIC

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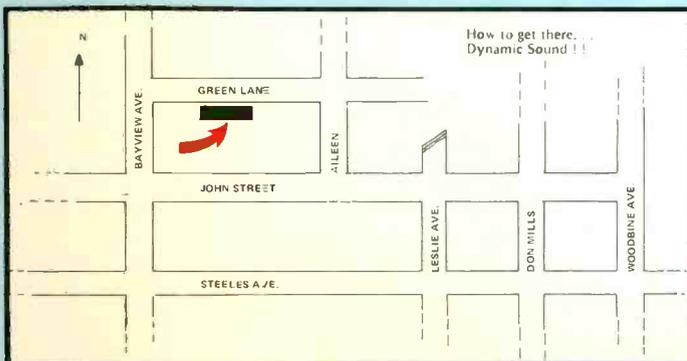
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B	2015A	LCD Bench DMM	\$159.00	\$239.00
C	8610A	600 MHz 8 Digit Frequency Counter	\$159.00	\$209.00
D	5020A	Function Generator .2 to 200 KHz	N/A	\$184.00
E	8000B	1 GHz Frequency Counter	N/A	\$339.00
F	2035	LCD Hand Held DMM	\$126.00	\$159.00
G	2037A	LCD Hand Held DMM/Thermometer with Probe	\$159.00	\$194.00
	8610B	600 MHz 9 Digit Frequency Counter	\$191.00	\$239.00
	8110A	100 MHz Frequency Counter	\$126.00	\$161.00

Accessories

Model	Description	Price
THP-20	Touch & Hold Probe, for use with Models 2010A, 2045A, 2035A and 2037A DMMs. Permits reading to be held in the display.	\$34.00
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AIM 65

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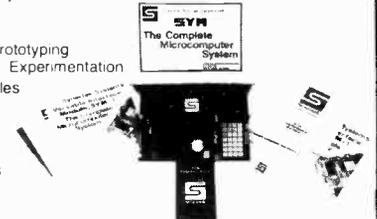
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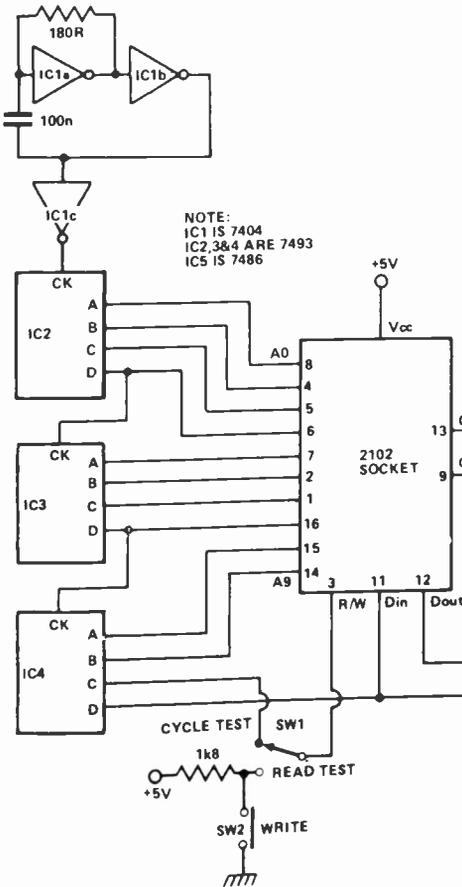
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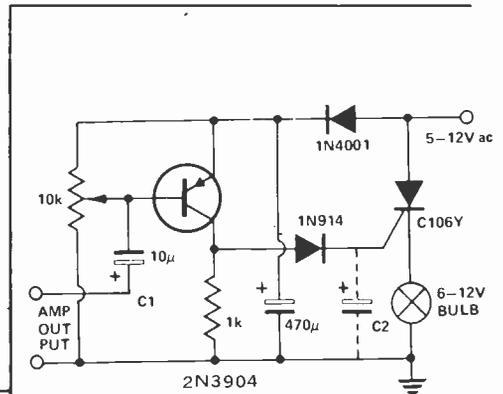
2102 Memory Tester

This circuit provides for the testing of 1024 bit X 1 memories, such as the 2102 series, in two modes. Mode-1 cycles the memory continuously through write and read, alternately writing zeros and ones then reading to ensure the write was successful. Mode-2 allows the write of a signal onto the memory, then continuously reads it to ensure the data is stable.



In both modes, the output from the memory is compared with what should be there, and if there is a difference, an LED flashes, accompanied by a click from the speaker. In Mode-2, on power on, a continuous noise will be heard from the speaker; on pressing the 'WRITE' button this should vanish. Similarly, a brief pulse of noise will be heard in Mode-1 before the write is completed. The oscillator frequency is about 20 kHz with components shown.

In Mode-2, when the supply voltage drops below 4.5V, memory is not stable for more than a fraction of a second, although this does not show up using Mode-1.



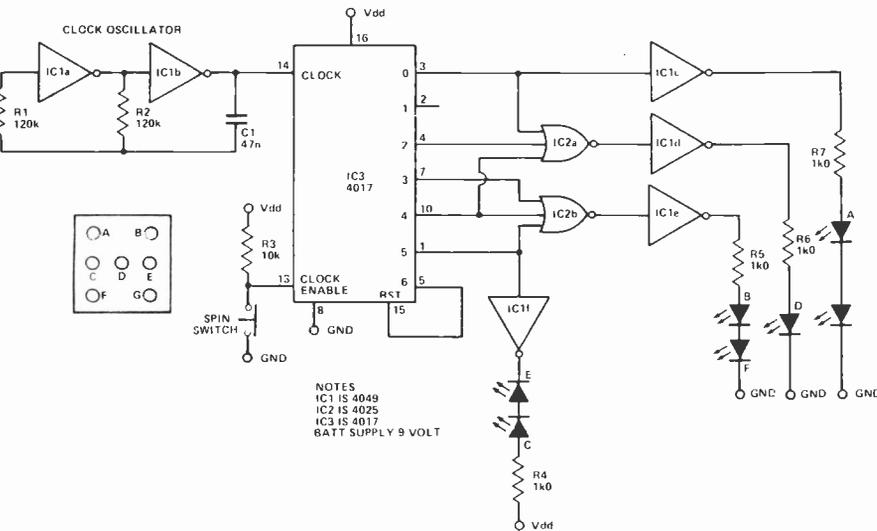
Sound-Modulated Light Source

Michael Thong

This circuit modulates a light beam with voice or music from the output of an amplifier. If the 10k pot is adjusted to slightly less than the V_{be} of the transistor, the circuit forms a peak detector.

This drives the gate of the SCR, lighting the globe, the brightness of which will vary as the sound level varies. C2 may be removed for a faster response.

Tech-Tips is an ideas forum and as such is not aimed at the beginner; we regret that we cannot answer queries on these items. We do not build up or test these circuits prior to publication. ETI is happy to consider ideas or circuits submitted by readers; all items used will be paid for. Drawings should be as clear as possible and the text preferably typed. Anything submitted should not be subject to copyright. Items for consideration should be sent to the Editor.



Electronic Travelling Dice

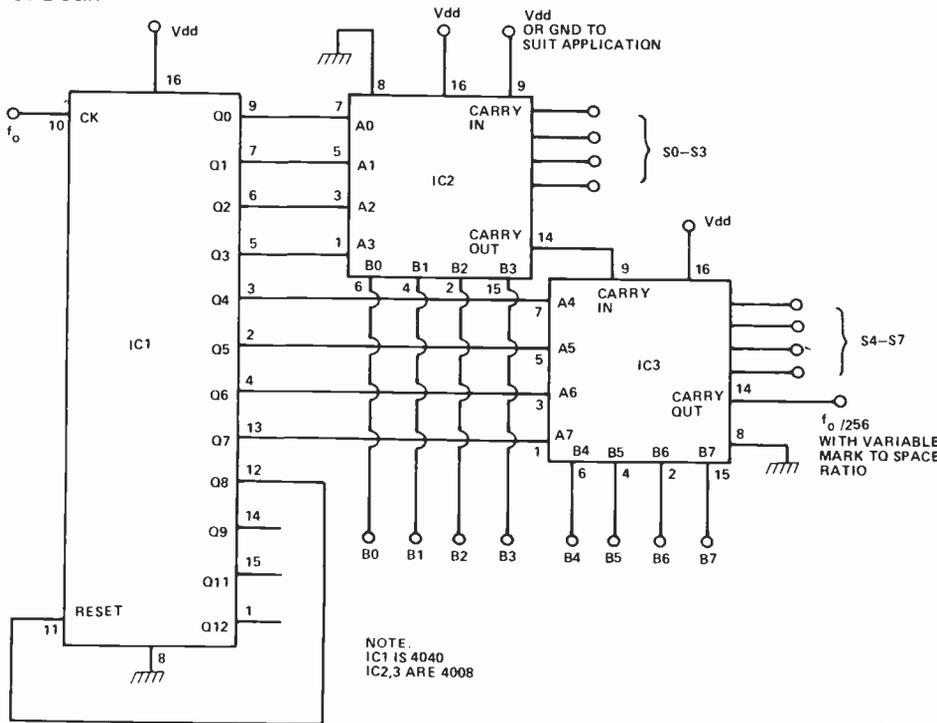
M.G. Argent

The heart of the unit is the 4017 divide by n counter, IC3. The outputs in turn give a logic 1 level (+9V) with each clock pulse. To divide by six as required by a dice, the seventh count (output six, confusingly) is connected to the reset (RST) input. This resets all outputs to logic 0 and the count starts all over again ad infinitum.

So long as the clock enable input is connected via the 10k resistor to V_{DD} , the count carries on as normal. If it is connected to 0 V the counter stops and remains in the state it was in at that time. This is achieved by a normally-open push switch which acts as the SPIN switch. When the switch is operated it stops the counter.

Digital Mark Space

C. Dean



This circuit provides a mark/space ratio at the C_{out} pin which depends on the binary value set up on B0 and B7. As Q0 to Q7 gradually increases in value, due to incoming clock pulses, $C_{out} = 0$ if $Q0...Q7 + B0...B7 \times 11111111$ and $C_{out} = 1$ if $Q0...Q7 + B0...B7 \times 11111111$. The higher the value of B0...B7, the quicker C_{out} will become 1 after Q0...Q7 is automatically reset, and the higher the value of the mark space ratio. The proportion of time that C_{out} is 1 is given by:

$$\frac{(\text{Value of } B0...B7) + C_{in} (= 0 \text{ or } 1)}{256}$$

Note that for C_{out} to be permanently 0 C_{in} must be 0 (and B0...B7 = 00000000) and that the C_{out} to be permanently 1 C_{in} must be 1 (and B0...B7 = 11111111).

The circuit could have its clock input connected to a microprocessor clock, B0...B7 connected to the data bus and C_{out} to moving coil meter or a red/green LED (RS 587-080). Then the meter reading will be proportional to, or the colour of the LED will depend on, the value of B0...B7.

Hey, It's Not Their Fault...

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However, atomic weapons never solved anything. It's probably just an odd coincidence that there was one fewer copies this time around... I'll bet it was something silly like a roving Bedouin mattress merchant came by and bought one to peruse whilst on the road, perchance atop his camel... no, I don't know the coordinates for Bedouin land off the top of my head, and I'd hardly tell you if I did. Listen, the old guy who runs that thing probably has a weak heart. Maybe you should put out the pilot light on the flame thrower and let him resume breathing. And I think that fuse is burning a bit short.

Yes, I realize that you're going to miss quite a lot of really neat stuff, features, circuits, news... excuse me, could you put the safety on that thing. I'm allergic to being sawn in half by a hail of bullets. You know, what you could do to avoid all this in the future would be to subscribe. That way, you'd have your ETI delivered to your front door once a month, with no hassle, and you could keep your artillery in the garage where it wouldn't get rusty. It would almost be like signing a truce.

Oh, uh, did I say something wrong. Just ease the pin back into that grenade, would you... subscribe to ETI and prevent armageddon. \$16.00 for one year. \$29.95 for two. Lower rates for orders of one century or longer. 7% provincial pinch for Ontario residents.

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Specification
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 Input Resistance: 10M Ω when used with Oscilloscopes with 1M Ω input (Probe resistance 9M Ω \pm 1%)
 Input Capacity: 9.5 pF when used with oscilloscopes which have 30 pF input capacity.
 Compensation Range: 10-60 pF
 Working Voltage: 600 Volts D.C. (including Pk A.C.)
 Cable Length: 1.5 Metres

\$35⁸⁵

2P150

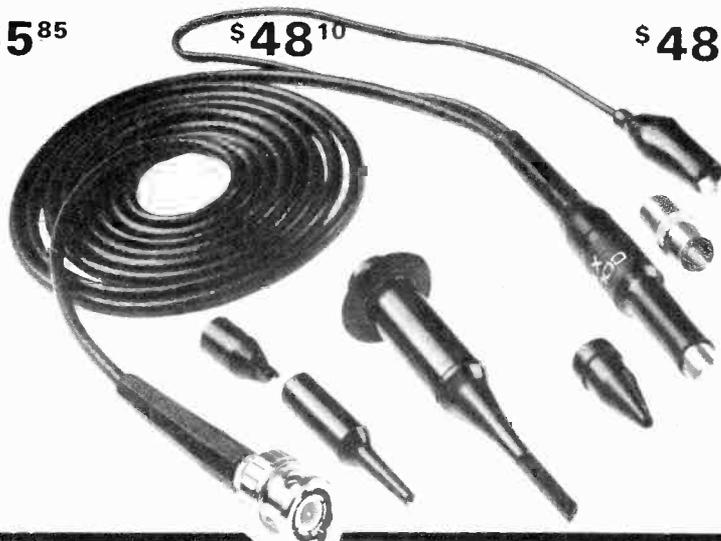
Specification
 Bandwidth: D.C. to 150 MHz
 Rise Time: 2.3 nanoseconds
 Input Resistance: 10M Ω when used with oscilloscopes with 1M Ω input (Probe resistance 9M Ω \pm 1%)
 Input Capacity: 11.0 pF when used with oscilloscopes which have 30 pF input capacity.
 Compensation Range: 10-60 pF
 Working Voltage: 600 Volts D.C. (including Pk A.C.)
 Cable Length: 2 Metres

\$48¹⁰

2P100

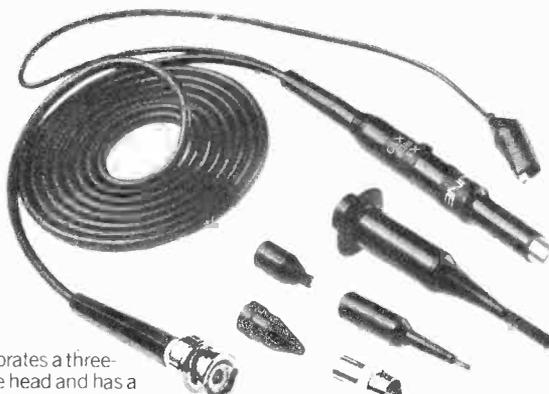
Specification
 Bandwidth: D.C. to 100 MHz
 Rise Time: 3.5 nanoseconds
 Input Resistance: 10M Ω when used with oscilloscopes with 1M Ω input (Probe resistance 9M Ω \pm 1%)
 Input Capacity: 13.5 pF when used with oscilloscopes which have 30 pF input capacity.
 Compensation Range: 10-60 pF
 Working Voltage: 600 Volts D.C. (including Pk A.C.)
 Cable Length: 2 Metres

\$48¹⁰



SP100 Oscilloscope Probe

\$51²⁰



This passive probe incorporates a three-position slide switch in the head and has a cable length of 1.5 metres. The specification is as follows.

Position x 1

Bandwidth: D.C. to 10MHz
 Input Resistance: 1M Ω (oscilloscope input)
 Input Capacity: 40 pF. Plus oscilloscope capacity
 Working Voltage: 600 Volts D.C. (including Peak A.C.)
 Cable Length: 1.5 Metres

Position Ref.

Probe tip grounded via 9M Ω resistor, oscilloscope input grounded

Position x 10

Bandwidth: D.C. to 100 MHz
 Rise Time: 3.5 nanoseconds

Input Resistance: 10M Ω when used with oscilloscopes which have 1M Ω input. (Probe resistance 9M Ω \pm 1%)
 Input Capacity: 11.5 pF when used with oscilloscopes which have a 30 pF input capacity.

Compensation Range: 10-60 pF
 Working Voltage: 600 Volts D.C. (including Peak A.C.)

\$26⁶⁰



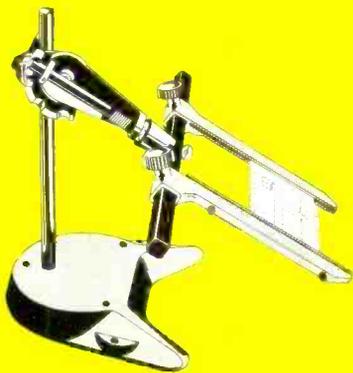
1P20

X1 Oscilloscope Probe

Specification
 Bandwidth: D.C. to 20 MHz
 Input Resistance: 1M Ω (oscilloscope input)
 Input Capacity: 47 pF. Plus oscilloscope input
 Working Voltage: 600 Volts D.C. (including Peak A.C.)
 Cable Length: 1.5 Metres

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MOS Static RAM's

Table listing MOS Static RAMs with Part No, capacity, and Price.

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