

CB RADIO - NEWS AND VIEWS INSIDE

# Hobby Electronics

October '80

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55p

**SPECIAL ISSUE**

**ELECTRONICS AROUND THE HOUSE**

Including six DIY projects for the home



**WITH THIS ISSUE YOU CAN BUILD:**

AN INTRUDER ALARM TO PROTECT YOUR VALUBLES

A TUG-OF-WAR GAME TO TEST YOUR STRENGTH

A TEMPERTURE CONTROLLED SOLDERING IRON

AN INEXPENSIVE LIGHT DIMMER

AS  
ADVERTISED  
ON  
**LOCAL  
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and it didn't take very long either. Electronics have evolved faster than anything else. From Marconi's first crackling morse transmissions to minichip in a lifetime. But space-age technology poses it's own problems to dealers anywhere. The days you strung your own aerial with a length of copper wire bought just around the corner are over. Nowadays,

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or you can contact us. We're not just around the corner, but very nearly so.

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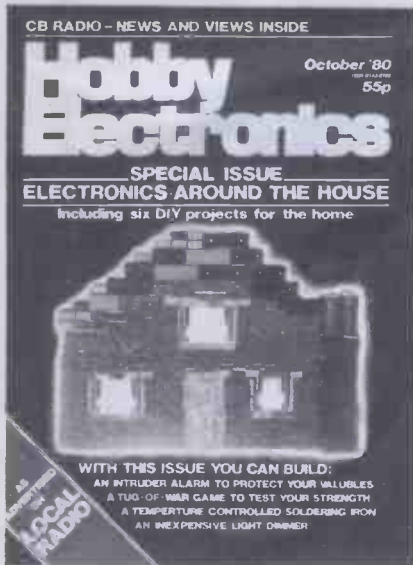
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**ELECTRONICS HAVE GROWN UP  
WHY DON'T YOU, TOO**



# Hobby Electronics

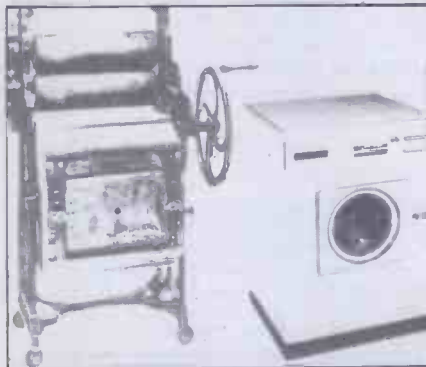
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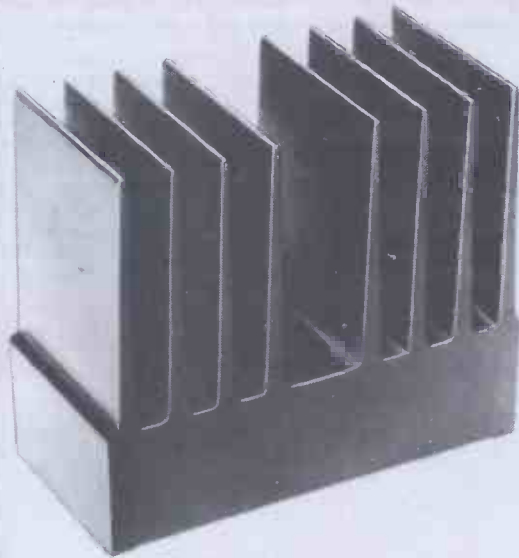
## NEWS & INFO

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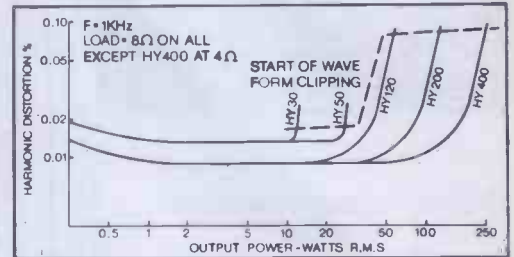
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HY120	60 W into 8 Ω	0.01%	100 dB	-35 -0 +35	114x50x85	575	£15.20 + £2.28
HY200	120 W into 8 Ω	0.01%	100 dB	-45 -0 +45	114x50x85	575	£18.44 + £2.77
HY400	240 W into 4 Ω	0.01%	100 dB	-45 -0 +45	114x100x85	1.15Kg	£27.68 + £4.15

Load impedance - all models 4Ω - ∞  
Input sensitivity - all models 500 mV  
Input impedance - all models 100K Ω  
Frequency response - all models 10Hz - 45KHz -3dB

## POWER SUPPLY UNITS



AVAILABLE ALSO FROM WATFORD ELECTRONICS, MARSHALLS AND CERTAIN OTHER SELECTED STOCKISTS.

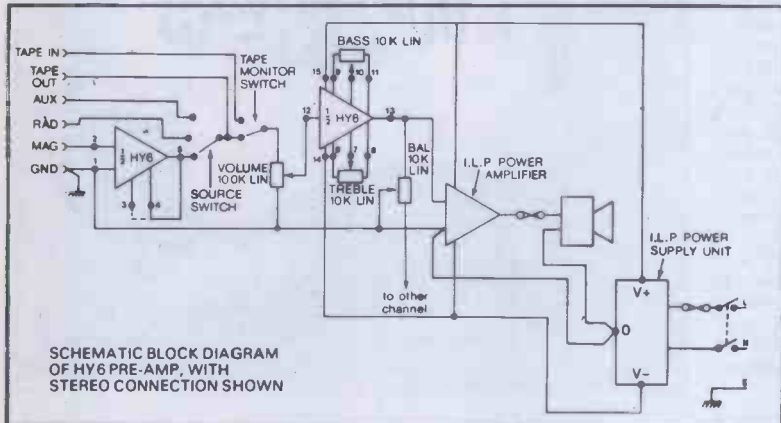
ILP Power Supply Units with transformers made in our own factory are designed specifically for use with ILP power amplifiers and are in two basic forms — one with circuit panel mounted on conventionally styled laminated transformer, for PSU 30 and 36 — in the other, for larger PSUs, ILP toroidal transformers are used which are half the size and weight of laminated equivalents, are more efficient and have greatly reduced radiation.

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# this time with two new pre-amps



## HY6 mono HY66 stereo

When ILP add a new design to their audio-module range, there have to be very special reasons for doing so. You expect even better results. We have achieved this with two new pre-amplifiers - HY6 for mono operation, HY66 for stereo. We have simplified connections, and improved performance figures all round. Our new pre-amps are short-circuit and polarity protected; mounting boards are available to simplify construction.

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### HY6 mono

£5.60  
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Connectors included

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# Monitor

## Shoulder Sounds

You may have heard of the 'Bone Fone', it's a kind of flexible stereo radio that hangs around your neck. Well, we've just had the opportunity to try one out. The Bone Fone has been on sale in the USA for a few months now and it's proving very popular with joggers and skaters. Not having too many joggers or skaters in the HE office our 'field tests' have been a little less than vigorous. Initial reports were less than enthusiastic as stereo reception was a little noisy, which we discovered was due to our review model having an aerial designed for the US market. Once outside the office though, things improved dramatically (it must be the bars on the doors and windows designed to keep us in). Stereo reception was quite acceptable and the AM side worked OK under all conditions. Only two little niggles, in the first

place the controls are badly sited, it's quite difficult to tune it in by 'feel' only and the stereo indicator light might as well have been left out as there's no way you could ever see it unless you looked at yourself in a mirror. The second problem arose when gyrating with the music (as is our wont after the odd shandy), the directional nature of FM transmissions caused a certain amount of fading which could be awkward for joggers unless they jog in straight lines, parallel to the transmission path. In all fairness though we suspect this may be due to the aerial which is not really suitable for our FM service. The US style of 'saturation' FM broadcasting dictates that a certain amount of insensitivity be built in. The Bone Fone will be available in the next couple of weeks. Kramer and Co are the people to see, take along £39 and the Bone Fone will be all yours. Kramer and Co lurk at 9 October Place, London NW4 1EJ.



## Knight Moves

You guessed it, another chess computer, this one is called simply 'Intelligent Chess' and comes from Optim Games Ltd. At around £295 it must be one of the most expensive chess computers ever but it does have an impressive line up of features. First away is the built-in cassette recorder, it will record up to 1,000 different games and/or an audio commentary on a C90 cassette. The cassette recorder can be used with the 'Teacher' cassette (supplied free) to help a beginner with the basic moves, optional extras include a selection of other pre-recorded

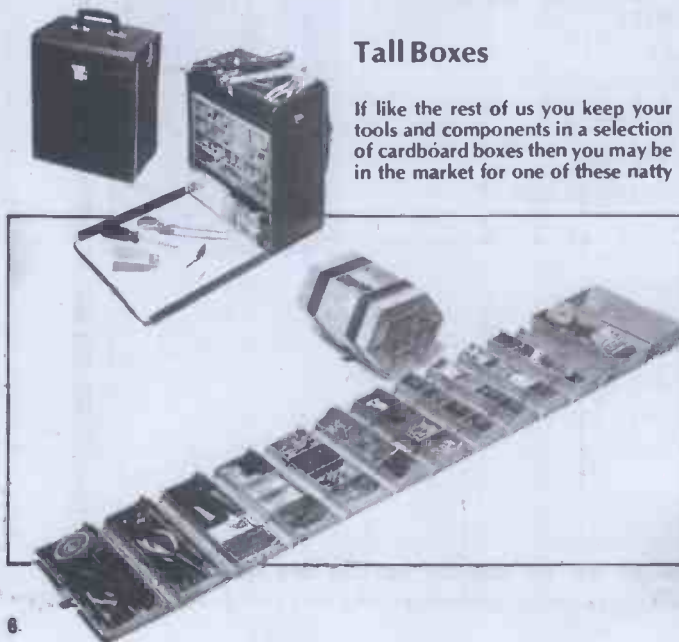


cassettes with titles like 'All Karpov's games' or 'All named variations'. The game is displayed directly on to a standard colour TV set and will play in any one of 13 levels.

Intelligent Chess is the first British designed chess computer and has an impressive pedigree. International chess master David Levy was responsible for the overall design and Barry Savage of 'Softy' fame was responsible for the electronics. The programmer is one Mike Johnson, winner of the first European microprocessor chess tournament in 1978. With names like that how can it fail? The game will be available in October. Optim Games live at 45 South Street, Bishops Stortford, Hertfordshire.

## Tall Boxes

If like the rest of us you keep your tools and components in a selection of cardboard boxes then you may be in the market for one of these natty



little tool/component receptacles.

To give it its full (and rather splendid sounding) title, it's a 'Link-Hampson Multiple Services Cabinet', impressed huh? As you can see from the photograph the top section houses tools and the lower drawer cabinet will happily hold all your components. To stop them falling out on the floor a hinged front panel folds down to allow access to the clear plastic drawers. The outer case comes in a no-nonsense simulated leather (at least they're honest about it) with a sturdy carrying handle. Link-Hampson assure us that extra strength is guaranteed by incorporating reinforced side straps. All this can be yours (without the tools) for just £29.95, the cabinet on its own is only £10. Link-Hampson are awaiting your enquiry at 5 Bone Lane, Newbury, Berkshire RG14 5TD.

Just before we went to press we received news of another tool box,

this one is called the 'Rolykit'. It's rather unusual in that instead of having separate drawers or boxes it rolls out from a handy looking hexagonal-shaped carrying case. At first glance it would appear that this is the ideal method of jumbling up all your carefully sorted bits and pieces but some clever design work has taken care of that. Each compartment automatically covers the one underneath. The manufacturers claim it can be dropped, thrown about and generally handled quite carelessly without any kind of spillage. Rolykit is being launched in the UK in a few weeks and two sizes will be available, the smaller at £12 and the larger at £15. The Rolykit has already been a great success in Holland, it will be interesting to see how it fares over here. The people to talk to are Co-Ordinated Marketing Services, 21 Great Portland Street, London W1N 5DB.



# All these advantages...

- Instant all-weather starting
- Smoother running
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- Longer battery & plug life
- Improved fuel consumption
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## ..in kit form

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The superb technical design of the Sparkrite circuit eliminates problems of the contact breaker. There is no misfire due to contact breaker bounce which is eliminated electronically by a pulse suppression circuit which prevents the unit firing if the points bounce open at high R.P.M. Contact breaker burn is eliminated by reducing the current by 95% of the norm.

There is also a unique extended dwell circuit which allows the coil a longer period of time to store its energy before discharging to the plugs. The unit includes built in static timing light, systems function light, and security changeover switch. Will work all rev counters.

**Fits all 12 v negative-earth vehicles with coil/distributor ignition up to 8 cylinders.**

### THE KIT COMPRISES EVERYTHING NEEDED

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# Monitor

## News from the Electronics World



### Bug Swatter

Stories about phone tapping and bugging seem to be hitting the headlines with alarming regularity. It's not surprising that companies offering anti-bugging services are enjoying a mini-boom at the moment. Here we have an interesting device, it's called the Scanlock Mark V8. It's basically a broad band radio receiver that can 'scan' up and down a range of frequencies (10 to 1800 MHz) four times a second. It analyses all the signals on those frequencies, picking out any that are significantly stronger than the others. Once it has locked onto a likely transmission it tests it by emitting a short tone. All this can take less than one second. Scanlock will demodulate any signal, whether it is AM, FM, or Subcarrier (Phantom Modulation). It can also be used to detect 'sleeper' bugs that are activated automatically by radio control. Once the presence of a bug has been established the Scanlock can locate it by means of a hand-held antenna, a continuous tone from the Scanlock rises in frequency as the antenna gets closer to the bug.

The Scanlock is completely portable and can be used in a car. It comes with all the accessories, leather carrying case and Ni-Cad batteries. The price is available on application from Audiotel International Ltd, Saddlers Court, 100 Reading Road, Yateley, Surrey GU17 7RX.

### Errata

Someone somewhere has really got it in for use, we even managed to get the Errata wrong last month. The correction on the overlay diagram for Pass The Loop should have said that IC2 and IC3 numbering was transposed, NOT IC1 & IC2. Heads will roll.

The Auto Probe last month had a similar error on the overlay diagram (Fig.3), LED 1 & LED 2 should be swapped over. Still with the Auto Probe, some people have been experiencing difficulty in obtaining the transistor Q1, this is not a critical component and almost any general purpose PNP type will do (the BC179 is ideal).

The Guitar Phaser overlay (Fig.3 yet again) shows the connections for Q1 & 2. Drain and Source reversed, the pin out diagram beneath Fig.1 is correct.

Last but not least it seems that one or two people have been experiencing instability problems with the Car Booster published in the July issue. We're not sure why but there's a possibility that a suspect batch of ICs have been floating around. If you are experiencing a low 1 Hz click then it can be cured by putting a 2R2 resistor in series with both C7 & C8 (on the earthy side) and removing the link from Pin 7 of IC1. Take the speaker connection via a flying lead from Pin 7 making sure it is well away from IC1.

### Book Reviews

Yet another pair of books from Babani Publishing Ltd, both with a workshop theme. The first is called *Electronic Test Equipment Construction*. (F G Rayer, ISBN 0900162 95 3, £1.75). As you might expect it contains constructional projects and advice on how to use a wide range of

useful test gear. As anyone who has been faced with a dead project will tell you, fault finding with a wet finger and a light bulb is no fun. Several of the circuits have full constructional details though most are left up to the individual constructor. The designs include an FET Voltmeter, Field Strength Meter, Watt

Meter, Capacitance Bridge and a worthy assortment of RF and AF Generators. A valuable addition to the budding faultfinder's library.

Number two is called *Power Supply Projects*. (R A Penfold, ISBN 0 900162 96 1, £1.75). You can't really go wrong with this one, it could be called 'Everything you ever wanted

to know about Power Supplies', it really is very comprehensive. Projects range from the simplest unregulated, Half-Wave power supply to a 5-15 volt, 3 amp, fully stabilised bench supply. Again constructional details are left largely up to the individual. This book is aimed at the more experienced constructor.

### Speaks For Itself!

"Does your watch tell the time?" "No, you have to look at it." OK, so it never was the funniest of jokes. Now it's not true either. Those wily Orientals at Sharp have devised a speaking clock, which is a lot more fun than the GPO's version even if it doesn't have the same cut-glass accent.

At first glance the Sharp CT-660 looks like an ordinary multi-function travelling alarm clock, with an LCD display. Leave it sitting on your desk, however, and it announces the time at half-hourly intervals. If you believe that clocks should be seen and not heard, this facility can be turned off. Press a button on the top of the clock and it tells you the current time. All of the other functions of the clock use the voice too. When the alarm goes off, a short fanfare is followed by an announcement of the

time. Just to make sure you're awake, this is followed by a very penetrating rendition of Boccherini's Minuet. The clock reminds you of the time after five and ten minutes, tells you to hurry up, and plays the tune again (hope you like Boccherini).

In the timer mode, the elapsed time is spoken every minute, five minutes, or thirty minutes, for up to ten hours (depending on setting). The stopwatch mode is similar, except that the announcements are made every ten seconds and lap times and accumulated times are provided.

All this electronic trickery is packed into a tiny chrome case 114mm by 60mm by 22mm, which shows how advanced electronic speech generation has become. 'Talking Time' should be in the shops about now, and is ideal for gadget freaks or the blind. Wintjoy Ltd have a limited number of clocks at the moment for around £40 each.

### Equal Opportunities

Yes, we've all seen car graphic equalisers before, we've even seen them with booster amplifiers but here's the catch, how many have you seen for only £25.00?

It sounds too cheap to be true but it's not, this well built booster/ equaliser delivers 25 watts per channel with full equalisation over the range of 60 Hz to 15 kHz. It has a sturdy metal case with hefty heat-sinks on the side. The quality is ex-

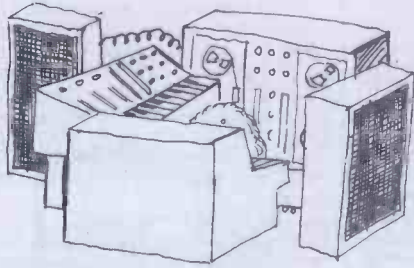
cellent, worthy of units costing several times as much. Connection to your existing stereo is a simple matter, all the common connector sockets are fitted and it is small enough to fit unobtrusively underneath the dashboard. The Harvard Graphic Equaliser Amplifier is currently being sold for this derisory sum by Minikits Ltd. You can find them at: 88 Hainault Road, Leytonstone, London E11 1EH.



# Hobby Electronics

Next Month

ON SALE  
OCTOBER 10th



## Thirty Pound Synthesiser

No, not weight, price! That's right, for around thirty quid you can build yourself this high quality, versatile and above all, economical synthesiser. Create outlandish noises, scare your granny, even play a few tunes. This easy-to-build unit features the latest LSI technology to reliably generate the sounds.

We're keeping quiet about the technical details, walls have ears and all that. Suffice it to say that this is the design you've been waiting for. You have four weeks, starting from now to find your £30. It'll be money well spent, we promise you that.

## Electronic Hand Grenade

You'll get a real 'bang' out of this new game. It's the electronic version of that old parlour game 'musical chairs'. The grenade is passed around a circle of players, the longer it is held the greater the chance it will go 'off'. The person that has it then leaves. This ingenious little circuit will provide hours of amusement at parties and can be built by even the most inexperienced constructor in just a couple of hours.



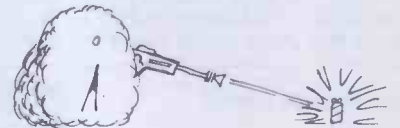
## Guitar Sound Shaper



Gasp, shock, horror, you haven't heard of a Guitar Sound Shaper before. Shame on you. How can you ever hold your head up in decent company? People like you give our hobby a bad name, no wonder dogs cross the street when they see you. There's only one thing you can do, rush out and get next month's copy of HE or forever be a social outcast.

## Battery Eliminator

This 35 kilowatt laser is guaranteed to instantly vapourise any battery from a HP7 to a PP9. Batteries are really becoming a nuisance. Stop their takeover right now. The HE battery Eliminator will forever remove the menace of the dry-cell. Just plug it into your local mains socket and laugh as you count all the money you'll save. Actually it's not really a 35 kilowatt laser but it will save you a few quid. Look out for it in next month's bigger-than-ever issue.



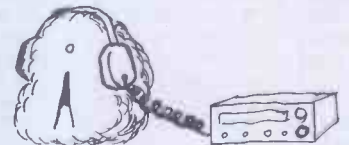
## Transistor Tester



What can we say? Not a lot really, we don't have to tell you that this is the most advanced design ever to measure the collector current of a BC109, you know that already because it comes from Hobby Electronics!

## Stereo

Now for the first time anywhere this century Hobby Electronics has commissioned that Master of the Microcircuit, the Baron of the Breadboard, that well known man of digits, Ian Sinclair (who?) to write the definitive lowdown on Stereo. What is it, how does it do it, what do I do with it? These are just some of the questions that will finally get answered next month in this exciting top-level feature.



The items mentioned here are those planned, but unforeseen circumstances may affect the actual contents.

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BREAKTHROUGH**



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UNITS OF MEASUREMENT DISPLAYED	mV, V, mA	mV, V, mA, A	mV, V, mA	mV, V, mA, A
FUNCTIONS DISPLAYED	Ω, KΩ, AUTO, BATT, ADJ, LO, – and AC			
MEASURES DC VOLTAGE TO	1000V	1000V	1000V	1000V
MEASURES AC VOLTAGE TO	750V	750V	750V	750V
MEASURES AC DC CURRENT TO	200mA	10A	200mA	10A
ZERO ADJUSTMENT	Zeros out minute test-lead resistances for precise measurements			
ACCURACY	0.5%	0.5%	0.8%	0.8%
LOW POWER OHM RANGES	For in-circuit resistance measurements on all models			
BUZZER – Continuity Test	✓	✓	✓	✓
BUZZER – Over Range Indicator	✓	✓	✓	✓
COMPLETE WITH	Batteries, pair of Test Leads, Spare Fuse, One Year's Guarantee			
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7404	14p	74368	100p
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7406	36p	74391	200p
7407	36p	74490	225p
7408	17p	74505	25p
7409	19p	74500	14p
7410	15p	74502	16p
7411	24p	74503	18p
7412	30p	74504	16p
7413	30p	74508	22p
7414	30p	74510	20p
7415	27p	74511	40p
7416	27p	74513	40p
7417	27p	74514	40p
7418	27p	74515	40p
7419	27p	74516	40p
7420	27p	74517	40p
7421	27p	74518	40p
7422	27p	74519	40p
7423	34p	74520	40p
7424	34p	74521	40p
7425	34p	74522	40p
7426	34p	74523	40p
7427	34p	74524	40p
7428	34p	74525	40p
7429	34p	74526	40p
7430	34p	74527	40p
7431	34p	74528	40p
7432	34p	74529	40p
7433	34p	74530	40p
7434	34p	74531	40p
7435	34p	74532	40p
7436	34p	74533	40p
7437	34p	74534	40p
7438	34p	74535	40p
7439	34p	74536	40p
7440	34p	74537	40p
7441	34p	74538	40p
7442	34p	74539	40p
7443	34p	74540	40p
7444	34p	74541	40p
7445	34p	74542	40p
7446	34p	74543	40p
7447	34p	74544	40p
7448	34p	74545	40p
7449	34p	74546	40p
7450	34p	74547	40p
7451	34p	74548	40p
7452	34p	74549	40p
7453	34p	74550	40p
7454	34p	74551	40p
7455	34p	74552	40p
7456	34p	74553	40p
7457	34p	74554	40p
7458	34p	74555	40p
7459	34p	74556	40p
7460	34p	74557	40p
7461	34p	74558	40p
7462	34p	74559	40p
7463	34p	74560	40p
7464	34p	74561	40p
7465	34p	74562	40p
7466	34p	74563	40p
7467	34p	74564	40p
7468	34p	74565	40p
7469	34p	74566	40p
7470	34p	74567	40p
7471	34p	74568	40p
7472	34p	74569	40p
7473	34p	74570	40p
7474	34p	74571	40p
7475	34p	74572	40p
7476	34p	74573	40p
7477	34p	74574	40p
7478	34p	74575	40p
7479	34p	74576	40p
7480	34p	74577	40p
7481	34p	74578	40p
7482	34p	74579	40p
7483	34p	74580	40p
7484	34p	74581	40p
7485	34p	74582	40p
7486	34p	74583	40p
7487	34p	74584	40p
7488	34p	74585	40p
7489	34p	74586	40p
7490	34p	74587	40p
7491	34p	74588	40p
7492	34p	74589	40p
7493	34p	74590	40p
7494	34p	74591	40p
7495	34p	74592	40p
7496	34p	74593	40p
7497	34p	74594	40p
7498	34p	74595	40p
7499	34p	74596	40p
7500	34p	74597	40p

93 SERIES	74S SERIES
9301 180p	74S00 80p
9302 175p	74S01 75p
9308 318p	74S05 75p
9310 275p	74S08 75p
9311 275p	74S10 75p
9312 180p	74S12 75p
9313 180p	74S13 75p
9316 225p	74S17 250p
9321 225p	74S17 250p
9322 150p	74S18 75p
9334 360p	74S21 450p
9368 250p	74S26 75p
9370 300p	74S30 75p
9374 200p	74S112 120p

LINEAR I.C.s	MC1496
AY1-0212 600p	600p
AY1-1313 658p	120p
AY1-1320 320p	75p
AY1-5050 140p	620p
AY3-1270 840p	150p
AYS-1224A 240p	250p
AYS-1351 600p	NE555 70p
AYS-1317A 775p	NE556 150p
AYS-4007D 520p	NE561 425p
CA3019 80p	NE565 130p
CA3046 70p	NE566 155p
CA3048 225p	NE567 140p
CA3086 48p	NE571 425p
CA3088 225p	NE584 420p
CA3090AQ 375p	NE588 200p
CA3130E 90p	SAB3209 POA
CA3140E 50p	SN1024A 1250p
CA3160E 140p	SL490 100p
CA3181E 100p	SN7603N 250p
CA3189E 300p	SN76013N 140p
CA3280 160p	SN76033N 120p
DA31408-B 200p	SN76023N 170p
FX209 200p	SN76033N 170p
ICL7108 850p	SN76477 150p
ICL7349 300p	SP8515 75p
ICM7555 80p	TA621 275p
LF351 45p	TBA61411 225p
LF356P 95p	TBA651 200p
LM100 428p	TBA900 200p
LM301A 30p	TBA810 100p
LM311 70p	TBA820 200p
LM317 200p	TBA950 200p
LM319 225p	TCA210 350p
LM324 45p	TCA220 350p
LM339 75p	TCA940 175p
LM348 95p	TDA1004 320p
LM377 175p	TDA1008 320p
LM380 75p	TDA1010 225p
LM381A 180p	TDA1022 570p
LM388 95p	TDA1024 120p
LM390 30p	TDA1034B 250p
LM393 100p	TDA1084 300p
LM397 35p	TDA2002V 325p
LM710 50p	TDA2020 320p
LM715 350p	TL071/81 45p
LM733 100p	TL072/82 75p
LM741 18p	TL074 110p
LM747 70p	TL084 110p
LM748 35p	TL170 40p
LM2917 250p	UAA170 150p
LM3900 70p	UDN6118 320p
LM3911 130p	UDN6184 320p
LM3914 225p	ULN2003 100p
LM3915 225p	XR2202 400p
LM4136 120p	ZN414 90p
LM4360 125p	ZN419C 225p
MC1301P 150p	ZN424E 135p
MC1458 48p	ZN425E 40p
MC1495L 350p	ZN427E 750p

VOLTAGE REGULATORS	-ve	+ve
1A 5V 7805 60p	7905 65p	
1A 5V 7805 60p	7912 65p	
15V 7815 60p	7915 70p	
18V 7818 60p	7918 70p	
24V 7824 60p	7924 70p	
100mA T092	79L05 70p	
5V 78L05 30p	79L12 70p	
15V 78L15 30p	79L15 70p	

OTHER REGULATORS	78HGKC
LM309K 13p	600p
LM317T 200p	600p
LM323K 580p	700p
LM723 37p	300p

OPTO-ELECTRONICS	
ORP60 120p	ORP61 120p
ORP12 130p	ORP12 55p

OPTO-ISOLATORS	
ILD74 130p	TL111 90p
MCT26 100p	TL112 90p
MCS2400 190p	TL116 90p

LEDS	0.2"
TL32 5p	TL220 Red 16p
TL209 Red 13p	TL222 Gr 16p
TL211 Gr 20p	TL228 Red 22p
TL212 Ye 25p	Rectangular 25p
TL216 Red 19p	LEDs (R, G, Y) 30p

DISPLAYS	
3015F 200p	NSB5681 570p
DL704 140p	TL311 80p
DL707 Red 140p	TL312/3 110p
DL747 Red 225p	TL321/2 130p
747 Gr 225p	TL330 140p
FND37 120p	7750/60 200p

DRIVERS	
FND507 120p	9368 250p
FND507 120p	9370 250p
MAN3640 175p	UDN6118 320p
MAN4640 200p	UDN6184 320p

TRANSISTORS	
AC126 25p	BF40 25p
AC127/8 20p	BF41 25p
AC176 25p	BF79 25p
AC178 25p	BF79 25p
AC187/8 25p	BF81 25p
AF116 50p	BFX29 25p
AD149 70p	BFX45/5 40p
AD161/2 45p	BFX86/7 50p
AD162 45p	BFX86/7 50p
BC107/8 11p	BFX86/7 50p
BC109 11p	BFV10 30p
BC117 20p	BFY50 30p
BC147/8 9p	BFY51/2 30p
BC149 10p	BFY56 33p
BC157/8 17p	BFY90 90p
BC159 11p	BR39 45p
BC169C 12p	BSX19/20 20p
BC172 12p	BU104 225p
BC177/8 17p	BU105 190p
BC179 17p	BU108 250p
BC181/3 10p	BU205 200p
BC184 11p	BU208 200p
BC187 30p	BU300 200p
BC212/3 11p	E300 60p
BC214 12p	E308 50p
BC237 15p	E310 50p
BC237 15p	MJ2501 225p
BC338 16p	MJ2955 90p
BC461 36p	MJ3001 225p
BC477/8 30p	MJE340 50p
BC576/7 40p	MJE2955 100p
BC577 40p	MJE3055 70p
BC548C 9p	MPF102 45p
BC549C 18p	MPF103/4 40p
BC557 16p	MPF105/6 40p
BC559C 18p	MPF531 50p
BCY70 18p	MPS634 50p
BD131/2 50p	MPSA06 30p
BD135/6 54p	MPSA10 50p
BD139 56p	MPSA12 50p
BD140 60p	MPSA13 50p
BD189 60p	MPSA20 50p
BD223 75p	MPSA42 50p
BD235 85p	MPSA43 50p
BD241 70p	MPSA56 32p
BD242 70p	MPSA70 30p
BDY56 200p	MPSA70 30p
BF244B 35p	OC28 130p
BF256/8 32p	OC35 130p
BF259 35p	TIP29A 45p
BF339 25p	TIP30A 45p
BF339 25p	TIP30C 60p

MEMORIES	
2101/4L 400p	2102/2L 400p
2107 500p	2107B 500p
2111 300p	2111A 300p
2112/4 300p	2112/4 300p
2114 300p	2114 300p
2114-2L 750p	2114-2L 750p
404 40p	4044 40p
4116 40p	4116 40p
5101 510p	5101 510p
6810 325p	6810 325p
74S201 350p	74S201 350p
82516 725p	82516 725p

ROM / PROMS	
71301 225p	74S188 225p
74S387 225p	74S387 225p
74S470 650p	74S470 650p
74S477 650p	74S477 650p
74S571 650p	74S571 650p
82S137 750p	82S137 750p

CPUs	
1600 1200p	1800CE 750p
2000 2000p	2600A 2000p
2750 750p	2750 750p
2800 650p	2800 650p
2800 650p	2800 650p
2800 1100p	2800 1100p
2800 2500p	2800 2500p
3080A 450p	3080A 450p
3080A 1100p	3080A 1100p
3080B 1100p	3080B 1100p
3250 450p	3250 450p
400 750p	400 750p
450 750p	450 750p
720 750p	720 750p
723 625p	723 625p
2716(+5V) £10	2716(+5V) £10
2732 £25	2732 £25

SUPPORT DEVICES	
3242 450p	3242 450p
4500 450p	4500 450p
4500 450p	4500 450p
522 800p	522 800p
5532 900p	5532 900p
6820 500p	6820 500p
6821 375p	6821 375p
6845 £20	6845 £20
6850 375p	6850 375p
6852 300p	6852 300p
8155 1100p	8155 1100p
8205 500p	8205 500p
8212 225p	8212 225p
8216 275p	8216 275p
8224 275p	8224 275p
8226 425p	8226 425p
8228 500p	8228 500p
8251 475p	8251 475p
8253 1000p	8253 1000p
8255 450p	8255 450p
8257 950p	8257 950p
280P10 600p	280P10 600p
280AP10 700p	280AP10 700p
Z80CCT 4500p	Z80CCT 4500p
Z80CCT 4500p	Z80CCT 4500p
Z80CCT 4500p	Z80CCT 4500p
Z80CCT 4500p	Z80CCT 4500p
Z80CCT 4500p	Z80CCT 4500p
Z80CCT 4500p	Z80CCT 4500p
Z80CCT 4500p	Z80CCT 4500p

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EXP350 3.6 x 2.1 (Up to 3 x 14 pin ICs) £3.15	Socket Strips / Bus Strips / Binding Posts mounted on sturdy base plate. £9.20
EXP650	

# Kitchen Timer

A cheap and simple circuit which is ideal for the newcomer to electronics.



THIS SIMPLE TIMER provides an audible alarm at the end of a preset timing period, which can be switch-selected in half-minute steps from one minute to six-and-a-half minutes. Although it's been designed for use in the kitchen it could of course be used in other applications such as photography.

The circuit uses a minimum of components and is based on the ever-popular 555 timer IC (what would we do without it?). The timer is automatically triggered when the unit is switched on and at the end of the chosen period a two-transistor oscillator is enabled. This generates an audible tone in a ceramic resonator, a solid-state device which produces quite a loud sound with little power consumption.

## How it Works

The circuit is based on a 555 timer (IC1) used in the monostable mode. R13 and C2 provide a negative trigger pulse to IC1 at switch-on, so that the timing run automatically commences and the output at pin 3 goes high. The output returns to the low state when the charge on C1 reaches the same level as a reference voltage. This voltage can be "trimmed" using RV1, which is adjusted so that a timing period of one minute is obtained with SW1 set to the "1 minute" position, i.e. with C1 charged through R12 only. SW2 is used to switch in additional resistors, slowing the charge rate of C1 and increasing the delay time by half a minute for each additional resistor.

Q1 and Q2 are used in a straightforward astable multivibrator circuit operating at a fre-

quency of a few kilohertz. Initially this is inoperative since the output of IC1 is high, and the transistors receive no significant supply voltage. At the end of the timing run the output of IC1 goes low, and the multivibrator then operates normally as it receives virtually the full supply voltage.

This produces an audio tone from the ceramic resonator which is driven from the collectors of Q1 and Q2. A ceramic resonator is not a low impedance device like an ordinary speaker, and needs little drive current. It does require a fairly high drive voltage though, and this is achieved by driving it from the antiphase signals at the collectors of Q1 and Q2. This effectively doubles the voltage swing across the resonator.

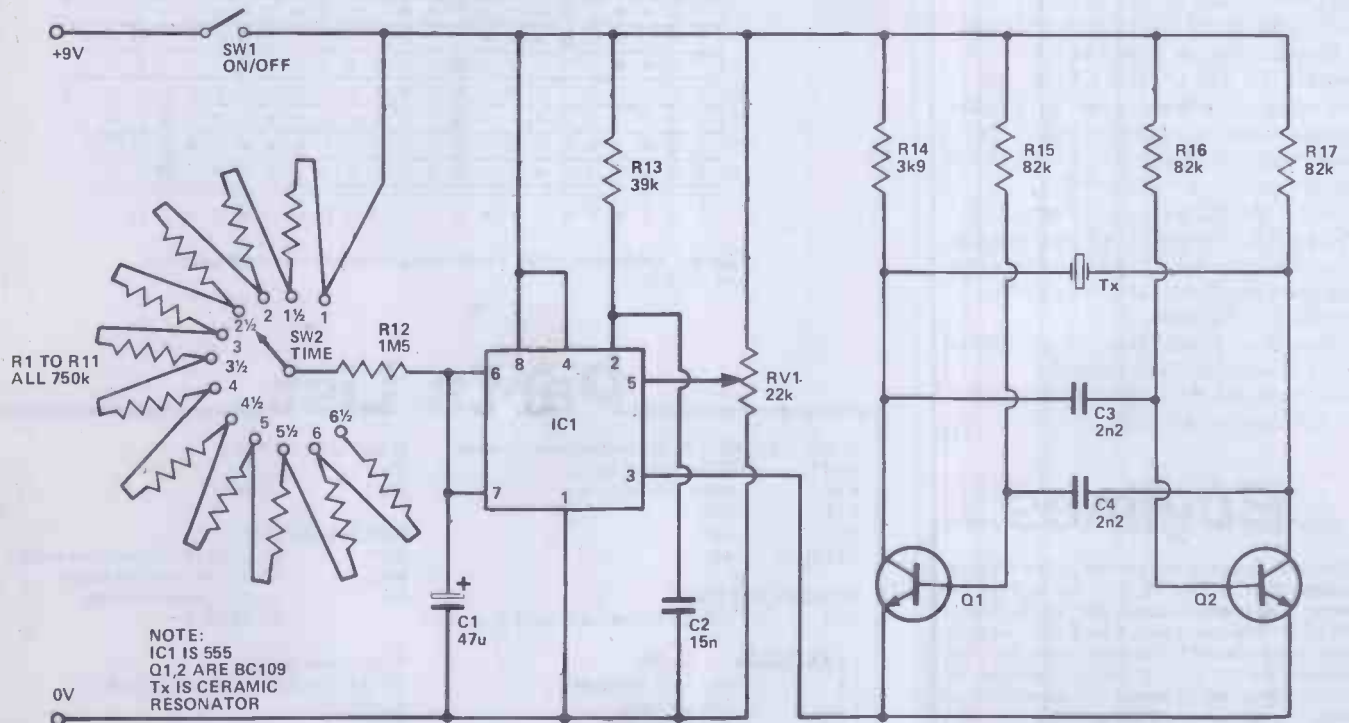
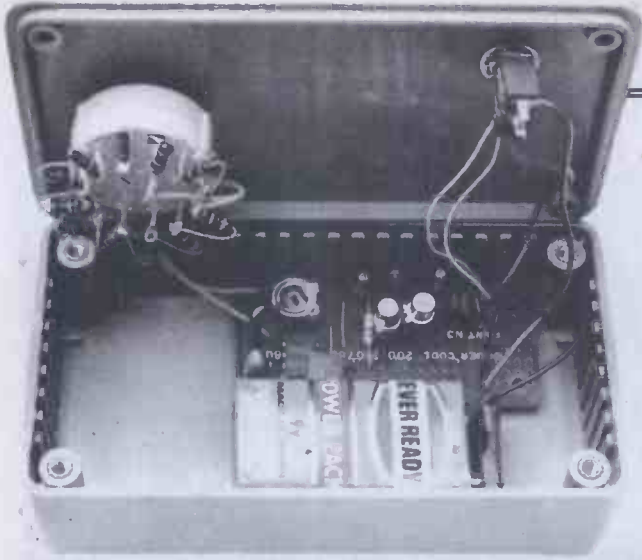


Figure 1. Circuit diagram of the HE Kitchen Timer.

# Kitchen Timer



This photograph shows the board and battery fastened to the box with sticky pads, and the controls mounted on the front panel. Note the resistors soldered to SW2.

## Time And Time Again

The timing period of a 555 is determined by the values of the capacitor and resistor connected to pins 6 and 7; in fact, the formula used is  $t = 1.1RC$ , where  $t$  is in seconds if  $R$  is in ohms and  $C$  is in Farads. By keeping  $C$  constant and changing  $R$  we can get different periods. In our circuit  $R$  is varied by connecting 11 resistors in series and using a twelve way switch to select a point in the chain. Fine adjustment of the timing period (to allow for errors due to component tolerances) is made with  $RV1$  which varies the control voltage on pin 5 of the IC. This only needs to be done on one of the ranges.

## Construction

The timer is built on our standard veroboard size of 10 strips by 24 holes, as shown in Figure 2. Be careful to connect  $IC1$ ,  $Q1$ ,  $Q2$  and  $C1$  the right way round as wrong connection could damage these components. All of the timing resistors except  $R12$  are mounted directly on the terminals of  $SW2$ , as shown in the diagram and photograph. Try to solder these to  $SW2$  very quickly, as overheating them could permanently alter their resistance and impair the accuracy of the unit.

Any small plastic box can be used to house this project. We fixed the veroboard and the battery inside with double-sided sticky pads.

HE

## Buylines

The only unusual component is the ceramic resonator type PB2720, and this is available from Ambit International, 200 North Service Road, Brentwood, Essex, CM14 4SG. Satisfactory results should be obtained using 5% components for  $R1$  to  $R12$ , but for optimum accuracy these should have a tolerance of 2% or better. Total cost of all components, excluding the case, shouldn't be more than £5.

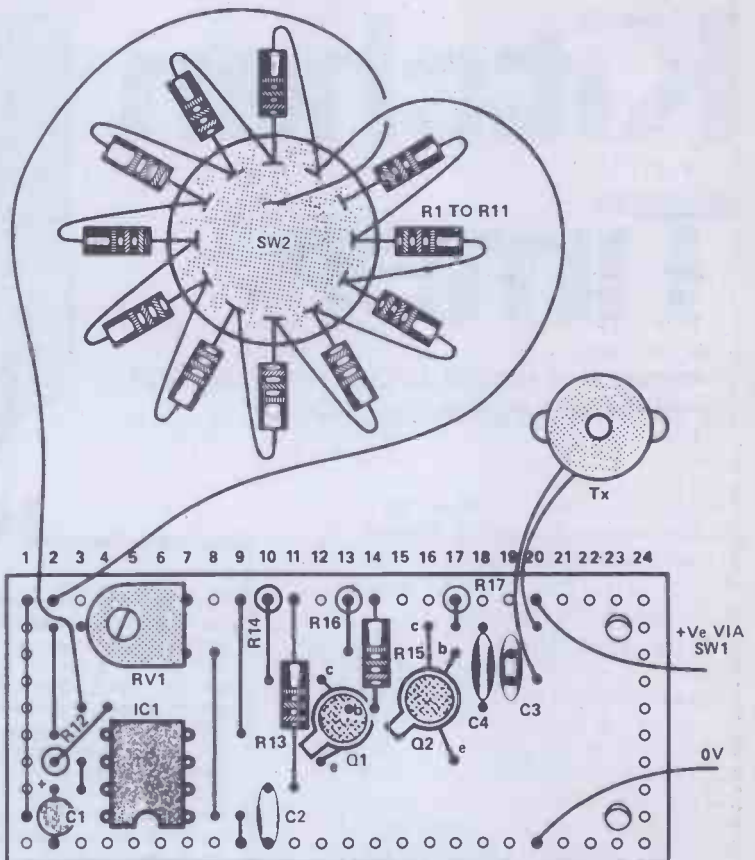


Figure 2. (Above) Veroboard layout and interconnection diagram.

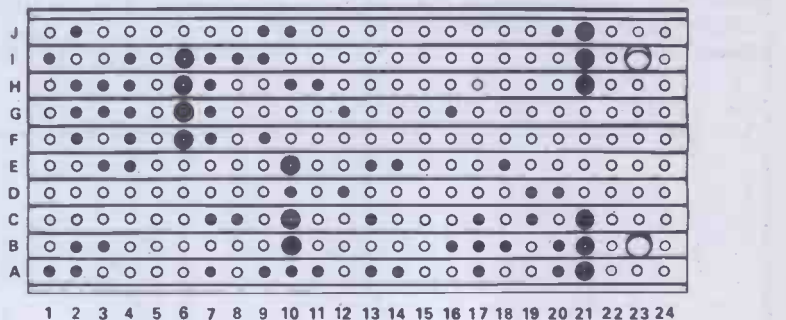


Figure 3. Underside of the Veroboard showing component positions and track cuts.

## Parts List

### RESISTORS (All 1/4 W, 5% except where stated)

R1-11	750k, 5% or better
R12	1M5, 5% or better
R13	39k
R14	3k9
R15,16,17	82k

### POTENTIOMETERS

RV1	22k miniature horizontal preset
-----	---------------------------------

### CAPACITORS

C1	47u 16 V tantalum
C2	15n ceramic
C3,4	2n2 ceramic

### SEMICONDUCTORS

IC1	555
Q1,2	BC109

### MISCELLANEOUS


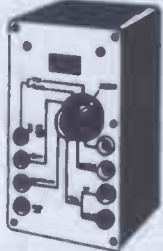
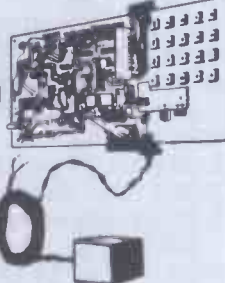
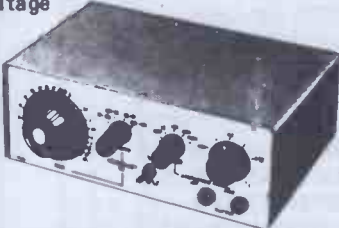
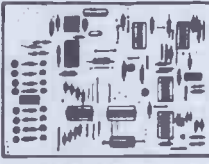
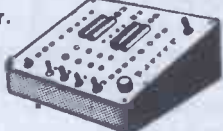
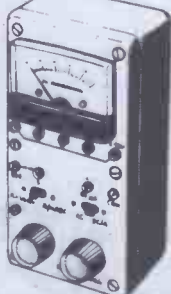

SW1	single-pole, single-throw toggle
SW2	12-way, single-pole rotary
Tx	ceramic resonator (see BUYLINES)

Battery and clip  
10 x 24 hole, 0.1" matrix veroboard.  
Case to suit  
Knob.

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<p><b>LK1 OSCILLOSCOPE</b> Solid state circuitry; D.C. coupled; 7 cm. dia. tube; Y input 0.3 v/cm. to 50 v/cm.; X input 1 volt/cm.; 1v. and 10v. cal. signals; response to 1MHz; Time base ranges to 8μS per cm.; Size 230 x 130 x 190mm. Wt. 2Kg. Operates from 110 volt or 220/240 volt A.C. High quality kit complete with carrying case.</p>  <p style="text-align: right;">£130.00</p>	<p><b>LK2 DIGITAL MULTIMETER</b> Solid state circuitry with large digital display. Ranges are up to 1000v. D.C. and A.C. and current D.C. to 100mA. Resistance ranges 100K ohms. Battery operated. Size 185 x 110 x 60mm. Digital display : 37 x 16mm</p>  <p style="text-align: right;">£40.00</p>
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# Into Digital Electronics

## PART TWO

Down to practicalities this month. Ian Sinclair looks at the LS132 NAND gate and some of the the circuits we can build with it.

CHIP OF THE MONTH, folks, is one whose full number is SN74LS132; its full name is a quad two input Schmitt NAND gate. Either way, it's quite a mouthful, and we'll refer to it as the LS132. Since this is a strictly practical series, we'll start in a practical way by finding out what this particular IC does. (Note: Non 'LS' types are OK).

**BOARD CONNECTIONS:**  
 1A LED ANODE (4)  
 3A LED ANODE (3)  
 5A LED ANODE (2)  
 7A LED ANODE (1)

CATHODE LEADS ON Y1

**1kΩ RESISTORS BETWEEN:**  
 1A AND 1B  
 3A AND 3B  
 5A AND 5B  
 7A AND 7B

**DIL SWITCH BETWEEN COLUMNS C AND D, LINES 1 TO 3 LINKS BETWEEN:**  
 X1 AND X2  
 Y1 AND Y2

Fig.2.1. A reminder of the wiring round the LEDs — this must be completed, along with the switch wiring (shown in previous part) before any further work can be done.

Start by checking the connections of the switches and LEDs which you should have from last month. Figure 2.1 is a reminder, showing where each component is located and which lines are linked by wires. Remember to use only single core wire, 0.5mm diameter or so; because stranded wire will get caught up in the clips of the Eurobreadboard. If you're using a 4½ V battery (No. 1285) as a power supply, remember to get it the right way round, with + going to X1 (or X2) and — to Y1 (or Y2).

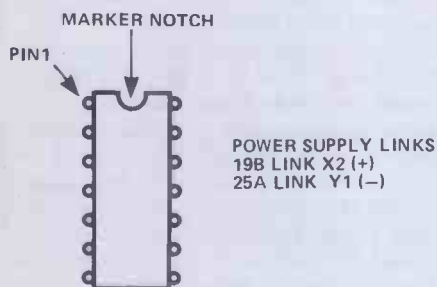


Fig.2.2. How to find Pin 1 of an IC. The links shown are for supplying power to the 74LS132.

Disconnect the battery and find out where pin number 1 of the IC is. Figure 2.2 shows you how you find the pin 1 of any IC which is in this block form (the DIL package). There's an identifying notch cut at one end of the IC — the end which has pin number 1 and also the last pin (14 on the LS132, 16 on some others we'll use). Now if you place the IC legs down as it's shown in the drawing of Fig.2.2 the position of pin 1 is to the left of the notch. Some manufacturers also mould a little hollow next to pin 1. Don't be confused if there is what looks like a notch at each end — only the one which is sunk into the plastic is the true one!

Now that you've located pin 1, place the LS132 on the Eurobreadboard so that pin 1 is on line A19 and pin 14 is on line B19. You don't need to use tweezers to avoid handling the pins, because these are TTL ICs, not the CMOS ones which can be so easily damaged. When you've got the IC correctly placed, push it gently down, rocking it a bit from end to end, so that the pins go into the Eurobreadboard holes until the chip is right down on to the board. Check again that the pins are in the right holes, because all of the wiring instructions in this part, and all the following parts, assume that each IC is in exactly the place we've specified.

### All You Need Are The Right Connections

We can now start making the connections which create a digital circuit. We're going to use just one of the four identical digital circuits which are on the LS132 chip, and we can make up the circuit by using just three wire links. One useful point about digital IC circuits is that most of them consist of just these links between ICs, with only a few odd resistors and capacitors to

worry about. The only point to worry about now is, how do we know which connections to make? If you're building a circuit from scratch, to your own design, then you have to do it all the hard way, by tracing which pins you need to connect. For this series we'll use the easy HE way, using the Eurobreadboard line letters and numbers.

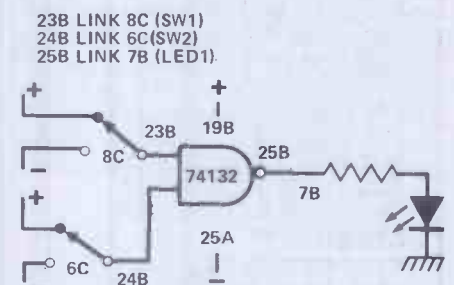


Fig.2.3. Link diagram (a) and circuit diagram (b) for a gate-test circuit. Only three wire links are needed to wire this up, because the switches and LEDs are already in place. This scheme assumes that the IC is in the correct place on the board.

Now there are two ways of showing how to make these connections, and Fig.2.3 shows both. One is a table of connections (Fig.2.3a) which shows which Eurobreadboard lines need to be linked with wires. The other way, which is a lot more useful, is to write the Eurobreadboard line numbers onto a circuit diagram. Why is it more useful? Because it gets you used to digital circuit diagrams, that's why. Once this series is finished you're on your own in the big bad world where there aren't any tables of Eurobreadboard connections, so we're training you to read the circuit diagrams and eventually to be able to fill in Eurobreadboard line numbers for yourself.

Fig.2.3(b), then, shows the circuit symbol for the digital device we're using. It's called a NAND gate, and this

particular example has two inputs and one output. In the circuit shown, the inputs are connected to the switches 1 and 2, and the output is connected to LED 1. Since we have only two signal levels to worry about, a switch is all we need to provide an input. The way we've wired our switches, up causes the switch to provide logic 1, down provides logic 0; and the LED lights when the output is at logic 1.

### The Truth Is On The Table

Now if this were a linear circuit, like an amplifier, we would probably want to measure some quantities like the voltage gain. We don't have to worry about such things when we use digital circuits, because the only quantities that exist are the two voltage levels 0 and 1. We can see what voltage levels we have at the inputs, because they're set by the switches, and at the output the LED shows whether we have a 1 or a 0. The only thing we need to know about a digital IC like this is what combination of inputs gives what output. Let's make that a bit clearer. If we had one input, we would want to know what the output was for a 0 at the input, and what the output was for a 1 at the input. With two inputs, there are four possible combinations of 0s and 1s which we could have at the inputs, and it's a bit easier to see what's happening if we write them down in the form of a table (Fig.2.4).

SW1	SW2	LED1
0	0	
0	1	
1	0	
1	1	

SWITCHES UP FOR 1  
DOWN FOR 0  
LED LIT FOR 1  
UNLIT FOR 0

Fig.2.4. A blank truth table, ready for you to fill in.

We can now try out each combination of signals at the inputs, and find what output we get for each line of the table. This is now a 'truth table' for the digital IC — it shows what combinations of inputs produce 1 and which combinations produce 0. Showing this information in the form of a truth table is neater and simpler than describing what happens in words, though not so brief as the mathematical method called Boolean Algebra.

Come back, don't panic — we're not going to do any Boolean Algebra, I just mentioned it!

Now how do we go about finding the truth table for a circuit like the one in Fig.2.3? The obvious place to start is with both switches at zero (sliders down). If the LED is lit, then a 1 goes in-

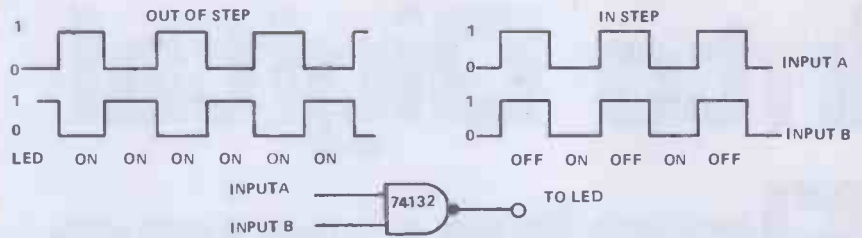


Fig.2.5. One possible use for the simple gate circuit.

to the output column on the line which has A and B inputs both 0; if the LED is not lit, then a 0 goes in the output. The next step is to try one of the switches at 1 (slider up), and we usually work from the right hand side, making A=0, B=1. Note the output for this one, then set A=1, B=0 and note the output for this, the third line of the truth table. Finally set both switches up so that the inputs are A=1, B=1 and see what the output is. Fill in this value, and your truth table is complete.

That really does tell you all you need to know about the way this gate works. The output is 1 unless both inputs are 1. When both inputs are 1, then the output is 0. That's all! It's called a NAND gate, for reasons we'll look at later.

Can you think of a use for this? Imagine that you have two oscillators, one supplying a signal to input A of this gate, and the other feeding its signals to input B. Could you tell when the oscillators were exactly in step? Yes, because the LED would be only dimly lit. When the oscillators are out of step, with one input of the gate high and the other low, the output is high, logic 1, keeping the LED shining reasonably brightly. When the oscillators are exactly in step, though, the LED is on when both signals are at their negative peak and off when both signals are at their positive peak (Fig.2.5), so that the eye sees the average brightness, somewhere between fully on and fully off.

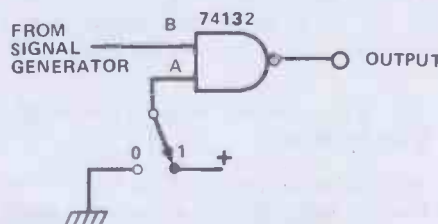


Fig.2.6. Using the gate as a signal relay.

Another application? Take a look at Fig.2.6. Here one input of the 74LS132 is from a switch and the other is from a signal generator. If the switch keeps input A at 0, then there is no signal output, because the output stays at 1. If

the switch keeps input at 1, however, the output goes to 0 whenever input B goes to 1 (check the truth table to see that this is so), and the output goes to 1 whenever output B goes to 0. This is a typical gating action, opening or shutting a gate to let a signal pass or to prevent it.

### Upside-Down Logic

That brings us to another very useful action of this gate. Suppose we use just one input, and forget about the other one? As it happens, we can't just forget about it, because if a TTL input is not connected, then it behaves as if it were connected to logic 1. Figure 2.7 shows the Eurobreadboard arrangement for trying this out, using switch 1 to set the remaining input, and LED 1 to indicate what the output is. The truth table for this is pretty simple, just two lines, one for A=0, the other for A=1. Try it for yourself, and fill in the output values.

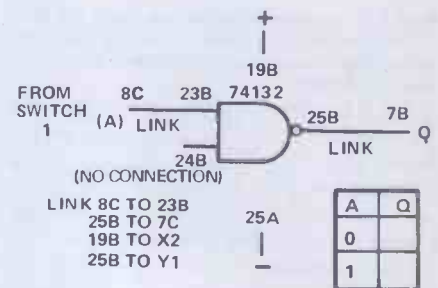


Fig.2.7. Using the gate as a signal inverter — another truth table for you.

Fig.2.8 shows a variation on this. Both of the inputs of the gate are connected to the same switch, so that we are using them as a single input. Try it out, and fill in the truth table.

By this time, you should be getting the hang of the simple Eurobreadboard method of connecting up, and we're going to use just the diagrams from now on. Remember that all the Eurobreadboard numbers and letters shown on one line of a diagram mean that these Eurobreadboard lines are linked by wire — that's all there is to building circuits this way.

Back to the digits. The action of the circuits of Fig.2.7 and Fig.2.8 is called

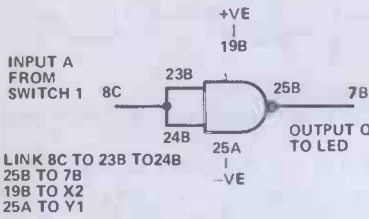


Fig.2.8. Another type of inverter connection.

inversion, and it's not hard to see why. For a 1 at the input, you get 0 at the output, and for a 0 at the input you get 1 at the output. The output is the inverse of the input, the other logic signal. Another name for this action is NOT, because NOT 0 must be 1 (there's nothing else) and NOT 1 must be 0 (same reason). A circuit which does this action only is called an inverter or NOT-gate, and its symbol is shown in Fig.2.9. The little circle at the output is what tells you that there is inversion, without the circle, the output of such a gate would be the same as the input. The same small circle occurs in the NAND gate symbol (Fig.2.8) which tells you that the NAND gate contains an inverter. More of that shortly.

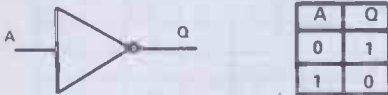


Fig.2.9. Inverter symbol and truth table.

Back to the board. Since we have a total of four NAND gates in one 74LS132, we can use more than one in a circuit.

Strip off all the links which go to the 74LS132, leaving only the switches and LEDs as they were. This clears the decks for the next circuit, and in future we'll assume that you've cleared the board before each circuit. Sometimes you'll find that the same links are used again but until you really get used to it it's always better to start with a clear board.

Try out the one shown in Fig.2.10. This has the circuit which you used before, with another gate used as an inverter at the output. Connect up and try it out, filling in the truth table for yourself. The action of this arrangement is on AND-gate, because the output is 1 only when both input A and input B are at 1. By using the second

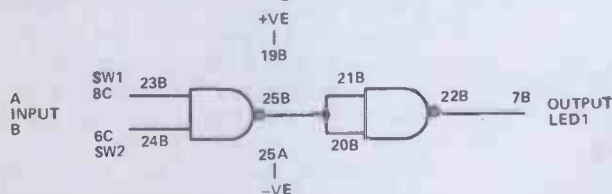


Fig.2.10. A circuit using two of the gates on the 74LS132. Construct your own truth table!

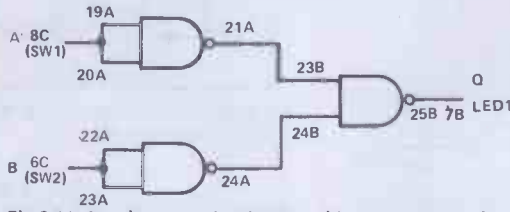


Fig.2.11. Another gate circuit. Does this one carry out the same action as the one in Fig.2.10?

gate as an inverter, we have cancelled the inverting action inside the NAND-gate. Yes, that's right, NAND is short for NOT-AND.

Something a bit more ambitious now — making use of three of the four gates of the 74LS132. The circuit shown in Fig.2.11, with two gates used simply as inverters, but this time at the inputs rather than at the outputs. Does this have the same effect as the circuit of Fig.2.10? Try it out, filling in the truth table so that you can compare them. Not the same, are they? In fact the truth table of Fig.2.11 shows that the output is at 1 if A or B is at one, and it's the truth table of a type of gate called the OR gate (Fig.2.12).

Uses? Well just imagine you want a circuit to switch an LED on from either of two switches. If that's too simple, imagine this combined with a NAND gate, so that a signal can be stopped or passed using either of two switches.

A	B	Q
0	0	0
0	1	1
1	0	1
1	1	1

Fig.2.12. The OR-gate truth table.

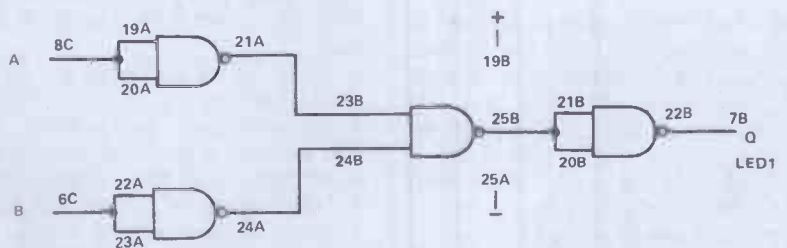


Fig.2.13. A circuit which makes use of all four gates of the 74LS132.

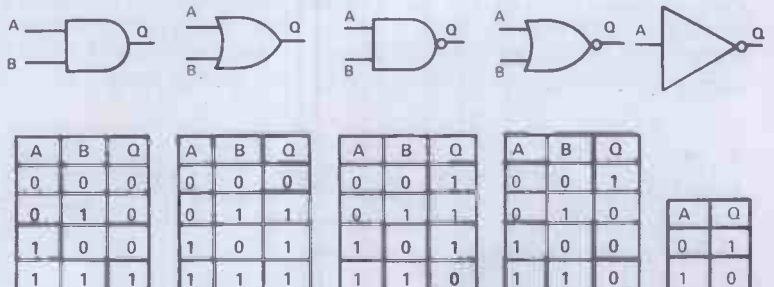


Fig.2.14. Gate types, symbols and truth tables summarised.

## Nand Nanother Nthing

As a grand finale to this part of the work, add the last gate of the 74LS132, so that you have the circuit of Fig.2.13. Connect up, and fill in the truth table for this lot, which carries out the action of what we call a NOR gate. You should also be able to explain by now why it's called a NOR gate!

You should have a fair collection of truth tables by now, and they are all important. We can make AND, OR, NOT, NAND and NOR gates in IC form, and Fig.2.14 shows a reminder of the truth tables for these gates when only two inputs are used. We've used just one type of gate to make these circuits, though, and that's one of the interesting things about digital electronics. A collection of NAND gates can be used to carry out any action we like, including the action of other types of gates, so that we could build up digital circuits using only NAND gates, if we liked. We do, in fact, use NAND gates very extensively simply because they are so useful; we could equally well use NOR gates. We couldn't use AND or OR gates for so many useful purposes, because they don't invert signals. We can, for example, produce the action of an AND gate by using two NAND gates (Fig.2.10) but we could never produce the action of a NAND gate by using any number of AND gates, unless we could also make use of an inverter.

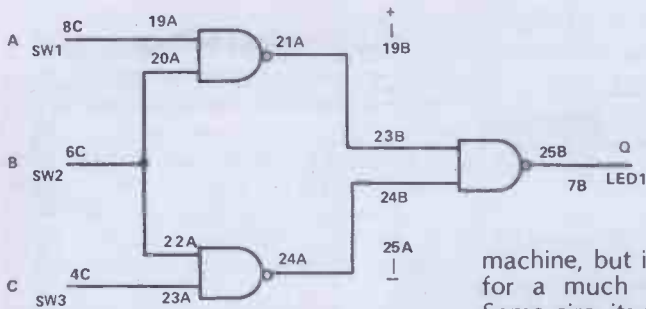


Fig. 2.15. Find the truth table for this gate system.

Let's go practical again. Fig. 2.15 shows a circuit which makes use of three NAND gates, and has three inputs. Now this extra input makes a big difference to the truth table, because it means eight lines instead of four. The general rule is that the number of lines of the truth table for a gating circuit has to be equal to 2 multiplied by itself as many times as we have inputs. For two inputs we need 2x2 lines, for three inputs we need 2x2x2 (which is eight). Mathematicians write this as  $2^n$  (2 to the power n), where n is the number of inputs.

A	B	C	Q
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

Fig. 2.16. Blank truth table to fill in.

The blank truth table is shown in Fig. 2.16, so you can fill in the output for each of the combinations of inputs which are shown. This one does not form any named type of gate, but its action is quite a useful one. Take a long hard look at that truth table. Notice that the output is always zero if B is zero and one or more of the other inputs is zero, and the output is 1 if B and more of the inputs are at 1. This is a simple form of a 'majority voting' circuit, so called because the output will be of the same polarity (0 to 1) as the majority of the inputs. It could, for example, be the basic of a simple voting

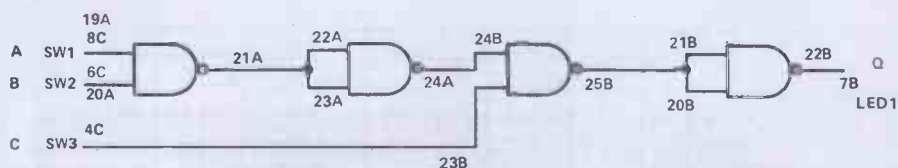


Fig. 2.17. Another gate system to investigate — try it out.

machine, but in engineering it is used for a much more serious purpose. Some circuits simply are so important that no failure must ever happen, even if the circuit cannot be repaired. The simplest way of doing this is to make many identical circuits, and use a 'majority voting' gate at the output. If all the circuits are operating perfectly, then all is well, but if some fail, then the output will still be decided by the majority. It can be a great comfort if you're 250,000 miles away from Earth!

Now for one last bit of practical work, try the circuit in Fig. 2.17. This uses all four gates of the 74LS132, with three inputs and one output. Because there are three inputs, there must be eight lines in the truth table, which you can complete for yourself by experiment. What sort of gate is this?

Gate circuits like this can be used as the basis for 'combination lock' circuits, which give a 1 at the output only for some particular combination of inputs. For this reason, the gate circuits are sometimes known as combinational logic — it's the combination of signals at the inputs which decide what the output will be. As it happens, we can make the circuit entirely from NAND gates if we like. The circuit of Fig. 2.17 produces the effect of a three-input AND gate, though we have used only two-input NAND gates in the circuit.

How can we find what a gate circuit does? One way is to try it out on the Eurobreadboard, but another way is just by writing truth tables. We need a truth table with lots of columns, one for each input, of course, but also one for each place where the output of one gate is connected to the input of another. Figure 2.18 shows the circuit of Fig. 2.17 labelled and a truth table drawn up in this way. If we now write in the usual collection of inputs ( $2^n$ , remember), we can fill in the rest of the columns simply because we know the

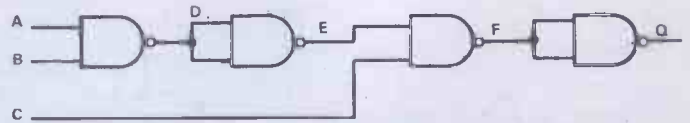


Figure 2.18. Marking out a gate circuit so that you can draw up its truth table without experiment.

truth table for the gates we are using. Figures 2.19 to 2.21 show this particular truth table being filled in bit by bit in this way. The final result is the output column, which shows the action of the whole circuit. In this case it's a 1 when all the inputs are 1, a three-input AND in fact.

A	B	C	D	E	F	Q
0	0	0				
0	0	1				
0	1	0				
0	1	1				
1	0	0				
1	0	1				
1	1	0				
1	1	1				

Figure 2.19. Filling in the truth table — the first step. Each possible A,B,C input has been entered.

A	B	C	D	E	F	Q
0	0	0	1	0		
0	0	1	1	0		
0	1	0	1	0		
0	1	1	1	0		
1	0	0	1	0		
1	0	1	1	0		
1	1	0	0	1		
1	1	1	0	1		

Figure 2.20. The next step — the E and D columns can be filled in because you know the truth table for the NAND gate and inverter.

A	B	C	D	E	F	Q
0	0	0	1	0	1	0
0	0	1	1	0	1	0
0	1	0	1	0	1	0
0	1	1	1	0	1	0
1	0	0	1	0	1	0
1	0	1	1	0	1	0
1	1	0	0	1	1	0
1	1	1	0	1	0	1

Figure 2.21. The table can now be completed, once again because the truth tables for NAND gate and inverter are known.

The important point is that gate circuits can be designed to give a 1 output for any combination of inputs we like. A lot of machinery can be controlled just by an ON(1) or OFF(0) signal, so that gate circuits are the ones we use to make control circuitry. The more complicated the control action has to be, the more suitable digital gates are to carry it out, because mechanical switches and relays are suitable only for comparatively simple circuits.

HE



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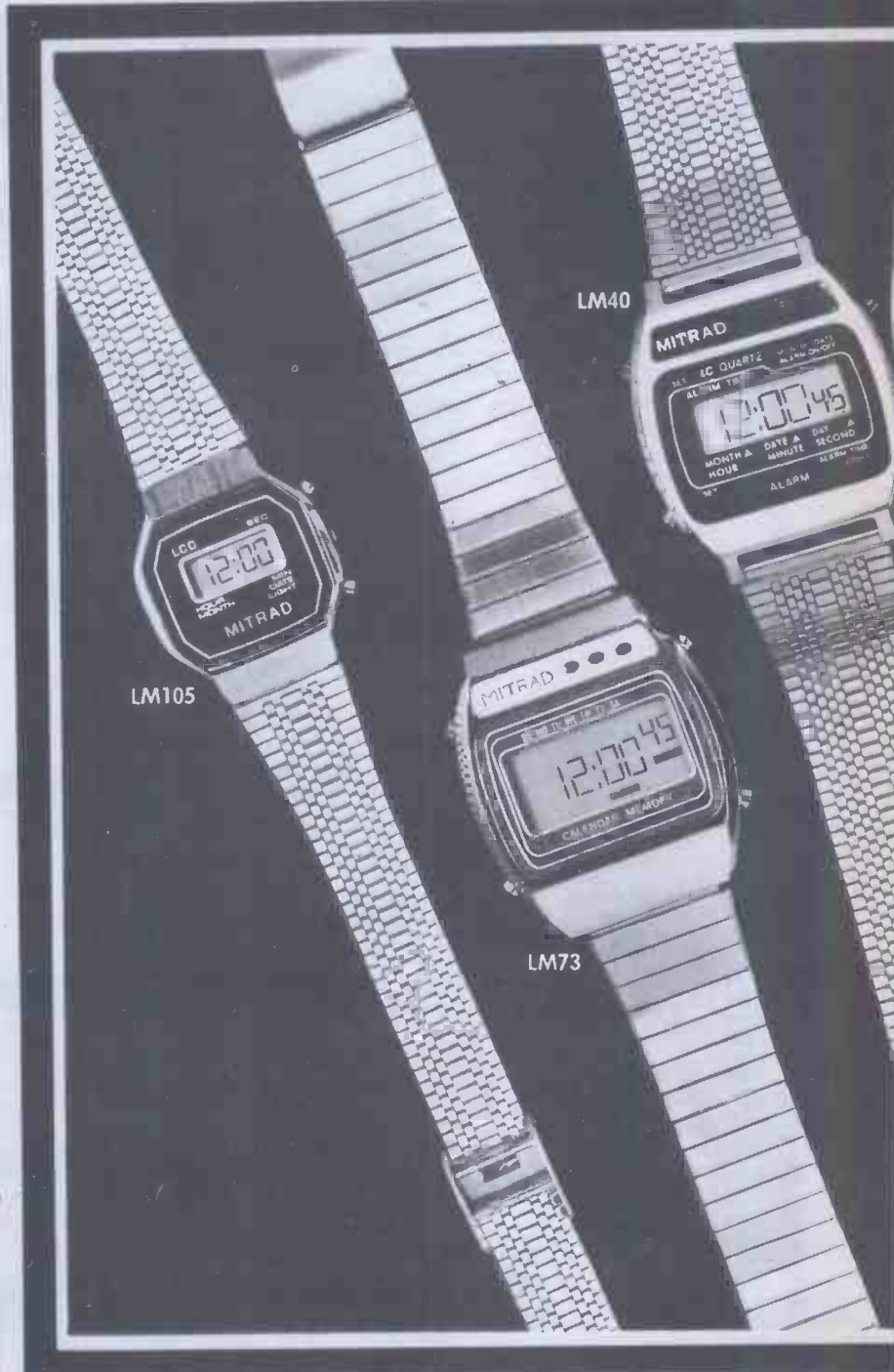
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# Tug O' War Game

Play an old game a new way with this design from HE — eliminate sweat, mud and sore palms. The HE Tug O'War is the ideal game for the less energetic who only wish to exercise their fingers — a genuine digital circuit in more ways than one!

HERE AT HE we are basically very lazy (who said 'hear hear?'). So we're always looking at ways to turn the physical excesses of the sporting life into games that we can play with one finger, in the comfort and privacy of our own arm-chairs. Our latest venture into this field (or rather off the field) is the Tug O'War game, which does for this sport what Shark did for swimming and the Scalextric Lap Counter did for motor racing.

In our version the game is not a trial of strength, (strain gauges are not readily available to the hobbyist!) but rather a contest to see who's finger is fastest on the button. The display consists of a line of LEDs, of which only the centre one is lit at the start of the game. A single flashing LED is provided and when it comes on the first player to press his button causes the light on the display to move towards him. The more often a player reacts first, the further the light moves. The winner is the person who gets the light to his end of the display. All of this is accompanied by the usual bleeps and buzzes that we know and love so well.

Our office philosopher once said that most electronic games could be reduced to just one, 'Spot the 4017'. You might think that the same is beginning to apply to the LM3914 — and why not? Like the 4017, it is a very useful and versatile chip which can be used for many different applications. Here we use it as a bargraph voltmeter in the 'dot' mode, so that only one LED in the display is lit up at any one time.

## Construction

We recommend the use of our PCB. Solder the resistors, capacitors, diodes, transistors, and IC sockets to the board, taking care that polarised components are fitted the right way round. We mounted the display LEDs in clips on the front panel. The anodes were linked together by a length of tinned copper wire which was then wired to the PCB, while the individual cathodes were wired to the corresponding pads on the PCB. If you hate interwiring, then it is possible to solder the LEDs

directly in position on the PCB — however you will have to use 0.125" LEDs or the more expensive square type as the size we used won't fit.

Wire up the switches, indicator LED, loudspeaker and battery clip and insert the ICs into their sockets. Now fasten the PCB inside the case. We simply stuck it to the bottom with double-sided sticky pads. The loudspeaker is glued to the base of the box; but don't forget to drill a few holes there first or the sound will be somewhat muted!

## How it Works

A player has to push his button first to move the light on the display towards him — the circuitry around IC1 detects who is first. A new chance to beat the other player is provided once a second, when IC3a resets IC1. IC3a is connected as an astable (oscillator) operating at one Hertz. When its output (pin 9) is high, IC1a and b are reset via D2 and D4. When pin 9 goes low again IC1a and b are enabled and LED1 lights to indicate this. The degree of difficulty of the game can be varied by altering the mark-space ratio of IC3a (time that it is on and off). This is done by adjustment of RV2.

IC1 contains two D-type flip-flops, or bistables, one for each player. In this type of bistable a pulse on the clock input causes the logic level (high or low) at the data input (D) to be transferred to the output (Q). Clock pulses are generated when a player presses his button, and the inclusion of C1 and C2 ensures that a player cannot cheat by holding his button down; a new pulse must be provided every time LED1 turns on. The reset pulse from IC3a forces the outputs of IC1a and b low and both D pins are held high by R3 and R5,

so the faster player will send his Q output high.

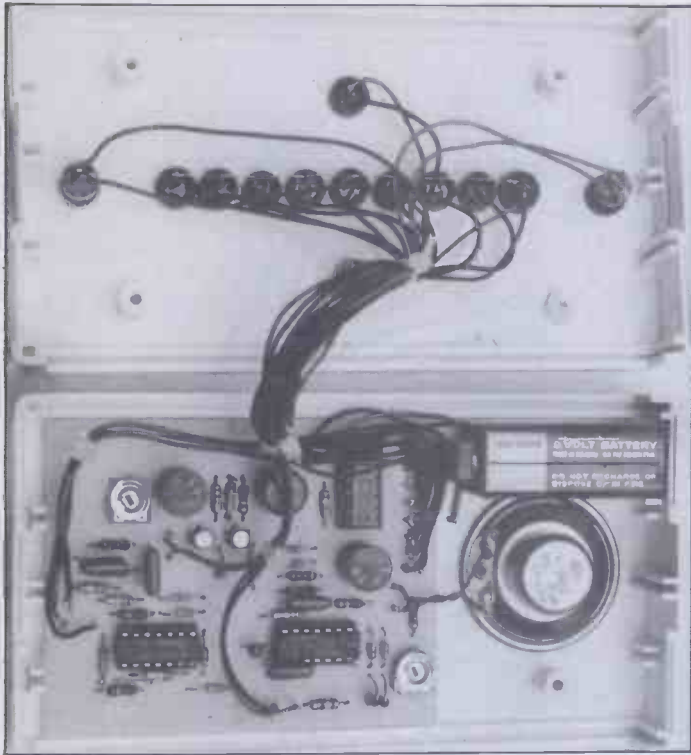
Each output is coupled to the reset pin of the other bistable via D1 and D3. Thus the faster player's high output disables his opponent's bistable for the remainder of that 'play' period. One of the transistors Q1 or Q2 will be turned on via R9 or R10, depending on who was first.

IC2, an LED voltmeter, senses the voltage at the junction of C3 and C4 via RV1. Normally this junction is charged to half supply voltage, and RV1 adjusted to light the middle LED of the display. If Q1 turns on, the voltage at the junction will rise as C3 discharges and C4 charges. Similarly the voltage will fall if Q2 turns on. IC2 responds by lighting LEDs further up or down the scale. This provides the game display.

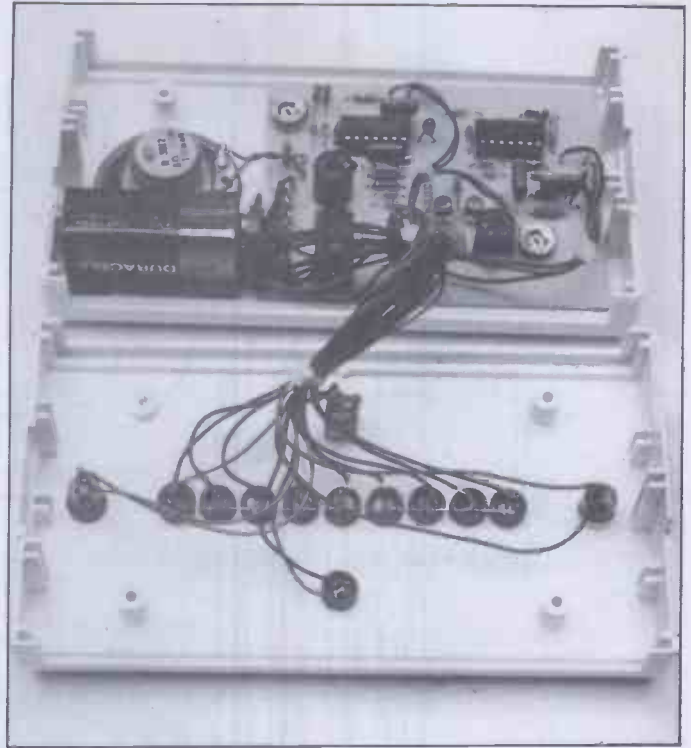
IC3b is connected as audio oscillator, normally off because its enable pin is grounded (pin 4). When either output of IC1 goes high, IC3b is enabled via D7 or D8 — the pitch depends on the control voltage applied to pin 3 via R20 and R21. The tone shows which player reacted first.







Inside the case, note position of the loudspeaker and battery.



Close up of the interwiring of the LEDs. A cable tie keeps things neat.

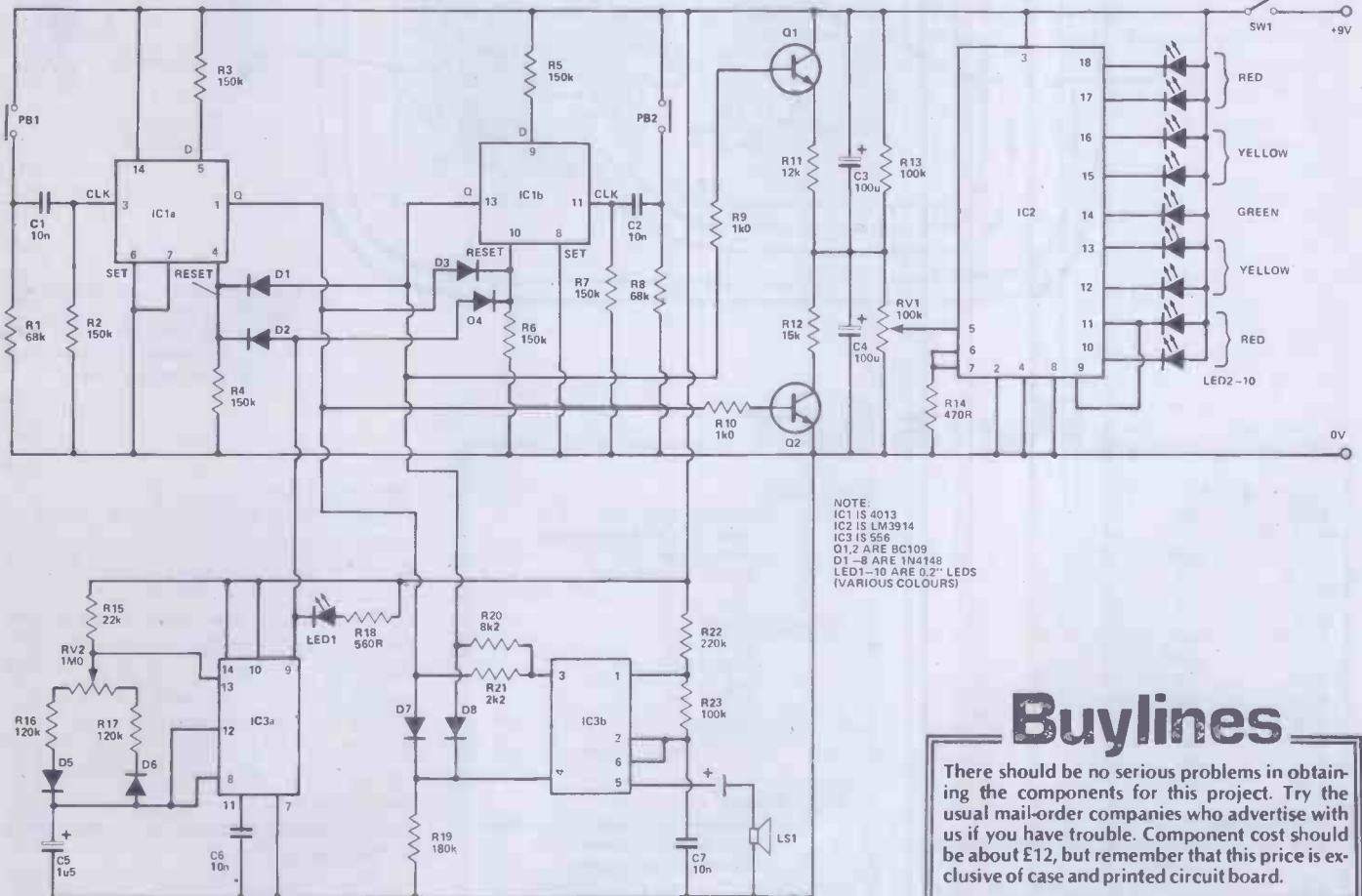


Figure 1. Circuit diagram of the HE Tug O'War

## Buylines

There should be no serious problems in obtaining the components for this project. Try the usual mail-order companies who advertise with us if you have trouble. Component cost should be about £12, but remember that this price is exclusive of case and printed circuit board.

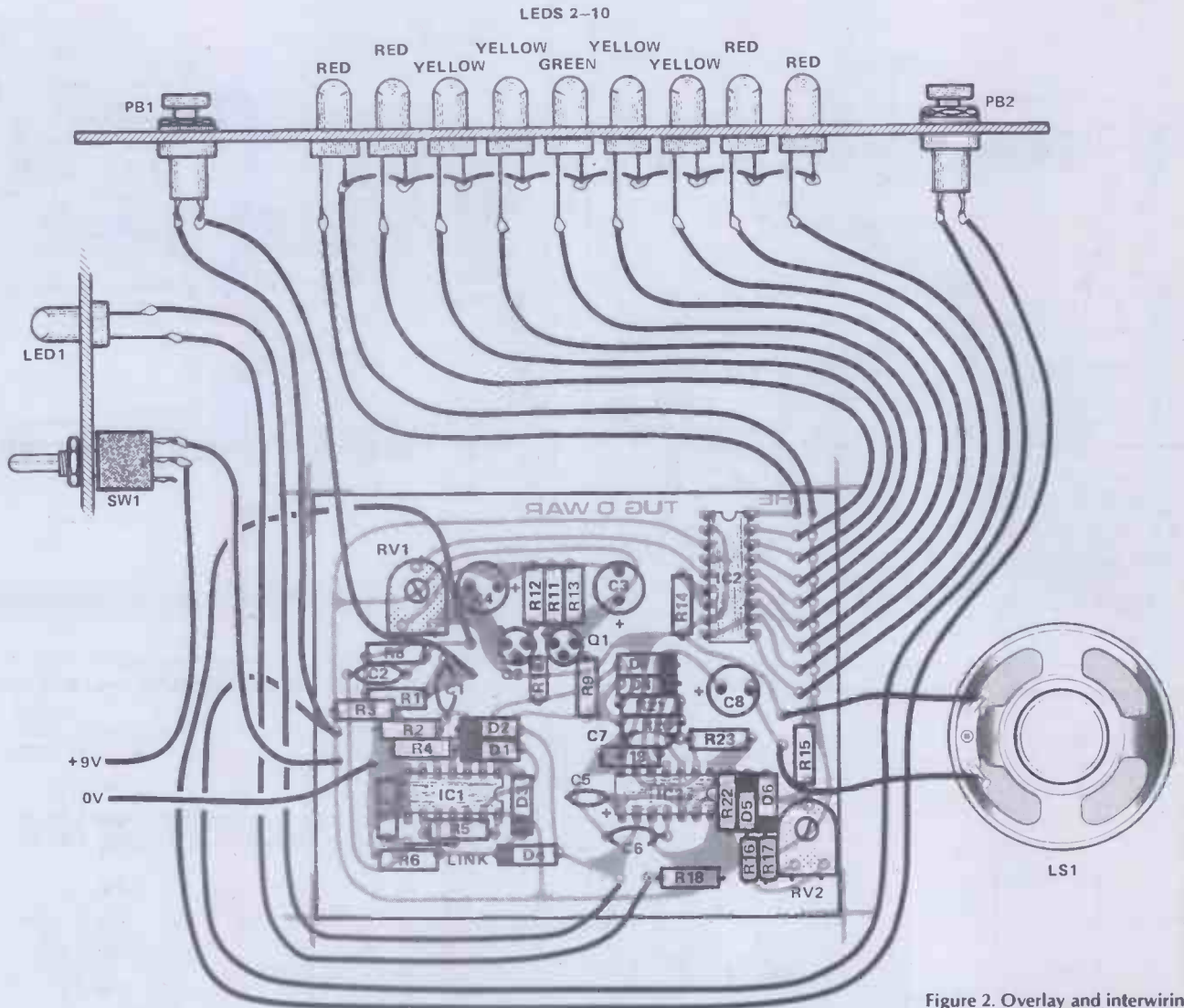


Figure 2. Overlay and interwiring diagram for the HE Tug O' War game. LED1 and SW1 mount on the front panel as well but we've drawn them as separate for clarity

## Parts List

### RESISTORS (all 1/4 W 5%)

R1,8	68k
R2,3,4,5,	
6,7,19	150k
R9,10	1k0
R11	12k
R12	15k
R13,23	100k
R14	470R
R15	22k
R16,17	120k
R18	560R
R20	8k2
R21	2k2
R22	220k

### POTENTIOMETERS

RV1	100k linear horizontal miniature preset
RV2	1M0 linear horizontal miniature preset

### CAPACITORS

C1,2,6,7	10n polyester
C3,4,8	100u 16 V PCB-mounting electrolytic
C5	1u5 35 V tantalum

### SEMICONDUCTORS

IC1	4013
IC2	LM3914
IC3	556
Q1,2	BC109
D1-8	1N4148
LED1-10	0.2", various colours

### MISCELLANEOUS

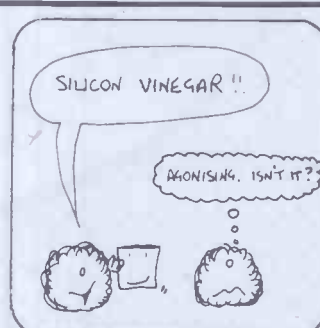
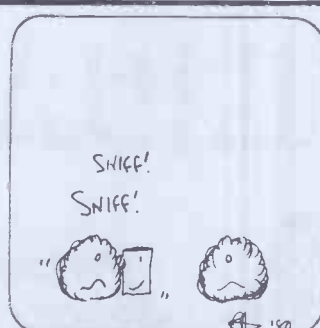
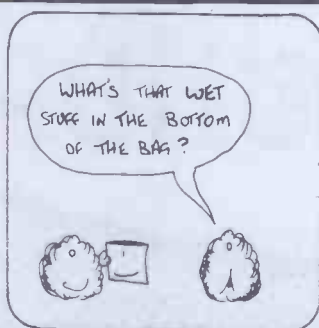
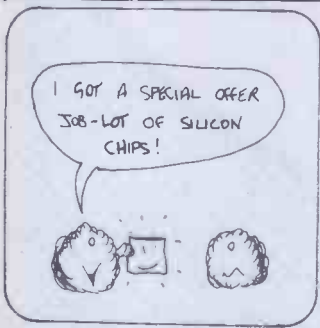
SW1	Single-pole, single-throw toggle
PB1,2	Push-to-make non-locking
LS1	Miniature 8R0 speaker
PCB, IC sockets, 9 V battery and connector, verocase, clips for LEDs.	

### Setting Up

Double check the position of all the components and wiring, then insert a PP3 into the battery connector. Switch on and check that the move indicator LED is flashing. The ratio of 'on' to 'off' times can be adjusted by RV2 to set the level of difficulty you require. Now rotate RV1 until the centre LED is lit. Check that pushing either button causes the light to move in that direction and a tone to sound (different for each button). If the light moves the opposite way, swap over the connections to the pushbuttons.

If all is well, snap the case together and the game is ready for use. All you have to find is a friend and two arm-chairs.

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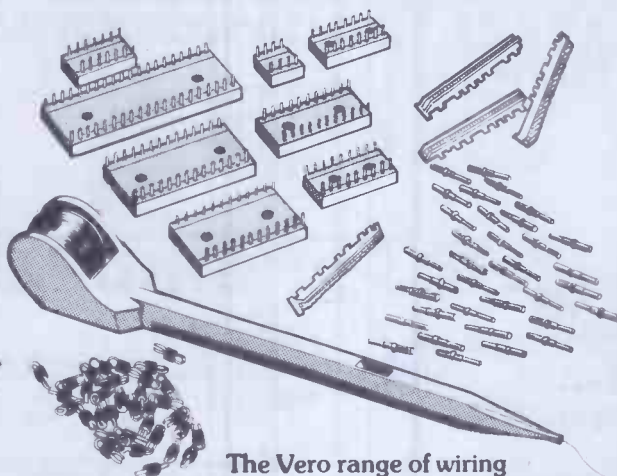
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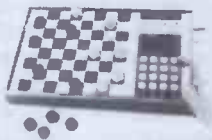
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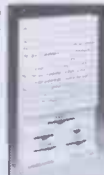


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## **SPACE INVADERS**

In the past few months we've seen all manner of Space Invaders games — from enormous pub machines to programs on tape cassette for home computers. We've spent many a long hour researching the game in pubs and clubs from Land's End (Watford) to John O' Groats. Next month we present the ETI Space Invaders game for you to build.  Plug the lead in to the back of your telly and sit back with the box of tricks on your lap. Off you go — blasting aliens out of existence (with full sound effects, of course).  World War III's OK, but there's nothing like the real thing — ETI Space Invaders — a computer game with a trick or two up its sleeve, as you'll find out next month.



Photos courtesy of Twentieth Century Fox.

## **FREE PCB**

As we finish printing each issue of ETI with our John Bull set, we're sticking a free, gratis, no-more-to-pay printed circuit board on the cover. It has a million and one uses — you can prop up a wobbly coffee table, make a shower for the budgie ... OR build the five projects we've designed for your free PCB. There's an RIAA equalised preamp, a 2 W amplifier, a touch doorbell, a light switch and a metronome.  We give you the PCB; we give you the project designs ... it couldn't be easier.

## **RADIOACTIVITY**

Know your alpha, beta, gammas? If it's all just radiation to you, you could learn a thing or two from A.S. Lipson's excursion into that fantastic, frazzling, phenomenon of modern physics — Radioactivity. What makes something radioactive? What exactly is radioactivity? All will be revealed next month.

## **EVEN MORE PROJECTS**

Not satisfied with bringing you our amazing Space Invaders game and FIVE projects for your free board, we've also got a doorbell with a difference (it plays tunes) and a straight-forward, no frills Bench Amplifier for your test bench. It's all in ETI November.

## **AND THAT'S NOT ALL**

Data Sheet puts in an appearance with all you need to know about a family of monolithic switched capacitor filter chips and a speech generator chip (a very clever little block of plastic).  Talking of blocks of plastic, voltage regulators this time — we look at a very simple discrete component regulator design (for when you don't have the necessary chip to hand then and there).  We know now that the Space Shuttle launch has definitely been postponed until at least next March. Astrologue explains why.

Articles described here are in an advanced state of preparation. However, circumstances may dictate changes to the final contents.

# Building Site



Although the National Grid, courtesy of the Electricity Board, provides us with a useful source of energy to power our projects, you won't be surprised to learn that it can also be dangerous if proper care is not taken. Keith Brindley offers a few suggestions as to how the mains can be safely harnessed.

SOME INTERESTING problems arose with three of this month's projects — the Freezer Alarm, the Light Dimmer and the Temperature Controlled Soldering Station, all of which are connected to the mains power supply.

Now, nobody can deny 220-240 V AC mains is exceptionally useful as an easy way of obtaining power for your projects and furthermore, running costs are minimal. But the problem still remains of the potential shock hazards encountered with its use. A mains shock will at best give you a painful jolt, leaving your arm quite numb for a few minutes. In the worst case, mains voltages are lethal. It all depends on which route the current takes to earth — it will automatically take the easiest path — so if you are the easiest path — BANG. For instance, if your left hand is resting on a good earth point eg. the earthed case of your project and you inadvertently touch a live point with your right hand, then the easiest current path is up your right arm, across your chest and down your left arm. Your heart suffers a bit in this sort of case, being in direct line with the current and you may find (or rather the first person to come across you after your shock may find) that it has stopped altogether.

## Don't Lose Heart

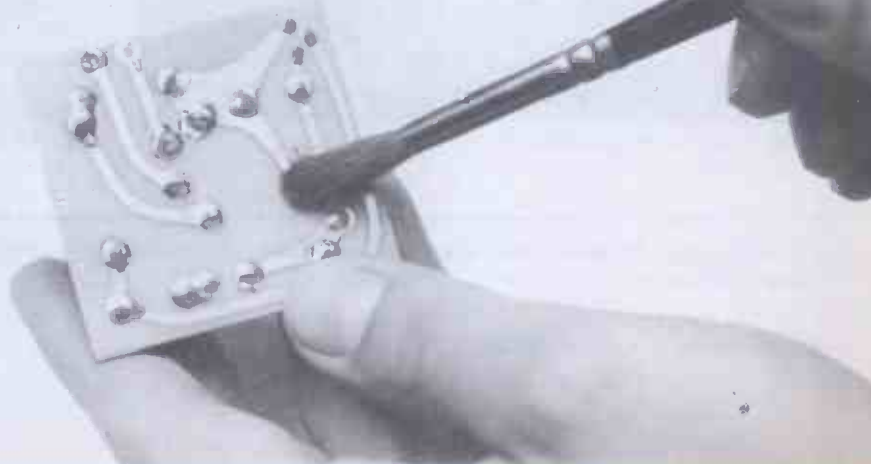
All joking apart, it cannot be stressed strongly enough that you should take care when dealing with mains voltages. If you must probe around inside equipment which is connected to the mains, keep one hand in your pocket, not because you are mean and want to keep

a firm grip on your money but simply to avoid setting up a path through your heart.

Mains powered projects can be designed with certain safety precautions built in. Take the HE Freezer Alarm for example, the constructional method is ideal for hobbyist purposes as a number of precautions having been taken. The first is the use of a grommet and some form of cable clip to prevent the mains cable from being pulled out or its insulation from being worn. Various forms of cable clip are available, that do the job satisfactorily, the type we mostly use is a simple tie-clip. The tie-clips have a non-release ratchet lock action (ie. pull them as tight as you can and simply cut off the long flying end), which holds the cable securely. They are very cheap, around 2 or 3 pence each. Tie-clips are also used to tie together all the interconnecting wires on the other projects, you may be able to spot them on some of the internal photographs — this can make a project look an awful lot tidier than the usual 'bird's-nest' type of arrangement.

Figure 2 shows the use of a very convenient method of mains connection known as European-style chassis connectors. None of this month's projects actually have this sort of plug and socket arrangement fitted but it is such an important method that it is shown here for your future reference. Connections to the inside of the circuit can be made using standard ¼-inch push-on tab connectors or they could simply be soldered on. An advantage of this type of chassis connector is that you will only need two or three made-up leads with the corresponding line plug, as they are readily interchangeable.

Another sensible precaution in the mains circuit of the Freezer Alarm is the fuse and fuse-holder. A fuse should usually be inserted in the live lead to protect the project itself. You should always ensure that a correctly rated fuse is used — it is pointless to have a 13 A fuse in a circuit which only draws 250 mA. If things go wrong in the project and more



current is drawn, then it is unlikely that the 13 A fuse will blow and your project may well suffer irreparable damage.

A terminal block can be a useful addition to a project because it provides a convenient way of 'commoning' any necessary points in the circuit. The photograph of the Freezer Alarm shows the terminal block method in use.

### The Light Of Your Life

Space restriction in the HE Light Dimmer precludes these connecting methods. Without them the whole unit becomes small enough to fit into a standard sized wall box, in place of the existing on/off type light switch. Once fitted you would be unlikely to take the dimmer out again, so possible hazards are avoided, and it is safe. Nevertheless, we coated the back of

every bit as important. The structure of a transformer is such that it has two *mechanically* joined coils of wire which are *electrically* isolated. This electrical isolation is the key to a project's safety. At no point (usually) is the low voltage side of the transformer joined to the high voltage mains side, with the possible exception of earth (i.e. zero potential). This may or may not be joined depending on the circuit.

The Light Dimmer and the Temperature Controlled Soldering Station do not have a mains isolating transformer in circuit. So due care must be taken — two measures are advised — varnish the copper track side of the board before use and do not case the devices in such a way that prying fingers can get at the insides.

much hotter), a gas or match flame, or, as we use, a hot soldering iron held close to *but not touching* the sleeving. Picture 1 shows such an operation. The sleeved joint on the left has already been heated and you can see how the sleeving has shrunk to tightly cover the joint. The one on the right is just about to be heated by the soldering iron. This is a good precaution to take on any project, not just mains powered ones, as it protects two or more close connections from ever short circuiting.

### Use Your Loaf

The important thing to remember if you build your own mains powered equipment is to take your time. Double check and triple check everything before you

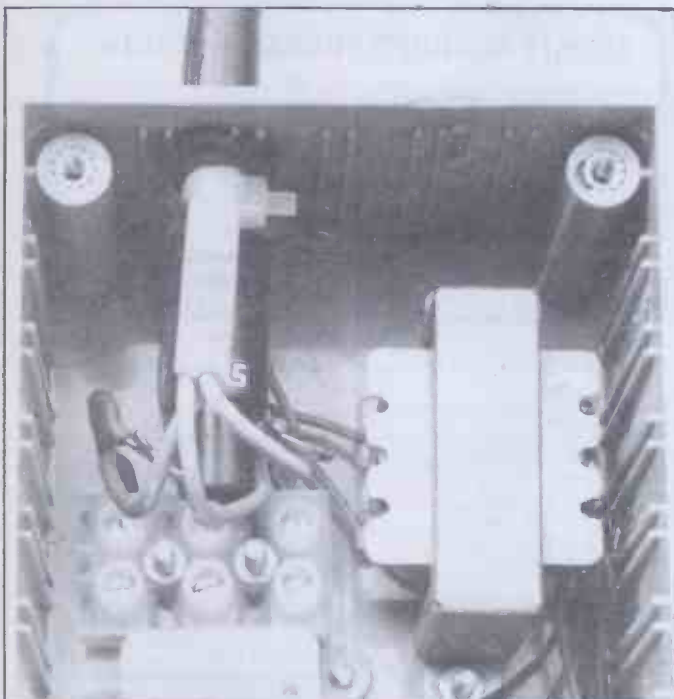


Fig. 1. Internal photograph of the mains connection circuitry of the Freezer Alarm, from this you can see the grommet, cable clip, fuse and fuseholder and terminal block.

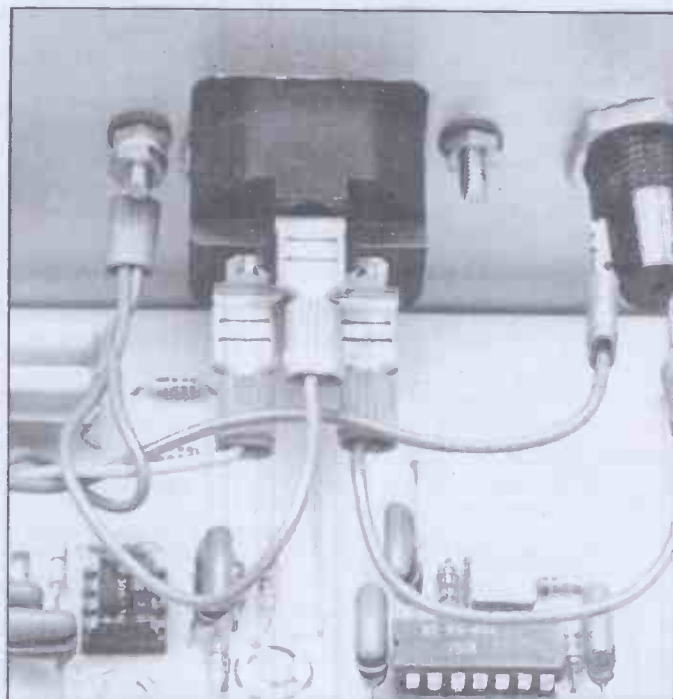


Fig. 2. A European style chassis connector. Quarter inch tab connectors were used to make connections.

our printed circuit board (ie. the copper track side) with insulating varnish just to be on the safe side and advise that you do the same. In fact, it's a good idea to do that to any PCB which carries mains voltages so it may just save a life — yours!

Most mains powered equipment uses a transformer to reduce the high mains voltage to a more manageable level (e.g. 12 V). It is only pure coincidence that two out of this month's three mains projects do *not* have a transformer in the circuit.

The mains transformer has a secondary purpose (pun? what pun?) which is

### The Heat Is On

One precaution that we often take when building projects in the HE Projects Lab is to use Heat Shrink Sleeving. This is a very effective method of covering up and, therefore, insulating any connections which may carry dangerous voltages. The sleeving is made from a polyolefin material which possesses the remarkable ability to shrink to about half its original diameter when heated. It's simple to use, just slip a short length (about 20 mm) over the lead and connection and then heat it up. The heat can be applied from a proprietary hot air blower (similar to a hand-held hair dryer but

switch on. Use your common sense!

From that harmless-looking socket on the wall you have three leads, coloured green/yellow (earth — safe), blue and brown (neutral and live — DANGEROUS). When you touch that live connection — if you're lucky, it'll hurt — if you're unlucky, you won't feel a thing!

Next month I'm planning to talk to you about how to make your own PCBs, as quite a few readers have written requesting more information on the subject. Well, next month you'll see how we do it and pick up a few hints on how to make really first class PCBs yourself, so don't miss it! **HE**

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# Light Dimmer

For those of you who are romantic, this project will let you set the right mood. If you're not, think of the saving on your electricity bill!

LIGHT DIMMERS are always a popular project. They are cheap, simple, and easy to build — furthermore they are useful things to show friends who wonder what on earth electronics is good for as a hobby. Our design is probably the simplest and smallest mains lamp dimmer possible — just eight components on a PCB two inches square. As we've used an MK blanking plate for the 'front panel' of this project it's also easy to fit. All you do is remove the existing light switch from the metal wall box and replace it with the HE Lamp Dimmer, soldering the two mains leads in position on the board first.

The single active component in this circuit is a combined triac and diac (trigger diode) which is cheaper than using two components and also takes up less space. Radio frequency interference, always a problem with this type of circuit, is suppressed by L1 and C1. L1 is not a critical coil and can easily be wound by hand. Details of this are given below.



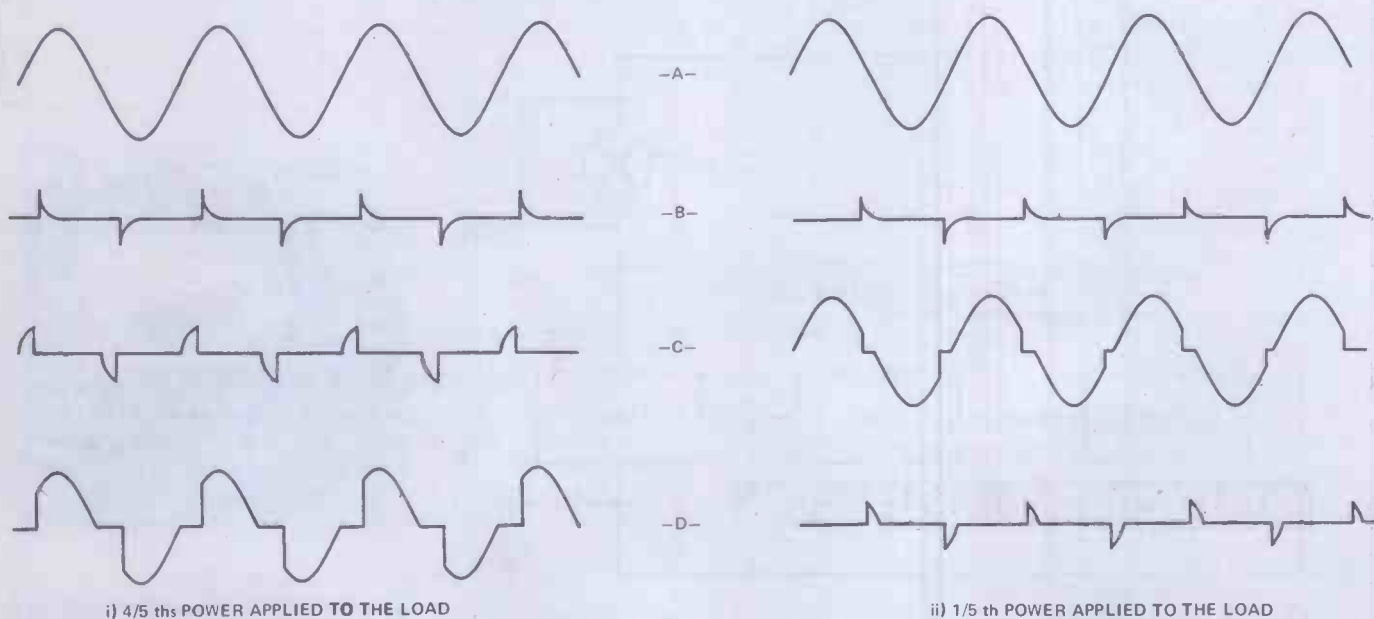
## Construction

All of the components, including the switched pot, are soldered directly to the PCB. Start by mounting RV1. The switch terminals on the back are

soldered to the PCB and the pot terminals connected to the corresponding pads on the board by means of short lengths of insulated wire. Now solder all the other components. The only polarised component is SCR1 — make sure you get it the right way round. Its leads should be bent at right-angles to match the pattern of the PCB pads, so that it lies flat against the board. Leave a slight gap to allow air circulation for cooling.

L1 is made by scramble-winding about 50 turns of 22 SWG enamelled copper wire on a  $\frac{3}{8}$  inch former. The finished coil should be about one inch long. Scrape the enamel off the ends and solder it in place. Now the whole board can be fastened to the MK blanking plate by means of RV1.

The HE Lamp Dimmer can control a load of about 250 W. We suggest that for safety you varnish or lacquer the track side of the board before use, and make sure that no part of the circuit is touching the metal mounting box.



i) 4/5 ths POWER APPLIED TO THE LOAD

ii) 1/5 th POWER APPLIED TO THE LOAD

Figure 1. The waveforms on the left occur when the dimmer is set near maximum brightness, those on the right near minimum brightness.





A view of the completed PCB mounted on the MK blanking plate. This gives you some idea how small it is.

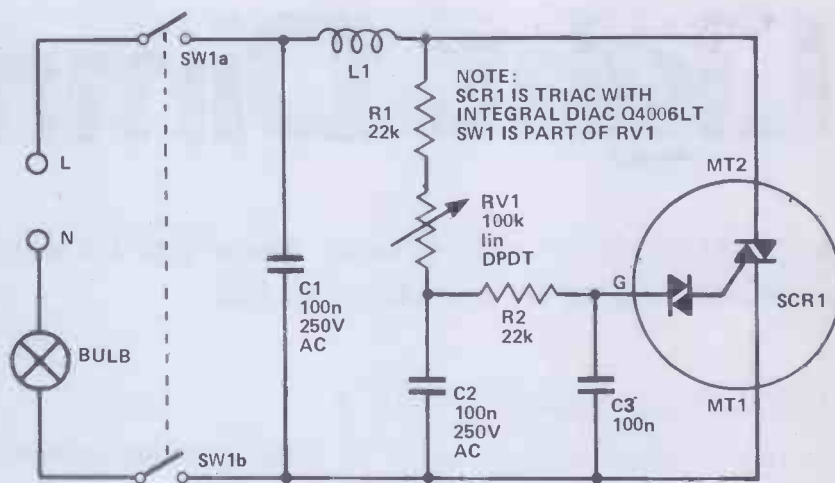


Figure 2. Circuit diagram of the Light Dimmer

## How it Works

### Buylines

We used an MK blanking plate to mount our dimmer, this particular variety has a punch through hole in its centre allowing insertion of the pot spindle. Any good electrical hardware store should stock them.

SCR1, the Q4006LT triac with integral diac is available from TK ELECTRONICS, who advertise with us. As far as we know they are the only stockists.

None of the other components should cause problems. Total cost including the blanking plate should be around £4.

The basic block diagram of the HE LIGHT DIMMER is shown in figure 2. (Figure 2 shows the waveforms within the circuit when approximately 4/5 power is applied to the load (the light bulb) and when approximately 1/5 power is applied.

A triac is, essentially, a power switch which can operate on either the positive or the negative half cycle of an applied AC waveform (waveform A in figure 1). The triac in the HE LIGHT DIMMER is in series with the lamp and so current cannot flow through the lamp until the triac is turned on. This is done by an internal trigger diode (more commonly called a diac) which provides a pulse to the triac gate. This "fires" the triac into conduction (waveform B illustrates this). The triac stays on for the remainder of the half cycle of applied power, i.e. until the voltage across it reaches zero. This is

shown in waveform C. At this point it switches off until a further pulse is applied to its gate.

If pulses are applied at the beginning of the AC cycles then the triac is on for the greater part of the time — therefore the bulb has current flowing through it most of the time (approaching maximum brightness).

If, however, the pulses are delayed for a time after the beginning of the cycle then the current only flows through the bulb for a small amount of the time (approaching minimum brightness). This time delay is provided by R1, RV1 and C2. The use of variable potential divider RV1 makes the time delay completely variable, allowing complete control from minimum to maximum brightness. RV1 has a built in switch, allowing the power to the dimmer and the lamp to be switched off completely.

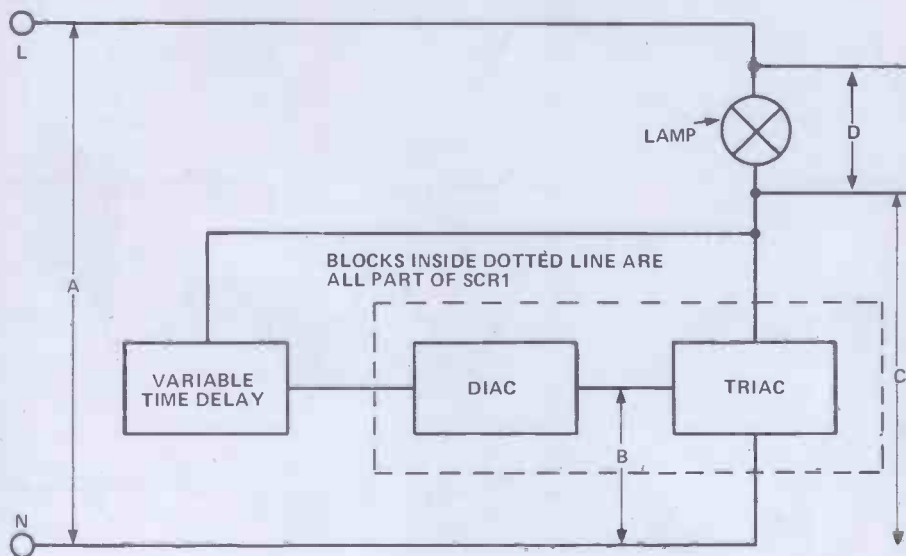
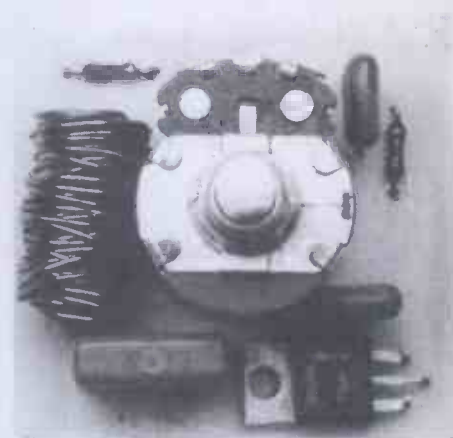


Figure 3. Block diagram of the Light Dimmer



This photograph shows the PCB with the components in place ready for mounting on the blanking plate.

## Parts List

### RESISTORS (1/4 W 5%)

R1,2 22k

### POTENTIOMETERS

RV1 100k linear with built-in DPDT switch

### CAPACITORS

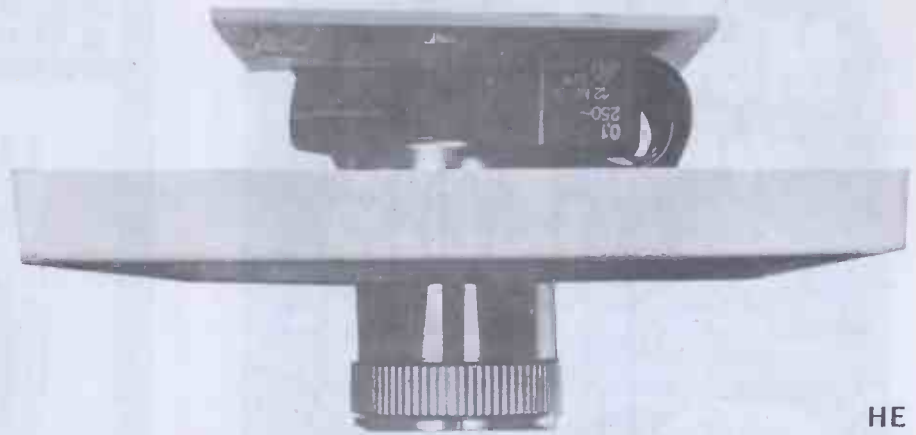
C1,2 100n 250 V AC polyester  
C3 100n polyester

### SEMICONDUCTORS

SCR1 Q4006LT

### MISCELLANEOUS

PCB, coil L1 (see text), MK blanking plate, knob.



HE

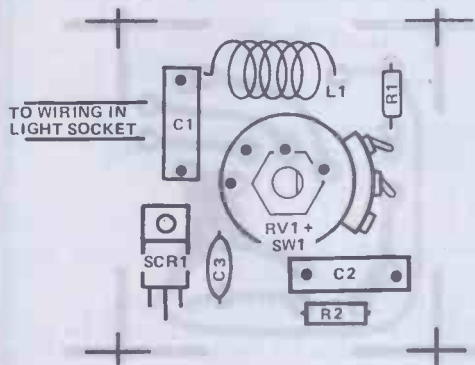


Figure 4. Component overlay of the Light Dimmer

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# What's In a Name

The Integrated Circuit is probably the most used and least understood of all the semiconductor devices. Rick Maybury looks at the remarkably short history of the 'chip' and what it may hold for the future.

FEW INVENTIONS or discoveries ever really change the way we live, the human race could continue without the delights afforded by non-stick frying pans and sliced bread. Our subject this month is altogether in a different league, possibly having consequences as far reaching as the wheel did five thousand years ago.

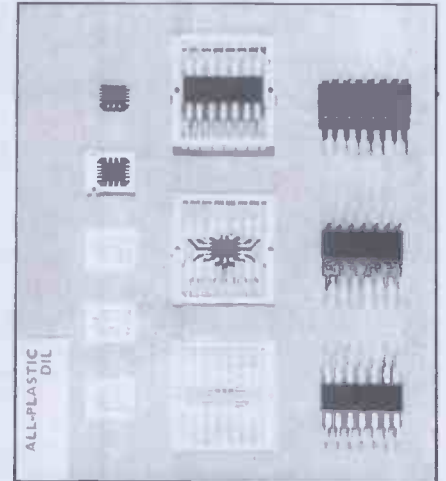
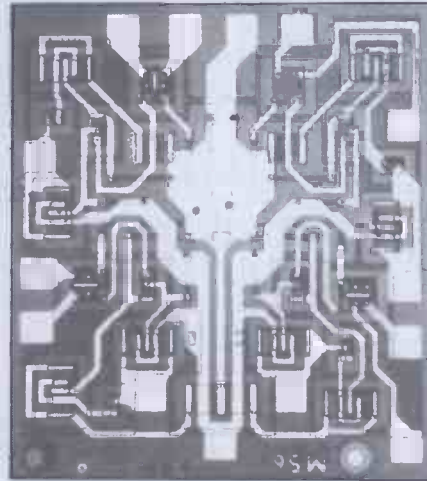
The name Integrated Circuit belies the importance of a family of electronic devices first developed some twenty-two years ago. Jack Kilby is the man generally reckoned to have produced the first IC, that was back in 1958 whilst he was working for Texas Instruments in Dallas USA. He perfected a photographic technique that allowed a number of active semiconductor devices to be built onto a single, minute piece of semiconductor material.

## Photographic Technique

Kilby's research was directly related to work already underway, attempting to find a way of producing transistors to a given specification. Early transistors were made by artificially growing a semiconductor crystal and the characteristics of the crystal were unpredictable, to say the least. The method Kilby developed involved depositing layers of semiconductor material, layer by layer, onto a semiconductor base or substrate. After each layer had been formed it was coated in a photographic resist and exposed to light. A mask between the light source and semiconductor layer had a pattern that corresponded to that part of the circuit, rather like making a multi-layer printed circuit board. After exposure the unwanted portions could be washed away.

## Computer Chips

During the early sixties little was heard of integrated circuits, most devices were relatively crude. The growing computer industry was the first to benefit. Computers are actually very simple devices, most of the circuitry is based upon our old friend the multivibrator, a basic electronic switch. Even the most basic com-



The infamous 'chip' in close up (left). The layered construction can be clearly seen. The picture on the right shows the various stages of encapsulation.

puter might need several thousand identical circuits, however, and computer manufacturers turned to the IC for help.

Initially the IC was just a convenient method of producing simple circuits in great quantity. The need for ever faster operation led to smaller and smaller circuits, (even the distances between components is considered critical these days). The decision to make a single type of device led to problems quite early on. Obviously some circuits would be needed more than others, typical examples include the AND and NAND gates which were produced in their millions. As the photographic methods improved, more and more single devices were put onto 'chips'. Around the late sixties things were getting out of hand. Literally thousands of separate devices were available and the designers started to look around for a 'universal' IC that could fulfill all their customers' needs but without having to keep re-designing their equipment. The answer came in 1969 with the now legendary microprocessor. It was in effect a programmable IC. Once it left the manufacturer it was up to the customer to program it.

## Computer Design

The development of the integrated circuit is a relatively short story. The basic techniques evolved during the late fifties are still in use today and IC manufacture is still a photographic process. Today, the IC manufacturer can put something like 500,000 active devices on a one square millimetre chip and this will continue to increase for some time. The materials used allow more advanced devices to be duplicated in greater quantity. From the early TTL devices (Transistor-Transistor Logic) to the latest generation of LSI CMOS devices (Large Scale Integration, Complementary Metal Oxide Semiconductors) marks one of the most dramatic periods in our history. ICs are everywhere, not only replacing old technology but creating new sciences that will ultimately dictate the way we live. Perhaps one of the most sobering aspects of this new era is the fact that nowadays the designs for new ICs are usually made by computer, itself a collection of ICs. The complexity of these devices is such that a mere human could never hope to do anything more than instruct the computer. 1984 is only four years away!

HE

# Metac

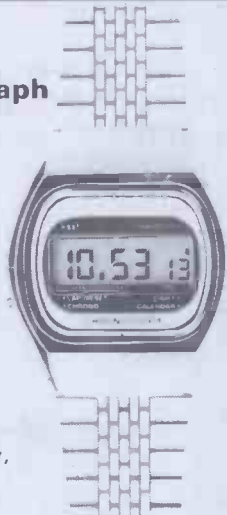
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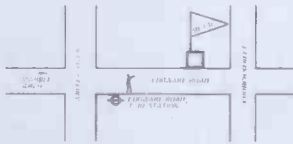
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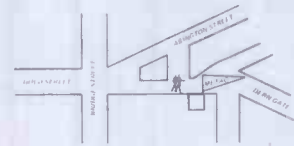


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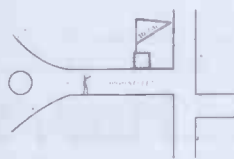
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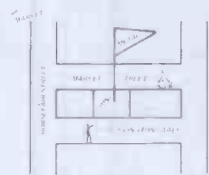
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# Freezer Alarm

When the temperature starts to rise you'll be glad you built the HE Freezer Alarm to protect your frozen food!

AFTER CENTURIES of complaining about the daily drudgery of their lives, it seems that women are finally getting a better deal. Manufacturers are finding more and more ways of applying technology in the home, from motors in the can-opener to microprocessors in the washing machine. One of the most useful items for a working woman (or bachelor, come to that) is a freezer. Not only does it remove the need for daily shopping trips, but meals can be prepared weeks in advance, in bulk, and simply heated up when required.

## Finding Fault

Unfortunately we don't live in a perfect world and the convenience of a freezer can become a great inconvenience should anything go wrong. A failure can be very difficult to detect as the pilot neon on the front will only tell you that the mains is connected. Any other fault may only become apparent the next time you open the door and find a messy heap of defrosted food. Despite the fact that a freezer is designed to stay cold without power for long periods (in case of power cuts), it is not a very good idea to rely on this and hope you'll spot something wrong next time you use it. It might be too late.

## Fault Finding

Prevention is better than cure, even if you are insured, and the obvious answer is to fit a temperature monitor that sounds an alarm if the temperature inside the freezer starts to rise above normal, towards the point of no return. This gives you a chance to get the freezer fixed before the contents are ruined.

The HE Freezer Alarm uses an LM3911 temperature controller IC as a

sensor. This is placed inside the freezer, connection to the rest of the circuit is made by a thin cable. This can pass under the rubber door seal without affecting the insulation. The alarm we used is the now-familiar solid-state buzzer.

You might think it strange that the circuit is powered from the mains but this is OK. It means that you can't forget to replace the battery, and in any case, as mentioned above, freezers are

## How it Works

The heart of the alarm is the LM3911 — an integrated circuit specifically manufactured for use in temperature control equipment, although we have adapted its use slightly for this project. The IC itself has three main sections as seen in Figure 1, a zener diode, a temperature sensor and an operational amplifier.

The zener diode is used with R2 in the circuit diagram to provide a stable reference voltage of 6V8 which supplies the temperature sensor and the internal op amp. The op amp is connected as a voltage comparator — i.e. when the voltage at the non-inverting (+) input rises above that at the inverting (-) input, the op amp output goes high. The voltage at the inverting input is set by potential divider chain R3, RV1 and R5. The voltage at the non-inverting input is set by the output of the temperature sensor — and this falls as the temperature increases.

RV1 is adjustable to allow for a temperature setting of approximately  $-25^{\circ}\text{C}$  to  $0^{\circ}\text{C}$ . Different resistors in the potential divider chain will alter the turnover temperature of the op amp to allow the IC to be used as a room thermostat, say. In fact the LM3911 can be used to measure temperatures of  $-25^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ . Power is provided via mains transformer T1 to isolate the circuit from mains voltage. BR1 is a bridge rectifier which changes the AC from the transformer to DC and C1 filters the voltage to give a smooth DC supply of about 16V.

The output of the internal op amp of the LM3911 drives Q2 via R4. As long as the temperature is below the present level, Q2 is turned on and prevents base current flowing into Q1, which is therefore held off. When the op amp swings low, Q2 is turned off and current can now flow into Q1 base via R1. Q1 turns on and sounds the alarm.

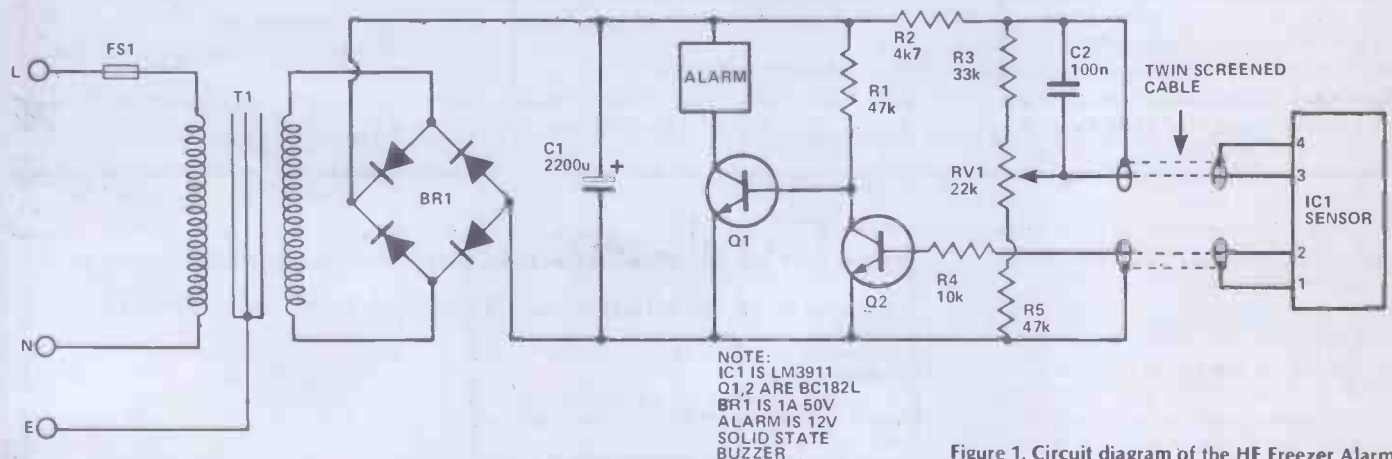


Figure 1. Circuit diagram of the HE Freezer Alarm



# Parts List

## RESISTORS (all 1/4 W, 5%)

R1,5	47k
R2	4k7
R3	33k
R4	10k

## POTENTIOMETER

RV1	22k linear
-----	------------

## CAPACITORS

C1	2200u 16 V PCB-mounting electrolytic
C2	100n polyester

## SEMICONDUCTORS

Q1,2	BC109
IC1	LM3911
BR1	1 A, 50 V bridge rectifier

## MISCELLANEOUS

9 V, 100mA transformer, fuse (500mA) and fuse holder, 10 x 24 hole veroboard, twin screened cable, solid state buzzer, socket for mounting IC (see text).

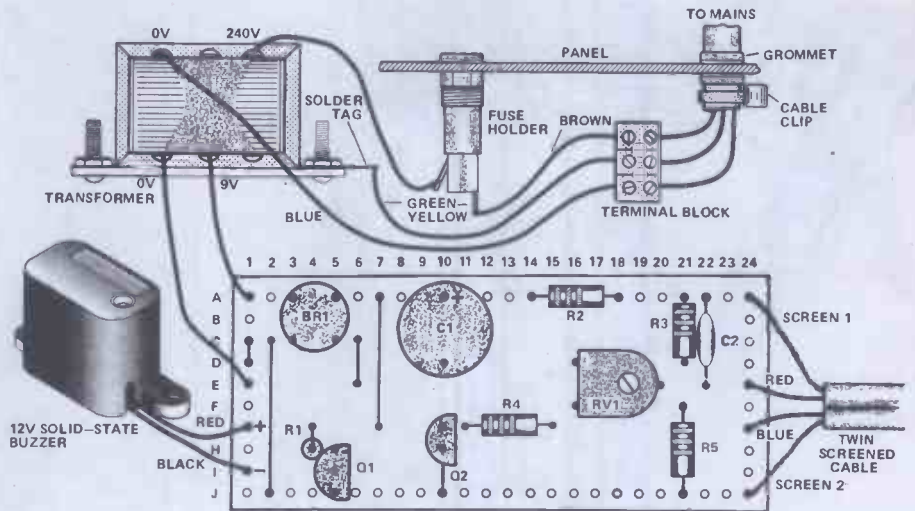


Figure 2. (above) Overlay and interwiring diagram.

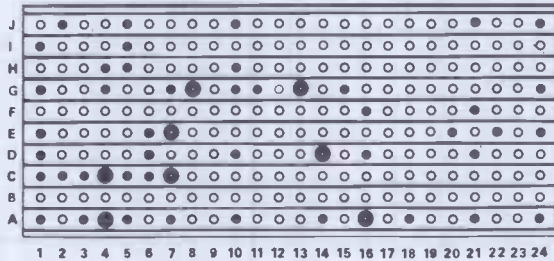


Figure 3. Veroboard layout showing component positions and track cuts.

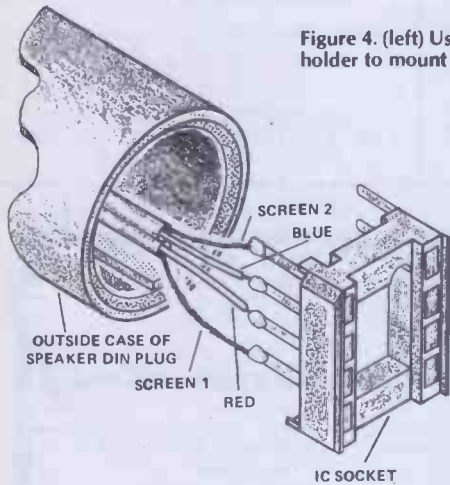
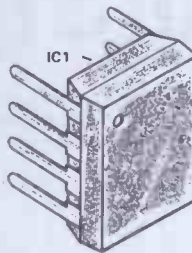


Figure 4. (left) Using an IC holder to mount the LM3911



designed to cope with power cuts provided you don't keep opening the door.

## Construction And Setting Up

Nothing unusual here apart from the mounting of the sensor. We soldered a length of twin miniature screened cable to the pins of an IC socket and encased the socket in the plastic cover from a DIN speaker plug. The drawing and photograph should make this clear. The LM3911 is then fitted into the socket. We only used a socket to make a tight fit in the plastic cover — if you choose some other method of construction there is no reason why you cannot solder directly to the pins of the IC (provided you do it quickly).

Take the usual precautions when building the rest of the circuit, making sure that transistors and electrolytic capacitor are the right way round.

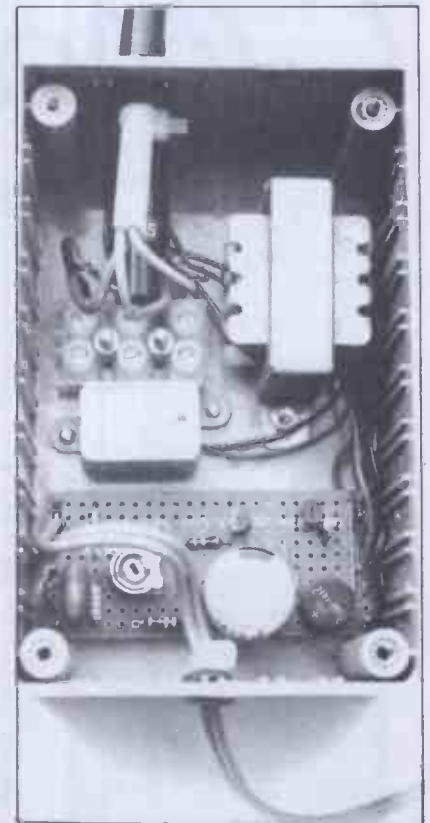
Please be careful with the mains circuitry — we would hate to lose any of you!

To set up the unit, switch the freezer to its highest working temperature and leave the sensor inside to cool down. Adjust RV1 until the buzzer sounds, then back it off slightly to turn the buzzer off. The alarm is now ready for use.

## Buylines

Nothing which will cause any trouble here — all parts should be easily obtainable at your normal component stockist or most of the usual mail order companies.

All parts (excluding the case) should total approximately £7 — not much to pay to protect the contents of your freezer.





Shown here are all of the back issues currently available. Each issue costs just £1, (that includes post and packing).

The latest addition to our stocks is the March issue. Features include: Automotive Electronics, PETting it Together and the second part of Ian Sinclair's new series Into Electronics Construction. The projects include: The 5080 modular amplifier system, PSU module for the 5080, Short Wave Radio and a novel Touch Switch.

For details of other issues see our main Index in the January issue. HOBBYPRINTS for this and all back issues are still available. For order codes and information on how to use HOBBYPRINTS see the ad. in this issue.

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SN7420N	E0 15	SN74145N	E0 64
SN7423N	E0 18	SN74148N	E1 05
SN7425N	E0 19	SN74150N	E0 79
SN7426N	E0 19	SN74151N	E0 55
SN7427N	E0 19	SN74153N	E0 55
SN7430N	E0 15	SN74154N	E0 90
SN7432N	E0 17	SN74155N	E0 60
SN7437N	E0 21	SN74157N	E0 59
SN7438N	E0 21	SN74160AN	E0 70
SN7440N	E0 18	SN74161AN	E0 70
SN7441AN	E0 52	SN74162AN	E0 70
SN7442N	E0 40	SN74163AN	E0 70
SN7445N	E0 66	SN74164N	E0 80
SN7446AN	E0 48	SN74165N	E0 80
SN7447AN	E0 48	SN74167N	E1 20
SN7448N	E0 45	SN74174N	E0 80
SN7450N	E0 15	SN74175N	E0 63
SN7451N	E0 15	SN74176N	E0 74
SN7453N	E0 15	SN74177N	E0 73
SN7454N	E0 15	SN74180N	E0 70
SN7460N	E0 15	SN74181N	E1 65
SN7470N	E0 26	SN74182N	E0 83
SN7472N	E0 24	SN74184N	E1 29
SN7473N	E0 25	SN74185AN	E1 10
SN7474N	E0 25	SN74186N	E1 35
SN7475N	E0 31	SN74188AN	E1 84
SN7476N	E0 26	SN74189N	E2 26
SN7480N	E0 39	SN74190N	E0 74
SN7481N	E0 71	SN74191N	E0 79
SN7482N	E0 65	SN74192N	E0 79
SN7483N	E0 60	SN74193N	E0 79
SN7484N	E0 95	SN74194N	E0 84
SN7485N	E0 70	SN74197N	E0 74
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SN7490AN	E0 33		

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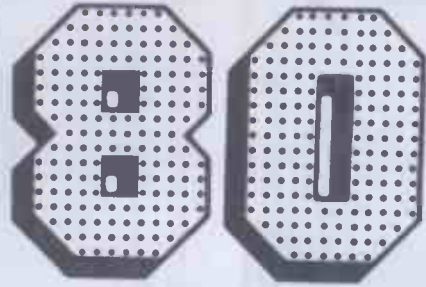


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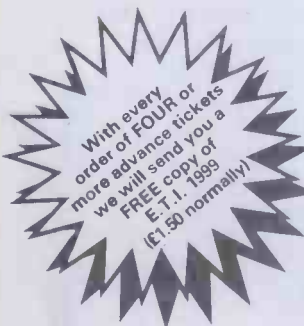
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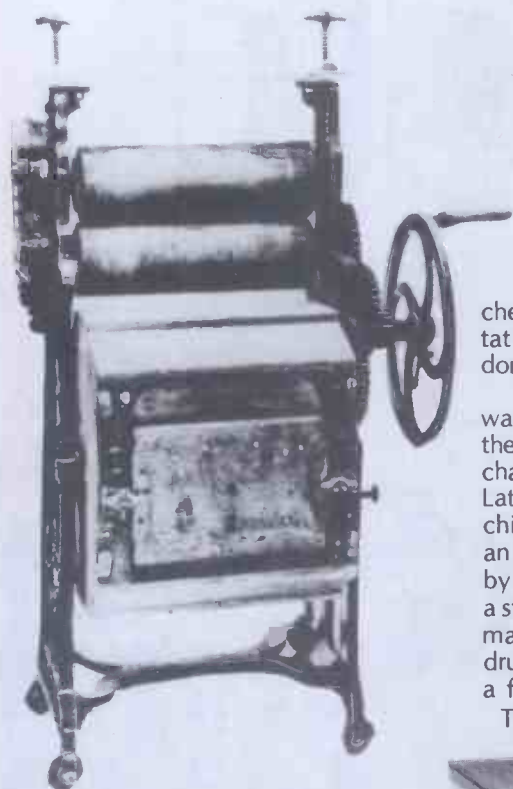


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# Electronics

Are you keeping up with the Joneses or have you been left behind?  
Tina Boylan examines the history of the home electronics revolution.



cheaper — the relatively high price dictating that it was not greatly exploited domestically.

The first electrical device to appear was the cooker, and it is safe to say that the basic concept of this item has changed little since those 'roaring' 20s. Later during the 1940s washing machines were being sold for home use, an example of which was manufactured by Hoover, a company still maintaining a strong grip on the domestic appliance market. Their machine consisted of a drum-like 'washer', impeller driven, with a folding manual wringer on the top.

The switch which controlled the

washing program was motor driven, and the machine really did nothing more than wash! The wringer was entirely manually operated, it was only there because it was more convenient to have it attached to the washer.

During this period the radio was being slowly introduced into British homes, and was finding its place at the centre of family entertainment. Television made its debut in Britain in 1935 when the BBC was experimenting with it. The Alexander Palace Transmitting station was opening in 1936, and by 1937 when the coronation of King George VI was televised, though, still relatively few people owned television sets — it seemed to be just an expensive gimmick as the picture quality was exceptionally poor.

THERE WAS A TIME, not so long ago when home life was a simple matter, filled with simple pleasures and simple menial tasks. Entertainment consisted mainly of songs sung around the family piano or the occasional visit to the local Music Hall. Heating meant lighting a coal fire, and food was cooked on the coal-fired kitchen range. Cleaning was done with a dustpan and brush, and gas and oil lamps needed to be trimmed to keep them working efficiently. Any household wishing to eat fresh meat and vegetables, had to buy them daily for immediate consumption, as the only methods of preservation were stewing, tinning, bottling and salting.

Today electronics are not only making life easier for the housewife, they are also making life more interesting and varied for the rest of us.

## Where It All Began

From an historical point of view, domestic electrical appliances first began to appear during the 1920s, a time considered 'great' for Britain, just recovering from the effects of the First World War. Electricity had originally been introduced into the average household at the turn of the century, at which time it was used purely as a luxury form of lighting, as gas was then far



## The Spoils Of War

It was not until the Second World War had ended that electronic devices for the home really began to make an impact. Television transmissions and receiving apparatus were greatly improved thanks to the advances made in radar defence systems used by the British during the War. Even so, it was as late as 1953/4 that the BBC opened its Sutton Coldfield transmitting station and this heralded the ultimately high level of television ownership we know today. It was at last an indication that television was here to stay.

# In The Home

Behind by the developments in the electronic gadget market? Labour saver and takes a look into the future.

In 1950 it was again the BBC who experimented with the concept of stereo. It first appeared as a way of demonstrating records in record shops. Of course it was not true stereo, as only mono recorded discs were available at the time, but this certainly prompted the record industry to begin producing stereo discs. Another form of now popular entertainment is the tape recorder. These were first introduced in 1954 for use as office dictating machines. The recordings were made on a 4" disc and quality was extremely poor. It wasn't until ferrite tapes were introduced around 1960 that recorders for music were considered a reasonable possibility. At this time the transistor revolution was beginning to take effect. Thermionic valves needed huge cases, and the eventual influx of small Japanese transistor radios brought home entertainment into the portable age. Miniaturisation was the name of the game — far more electronic capabilities could be included in each small device, many items became more sophisticated; radios, recorders, record players and televisions all became smaller and cheaper, indeed the way was well and truly paved for the beginning of the electronic era.

## We Have Lift Off . . .

The next great step forward in electronics was brought about by research carried out on the American Space Program during the late sixties and early seventies. The lunar modules used by the Astronauts had to be computer controlled, space was considerably limited, (sorry about the pun!), even transistors were not small enough, so ultimately the Integrated Circuit was developed. When we consider the specialised application of the IC in its original form, it is quite incredible to consider the extent of the impact it has made on each one of us. Its invention led to the computerisation of many devices, helped introduce remote control into the home, and made fuel injection possible in motor cars, something that was difficult to do by purely mechanical means. Today even the humble washing machine has had its chips and is truly programmable!

## Yesterday, Today, Tomorrow

Just imagine what the Victorian housewife would say with her washboard in one hand and her wooden spoon in the other, as she gazed round the treasure trove of 'domestic electrical appliances' which can be found in any local department store. There seems to be a labour saving device for virtually everything these days. They can cook your toast, boil your kettle, make your coffee, sharpen your knife, heat your water, dry your clothes, preserve your food, clean your teeth, dispense your loo paper . . . . dispense your loo paper?

Seriously though, amongst these relatively simple gadgets, one can spot some of the most sophisticated machines which the electronics industry can produce, and all widely available to the general public, if, of course, you have the money in your pocket, and can decipher the pidgin English of the instructions.





## Common As Muck

Washing machines with programs as long as your arm are capable of turning your dirty linen into clean, dry items without you having to do more than set the dial and put in the washing. The timers used today are electronically pulsed, moving to the desired heat and speed setting, taking in water, washing powder and pumping it all out again when necessary. Never again will a rainy Monday mean five days of dripping washing in the bathroom.

Food processors now mean that the aspiring 'Cordon Bleu' cooks can whip up exotic meals at the touch of a button — no more amputated fingers in the Goulash, and no need for muscles like a shot-putter in order to finely dice, grate or whisk your desired recipe into shape.

Cooking the food itself has also been quite drastically changed by the invention of the Microwave Oven. It must surely be the snack enthusiast's dream, as everything is cooked incredibly quickly, so not too much time elapses between deciding to eat and actually eating. You simply put into it whatever you want to cook, set the timer and stand well back. Of course they're not dangerous, but the concept used to heat the food is certainly revolutionary.

The oven works on the principle of producing an electromagnetic field of very short wavelength. This causes rapid molecular movement which generates heat cooking the food, but neither heats the dish nor browns the food, the latter being perhaps a slight disadvantage, except to the American lady who put her poodle in it to dry it after a bath. The effect this process has is to cook the food from within, instead of conventionally heating it on the outside and waiting for the heat to penetrate the mass. Therefore food is cooked in a fraction of the normal time. Among its less obvious advantages are that it runs cold, is very clean, and is useful for defrosting and cooking frozen foods quickly. Unfortunately if you happen to be one of the people who likes his roast chicken to look like roast chicken, you'll be disappointed, though an ordinary electrical heating element may soon be added to the microwave ovens, although the browning process may take up to four times as long as it takes to actually cook the chicken.

The question now must be 'what do the Englishmen of the 1980s do in their castles while their washing is being done and food prepared?' More than likely

they will be listening to their hi-fi radio/cassette/record deck, or relaxing in the comfort of an armchair, remotely switching on the colour telly, while keeping one eye on the quartz controlled LED/LCD alarm clock/radio waiting for the microwave oven to cook the dinner.

## 1984 And All That

So where does all this leave us. True, it's an easy and effortless life we lead these days, but with any luck it could become even easier. The future trends almost certainly lie in this direction. After all, we know there is no mechanical motion that can't be controlled electronically, and one step forward from this idea leads to computerisation and control systems, which are currently enjoying great popularity with researchers and manufacturers alike.

From a personal viewpoint I would eventually like to see homes completely controlled by a central computer, the type that will ensure that when I get home from work I could open the door to a perfectly clean house, punch out my instructions on the computer keyboard, then sit down while the hi-fi selects my favourite record, the robot prepared my meal, the bath was run and the coffee maker poured my coffee, sheer bliss!

With the way electronics are moving at the moment that might well be a dream which will materialise. After it happens someone will have to develop an exercising machine that can keep you totally fit — preferably in the comfort of your computerised home. HE





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HEF4008	100	HEF4051	87
HEF4011	22	HEF4052	90
HEF4012	22	HEF4053	90
HEF4013	57	HEF4056	62
HEF4014	105	HEF4067	425
HEF4015	100	HEF4068	22
HEF4016	27	HEF4069	22
HEF4017	100	HEF4070	22
HEF4018	100	HEF4071	23
HEF4019	58	HEF4072	23
HEF4020	112	HEF4073	23
HEF4021	107	HEF4075	23
HEF4022	103	HEF4076	130
HEF4023	22	HEF4077	22
HEF4024	76	HEF4078	23
HEF4025	22	HEF4081	23
HEF4026	244	HEF4082	23
HEF4027	57	HEF4083	80
HEF4028	89	HEF4086	80
HEF4029	113	HEF4093	63
HEF4030	58	HEF4094	219
HEF4031	250	HEF4104	130
HEF4035	136	HEF4502	114
HEF4040	107	HEF4505	714
HEF4041	94	HEF4508	230
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HEF4043	100	HEF4511	157

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CA3080E	77	IN4001	5
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CA3195E	253	IN4007	9
LM301AN	34	IN4148	4
LM339N	78	IN5402	15
LM380N	104	2N2369	21
LM331AM	198	2N2646	46
LM3900N	75	2N2926G	13
MC3403P	156	2N3053	19
NE531	131	2N3054	55
NE53T	759	2N3055	55
NE555N	28	2N3102	9
NE556N	66	2N3204	9
NE566N	171	2N3705	10
NE570N	485	2N3773	297
NE571N	505	2N3819	22
RC4136	146	2N3820	39
T8A1205	88	2N3904	9
TD1022	713	2N5457	39
TD1034B	239	2N5459	35
TLO81CP	84	40673	88
TLO84CN	156	BC107	14
UA741CN	20	BC108	14
UA741CT	47	BC109	18
		BC129	14
		BC199B	19
		BC199C	20
		BC148	10
		BC158	10
		BC177	17

**SEMICONDUCTORS**

BC182L	12
BC184	11
BC184L	12
BC212	11
BC213L	12
BC214L	12
BC549	11
BC549	12
BC557	15
BC558	15
BCV70	95
BCV71	15
BD131	39
BD132	39
BD139	39
BD140	39
BF890	333
BF895	29
BFV50	17
BFV51	17
BRV39	50
BSX20	21
CL8960	2850
TPP31	48
TPP32	54
TIP41C	76
TIP42C	76
TIP2955	75
TIP3055	60
TIP543	36

**Voltage Regulators**

LM309DAIK1	119
UA723CN	42
UA7805CU	78
UA7812CU	78
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UA7912CU	97
UA7915CU	97
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**CAPACITORS**

Electrolytic Axial		Order Code	
-10% to +50% Tol.		Cap 018	Cap 018
µF	V	16	28
1.0	15	8	83
1.5	15	9	7
2.2	15	9	7
3.3	15	9	7
4.7	15	9	7
6.8	15	9	7
10	15	9	7
15	15	9	7
22	15	11	7
33	15	11	7
47	15	11	7
68	15	11	7
100	15	13	7
150	15	13	7
220	15	31	7
330	15	30	7
470	15	32	7
680	15	30	7
1000	15	30	7
1500	15	39	7
2200	15	42	7

**Polyester Radial Leads**

Dipped Type, C280/352 Style		Order Code	
Moulded Type, 10.2mm Pitch		Cap 352	Cap 360
µF	V	15	360
.001	15	7	1
.0022	6	7	1
.0033	6	7	1
.0047	6	7	1
.0068	6	7	1
.01	6	7	1
.015	6	7	1
.022	6	7	1
.033	6	7	1
.047	6	7	1
.068	7	8	1

**Electrolytic Radial Leads**

-10% to +50% Tol.		Order Code	
Cap 034		Cap 034	Cap 034
µF	V	16	25
.47	15	9	7
1.0	15	9	7
1.5	15	9	7
2.2	15	9	7
3.3	15	9	7
4.7	15	9	7
6.8	15	9	7
10	15	9	7
15	15	9	7
22	15	9	7
33	15	9	7
47	15	9	7
68	15	9	7
100	15	9	7
150	15	9	7

**D.I.L. Sockets**

8 Pin Low Profile Socket Tin	12	DIL SKT B	8
14 Pin Low Profile Socket Tin	14	DIL SKT L4	14
16 Pin Low Profile Socket Tin	16	DIL SKT L6	16

**RESISTORS**

Carbon Film, Fixed		Order Code	
0.25W, E24 Values, 10R-10M, 5% Tol.		2 each	Rev RD%
0.5W, E12 Values, 10R-4M7, 10% Tol.	3 each	Rev RD%	Value
0.5W, E24 Values, 5R11M, 2% Tol.	8 each	Rev MR30	Value
2.5W, E12 Values, 10R-27K, 5% Tol.	16 each	Rev PR52	Value
0.5W, E24 Values, 1M-33M, 5% Tol.	15 each	Rev VR37	Value

**Skeleton Presets, Miniature**

0.1W, E3 Values, 100R-1M, Lin. Vertical Mounting	8	Min. Preset V
0.1W, E3 Values, 100R-1M, Lin. Horizontal Mount	8	Min. Preset H

**Skeleton Presets, Standard**

0.3W, E3 Values, 100R-4M7, Lin. Vertical Mounting	11	Std. Preset V
0.3W, E3 Values, 100R-4M7, Lin. Horizontal Mount	11	Std. Preset H

**P.C.B. Components**

0.25W, E3 Values, 1K-2M2, Lin.	39	Std. Preset V
0.25W, E3 Values, 4K7-2M2 Log	39	Std. Preset H
Potentiometer, Rotary	39	Std. Preset V
0.25W, E3 Values, 1K-2M2, Lin.	39	Std. Preset H
Potentiometer, Slider	45	Std. Preset V
0.25W, E3 Values, 2K2-47K, Lin.	45	Std. Preset H
0.25W, E3 Values, 1K0-1M0 Log	45	Std. Preset V

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0.5V, 0.6V	
0.12V, 0.12V	
0.15V, 0.15V	
0.17 5V, 0.17 5V	
0.20V, 0.20V	
70VA - Clamp Type Construction	360 each
Approx. 16% Regulation F.C. 70, H48, W46	
0.4 5V, 0.4 5V Secondaries	Trans 20VA
0.6V, 0.6V	
0.12V, 0.12V	
0.15V, 0.15V	
0.17 5V, 0.17 5V	
0.20V, 0.20V	

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ABS Box, C/W Brass Bushes, and Lid in Orange		Order Code
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L190 W110 D80	223	Case B1M2006 OR

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L111 W71 D42	150	Case B1M4004 OR
L161 W96 D53	208	Case B1M4005 OR

**Dipcast Boxes**

Diecast Box and Flanged Lid		
Aluminium Box and Lid in Natural Finish		Order Code
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L192 W113 D81	334	Case B1M5006 NA

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SPDT Double Bias To Centre	90	SW 8A1041
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SP Push To Make, Momentary	62	SW 8533
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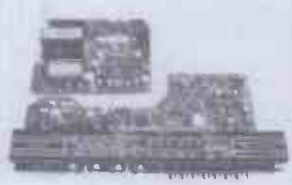
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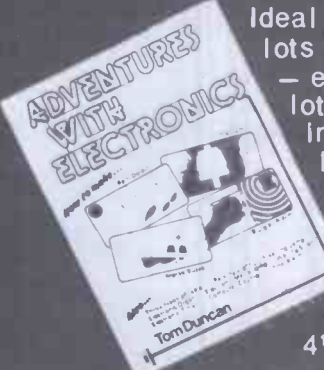
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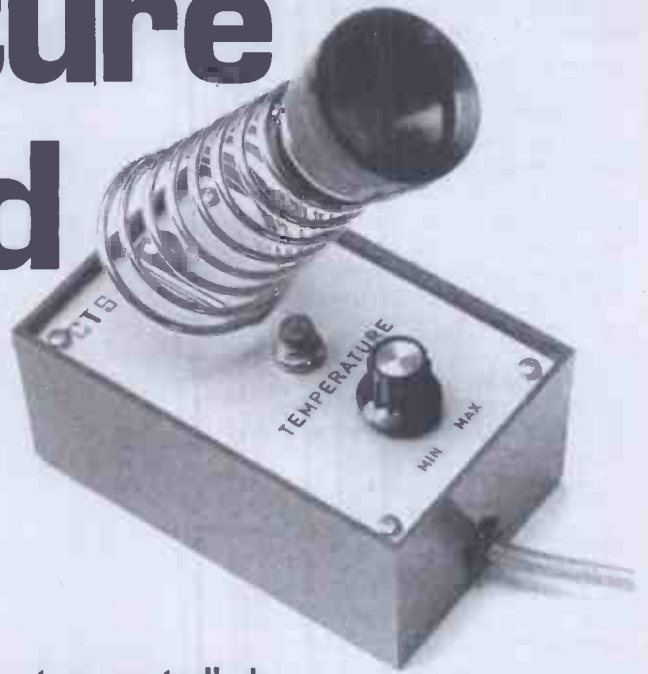
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944	65p	4044	86p	6800	695p
946	65p	4045	160p	6802	995p
957	55p	4047	95p	8080A	525p
962	55p	4048	58p	8085A	1095p
9099	90p	4049	38p	Z80	795p
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# Temperature Controlled Soldering Iron



Tame your soldering iron with this ingenious temperature controlled soldering station

A MAJOR FACTOR in the art of soldering concerns the ability of your soldering iron to do its job. For instance, if the iron is a high wattage type, say 100 watt, it obviously shouldn't be used to solder sensitive ICs into circuit (you may even find it lifts the track from the board because of the intense heat — never mind damaging the ICs!). Likewise, if the iron is only a 15 watt job, then it won't have the necessary power to solder components on to a hefty earth bus.

There are two ways in which an efficient level of soldering can be obtained — either use a specific iron for a corresponding job (which means you need a selection of three or four irons) or use a temperature controller which heats the iron to the correct temperature for any chosen use. It is a well documented fact that good control over soldering tip temperature not only improves the quality and integrity of soldered connections but also greatly increases efficiency and extends tip life, whilst reducing troublesome oxide buildup on the tip.

Now, all this sounds great, all you have to do is rush out and buy yourselves one of these tremendous gadgets and then you can solder away to your heart's content, whatever the job. But here's where you will hit a slight problem. A com-

plete soldering system will cost you quite a few weeks' pocket money.

One simple alternative to holding up the local High St. bank is the HE TEMPERATURE CONTROLLED SOLDERING STATION, which will enable you to convert any 15-100 W soldering iron to a fully controlled iron, capable of intermittent hobby use to full time production use, as well as providing a convenient soldering stand. (If you have a choice most electronic soldering applications are best handled using a 40 watt to 60 watt iron with this controller).

The 4000 series CMOS ICs were selected for their cheapness and versatility and to give the electronics enthusiast some insight into just how versatile these ICs are. The design has incorporated zero voltage switching which eliminates radio frequency interference (RFI) caused by phase control of line voltage and the potentially destructive spikes created by thermostatically or 'magnetically' controlled soldering irons. The soldering iron temperature can be varied from full off to full on whilst the iron is in use. A visual indication of controller operation is also provided.


The output waveform consists of controlled burst of pulsating DC and is, therefore, suitable for

resistive element soldering irons only. (Soldering irons or guns that use transformers cannot be used with the project). This waveform was selected to simplify power supply design, reduce internal power by dissipation and eliminates costly, sensitive gate triacs which would be required for direct interface with CMOS logic.

## Construction

Construction is reasonably straightforward — start with the PCB. Nothing special here, just remember to mount R1 and 2 (along with Rx if used) about three or four mm from the board, to help heat dissipation.

Remember that IC1 and 2 are CMOS and we advise the use of IC holders (not essential but helpful). Next, mount the spring and holding bolt, neon and RV1 on the front panel and follow the wiring diagram of figure 3 to connect up your soldering station.

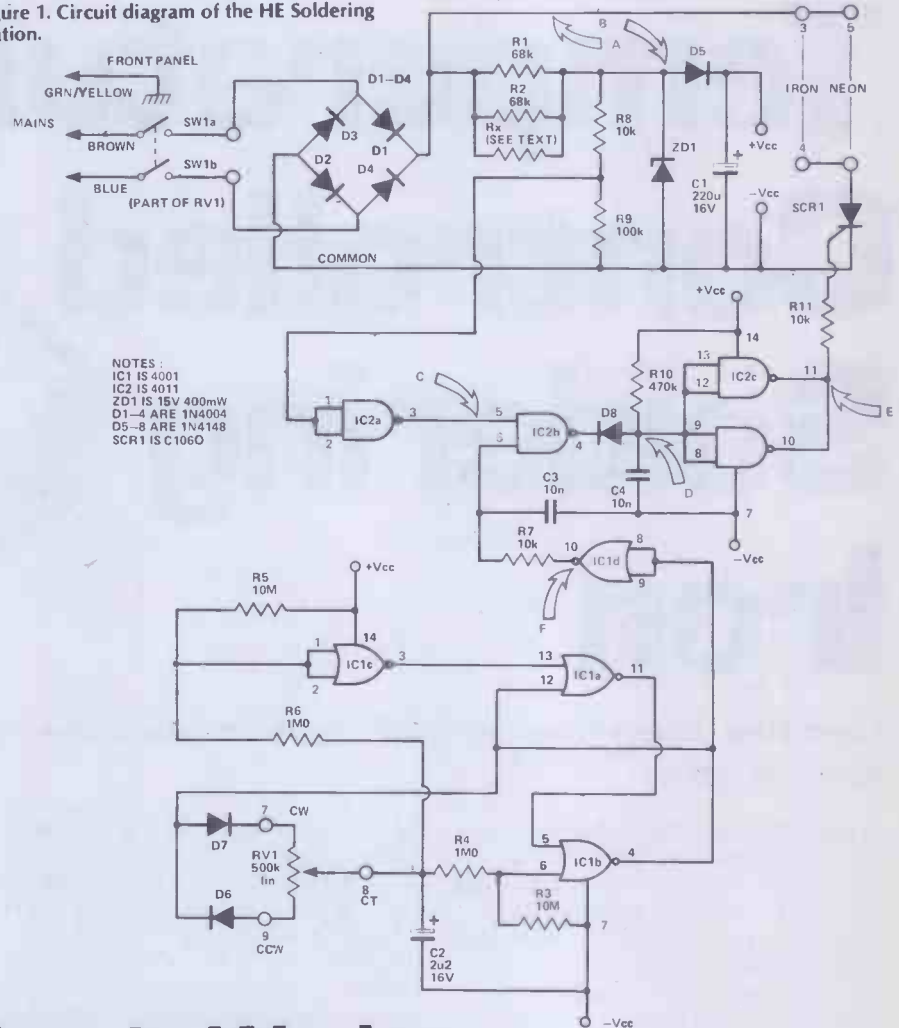
The cable ties at the mains input and iron output grommets are necessary to avoid strain on the cable connections. The PCB simply slides into one of the grooved slots in the case eliminating the use of special fixing procedures. Finally, make sure that the earth connection on the front panel is a good one. 

## Testing and Setting Up

Plug the controller into 220-250V AC mains. Advance the temperature control clockwise until the power switch clicks on. Advance the control further clockwise until the neon lamp just begins to flash. This is the lowest temperature setting of the controller. At this setting the soldering iron tip will be barely warm to the touch. Advance the control further clockwise. You will note that the on-off ratio of the neon lamp will slowly change as the control is advanced fully clockwise. Whenever the neon lamp is lit, power is being applied to the heating element. At the maximum clockwise position of the temperature control the neon lamp will remain on continuously and the soldering iron will produce full output.

The controller takes advantage of the 'thermal mass' of the soldering iron in maintaining a reasonably constant temperature at the tip (the larger the iron, the better the regulation). Any fluctuations in tip temperature due to increased or decreased loading can be easily compensated by adjusting the temperature control as required. If the neon lamp comes on at full intensity at the full counter-clockwise position and does not flash on and off, the wires to the 100 k potentiometer (R3) are probably reversed.

Figure 1. Circuit diagram of the HE Soldering Station.



NOTES:  
IC1 IS 4001  
IC2 IS 4011  
IC3 IS 4013  
ZD1 IS 15V 400mW  
D1-4 ARE 1N4004  
D5-8 ARE 1N4148  
SCR1 IS C1060

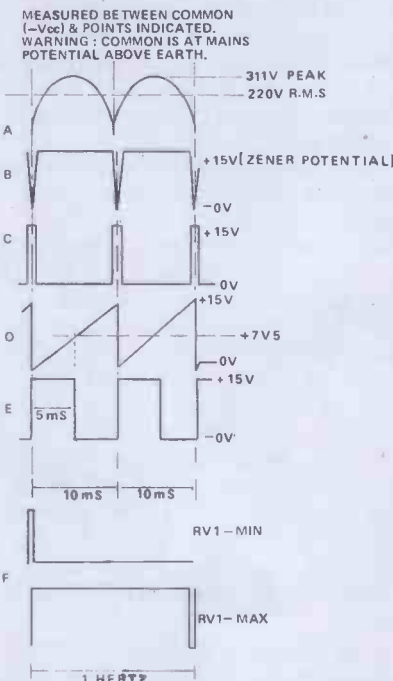
## How it Works

The incoming mains voltage is switched via SW1 which is integral with the temperature control RV1. The mains voltage is then full wave rectified by D1-D4. The resulting pulsating DC (illustrated in waveform 'A') can deliver the same heating power to a resistive element as 220-240V AC mains. The pulsating DC will heat the soldering iron element and illuminate the neon whenever the silicon controlled rectifier SCR1 is gated on by the combined logic of IC1 (1 hertz variable duty cycle multivibrator) and IC2 (zero voltage cross-over detection and SCR gate driver). Without gate drive SCR1 will cease to conduct each time the pulsating DC returns to 0V.

The mains potential pulsating DC is dropped via R1 and R2 and clamped to a pulsating +15V via ZD1. Waveform 'B' which is produced by the clamping action of ZD1 also pre-regulates the supply voltage for the integrated circuits. D5 prevents the power supply filter capacitor C1 from filtering out the sync pulses.

IC1 and the associated components form a variable duty cycle astable multivibrator with a frequency of 1 Hz.

At the fully counter-clockwise position of RV1, the output of this astable is low (logic 0) for 99% of the 1 second period. At the fully clockwise or maximum setting of the RV1, the astable output is high (logic 1) for 99% of the



period. Waveforms 'F' show these two modes. Mid-positions of RV1 produce outputs which vary between these two extremes. In summary, the setting of RV1 will vary the ratio between the logic '1' state and the logic '0' state (duty cycle) without appreciably altering the period of the complete cycle.

The line synchronisation signal illustrated in waveform 'B' is coupled to the input of IC2a via voltage divider R8 and R9 which protects IC2a from the sync signal which is slightly higher in potential from IC2's operating supply. IC2a inverts the line sync signal shown in waveform C and improves the transition between the logic levels. IC2b, c and d serve as a logic AND gate i.e. only when its two inputs (pins 5 AND 6) are at logic 1, will the output (pins 10 and 11) be at logic 1.

Therefore, whenever the line sync pulse is at 0V (logic 0 inverted to logic 1 by IC2a) and the output of the proportionally controlled astable is at logic 1, a pulse is applied to the gate of the SCR. This applies power to the soldering iron element in fully controlled bursts.

The combination of all sections described above results in SCR1 being gated on only near zero crossings of the mains voltage. This eliminates RFI. The on-off ratio and therefore the soldering iron temperature is proportional to the setting of the temperature control RV1.

# Temperature Controlled Soldering Iron

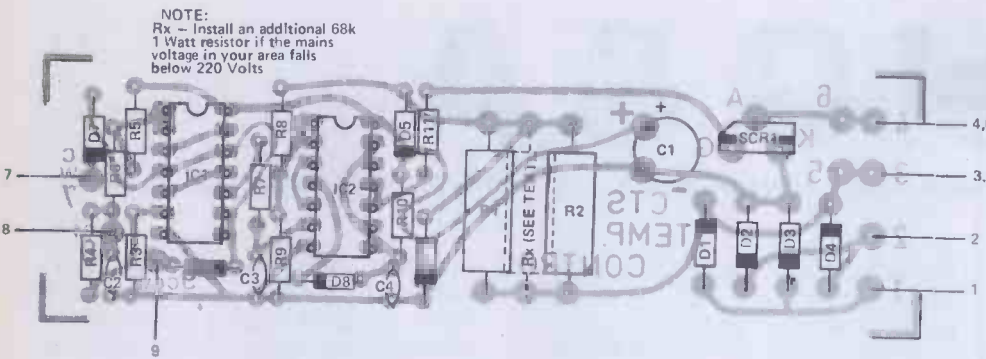


Figure 2. Overlay diagram for the Soldering Iron controller.

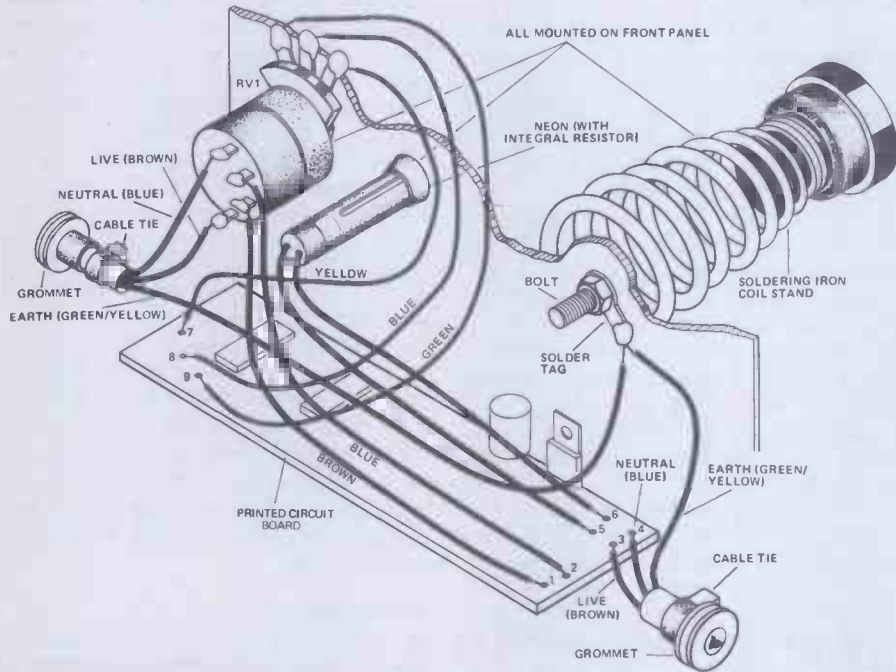


Figure 3. (Above) Wiring and interconnection diagram. To ensure safe operation you must follow this diagram closely. Remember, mains voltages are lethal!

## Warning

The circuit described here does not use an isolation transformer and therefore all sections of the circuit must be considered dangerous.

It is advisable not to operate the device without its case.

## Parts List

RESISTORS (All 1/4W, 5%, except where stated)

R1, 2, x	68k 1 watt
R3, 5	10M
R4, 6	1M0
R7, 8, 11	10k
R9	100k
R10	470k

POTENTIOMETERS

RV1	500k lin with double-pole, single-throw switch
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CAPACITORS

C1	220u 16 V printed circuit mounting electrolytic
C2	2u2 16 V tantalum
C3, 4	10n ceramic

SEMICONDUCTORS

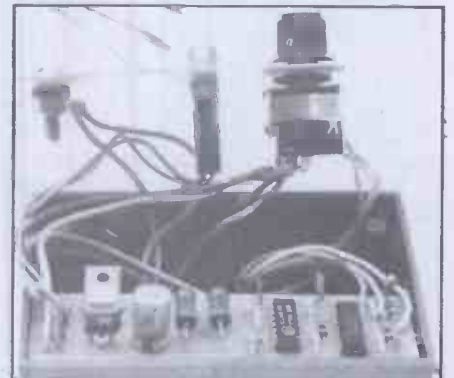
IC1	4001 quad NOR gate
IC2	4011 quad NAND gate
ZD1	15V 400 mW zener diode
D1-4	1N4004
D5-8	1N4148
SCR1	C106D

MISCELLANEOUS

- Spring mount for soldering iron
- Neon with integral resistor
- Knob for potentiometer
- Case to suit
- Grommets and cable clips
- Heavy weight (for bottom of case)

## Buylines

A complete kit for this project (including PCB, all PCB mounted components, a silk-screened case and all case components) is available from Compu-Tech Systems for £11.95, all inclusive. All you have to find is the mains plug and soldering iron. Compu-Tech will also supply the copyrighted PCB separately.  
Compu-Tech Systems  
Gaymers Way  
Laundry Loke Industrial Estate  
North Walsham  
Norfolk



HE

# O Level Q & A

Nick Walton, our tame teacher now looks at some of the units and quantities we shall be using throughout this series.

THIS MONTH we will take a look at some of the basic concepts of electricity. Once these have been established (or you have been thoroughly confused!) we will relax and consider the energy sources that help to make electricity and how that electricity gets to us by means of the National Grid.

The little beast around which it all centres is the electron, one of the three most important particles that make up the atom. The other two are the neutron and the proton and they live in the centre of the atom, called the nucleus. Everything and everybody around us is made up of atoms and there are slightly over one hundred different stable varieties; hydrogen, oxygen, copper and silicon to name but four. Of course most substances contain combinations of many different elements. Atoms are so small that approximately five million would fit across the full stop at the end of this sentence. Atoms have been thought about since ancient times but it was not till a bright New Zealander, Lord Rutherford, arrived in 1911 that they came to be regarded as tiny "solar systems" with electrons (which carry negative charge) buzzing in their orbits round a central part called the nucleus, rather like our planets move in their orbits round the Sun.

## Big and Small

The nucleus, which is about a ten thousandth the diameter of the atom, contains protons which carry a positive charge and neutrons which do not carry any charge at all, together with various other subatomic particles we need not worry about. So, for example, the carbon atom illustrated in Figure 1 has six electrons round the nucleus which itself contains six protons (whose six positive charges balance the negative charges of the six electrons) tucked together with six neutrons.

Relative sizes when playing with atoms can sometimes be a bit mind-bending. For instance, if we look at it the other way round and magnify our nucleus up to the size of a full stop, then the atom will be five metres across, (i.e. about ten thousand full stop diameters) and our original full stop, which if you remember was five million atoms across, will now have

grown to a blob twenty five million metres across; this is twenty five thousand kilometres across, or approximately twice the diameter of the earth and rather a lot of printing ink!

## The Coulomb

In fact for electrical purposes all we are concerned with is the electron and the negative charge it carries. Charge is measured in units called coulombs (named after a French scientist) and one coulomb is the charge of about six million million million electrons. This can be written as  $6 \times 10^{18}$  electrons. When electrons start to flow in an electrical circuit we get a current. It is measured in amps or amperes (named after another French scientist, Monsieur Ampère, the archtypal absent-minded professor. He once forgot a dinner date with the Emperor Napoleon — and got away with it; his father was guillotined during the French Revolution).

If those units are too big you can always subdivide amps into thousandths and call them milliamps (nothing to do with Ampère's daughter) or mA for short. If you could sit in the wire and watch the electrons going past, then a coulomb's worth of electrons (i.e.  $6 \times 10^{18}$  of them) passing you every second would constitute a current of one amp.

## The Volt

Our next problem is to consider what is pushing this charge round the circuit. Whatever it is that causes this to flow is measured in volts (named after Volta, an Italian scientist). If it is a battery then the term electromotive force can be used (though strictly it is not a force in the purely scientific sense). We might for instance talk of a battery having an electromotive force (or EMF for short) of 9 volts, this being the total voltage it can offer. Note that a voltage can be present even when there is no flow of charge — a battery has an EMF of 9 volts even when it is not connected to a circuit. As the voltage is *potentially* available to push charge around, the word "potential" has come to mean voltage, and we can refer to the difference in voltage between parts of the circuit as a "potential difference".

Volts pushing charge round a circuit implies that the charge has been given some energy. Energy is measured in joules (named after an English scientist this time: a Manchester brewer in fact who is reputed to have spent his honeymoon, well some of it, measuring the temperature difference between the water at the top and the bottom of waterfalls in Switzerland). The more joules you supply to your coulombs of electricity (or they supply to you) the greater the voltage, or in other words the greater the quantity of joules per coulomb. Incidentally the units of your electricity bill (which are in fact kilowatt-hours) are no more and no less than units of energy — lumps of 3,600,000 joules at a time.

While on the subject of British scientists, we should not forget our Scottish friend James Watt who did great things with steam engines. He gave his name to the unit of power which is the rate at which energy is being used up or provided. Thus a watt refers to one joule being used every second (1 joule per second).

## Summary

If all that was new to you and you got it first time, you're either a genius or you're kidding yourself. Anyway, let's summarise it.

Units of electric charge are coulombs. 1 coulomb is the charge of about  $6 \times 10^{18}$  electrons.

Units of current are amperes, amps or milliamps. 1 amp is the flow of 1 coulomb of electric charge per second.

Units of voltage are volts (Surprise!) 1 volt is 1 joule per coulomb.

Units of energy are joules (or kilowatt-hours. 1 kWh = 3,600,000 joules).

Units of power are joules per second. 1 watt is 1 joule per second.

Battery voltage (total) can be described as electromotive force (EMF).

Voltage between two points can be described as potential difference (PD).

## AC/DC

Having now established the idea of a steady voltage driving a steady current, we need to be aware of the existence of a commonly occurring form of voltage that is by no means steady. This is called alternating voltage (giv-

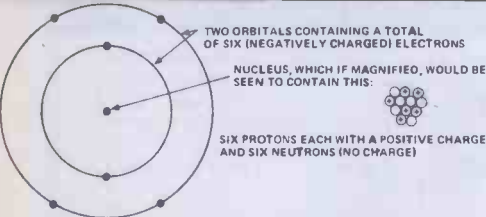


Figure 1. Simplified structure of a carbon atom showing the positions of the electron orbitals and nucleus.

ing rise to alternating current or AC and we have all met it in the form of our 240 volt mains supply (not literally I hope!) This rises smoothly from zero to a peak of about 340 volts and then drops again to zero and goes on dropping till it reaches -340 volts at which point it smoothly turns round and comes back to zero. This cycle is repeated fifty times every second which is why we talk about mains frequency being 50 cycles per second, or 50 Hertz or Hz (a German scientist this time, who discovered radio waves). All this to and fro motion gives out the same amount of energy as we would get from 240 volts direct which is where the figure of 240 comes from.

### Power Problems

Our coal resources are not going to last forever - I have seen estimates which range from 100 to 300 years and


oil is going to run out during the lifetimes of most of us. Estimates range from 15 years if you are a pessimist to about 30 if you are an optimist. Whatever your personal feelings about nuclear power, the fact is that it is the only form of energy capable of fulfilling our expanding needs. The technology exists and so do the risks and unless a series of governments take active steps to fund research into alternative sources at a scale that can meet our needs, the more certain it will become that you will be powering your HE project or home computer from electricity generated by energy unlocked from that little nucleus I mentioned at the beginning.

Other forms are interesting and promising. Solar energy in its present form can help us reduce our hot water bills but no sane person in this country seriously reckons it can do more than make a small contribution. Then again there is wind power; windmill sails or rather propellers could well enjoy a comeback and waves and tidal energy may help too. Areas in Italy, Iceland and New Zealand are fortunate in being able to tap energy from naturally occurring steam, but these are just not


capable of supplying energy in the required quantities.

Supposing we do solve our energy problems we will still need power stations and the huge network of pylons to distribute all the power they produce. This network is known as the National Grid and it carries electricity at very high voltages (132,000 volts, i.e. 132 kV is typical). The reason for the high voltage is that the electrical power is multiplied by the current. So a high voltage allows you to get away with having a small current, and it is the size of the current which determines how much power is wasted in heating up the transmission lines. Actually the power wasted depends on the square of the current, so for instance, if you could reduce the current to a third of its original value you would have reduced the wasted power to a ninth.


So much for the difficult stuff; but don't forget it as we shall be needing it over and over again. Next month it will be resistors and capacitors and meters which hopefully will bring us a little nearer to the real world of HE projects. Meanwhile happy soldering and keep thinking! HE




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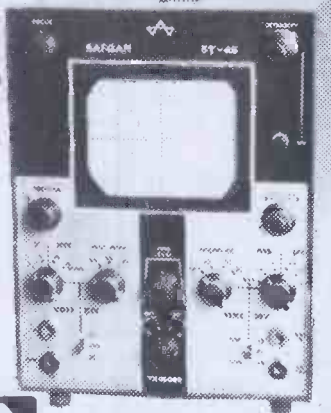
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# AND THERE'S MORE WHERE THIS CAME FROM

It's a long time since one of our adverts was presented in 'list' form - but simply because we do not try to squeeze this lot in every time doesn't mean that it's not available. Our new style price list (now some 40 pages long) includes all this and more, including quantity prices and a brief description. The kits, modules and specialized RF components - such as TOKO coils, filters etc. are covered in the general price list - so send now for a free copy (with an SAE please). Part 4 of the catalogue is due out now (incorporating a revised version of pt.1).

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4021	0.82
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4024	0.76
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7400N	0.13	7445N	1.12	74LS113	0.38	74LS170N	2.00
74LS00	0.20	7446N	0.94	74LS114	0.38	74LS171	2.30
7401N	0.13	74LS47	0.89	74LS118N	0.83	74LS174	1.20
74LS01	0.20	7448N	0.56	74LS120N	1.15	74LS175	1.10
7402N	0.14	74LS48	0.99	74LS121N	0.42	74LS177N	0.75
74LS02	0.20	74LS49	0.99	74LS122N	0.46	74LS181N	1.65
7403N	0.14	74LS51	0.17	74LS124	1.75	74LS181	3.50
74LS03	0.20	74LS51	0.24	74LS125N	0.38	74LS183	2.10
7404N	0.14	74LS51	0.17	74LS125	0.44	74LS184N	1.35
74LS04	0.24	74LS49	0.17	74LS126N	0.57	74LS185N	1.34
7405N	0.18	74LS54	0.24	74LS126	0.44	74LS190	0.92
74LS05	0.26	74LS55	0.24	74LS128N	0.74	74LS192	1.05
7406N	0.28	7460N	0.17	74LS128	0.73	74LS193	1.80
7407N	0.38	74LS63	1.24	74LS132	0.78	74LS194	1.05
7408N	0.17	7470N	0.28	74LS136	0.40	74LS196	1.10
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7409N	0.17	7473N	0.32	74LS141N	0.56	74LS199	1.10
74LS09	0.24	7474N	0.28	74LS142N	2.65	74LS199	1.10
7410N	0.15	7475N	0.28	74LS143N	3.12	74LS199	1.10
74LS10	0.24	74LS74	0.28	74LS144N	3.12	74LS199	1.10
7411N	0.20	7475N	0.38	74LS145	0.97	74LS199	1.10
74LS11	0.24	7476N	0.37	74LS147N	1.75	74LS199	1.60
74LS12	0.20	74LS76	0.38	74LS148N	1.09	74LS247	0.93
7412N	0.17	74LS78	0.38	74LS148	1.19	74LS257	1.08
7413N	0.30	74LS78	0.38	74LS150N	0.99	74LS260	1.53
7414N	0.51	7480N	0.48	74LS151N	0.55	74LS279	0.52
74LS15	0.24	7481N	0.86	74LS151	0.84	74LS283	1.20
7416N	0.30	7482N	0.69	74LS152N	0.64	74LS293	0.95
7417N	0.30	7485N	1.04	74LS153	0.54	74LS365	0.49
7420N	0.16	74LS85	0.99	74LS154	0.96	74LS367	0.43
74LS20	0.24	74LS86	0.40	74LS154N	0.96	74LS368	0.49
7421N	0.29	7489N	2.05	74LS155	1.10	74LS374	1.80
74LS21	0.24	7490N	0.33	74LS155N	1.10	74LS377	1.95
7423N	0.27	74LS90	0.90	74LS156N	0.80	74LS379	1.30
7425N	0.27	7491N	0.76	74LS157	0.67	74LS393	1.40
7427N	0.27	74LS91	1.10	74LS157	0.55		
74LS27	0.44	7492N	0.38	74LS158	0.60		
7428N	0.35	74LS92	0.78	74LS159N	2.10		
74LS28	0.32	7493N	0.32	74LS160N	0.82		
7430N	0.17	74LS93	0.99	74LS160	1.30		
74LS30	0.24	7494N	0.78	74LS161N	0.92		
7432N	0.25	7495N	0.65	74LS161	0.78		
74LS32	0.24	74LS95	1.14	74LS162	1.30		
7437N	0.40	7496N	0.58	74LS163	0.78		
7438N	0.33	74LS96	1.20	74LS163	0.92		
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7440N	0.17	74LS107	0.38	74LS164	1.30		
74LS40	0.24	74109N	0.63	74LS165N	1.05		
7441N	0.74	74LS109	0.70	74LS165	1.50		
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4050	0.55
4051	0.65
4052	0.65
4053	0.65
4063	1.09
4066	0.56
4068	0.25
4069	0.20
4070	0.20
4071	0.20
4072	0.20
4073	0.20
4075	0.20
4076	0.90
4077	0.20
4078	0.20
4082	0.20
4093	0.78
4175	0.95
4503	0.69
4506	0.51
4510	0.99
4511	1.49
4512	0.98
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4529	1.41
4539	1.10
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# Talking Design

**Pulse Width Modulation is a phrase you'll be hearing more and more. This important control technique looks set to revolutionise digital electronics.**

THIS MONTH we are going to delve into the realms of digital control. The particular technique involved is pulse width modulation. This technique is likely to become more and more common in audio amplification and power supplies, especially now that high speed switching devices are becoming widely available.

To understand the principle, look at the simple circuit of Fig. 1d. Here a transistor, used in the common emitter mode, has a square wave of equal mark space ratio as an input. The transistor is in saturation or cut off for equal periods, so the average voltage at the collector, as measured with a multimeter will be half the supply voltage (Fig. 1a). If the mark to space ratio is increased as in Fig. 1b then the average voltage will rise. Conversely if the mark to space ratio is decreased (Fig. 1c) then the output voltage will fall. Taken to extremes the transistor would be either in saturation or cut off for the whole time and the output voltage would either be zero or supply voltage.

Well, you say, so what? The simple answer is that, unlike an analogue design, a current can be delivered to a load with hardly any power loss or dissipation in the driving device. For instance, look back to the circuit of Fig. 1 and assume that we have a supply voltage of 9 V and a collector resistance  $R_C$  of 100 $\Omega$ . To maintain a voltage of 4.5V across this resistor there must be a current flow of 45 mA. The power dissipated in the transistor and the resistor is found by multiplying the voltage drop by the current flowing. In this case  $4.5 \text{ V} \times 4.5 \times 10^{-2} \text{ A} = 0.2025 \text{ W}$ . In the switching circuit a 1:1 mark space ratio square wave would be used to set the required voltage across the resistor. Ideally the voltage drop across the transistor would be zero when it was in saturation, and the current through  $R_C$  is then  $9 \text{ V} \div 100\Omega = 90 \text{ mA}$ . So the power dissipated would be  $V \times I$ , i.e.  $0 \text{ V} \times 90 \text{ mA}$ , zero! When the transistor is cut off the full supply voltage would appear across it and the power dissipation would again be equal to  $V \times I$ ,  $9 \text{ V} \times 0$

mA, again zero! In reality there will always be a small saturation voltage across the transistor of a few hundred millivolts, and even when the transistor is cut off there will still be a small leakage current flowing, although this will only be in the order of a few microamps.

Although transistors are imperfect devices, you can see that the square wave circuit is many times more efficient than an analogue one.

## Square Waves

Before the idea can be used practically, a means must be found of generating a square wave with an easily adjustable mark space ratio. A simple method of doing this is to feed a triangle wave of

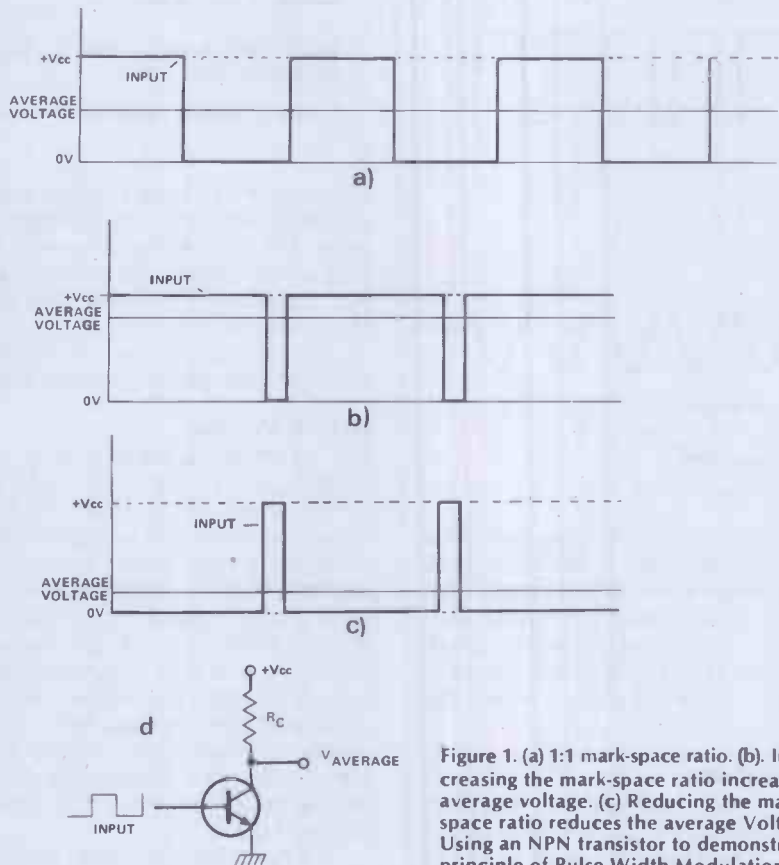
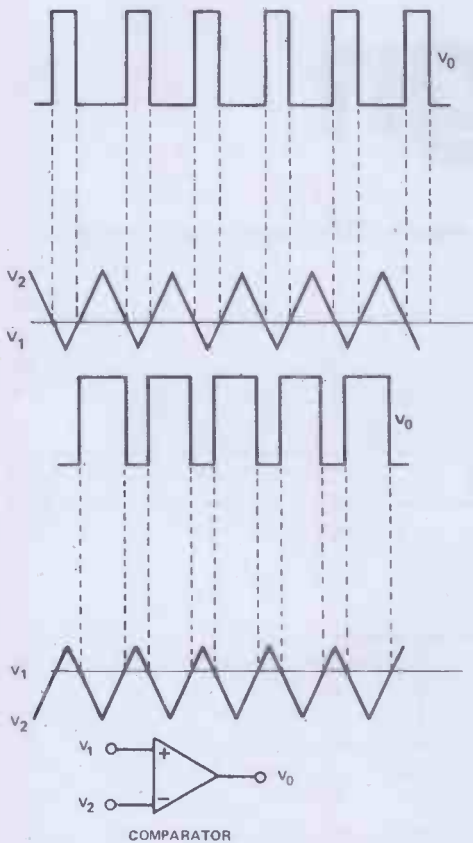


Figure 1. (a) 1:1 mark-space ratio. (b) Increasing the mark-space ratio increases the average voltage. (c) Reducing the mark-space ratio reduces the average voltage. (d) Using an NPN transistor to demonstrate the principle of Pulse Width Modulation.

known amplitude into one input of a comparator, and a control voltage into the other. For those unfamiliar with comparators, a quick description is probably in order. A comparator has two inputs, an inverting and a non-inverting, like an op amp. It also has a high voltage gain but unlike an op amp is operated without negative feedback. It functions as a switch — the output is at zero potential when the non-inverting input is more negative than the inverting while the output is fully positive when the non-inverting input is more positive than the inverting one. Because the gain of the comparator is very high a voltage difference of a few millivolts at the inputs will be sufficient to ensure switching. Comparators, as the name im-



plies, are used for detecting and comparing voltage levels. If one input is fed with a triangle wave and the other with a variable voltage level the output consists of a square wave whose mark space ratio depends upon the voltage at the input. Figure 2 should make this clear.

### Practicalities

The practical application is shown in Fig. 3, a pulse width modulator that will deliver in excess of one amp to a load (such as a motor or lamp) that can be simply adjusted by a control voltage.

The circuit is an excellent power saving device with an efficiency of 90% and is ideally suited to battery operated equipment.

To keep the circuit simple whilst providing maximum flexibility, a low cost quad op amp is used as the active device. The type chosen, the LM324, contains four op amps that are similar to the good old 741 but with the advantage that the output can go down to ground even when operated from a single supply voltage.

IC1a is used as an astable multivibrator that produces a 1:1 mark space square wave at its output. These are input to an integrator, which converts the square wave into a linear triangle wave suitable for the pulse width modulator, IC1c. IC1c is used as a

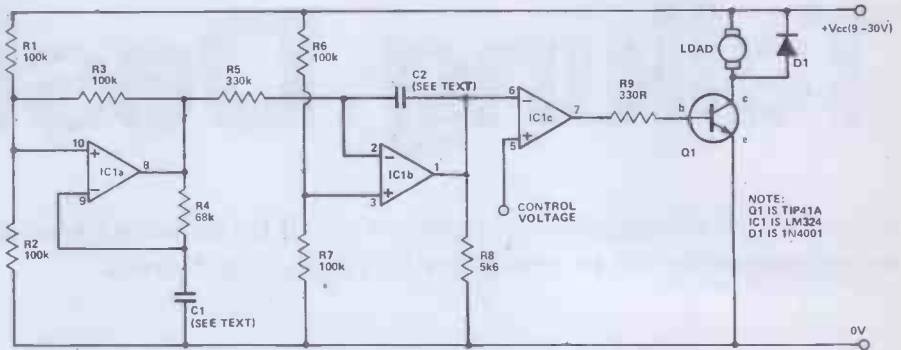


Figure 2. (left) Using a comparator to produce square wave from a triangle wave and a variable DC level.

Figure 3. (above) A practical circuit using Pulse Width Modulation to control a motor.

comparator with the triangle wave at one input and the control voltage at the other. The resulting square waves at the output of IC1c are used to drive the output transistor, a TIP41A which is used in the common emitter mode.

Having outlined the circuit we can consider its operation in more detail.

### How It Works

The non-inverting input of IC1a is connected to the junction of R1, R2 and R3. IC1a is being used as a comparator and its output must either be high or low.

When power is first applied C1 is discharged. Thus the voltage at the inverting input is held lower than that of the non-inverting input, and the output of the op amp is at supply voltage. C1 starts to charge up via R4 and when the voltage at the inverting input exceeds that at non-inverting input the output of the op amp goes down to 0 V. Now C1 discharges through R4 and the op amp's output stage.

The non-inverting output is held at a potential that depends on the values of R1, 2 and 3. When the output is high R1 and R3 are effectively in parallel whilst when the output is low R2 and R3 are in parallel. Since R3 is connected from the output to the non-inverting input a positive feedback loop is obtained. In practice this ensures that the output of the op amp changes from high to low state and vice versa very rapidly. If all three are made equal in value then the potential at the non-inverting input will oscillate between 1/3rd and 2/3rds of the supply voltage.

The frequency at which the circuit runs is determined by the values of R4 and C1 and can be calculated from the formula

$$f = \frac{1}{1.4 R4 C1}$$

To operate small motors and lamps from the pulse width modulator the actual frequency employed is not critical. The lower limit for reliable operation seems to be 100Hz. At the upper end this particular circuit is limited by the rate at which the output of the op amp can change. This is known as the slew rate and you will find it quoted on op amp data sheets. For the LM324 the slew rate is 0.5 V/microsecond. Another measure of this same effect is the full power bandwidth, also quoted in data sheets. For the 324 this is 6kHz. Within these limits the values of R4 and C1 can be whatever happens to be at hand. In the prototype an operating frequency of 1kHz was chosen. A 10nF capacitor was available for C1 and so the equation was rearranged thus

$$R4 = \frac{1}{1.4 f C1} = 1 \div (1.4 \times 10^3 \times 10^{-8})$$

68k is the nearest value.

Our square wave must now be converted into a triangle wave by a circuit known as an integrator. The output of this circuit is directly proportional to the integral of the input. The integral of a square wave is a linear triangle wave. A positive voltage level at the integrator's input produces a negative ramp at the output. If a negative voltage level is input, a positive-going ramp comes out. Since our square wave consists of alternate high and low levels the triangle wave at the output will resemble that shown as V<sub>2</sub> in Fig. 2. To calculate the values that we require for R5 and C2 we use the following formula,

$$V_0 = \frac{V_{cc}}{4RCf}$$

Again a large range of values can be employed and by simply rearranging the equation one can easily calculate the required values. An example of the procedure follows. To get a large adjust-



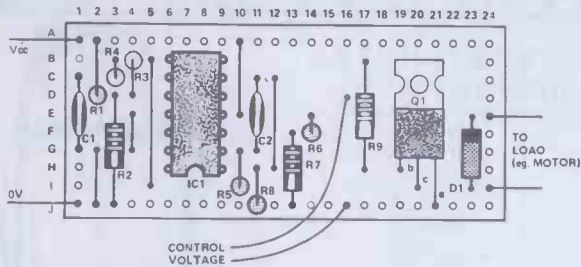


Figure 4. Veroboard layout for the circuit in Figure 3.

ment range a fairly large signal swing is required. Assuming that the circuit will be employed over a range of supply voltages it is necessary to ensure that an undistorted and unclipped signal is available. For this reason a peak-to-peak voltage of 7 V was chosen and the required component values were calculated as follows. Choose an arbitrary value for C2, say 100nF. The value of R5 can be calculated by rearranging the above equation thus:

$$R = \frac{V_{cc}}{4V_0 C_f}$$

$$= \frac{9}{4 \times 7 \times 10^{-7} \times 10^{-9}} = 3 \cdot 2 \times 10^5$$

The nearest value is 330k.

Note that 9 V was taken for the supply voltage. This calculation does not need to be repeated for other voltages as the amplitude of the triangle wave will be in direct proportion to the supply voltage used.

The last part of the circuit is built around IC1c. This is the pulse width modulator proper and its function has already been described. The output square wave drives the power transistor, a TIP41A. Base current is limited by R9.

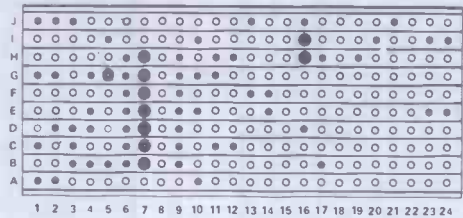
D1 is included to protect Q1. When a current is fed into an inductive load, for instance, a motor winding, energy is stored in the magnetic field that builds up around the wire. When the supply is interrupted the field collapses and as it does so the magnetic flux produces a

large reverse polarity voltage spike.

This spike can have sufficient amplitude to destroy the driving transistor. The diode will short any such spikes to the positive rail thus protecting the transistor. If you glance through any projects in HE where transistors are used to drive relays, for example, you will notice this feature has been included.

## Layout

A simple stripboard layout for the circuit is given in Fig. 4. The TIP41A does not require a heatsink. As it stands the circuit has many applications. A typical application would be a model train speed controller. HE



### TRIACS

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12.0-12V	0.2" Green	12p
	0.2" Yellow	12p
	0.2" clips	3p
	Rectangular Red	11p
	Rectangular Green	20p
	Rectangular Yellow	21p

### MINI KITS

These kits form useful subsystems which may be incorporated into larger designs or used alone. Kits include PCB, short instructions and all components.

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### D.V.M. THERMOMETER KIT

Based on the ICL 7106. This kit contains a PCB, resistors, presets, capacitors, diodes, IC and 0.5" liquid crystal display. Components are also included to enable the basic DVM kit to be modified to a Digital Thermometer using a single diode as the sensor. Requires a 3mA 9V supply (PP3 battery). £20.75

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### INTEGRATED CIRCUITS

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741 Op Amp	10p
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AY-3-1270 Thermometer	£8.20
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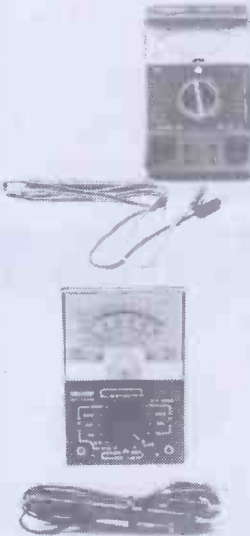


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# Intruder Alarm

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CONVENTIONAL BURGLAR alarm circuits show up in electronics magazines with disturbing regularity — we say disturbing because it's a sad reflection on the state of society that such projects are made popular by necessity. Generally these circuits involve concealed switches in doors and windows which can be connected in one of two ways — all of them wired in series and normally closed, so that opening one switch breaks a circuit and sounds the alarm, or all of them wired in parallel and normally open, so that closing one switch completes a circuit and sounds the alarm. It is also possible to mix the two systems, for example you could have normally-closed switches on the doors and windows combined with normally-open switches in the form of pressure mats under the carpets.

The problem with such systems is that, although they will deter (or trap) the amateur housebreaker or the kids looking for cash and kicks, a professional burglar is quite another matter. The normally-closed switch system can be disabled by shorting the wires, and the normally-open by cutting them. A professional could have the knowledge and experience to make a guess about your system and risk tampering with it. Three courses of action are possible. You can make it impossible for anyone to get at the wires by burying them in the plaster or running them under the floorboards — this requires lots of hard work and extensive redecoration. Or you can opt for a different system altogether, using infra-red beams or ultrasonic movement detectors, but these are more expensive and more complex, and complex burglar alarms have a nasty habit of giving a high proportion of false alarms.

The third possibility is to devise a circuit in which the wires are tamper-proof. This is the approach we have used in our latest design.

This burglar alarm is based on a window comparator. Note that this is not a device that compares open windows with closed ones! In its basic form a window comparator is a device whose output is in one logic state unless the voltage it is monitoring moves outside certain limits (the 'window'), in which case its output changes state. The window comparator in our circuit is slightly more complex than this, as we need to indicate whether the input voltage is above or below the 'window' in the event of an alarm.

The external wiring of the alarm is made as follows. Each protected point has a concealed switch fitted which is normally closed, and each switch has a resistor soldered in series. Each of these switch/resistor combinations is then wired in parallel with the others. Figure 1 should make this clear. The total resistance of this chain is therefore equal to the parallel sum of the individual resistors, and this value is used in one arm of a potential divider that is monitored by the window comparator. Any change in the value of this resistor chain will trigger the window comparator and set off the alarm.

This solves the problem of tampering with the wiring. If a door or window is opened the corresponding resistor is taken out of circuit and the alarm sounds, as it will if the wires are cut, or a short or resistance of any value connected between them. This means the wiring can be run anywhere in complete safety, even along the outside wall of the building if you want. It also

allows you some flexibility in use — since the threshold can be adjusted with a potentiometer, you can leave a protected window open (on a hot night for example) and alter the setting to allow for the changed circuit resistance. An 'alarm' LED is included in the circuit so that you can make these setting-up adjustments without the bell or siren going off — this avoids the need to assist several large members of the constabulary with their enquiries.

Burglar alarms should always be battery-powered, as power cuts provide good cover for those with nasty intentions towards your belongings, so we've used a new CMOS op amp, the ICL7611. This only draws 10 microamps quiescent current, less than that through the resistor chain, so your PP3 should last for months. The external alarm should also be battery powered, preferably a high-capacity, heavy-duty type. A mechanical bell is probably still the best choice for an alarm — being resonant it can produce vast quantities of decibels with only a small current drain. You might consider making the bell circuit self-latching, so it rings for a long time even if the PP3 gets drained by the relay. This is left as an exercise for the reader!

## Construction

Nothing unusual here; the controls and the LEDs fit on the front panel and everything else fits on the printed circuit board. Use sockets for the ICs and don't touch the pins of any of them when inserting them — the op amps are CMOS and therefore static-sensitive too. If you can't find a relay whose pins fit the PCB, just mount it off the board and wire it to the pads. We made the external connection via a jackplug and

socket, as shown in Fig. 3, but if you're worried about the plug being pulled out you can make a direct solder connection to the board.

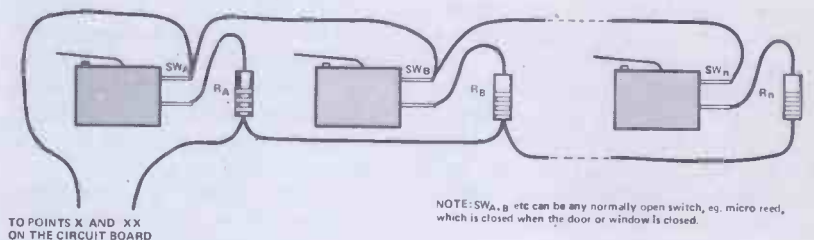
It is possible to use microswitches in the alarm circuit but we aren't that keen on them — they are prone to give false alarms if the door vibrates in a strong wind or if the woodwork warps. Reed switches are a better bet, mounted in the doorframe with the magnet let into the door.

The resistors associated with the switches should be of equal values — the correct value depends on the number of switches and is chosen to give a total parallel resistance of about 50k. For example, if you have 12 switches each resistor must be about  $12 \times 50k$  i.e. 600k. The nearest preferred value is 620k. Solder the resistor close to one of the switch terminals. It might be an idea to sheath it in heat shrink sleeving for protection (see this month's Building Site for details).

To set up, close all the doors and windows that you want closed, disable the relay, switch on the unit and adjust RV1 until the alarm LED stays off when the reset button is pushed. Then switch the relay back in.

Some final points about protection against theft; a burglar alarm is no substitute for proper locks on your doors and windows, nor for forgetting to lock up when you 'just pop round the corner'!

Figure 1. This drawing shows how the resistors and alarm switches are wired in the external circuit, one pair for each protected door and window. You can use any convenient twin-core cable (e.g. speaker cable) and loop it from one installation to the next. We have shown the switches as microswitches (easier to draw!) but reed switches and magnets are probably more reliable. Resistors  $R_A$  to  $R_n$  should all have the same value; see text for details of how to calculate the values.



## How it Works

IC1 and IC2 are two op amps with no feedback connection between output and input i.e. they function as comparators (for more information on comparators, see this month's 'Talking Design' feature). In this circuit the two comparators are connected together to form a window comparator, one to monitor the upper limit of the window and one for the lower limit.

The reference voltages for IC1 and IC2 are applied to pin 3 (non-inverting input) and are set by resistors R1, R2 and R3. R1 and R3 are equal and have large values compared to R2 so the reference voltages are approximately at half the supply level. R2 sets the reference voltage for IC1 and IC2 slightly above and slightly below half-supply voltage respectively. The monitored voltage is fed to pin 2 of the two ICs.

This input voltage is taken from point XX of a divider chain consisting of RV1 and the resistors associated with the door and window switches (see Fig. 1). When all the switches are closed, the resistors are connected in parallel and the total resistance is therefore given by  $R = R_A/n$  where n is the number of resistors and  $R_A$  is the value of each resistor in Fig. 1 (all equal). If RV1 is now adjusted to equal this resistance, the voltage at point XX will be half the supply voltage (i.e. inside the window). Hence the output of IC1 will be high and the output of IC2 will be low.

The outputs of the two comparators are taken directly to the inputs of NAND gate IC3a, and to the inputs of IC3b, another NAND gate, via inverters IC4a, IC4b. Both NAND gates have one

input high and the other low, so both their outputs are high. This holds LEDs 1 and 2 off.

Suppose a door or window switch is now opened or the alarm wiring cut. The corresponding resistor will now be out of circuit and the total resistance of the external chain increases. This causes the voltage at point XX to drop below the lower window threshold and the output of IC2 goes high. This has no effect on the state of IC3b since its inputs will both be low, maintaining its high output. However, both inputs of IC3a will be high and its output switches low, turning on LED1 to indicate an open door.

However, if the external wiring is shorted at any point, the voltage at point XX is taken above the upper threshold and IC1 output goes low. IC3a is now unaffected (both inputs low) but IC3b will have both its inputs high. Its output goes low and turns on LED2, indicating a short.

The two remaining NAND gates IC3c and IC3d are connected as a set-reset latch. Normally its 'set' input is held high by R6. If either IC3a or IC3b goes low, the associated diode (D1 or D2) pulls this input low and sets the latch (pin 11 goes high). The outputs of the inverters IC4c-IC4f go low and turn on LED3 (alarm indicator) and the relay. The inverters are connected in parallel to increase their drive capability. Pressing PB1 resets the latch and turns off the alarm.

The relay contacts may be used to operate any external bell, siren etc. SW1 is included to disable the external alarm while setting up the threshold control. D3 prevents any voltage spikes from the relay damaging LED3.

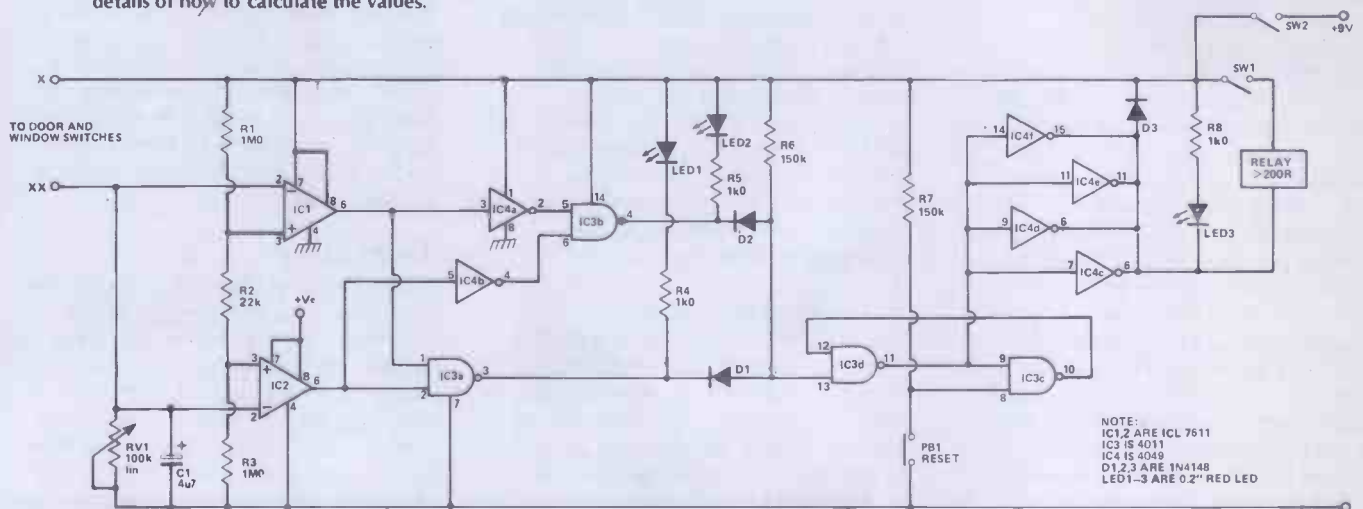
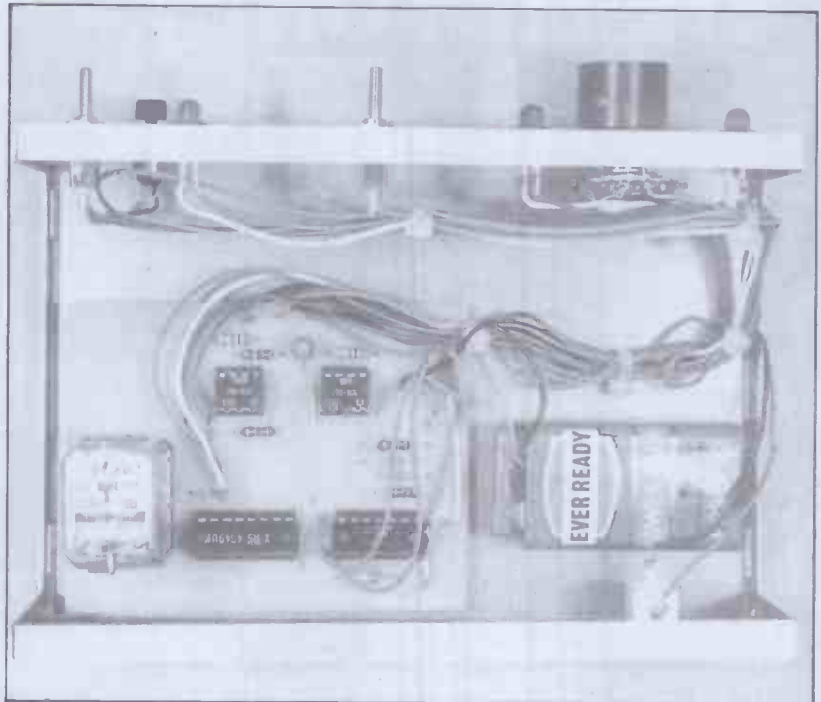


Figure 2. Circuit diagram of the Intruder Alarm showing the components contained in the main control box. Points X and XX are connected to the door and window switches as shown in Figure 1.

## Buylines

The components for this project, excluding case and PCB will amount to around £10. The window and door switches will cost extra and their total price will depend upon how many and what types you use — we estimate that micro-switches should be available for about £1 each, reed switches and magnets should be somewhat cheaper — shop around, you will probably find a great deal of difference from one place to another.

The only hard-to-come-by components may be IC1 and 2. They are from a new family of integrated circuits and at the moment may be slightly difficult to find. Any of the mail-order companies will, no doubt, advise you if you have trouble.



Photograph showing the internal layout of the Intruder Alarm control box. Follow the interwiring diagram (Figure 3) and you should have no problems. Cable ties keep the wiring neat and tidy.

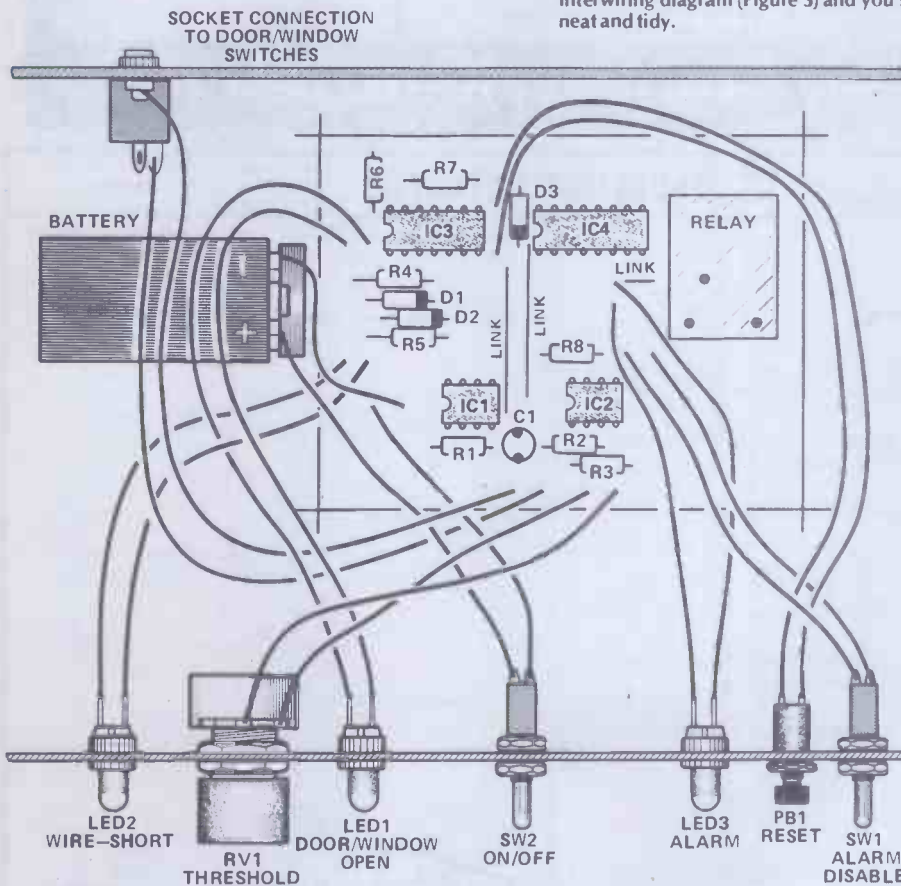


Figure 3. Component overlay and interwiring diagram for the main control box, showing the controls fixed to the front panel and the input jack socket on the back panel. If you think a jack plug might get pulled out, you can leave it out and solder the wires from the alarm switches directly to the printed circuit board.

## Parts List

### RESISTORS (all 1/4 W, 5%)

R1,3	1M0
R2	22k
R4,5,8	1k0
R6,7	150k
R <sub>A</sub> -R <sub>n</sub>	see text

### POTENTIOMETERS

RV1	100k linear
-----	-------------

### CAPACITORS

C1	4u7 35 V tantalum
----	-------------------

### SEMICONDUCTORS

IC1,2	ICL7611
IC3	4011
IC4	4049
D1-3	1N4148
LED1-3	0.2" red LED

### MISCELLANEOUS

PB1	Push switch (non-locking)
SW1,2	Single-pole single-throw toggle
Relay	Coil > 200R
PCB	
Case	
	9 V battery and connector.

# STEVENSON

### REGULATORS

78L05	33p
78L12	33p
78L15	33p
7905	85p
7912	85p
7915	85p
TIC246 16A 400V Triac	115p
C106D 4A 400V 50 SCR	45p

### SPEAKERS

64mm 8 $\Omega$	110p
64mm 64 $\Omega$	110p
70mm 8 $\Omega$	140p
70mm 80 $\Omega$	170p
56mm 8 $\Omega$	100p
Pair of ultrasonic transducers	380p
Magnetic earphone + 3.5mm plug	17p
Crystal earphone + 3.5mm plug	48p

### POTENTIOMETERS

Preset ver. or hor.	8p
Rotary 5K-1M Log or Lin	33p
Rotary 5K-1M stereo	110p
Slide 60mm travel 5K-500K log or Lin, single	65p

Suitable knobs for above with coloured caps in red, blue, green, grey, yellow and black. Rotary 16p, Slide 12p each.

### CONNECTORS

Chassis Socket	Line Socket
DIN	Plug
2 pin	9p
3 pin	12p
5 pin 180	11p
JACK	Plug
2.5mm	10p
3.5mm	11p
std.	17p
Stereo	25p
Scr. plug	39p
Socket	9p
	12p
	14p
	16p

### MISC.

8mm stranded conn. cable	30p
Min. mains cable per metre	25p
PP3 battery clips	6p
Crocodile clips	6p
AA rechargeable cells	145p
PP3 rechargeable cells	495p
Red or black terminals	30p
3 lead TO18 socket	15p
Red or amber neon indicator	42p
Subminiature SPST toggle	65p
Standard SPST toggle	40p
Miniature slide switches	16p
IP12W rotary switches	52p
Push to make switches	16p
TO5 heatsinks	12p
20mm panel fuseholders	22p
ORP12 LDR	70p
3.75 x 5 0.1 veroboard	99p
2.5 x 1 0.1 veroboard	21p
3 x 2 x 1 aluminium box	82p
6 x 4 x 2 aluminium box	99p
Miniature 606, 909 transformer	110p
TIL111 optoisolator	80p
4 self adhesive feet	20p
SFB Soldering iron	430p
Desoldering tool	550p

### TRANSISTORS

AC127	25p	BC547	8p
AC128	25p	BCY71	18p
AD162	40p	BD131	35p
BC107	10p	BD132	35p
BC108	10p	BD139	35p
BC109	10p	BD140	35p
BC147	9p	BFX29	25p
BC178	16p	BFX84	26p
BC182	10p	BFY50	23p
BC182L	10p	BFY51	23p
BC184	10p	MJ2955	98p
BC184L	10p	TIP29C	60p
BC212	10p		
BC212L	10p		
BC214	10p		
BC214L	10p		
TIP30C	70p		
TIP2955	65p		
TIP3055	60p		
ZTX107	12p		
ZTX108	12p		
ZTX109	12p		
ZTX300	14p		
ZTX500	15p		
2N3053	25p		
2N3055	55p		
2N3702	9p		
2N3703	9p		
2N3704	9p		
2N3819	22p		
2N3905	10p		
2N5777	50p		

### CMOS

4001	25p	4025	25p	4072	25p
4002	25p	4026	50p	4081	30p
4006	95p	4027	50p	4082	30p
4007	25p	4028	90p	4085	85p
4011	30p	4029	110p	4093	80p
4013	45p	4040	110p	4095	110p
4015	85p	4042	85p	4510	90p
4016	48p	4046	110p	4511	100p
4017	80p	4048	60p	4518	90p
4020	110p	4050	50p	4520	110p
4022	100p	4052	80p	4527	165p
4023	25p	4054	50p	4532	125p
4024	60p	4066	63p	4543	170p
		4068	25p	4583	80p
		4069	25p	4585	115p
		4070	25p		
		4071	25p		

### DIODES

1N914	4p	1N4148	3p
1N4001	4p	1N4002	5p
1N4006	7p	1N5401	14p
BZ Y88 series	8p each		

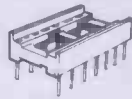
### LINEAR

LM374	52p	MM57160	650p
LM339	55p	NE631	140p
LM348	100p	NE555	23p
LM377	170p	NE556	60p
LM378	230p	NE567	120p
LM380	80p	RC4136	100p
LM381	140p	SN76477	230p
LM382	120p	TBA800	80p
LM386	90p	TBA810	110p
LM387	120p	TDA1022	630p
LM1458	40p	TLO81	45p
LM1830	180p	TLO82	85p
LM3900	60p	TLO84	125p
LM3909	72p	XR2206	390p
LM3911	120p	ZN414	80p
LM3914	30p	ZN425E	475p
LM3915	320p		

### SKTS

8 pin	9p	22pin	20p
14pin	11p	24pin	22p
16pin	12p	28pin	26p
18pin	16p	40pin	38p
20pin	18p		

Low Profile Texas



### OPTO

Red	0.125in.	0.2in.	
Green	TIL209	TIL220	10p
Yellow	TIL211	TIL221	16p
Clips	TIL213	TIL223	16p
			3p
DL704	0.3in	CC	130p
DL707	0.3in	CA	130p
FND500	0.5in	CC	100p

### CAPACITORS

TANTALUM BEAD

0.1, 0.15, 0.22, 0.33, 0.47, 0.68, 1 and 2.2uF @ 35V	12p
4.7, 6.8, 10uF @ 25V	20p
22 @ 16V, 47 @ 6V, 100 @ 3V	26p
POLYESTER (Mullard C280 series)	
0.01, 0.015, 0.022, 0.033, 0.047, 0.1	6p
0.15, 0.22	8p
0.33, 0.47	12p

### RADIAL LEAD ELECTROLYTICS

63V	0.47	1.0	2.2	4.7	10	7p
			22	33	47	9p
25V	10	22	33	47		7p
						9p
						100
						470
						200
						1000
						32p

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#### Principle:

The dosimeter is an ionisation chamber type using a quartz fibre electroscope as the indicating element. A microscope is used to project the image of the moving quartz fibre element on to a graticule scale. The quartz fibre is mounted on a wire electrode, which in turn is supported by a high quality insulator. When the instrument is charged, positive charges distribute themselves over the wire electrode and quartz fibre causing the fibre to bend away from the electrode. The fibre will take up a position depending on the amount of charge on the system.

When the surrounding air in the ionisation chamber is ionised negative ions will be attracted to the positively charged electrode thereby reducing its charge. The resulting fibre movement will be related directly to the quantity of radiation producing the ionisation. The fibre movement can thus be calibrated directly in roentgen units and the rate of movement of the fibre will be proportional to the roentgens received per unit time.

#### Construction:

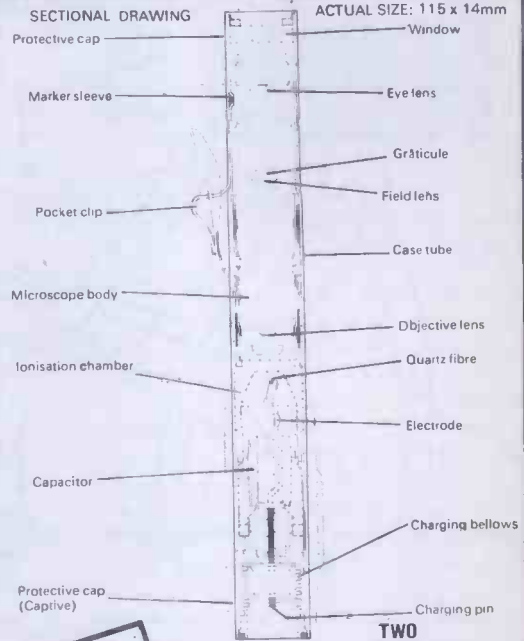
The microscope, electroscope and ionisation chamber are housed in an outer skin which may be of brass or aluminium. At one end of the tubular case is fixed a charging assembly, and at the other an eye-piece window. These two assemblies are soldered into the outer case to ensure a hermetic seal.

Each dosimeter is provided with protective end cap translucent window so that the cap need not be removed for reading.

Dosimeters meet vibration, drop, salt spray, humidity, water immersion and temperature tests.

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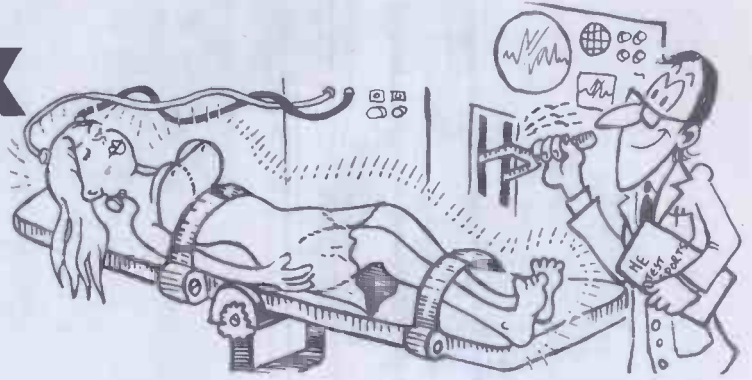
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VIEW THRU LENS



# Clever Dick



**Worried about hard-to-get service manuals, troubled by ultrasonic record players? Your worries are over as Clever Dick attempts to answer some of your weird and wonderful questions.**

OUR FIRST LETTER this month comes from a Welsh Flasher. Mystified? Well read on:

Dear Seedy,

A few questions:

1. Will the Flash Trigger project (July issue) work on the external trigger socket of the motor drive unit of my Nikon FE?
2. Could you design a Time-Lapse photography project? The Nikon Intervalometer is rather prohibitive at £325.
3. How about a slide projector dissolve unit?
4. And a tape/slide synchroniser to work with the dissolve unit.

Thank you for reading/publishing this letter and also for the excellent mag.

P.S. Thanks also for the Binder.

P K Roberts  
New Quay, Wales

Seedy?? Well, it's original. Now, about your Nikon, I've checked the office Brownie only to discover it doesn't have a motor drive. We're not rich enough to afford a Nikon so at a guess I'll have to say no. The Flash Trigger was designed to operate an electronic flash gun. I assume you want the camera to wind on after each exposure. This may or may not involve mucking about with the motor drive unit's innards so unless you want to take a chance on ruining it I'd leave it well alone. If anyone else has some thoughts on this matter we would be pleased to hear from them.

Your idea for a time-lapse unit sounds most interesting, it has been passed on to the project department. The slide projector dissolve unit is easy, how about a large tub of very strong Sulphuric acid, no? OK that was just a little joke (very little), that idea and your suggestion for the synchroniser have all been passed on. One last point, you must be extremely rich to own a Nikon so you can buy your own Binder, the cheek of this man!

David Clark starts his letter in a much more promising manner, a definite candidate for the Binder of the month.

Dear Richard-The-Intellectual,

I am planning to build the Car Booster and Equitone but as my cassette player has a rather insensitive volume control I am wondering if I could modify the booster with a pot in series with R1, if so what value would you suggest?

A quick point concerning the CB monitor offer in the August issue, I seem to remember that it was illegal to monitor transmissions on 27 MHz, if this is not the case how about a circuit for a converter?

David Carle  
Strathaven

Your problem with the insensitive volume control should disappear with the Booster in circuit. You could put a pot in series with R1 but I suspect that you won't need to. The CB monitor is technically illegal if it is used to monitor illicit transmissions, listening to Police broadcasts also comes under this heading. If you use it to monitor Radio Control or foreign CB you should be OK. We have actually got a circuit for a CB monitor but the parts alone would come to more than £11.50!

Do you remember Adrian Hallas's letter in the August CD? He wanted to know if ultrasonics could be used to replace the mechanical stylus on a record player. We asked for comments, here's one from Paul Fletch.

Dear CD,

Concerning Adrian Hallas's letter about playing records by ultrasonics, I'm sorry to put the damper on it but the resolution of a system using normal ultrasonic sound would be far too low, for the following reasons:

Say 100kHz (and that's rather high) and the speed of sound around 300 metres per second.

Now:  
 $velocity = frequency \times wavelength.$

So  $wavelength = \frac{300}{3000} = 3mm$

The resolution of a wave system (eg light in an optical microscope) is always less

than the wavelength. So the smallest distance that can be judged is larger than 3mm — which is far too large. A higher resolution can only be obtained with impractically higher frequencies, sorry.

Paul Fletch  
Watford

That sounds like fairly logical reasoning, we have heard of ultrasonic microscopes though the frequency is into the megahertz and gigahertz region. It looks as though the Ultrasonic Record Player idea is doomed to failure.

As you can imagine we get hundreds of letters each month, and many good ones have to go unanswered. We'll finish off with some abbreviated versions of the more urgent questions but please try to keep your letters as short and to the point as possible.

Where do you get those 'chunky' PP3 battery clips?

Steven Turner  
Gwynedd

Any of the larger mail-order companies, Watford, Maplin, Stevenson etc.

Where can I get a service handbook for a Single Beam Oscilloscope Model MSB 100?

Jim McMahon  
Manchester

Try Austrec Ltd, 76 Church Street, Larkhall, Lanarkshire ML9 1EH. Send an SAE for their list.

Where can I get a IR106 thyristor or equivalent?

Robert Ewing  
Coventry

The IR stands for International Rectifier, any 106 device will do, eg. C106 etc, these are obtainable from any of the mail order companies previously mentioned.

That's it again for another month, thanks for your letters, see you in four weeks.

HE

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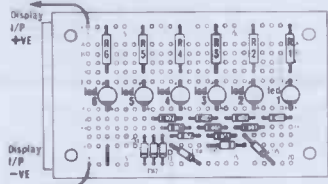
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For full detailed instructions and layouts of Projects, 7, 8 and 9, simply take the coupon to your nearest CSC stockist, or send direct to us, and you will receive the latest 'ELECTRONICS BY NUMBERS' leaflet.

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## EXPERIMENTOR BREADBOARDS

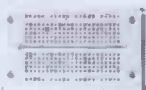
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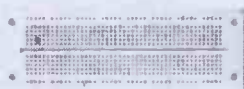
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EXP 350	270	3	£ 4.48	
EXP 300	550	6	£ 7.76	
EXP 600			£ 8.38	
EXP 650	270	use with 0.6 pitch Dip's Strip Bus Bar	£ 5.00	
EXP 4B	Four 40 Point Bus Bars		£ 3.50	

PROTO BOARDS	CONTACT	IC CAPACITY 14 PIN DIP	UNIT PRICE INC P&P & 15% VAT	Qty req.
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74S02	14p	7427	34p	7497	175p	7486	34p
74LS02	15p	7428	35p	74107	32p	74LS86	35p
7403	14p	7430	17p	74109	50p	7490	28p
74S03	16p	74LS30	20p	74S112	90p	7493	28p
7404	14p	7432	28p	74S114	45p	7495	65p
74H04	16p	74LS32	28p	74116	195p	7496	60p
74LS04	15p	7438	35p	74118	75p	7497	175p
7405	18p	74LS38	35p	74121	28p	74107	32p
7406	32p	7440	17p	74122	41p	74109	50p
7407	32p	74S40	19p	74123	45p	74S112	90p
7408	17p	7441	65p	74LS123	60p	74S114	45p
74LS08	22p	7442	55p	74125	53p	74116	195p
7410	15p	7447	45p	74128	72p	74170	235p
74H10	17p	7450	17p	74132	68p	74172	445p
74LS10	19p	74LS51	22p	74148	103p	74173	110p
74LS11	38p	7454	17p	74150	98p	74174	85p
7413	30p	74LS54	23p	74151	60p	74LS174	105p
7414	50p	7470	33p	74LS151	100p	74175	80p
7416	27p	7472	28p	74153	65p	74180	92p
						74181	150p
						74LS182	90p
						74190	85p
						74191	85p
						74193	85p
						74LS193	95p
						74194	85p
						74197	75p
						74198	140p
						74LS266	95p
						74283	155p
						74284	400p
						74285	400p
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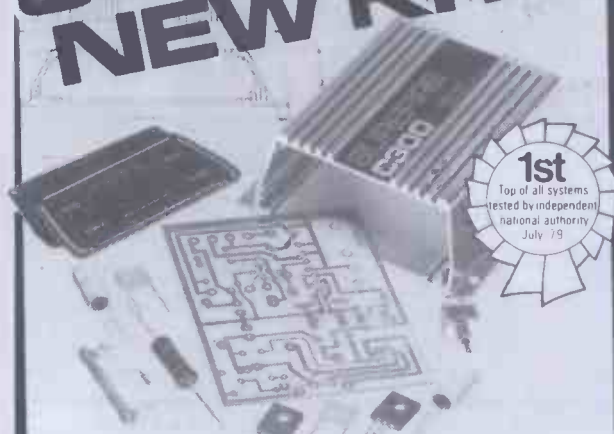
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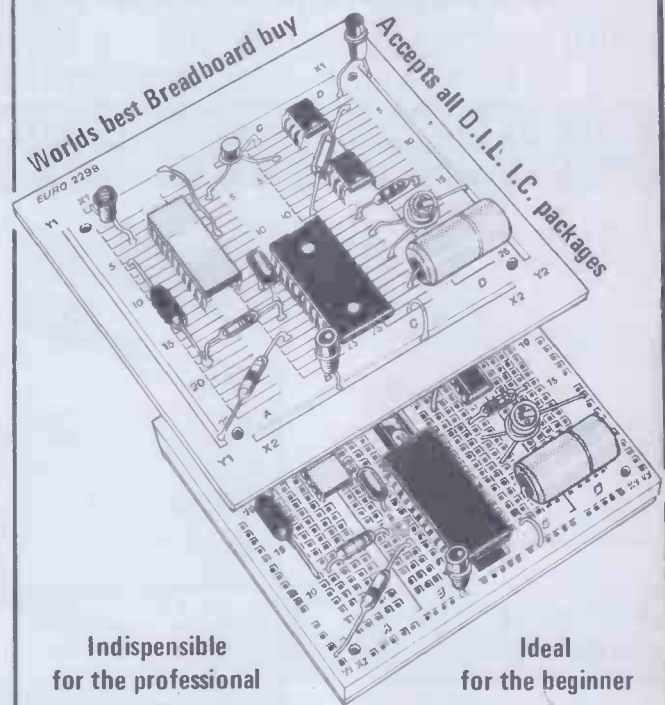
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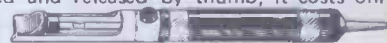
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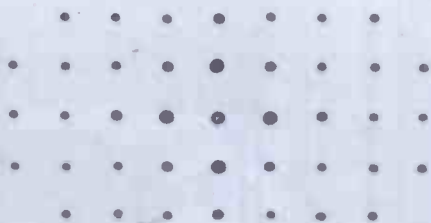
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**HE****NOBELL**

# Nobell Doorbell

Ring in the changes with this revolutionary design that faithfully reproduces the noise of those old time door knockers.

GLANCE THROUGH THE newspapers and it seems that almost every day another field of human activity has been taken over by the relentless march of the microprocessor. It's obvious that there's no limit to man's ingenuity for computerising anything and everything, no matter how trivial. Not even the humble doorbell has escaped, and you can now have the arrival of a visitor brought to your attention with a blast of almost any popular tune you fancy.

## Knock Knock ...

Although we at HE don't exactly disapprove of this electronic takeover bid (it keeps us employed), we feel a bit nostalgic for the good old days when you made your presence known to a householder by banging away on a huge brass knocker. So we've combined the past and the present in the form of the HE Nobell, an electronic doorknocker. The Nobell's a prize-winning design that won't leave you in peace (OK, don't turn over the page, we promise not to do it again).

The audio generator is built around a single transistor oscillator. When it receives a trigger pulse it produces a 'boing' noise which can be tailored to resemble a knocking sound. Other sounds are possible as detailed in the setting-up procedure below. The sound is amplified by a standard LM380 audio power amp IC, a chip which should be familiar to regular readers of HE.

The rest of the circuit is there to provide a set of five triggering pulses

for the audio generator from the single pulse caused by pressing the push switch on the front door. This is done by a tone burst generator, a fairly standard electronic circuit. Two 555-type timer/oscillators are connected together, one wired as a monostable (i.e. it produces only one output pulse of fixed length) and the other as an astable (it produces pulses as long as it is turned on). The push switch turns on the monostable which then turns on the astable. This results in a burst of pulses at the output. Normally the frequency of the tone is in the audio range and it is used for testing amplifiers and loudspeakers. In this project we use a very low frequency to generate our set of knocks.

Power can be obtained from any AC or DC supply in the 6 V to 12 V range. If a DC supply is used it may be connected either way round because of the steering action of the bridge rectifier D3 — D6.

## Construction

Construction of this project is straightforward, especially if you use our printed circuit board. Make the usual careful checks to ensure that the ICs, electrolytic capacitors and the transistor are soldered in the right way round. How you case the project is largely up to you. As the photographs and overlay show, we mounted the PCB and loudspeaker in a verobox and connected the input leads to a miniature jack socket. The wires from the push switch were terminated in a

matching jack plug. Connect up the power and you're ready to set up the circuit. If you are using this project to replace your existing doorbell then you can make use of the existing bell transformer and push switch.

## Setting Up and Customising

RV1 is adjusted to set the correct operating point for the Q1 oscillator, and should be turned until oscillations occur only when a trigger pulse is received. However, the exact position depends on your own personal taste. The sound can be varied from a short, sharp tick, through a sound resembling a knock, to an extremely good impersonation of a bongo drum.

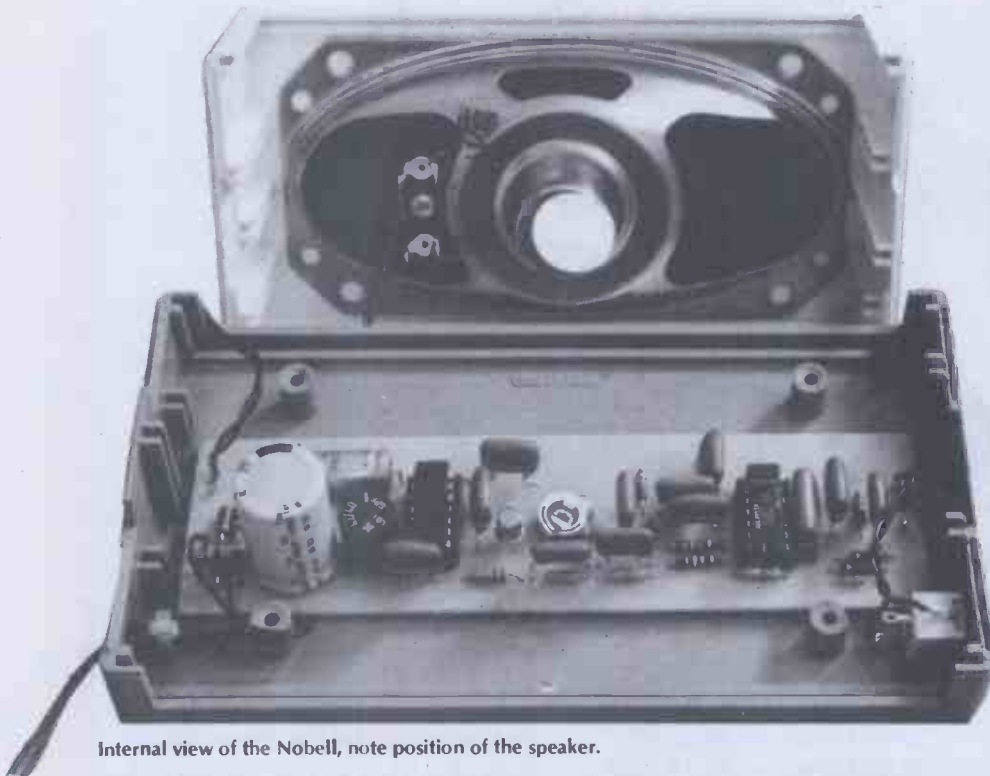
Further alterations can be made by changing component values. As already mentioned, the number of knocks depends on the time period of the monostable and the frequency of the astable. In our circuit, these are set at half a second and ten Hertz respectively, so there will be five knocks. The monostable period is set by R3 and C2 and increasing either of them lengthens the time of operation. The astable frequency is set by R5, R6 and C5 and if one or more of them is decreased the 'knocks' will come faster.

If you decide to use the bongo sound, then you can vary the pitch by altering the values of C7, C8 and C9 in the twin-T filter. The same approximate ratios between the capacitors should be maintained — for example if you halve their values (to 4n7, 4n7 and 10n) then the pitch of the bongos will be doubled.



# Parts List

<b>RESISTORS (all 1/4W, 5%)</b>	
R1,2	8k2
R3	2M7
R4	10k
R5,6	680k
R7,11	15k
R8	22k
R9,10	47k
R12	2R7
<b>POTENTIOMETERS</b>	
RV1	100k linear horizontal miniature preset
<b>CAPACITORS</b>	
C1,7,8	10n polyester
C2	220n polyester
C3,4,5,10,11,12	100n polyester
C6,9	22n polyester
C13	47u 25V PCB-mounting electrolytic
C14	1000u 25V PCB-mounting electrolytic
C15	100u 25V axial electrolytic
<b>SEMICONDUCTORS</b>	
IC1	556
IC2	LM380
D1,2	1N4148
D3-6	1N4001
Q1	BC109
<b>MISCELLANEOUS</b>	
PCB, push switch, loudspeaker ( $\geq 8$ ohms), Verocase.	



Internal view of the Nobell, note position of the speaker.

## How it Works

When the push switch on the door is pressed, the brief pulse that is generated must be stretched out to operate the rest of the circuit. This is done by one half of IC1, a dual 555-type timer/oscillator. This half (pins 1-6) is connected as a monostable multivibrator i.e. a pulse of fixed length appears at the output (pin 5) whenever a trigger pulse from the push switch is received at the input (pin 6). The length of the output pulse is determined by the values of C2 and R3.

The other half of IC1 (pins 8-13) is wired as an astable multivibrator, or oscillator. It produces a square wave at pin 9 whenever the output

pulse from the monostable forces pin 10 (enable input) high. The frequency of the square wave is determined by the values of R5, R6 and C5. The square wave passes to the sound generator via C6 and D2.

The sound generator circuitry is a 'twin-T' type sine-wave oscillator. Q1 is an amplifier with a twin-T filter in its feedback loop (R9, R10 and C9 form one 'T' and C7, C8 and RV1 form the other). If the loop gain of this circuit is greater than one, oscillation occurs at the resonant frequency of the filter. RV1 is adjusted so that Q1 is just on the verge of oscillation — a

pulse via D2 will force the oscillations to start but they quickly die away. This makes a 'bong' type of sound.

The signal is amplified by audio amplifier IC2, and LM380, and fed to the loudspeaker.

The power supply is not at all critical. An AC supply rectified by diodes D3 — D6 and these same diodes mean that a DC supply can be connected either way round. The supply is smoothed by capacitor C14 and additional decoupling of the supply to IC2 is provided by C12 and C13.

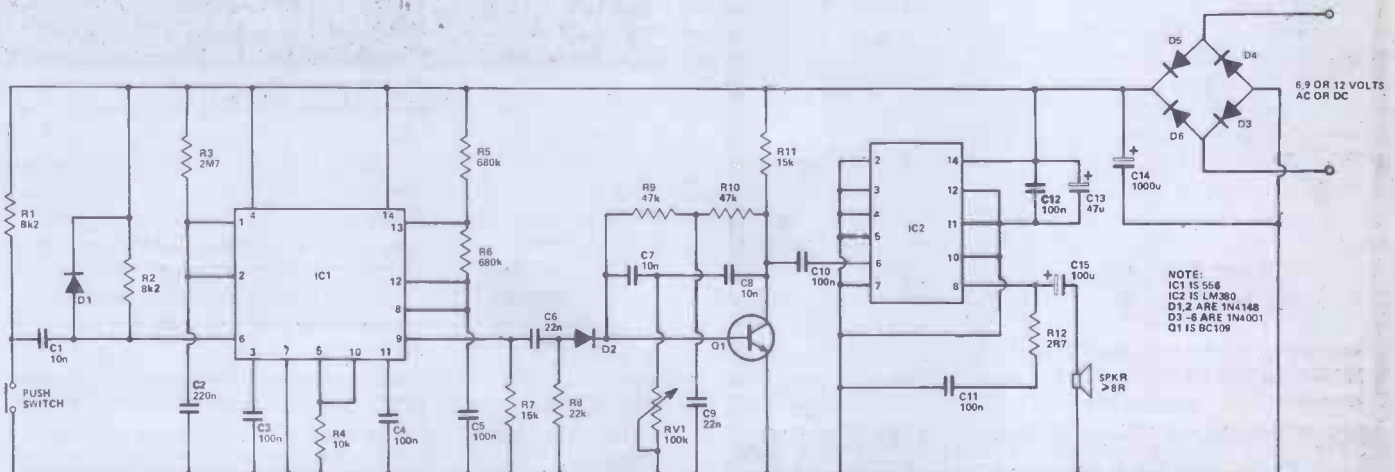


Figure 1. Circuit diagram of the HE Nobell

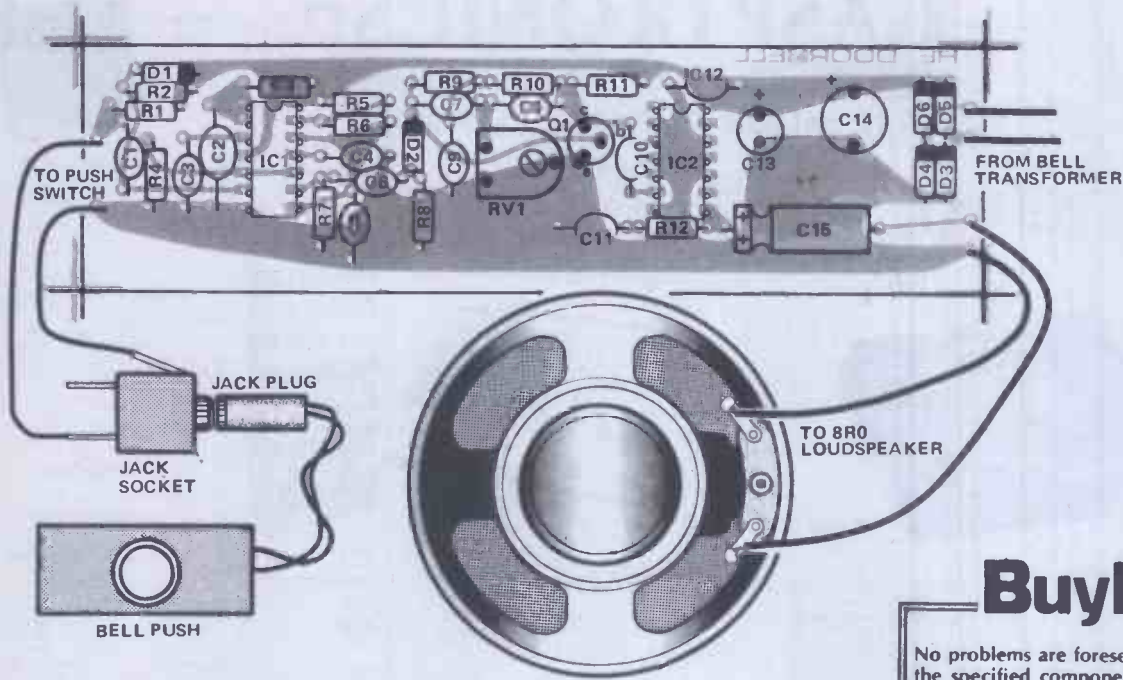


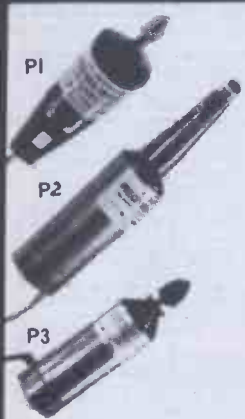
Figure 2. Component overlay and wiring diagram.

## Buylines

No problems are foreseen in obtaining any of the specified components at your neighbourhood electronic supermarket. An approximation of the cost of components (with the usual exception of case and PCB) comes to £7.50.

HE

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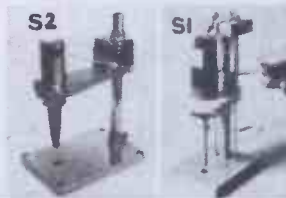


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The system is handsomely finished in cocoa brown and wood grain with brushed aluminum accents. Packaged in an eye-catching, self-display carton.

### MP-300/301

HERE IT IS! THE BEST SELLING, BEST VALUE CORDLESS TELEPHONE SYSTEM IN AMERICA.



Range depends on conditions **£99.95**

This deluxe system at a very affordable price permits the user to both receive phone calls and originate phone calls from anywhere within its 900 ft range.

The MP-300/301's stylish beige and wood grain finish and outstanding features are sure to capture the attention of the rapidly expanding cordless phone market that MURAPHONE has been so instrumental in creating.

MP-300/301 individual features and controls include: The MP-300 Remote Unit ■ Operates 12-15 hours on a rechargeable nicad battery ■ Slide type volume control ■ A great convenience is the automatic "last number recall" memory. By simply pressing a button the MP-300 automatically redials the last number

dialled ■ The remote weighs 14 oz and easily slips into a pocket or clips onto belt. The MP-301 Base Station ■ Incorporates a 3 LED display (yellow, red, green) to indicate "Charging," "Power" and "In Use" modes ■ Built-in remote charger ■ A "Line Release" button to assure telephone privacy and an "Intercom" button for paging the remote unit.

The system is smartly styled to complement any home or office decor. Attaches to the phone lines and AC power.

Owner's Manual that completely and clearly describes installation and operating procedures.

The MP-300/301 system is compatible with either rotary dial or touch button telephone systems.

Beautifully packaged.

**MURAPHONE MP-100 REMOTE & RECHARGER**

An extra MP-100 remote enables the owner of any MURAPHONE System to have available at all times a fully charged remote. No more down time waiting for a remote to charge. The system is now operational 24 hours a day.

Completely compatible with all MURAPHONE Systems, though it cannot be used to dial out over the MP-301 full function base unit.

Individually packaged with recharger. 90 days limited warranty.

£25

**MURAPHONE MP-300 REMOTE & RECHARGER**

Compatible with any MURAPHONE System, the MP-300 remote permits around-the-clock operation in the system because a fully charged remote is always available. The addition of an MP-300 remote to an MP-100/101 system will not upgrade that system by giving it a "call out" capability. Dual capability requires both the MP-300 remote and the MP-301 base.

Individually packaged with recharger, owner's manual and 90 day limited warranty.

£45

#### CBM-10 Dual-Function CB Meter

The two functions most critical for tuning and checking CB antennas are combined in this one-low cost unit.

The CBM-10 measures Standing Wave Ratio (SWR) and Field Strength (FS) on an easy-to-read meter with D'Arsonval precision movement. The CBM-10 is provided with its own antenna for relative field strength measurement.

The unit can be left in a coax line permanently with no appreciable signal loss, comes with detailed instructions for use, and is covered by Mura's 3-month limited warranty.

**SPECIFICATIONS**—SWR Scale: 1:1-1:3 VSWR • FS Scale: 0.5 relative scale • Frequency Range: 3.5-150 MHz • Impedance: 52 Ohms • Antenna: 5-section telescopic • Dimensions: 6" x 2 1/4" x 2 1/4"

#### CBM-20 3-Function Meter

The versatile CBM-20 measures transmitter RF output power on two scales, as well as measuring SWR and relative field strength.

The unit is equipped with a telescopic antenna for field strength measurement and can be left permanently in coax line with negligible signal loss.

A highly useful feature of the CBM-20 is a switchable impedance setting for testing twin antennas.

The CBM-20 is provided with 2-foot connecting cable permanently attached, complete instructions, and Mura's 3-month limited warranty.

**SPECIFICATIONS**—SWR Scale: 1:1-3:1 VSWR • Power Scales: 0-10, 0-100 Watts • FS Scale: 1-10 relative scale • Frequency Range: 1.5-55 MHz • Impedances: 52, 75 Ohms • Antenna: 2-section telescopic • Dimensions: 6" x 2 1/4" x 2 1/4"

#### CBT-25 SWR Power Antenna Impedance Matcher

Incorporating all the features of the CBT-5 and CBT-15, the CBT-25, in addition, offers an RF power scale for measuring transmitter output power.

The RF power scale enables the user to achieve the lowest possible SWR while maintaining optimal transmitter output.

Other features of the CBT-25 include a backlight meter scale for each night-time viewing, and a 2-foot connecting cable pre-wired to the unit.

**SPECIFICATIONS**—Impedance Matching Range: 25-140 Ohms • SWR Scale: 1:1-3:1 VSWR • Power Scale: 0-10, 0-100 Watts • Dimensions: 5" x 2 1/4" x 2 1/4"

#### CBT-35 Dual Scale Meter Antenna Impedance Matcher

This deluxe unit feature separate scales for simultaneous measurement of SWR and RF power. Used in conjunction with the antenna tuning controls, the twin meters allow a greater degree of tuning precision. A new feature of this model is a % Voice Modulation Scale. This scale is located on the SWR meter face.

Like CBT-15 and CBT-25, this model is equipped with backlight meter scales a 2-foot coaxial connector. An additional feature of the CBT-35 is a special mounting bracket supplied with the unit for easy attachment above or beneath the transceiver.

**SPECIFICATIONS**—Impedance Matching Range: 25-140 Ohms • SWR Scale: 1:1-3:1 VSWR • Power Scale: 0-10, 0-100 Watts • Dimensions: 6" x 2 1/4" x 2 1/4"

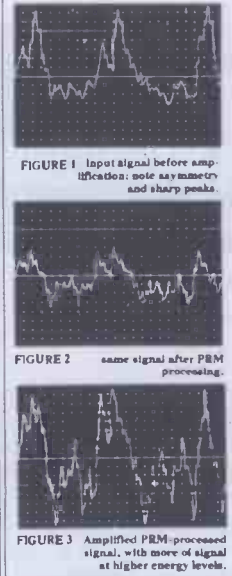


FIGURE 1 Input signal before amplification; note asymmetry and sharp peaks.

FIGURE 2 same signal after PRM processing.

FIGURE 3 Amplified PRM-processed signal, with more of signal at higher energy levels.

#### PRX-100 Variable Gain Power Microphone

With our PRM — Unlike test instruments that generate the clean audio signals known as sine waves, the human voice, when transformed by a microphone cartridge into electrical energy, produces a signal that is asymmetrical — that is, a signal with sharp excursions (peaks) in only one direction. This type of signal prevents uniform amplification, since the peaks will exceed the clipping point (causing audio distortion) while the less-modulated areas of the signal are just reaching audible levels. Ordinary CB microphones do nothing to correct this signal imbalance.

With PRM — Mura engineers tackled the problem by developing a way to electronically redistribute the peak portions of the signal to less modulated areas. This peak-redistribution modulation (PRM) effect is made possible by delaying peak components for minute amounts of time before being passed on to the amplifier stage of the transceiver. This process effectively creates symmetry in the signal and lessens the average energy levels of the peaks. The evenly distributed input signal can now be amplified to maximum (preclipping) level with a significantly greater portion of the signal at close to total modulation. Result: a tremendous increase in modulated power — more than twice the talk powers of conventional equipment, with far less distortion (since clipping is not required to produce high overall modulation).

The final product — Six of the finest CB mikes ever made, including three old favourites and three brand new additions to the line.

#### CBM-30 Twin-Scale Meter

This meter is provided with separate power and SWR scales, allowing for simultaneous monitoring of SWR and RF output power functions.

The wide, easy-to-read scales are matched with a precision-built D'Arsonval movement for accurate readings of both functions.

The CBM-30 is provided with a 2-foot connecting cable permanently attached for easy installation. The unit comes with a detailed instruction booklet.

3-month limited warranty.

**SPECIFICATIONS**—SWR Scale: 1:1-10:1 VSWR+5% • Power Scale: 0-100 Watts +20% • Frequency Range: 3.5-35 MHz • Impedance: 52 Ohms • Dimensions: 6" x 3" x 2"

#### CBT-15 SWR Antenna Impedance Matcher

Ease of operation, convenience and accuracy distinguish the CBT-15, an antenna impedance matcher with a built-in SWR meter.

Since the SWR meter is an integral part of the unit, everything necessary for precise tuning of the antenna system is in one compact cabinet.

Like the CBT-8, the CBT-15 incorporates a wide impedance-matching range, facilitating accurate adjustment under all conditions and for all channels. For night-time use, the SWR meter scale is backlighted — a Mura innovation. A 2-foot connecting cable is prewired to the unit.

**SPECIFICATIONS**—Impedance Matching Range: 25-140 Ohms • SWR scale: 1:1-3:1 VSWR • Dimensions: 5" x 2 1/4" x 2 1/4"



**CBC-24**

Required to connect CB transceivers to test equipment.

This 24-inch coaxial cable is fitted with standard PL-259 connectors.

**SPECIAL OFFER ON HI-GAIN ANTENNAS AM/PM/CB WITH SPLITTER BOX DISCOUNT** ..... £20.95

**570 TRUNK OR ROOF MOUNT** ..... £9.25

All prices include VAT.

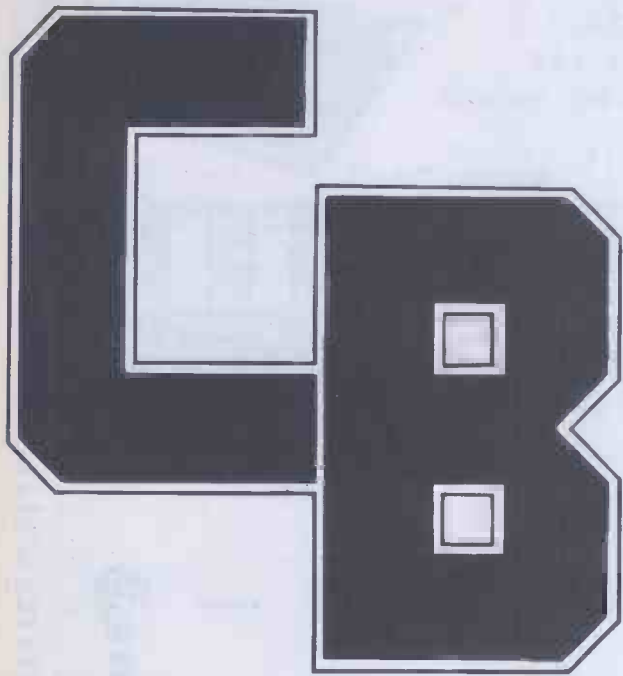
Post and Packing charges and Antennas £1.50 meters and speakers £1.50 all other items .50

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CBC 24	£2.95
CBH 5	£6.95
CBH 44	£6.95
PL 259	.65
ODK 18	£3.95
WMS 49	£5.00
All prices include VAT.	



# Breaker One Four

Send any news, comments or information you have to:  
Breaker One Four, Hobby Electronics, 145 Charing Cross  
Road, London WC2H 0EE

Now that the Open Channel Green Paper has finally appeared we have a chance to air our views. Rick Maybury reports on the latest happenings on the CB scene.

TWO OUT OF THREE, that's our rating. The Government Green Paper published on the 5th of August made interesting reading. We wholeheartedly agree with the suggestion that 40 channels would be needed. Even the inference that 25 watts would be the optimum power level sounds reasonable, it was the choice of frequency that spoils an otherwise interesting document.

Looking at it rationally 928 MHz is a strange figure, how on earth did they decide upon it? (We reckon it was scientifically chosen with a sharp pin and a shakey hand). In setting out their arguments the Government have made two serious errors of judgement. The first is the mood of current CBers. When asked what would the Government do about the thousands of illegal operators Timothy Raison MP replied 'Well, they'll just have to stop doing it ...' Optimism in Government employees must be at an all time high. Not one single Breaker is going to dump his rig in his dustbin and wait for the glorious day when he can spend an unspecified amount of money on equipment that might or might not work as well as cheap and readily available gear will.

Their second mistake is the choice of 928MHz, over and over again tests have proved that high frequencies are not suitable for short range urban communication, even less so for open country where a leaf on a tree is an effective barrier to any RF signal above 700 MHz.

## Do Something About It

As soon as the document was published we had dozens of phone calls from people complaining that 928 MHz was no good and asking what we were going to do about it. The simple answer is we can't do much, but you can. The Green Paper is meant to promote discussion and comment, in fact it invites it. Every single one of you has the opportunity to



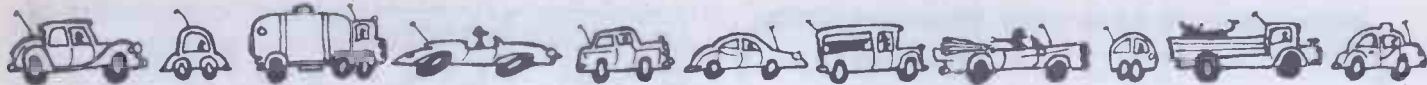
Has this got anything to do with CB?

tell the Government exactly what you think about it. If you haven't already seen a copy then you can obtain one by writing to: The Officer in Charge; Home Office, Supply and Transport Branch, Royston Road, Caxton, Cambridge CB2 8PN (natty post code!) and ask for 'Open Channel — a Discussion Document'. Read it carefully then send your comments no later than the 30th November to: Radio Regulatory Department, Home Office, Waterloo Bridge House, Waterloo Road, London SE1 8UA. We won't tell you what to write but we will say that if enough people make a fuss something may be done about it. Don't moan, do it.









## Big Ears

Earlier this month we took the M1 north to meet the famous Big Ears, CB accessory dealer extraordinaire. The journey itself was something of an advertisement for CB, the almost perpetual roadworks and numerous accidents took some three hours to negotiate. Even when we arrived the rather vague directions had us looking everywhere but the right place. Eventually we found the shop, where Terry (Big Ears) assured us that a day earlier you couldn't move for stock, we could hardly get in that day so you can guess what sort of trade he has. Just about every conceivable accessory was on show and prices were as good as (and in some cases cheaper than) any we've seen. After a diabolically hot curry Terry showed us around Leicester, it turned out to be an eventful journey as you'll see from the picture. A young police constable tailed us for some five miles before pulling the Big Ears van over. One of the Big Ears employees is seen here telling the constable his rights (more of that later). After some 20 minutes he actually managed to persuade the Constable to give up. That man could talk the hind legs off a donkey, (and then convince the donkey it didn't need them in the first place). The next day we heard from Big Ears, apparently the shop had another visit just after we left, this time from the Home Office and Customs & Excise. Again they found nothing.

## Your Rights

The question of right of entry by police, Post Office, Home Office etc. is an old one. Recently a document came into our possession. It is a general guide to the authorities on how to handle a situation involving use of an unlicensed transmitter. It starts off with an interview. The questions are fairly straightforward:

'Are you the owner of this equipment?'

'Where did you get it?'

'What call-sign do you use?.....'

This is interposed by the usual cautions, 'You are not obliged to say anything ...' etc and details of test transmissions made giving frequency (isn't that illegal?) and channels. The second part of the document goes on to tell the interviewer what the law allows. The most interesting part comes at the end of the second page:

*'It is emphasised that there is no power under the Wireless Telegraphy Acts for the Police, Post Office or Customs & Excise to detain apparatus for evidential or any other purpose. Apparatus may only be removed with the owner's consent.'* Before you get too smug, the Police may detain the equipment under the Customs and Excise Management Act but



He got away with it too!



The Big Ears Shop

this must be with prior agreement from the C&E. In practice this can be almost impossible to do. So now you know your rights but try arguing that with half-a-dozen burly policemen!

## Club Scene

It didn't take long for a new club to be born from the disquiet generated by the Green Paper. In fact as we go to press no less than four organisations are about to or are already looking for members. The first one we have any firm details of is the Campaign for British Citizens Band (BCB). The inaugural meeting was held on the 14th of last month. For further details of the club's activities contact our old friend Keith Townsend at:

### CBCB

1163 Yardley Wood Road,  
Birmingham, B14 4LE  
(Love the postcode Keith!)

### Telford CB Radio Club

Chairman: P. McGuiness,  
192 Bishopdale,  
Brookside,  
Telford.

### Glasgow CB Club,

President: Ian Patterson,  
147 Trassachs Road,  
Rutherglen,  
Glasgow.  
(Phone 041-647-6923)

### South Birmingham CB Club (SBCBC)

Secretary: R.A. Smith,  
14 Delreme Road,  
Solihull,  
West Midlands B90 2HH.

**South Coast Area Breakers,**  
Telephone Worthing 62929.

### Circle City Breakers (CCB)

Leeds: (Call Breaker Channel for details)

The South Birmingham Club have been very active during their relatively short existence, already they boast over 100 members and a regular monthly meeting. Whilst we're on the subject of well organised clubs the North Birmingham group have also been doing well. Already they are printing a well thought out newsletter with masses of local information for their members. We would like to see any newsletters from any of the other clubs, we might even print the bits that are of national interest.

Thanks too to all those of you that have sent in newspaper clippings, again we would like to see any reports of CB in your local papers especially if it is out of the ordinary, emergencies, stolen cars, dramatic busts, etc.



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Basic Kit £19.95  
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SWR/Power/F.S. Meter	£24.95
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Linear Amps from	£59.95
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\*These are a few of the items available\*

The latest from the U.S.A.

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\*Still available\*

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Contains everything except box and controls

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ATARI £138

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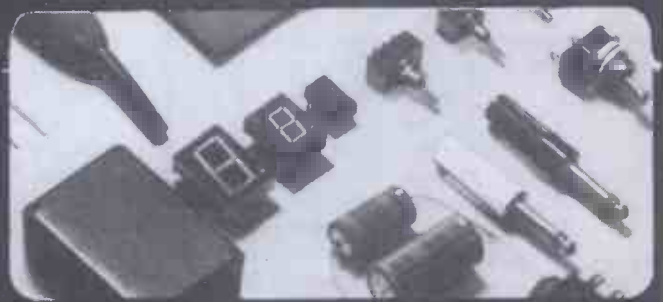
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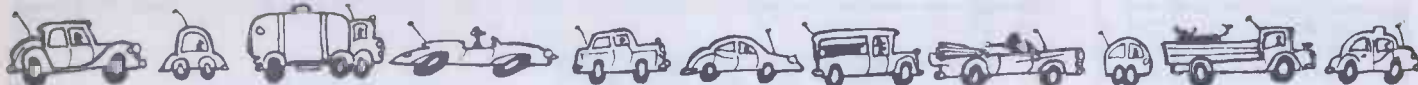
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## CB VIP

### TERRY (BIG EARS) NEWELL

Big Ears is our CBVIP this month, as you'll see he has had a very full and interesting life. We asked him for his views on Open Channel, we think he's not alone with some of his observations! By the way, he asked us not to publish his picture, the gentleman on the right is a good friend of Terry's.

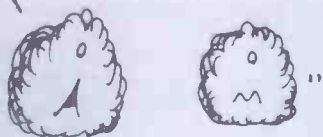
- BOF.** OK Terry, tell us your life story.  
**TERRY.** I was born at a very early age, in 1948 to be precise.  
**B.** What were you doing before you got involved with CB?  
**T.** I was heavily involved with the Rock and Roll business as a 'Rodent' for some years.  
**B.** Rodent, what's that?  
**T.** I was a go-getter.  
**B.** How long did you do that?  
**T.** Fourteen years.  
**B.** That's a long time, were you involved with any big bands?  
**T.** Yeah, Black Sabbath, PFM, Magma, Pretty Things.  
**B.** You must have travelled quite a bit then?  
**T.** Four countries in as many days, and that was taking it easy!  
**B.** So when did you first come across CB?  
**T.** In the States, I was a truck driver for a while.  
**B.** How long?  
**T.** Not long, New York to LA and you know all about it, 3000 miles non-stop. I've had white line fever, you can stop the truck and the road is still moving.  
**B.** So when did you come back to the UK?  
**T.** I never really left.  
**B.** No, I mean when did Big Ears and you start, was it when you returned?  
**T.** Big Ears as a company began on the 1st of January this year, I was involved in the CB scene for the past two years though.  
**B.** I hear you've got a shop in Wales.  
**T.** That's right, and maybe one in London soon.  
**B.** What are your printable interests?  
**T.** Horse riding, radio control modelling, I've got a Stock car at the moment that I race.  
**B.** (The rest of Terry's interests are most certainly not printable but are common to most red-blooded males)  
**B.** Do you race seriously?  
**T.** Oh yes.  
**B.** Are you any good?  
**T.** Not yet.  
**B.** Do you get any interference from CB?  
**T.** Believe it or not, no.  
**B.** So how do you see the future?  
**T.** The number of 27 MHz rigs in this country is grossly underestimated, I've got reliable figures that show at least 250,000 rigs in operation. The Government have left it too late. All the people I've spoken to are not prepared to accept the Open Channel system with all its limitations and probable cost.  
**B.** What are you going to do about it?  
**T.** Well, we've formed the National Association for the Legalisation of 27 MHz and we'll be starting our campaign of action very soon.



- B.** Would you like to tell us exactly what you'll be doing?  
**T.** No Comment, you'll see soon enough.  
**B.** Is this organisation backed by any big names?  
**T.** No, just the people who matter, the Breakers, but it's not a Breakers' organisation as such. We want to totally divorce ourselves from the UBA, UKCBC and all the other publicity-seeking organisations. We're not interested in getting our faces on TV, just getting CB legalised and preferably on 27 MHz.  
**B.** I can see your point but what will you say to those who claim 27 MHz CB interferes with other electronic equipment?  
**T.** The evidence is pretty slim, I do accept that aero modellers can suffer but the recent announcement by the Home Office that R/C is to get another channel should take care of that.  
**B.** How about hospital paging systems, I hear that the Breaker Channel in Leicester is 19, isn't that because of a paging system on 14?  
**T.** Exactly, it interferes with CB, not vice-versa. There are 39 other channels, there is no need to use 14. There are several reasons the Government do not want CB to exist in this country. For instance, and I want you to print this, the situation at Grunwick could have been far worse if only half a dozen stewards had CB sets, and the same applies to the recent Steel dispute. The Government sees CB as a social/political menace, all forms of communication, except word of mouth, are controlled by the Government. Open Channel is a con, they are putting it into a prohibitive price bracket and limiting the number of sets, if it ever happens. The whole point is that 27 MHz is available, it works, people like it and want it, we can have it now. The constitution is surely Government for the people by the people. The people say they want 27 MHz so the people should have 27 MHz. If enough people get together then they will have to do something about it. The benefits are well known, if you were on a motorway and you had five miles warning of an accident you could do something about it.  
**B.** That's right, we could have got here an hour earlier.  
**T.** Right, if you had a CB in the car you might have avoided taking an hour to find my shop, you could have put out a 'Break' and I would have helped you straight away. A three minute call dialled on your own rig costs nothing.  
**B.** So what do you think will happen?  
**T.** The Government have got one thing working for them, apathy. If enough people get off their backsides we can do something about it, everyone must make their views known.  
**B.** Thank you very much and good luck with the campaign.

## C-Beasties

C.B. LEGISLATION IS LIKE A JAMMED  
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Ry '80

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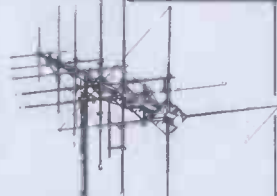
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 Length - 15'9"  
 S.W.R. - 1.21 or less  
 Ship Wt. - 25 Lbs.  
 Rotor required - med or heavy duty  
 supplied with switch box.  
**AV-140**



### MOONRAKER 6

This is the one you buy when you want the best. Unique fiberglass inner guy wires are used in an exclusive design to make the antenna stronger and keep it perfectly aligned for top performance. This antenna takes whatever power you're putting out and actually multiplies it 50 times. Provides tremendous transmit and receive capabilities never before found in CB antennas. Lightning protected. Gamma match.

Gain - 17 db over isotropics  
 Power multiplication - 50X  
 Rejection - 44 db  
 Impedance - 50-52 OHMS  
 Length - 31'5"  
 S.W.R. - 1.3 to 1 or less  
 Ship Wt. - 50 Lbs.  
 Rotor Required - Heavy duty  
 Use Dual coax switch (supplied).  
**AV-146**

### ASTRO-PLANE

Patent #3867108

Radiates from the top for more range. Uses no coils to burn out or detune, so it's quieter and more trouble free. Compact design uses no long drooping radials to ice up or break. Easy assembly. Light weight. One of the most popular CB antennas ever made. Don't be fooled by higher gain figures, this one makes better use of the gain by putting your signal out at a lower angle to get it where you need it. Lightning protected.

Gain - 4.45 db  
 Power multiplication - 2.8X  
 Impedance - 50-52 Ohms  
 Length - 12 Feet  
 S.W.R. - 1.2:1

Ship Wt. 5 Lbs. **AV-181**

### RAMROD

Patent #3867108

A versatile all purpose 1/2 wave dipole. Can be cut or adjusted to suit any frequency from 27 MHz CB to 174 MHz. Consists of a quality A.B.S. hub and aluminum and stainless steel elements.

Gain - unity  
 Impedance - 50.72  
 Ohm may be used  
**AV-100**

### SIGMA II

SIGMA II is 22" tall 5/8 wave ground plane designed to give strong, noise free long distance performance. An efficient matching loop, which prevents burn outs and detuning, eliminates the need for coils or transformers. The radiator is adjustable for fine tuning and pre-mounted for easy "no-measuring" assembly. This telescoping section uses full circle clamps for positive electrical contact and sturdy construction. The sturdy heavy-duty radials have stain less steel tips for reduced wind loading. Construction is all heavy wall aircraft quality aluminum, aluminum castings, stainless steel and fiberglass.

### SPECIFICATIONS

Gain 5.14 db over isotrop  
 4.17 db over 1/2 wave ground plane  
 3.00 db over 1/4 wave dipole  
 V.S.W.R. 1.3:1 or less  
 Power Multiplication Factor - 3.3  
 Impedance - 50.52 ohms  
 Omnidirectional no rotor needed  
 Height 22 feet  
 Radials 9 feet  
 Weight 13 lbs.  
 NOTE: In an effort to clean up the use of mounting gear, AVANTI has 2 ranges into 1 wire ground plane. One range is for use with 1/2" diameter wire and the other is for use with 3/8" diameter wire. Both ranges are compared in other literature of the same type. Care must be taken to use the correct wire size.

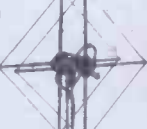
### PDL-2 WITH ORBITAL GAMMA MATCH

Patent #3675768

A new PDL designed by Avanti Research & Development. Has all the advantages of dual polarity in a compact powerful design. Actually consists of 2.5 element beams. Uses the new exclusive orbital gamma match for highest "D" and lowest loss. Gives better reception and less noise.

Since the PDL-2 has no coils to burn out or detune it will perform perfectly for a longer period of time. Offers better lightning protection than commercially available lightning arrestors.

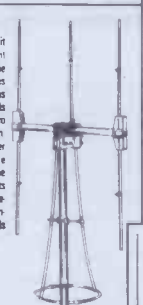
Rotor required - light or med  
 Gain - 12 db  
 Power multiplication - 16X  
 Rejection - 32 db  
 Impedance - 50-52 Ohms  
 Length - 38"  
 S.W.R. - 1.2:1 adjustable  
 Ship wt. - 15 lbs.  
 Supplied with switch box  
**AV-122**



### ASTRO-BEAM

Increased coupling makes it the most efficient 3 element beam antenna available to the CBer. The Astro-beam uses Avanti's famous Astro-plane as a driven element then adds a director and reflector to achieve a beam configuration. The Astro-plane makes a better driven element because it's more powerful than a dipole. The close coupling achieved results in 11 db gain and 40 db rejection. Unprecedented in an antenna of this type. Uses no coils for lightning protection.

Gain - 11 db  
 Power multiplication - 12.5  
 Rejection - 40 db +  
 Impedance - 50-52 Ohms  
 Length - 10 1/2 Feet  
 S.W.R. - 1.3:1 or less  
 Ship Wt. - 15 Lbs.  
 Rotor required - light or med. duty  
**AV-150**



### STACKING KIT FOR PDL-2's

Includes cross beam, guy supports, phasing harness for stacking PDL-2's

Gain of stacked PDL-2's - 15 db over isotrop  
 Width - 16"  
 Rotor required - Heavy duty  
 S.W.R. - 1.2:1  
 Rejection - 40 db  
 Side rejection - 40 db  
**AV-138**

### REVOLUTIONARY BREAKTHROUGH IN CB ANTENNA DESIGN...

#### AVANTI INVENTS THE SATURN™ BASE

The reason the "Saturn" is so revolutionary is that it is absolutely the only combination vertical and horizontal omni-directional antenna. That's right, it needs no rotor! You can pick up mobiles which are vertical or horizontal and vertical beams.

The "Saturn" invented after years of research by Avanti engineers, is the latest development using AVANTI's unique CO-INDUCTIVE principle to give you the performance of two antennas combined into one.

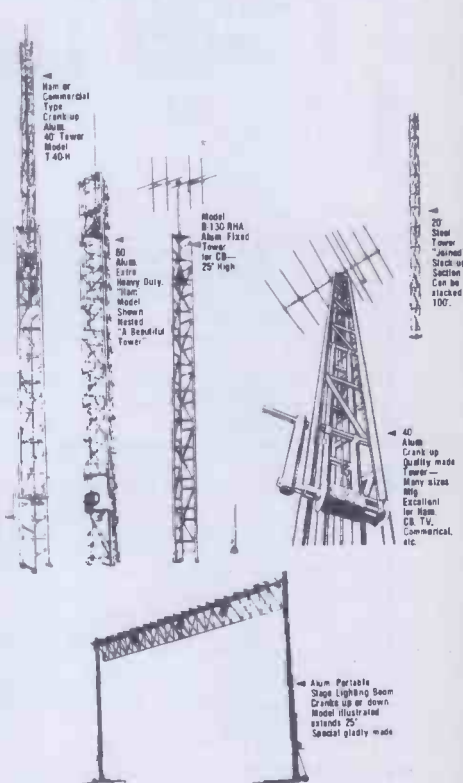
The P.D.L. and Moonraker made dual polarity famous as the only antennas to have during the last sun spot cycle, and this time around any serious C.B.er will want to have the "Saturn".

Height 22" Radials 8" Weight 25 lbs.

### THE SIGMA'S BIG BROTHER



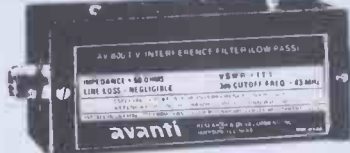
- Omni-directional - No rotor
- AV 501 Switchlocks included
- New Tri-Gamma Matching Network
- New Cam-Lock Radial Hub
- Co-Inductive Design
- Dual Polarity
- No Coils
- Pre-Cut and Pre-Measured Circumference Wire



<p><b>BRINKMANN</b>  <b>Q-Beam® Big Max™</b>                  #1801-0</p> <p>• 300,000 Candle-power spotlight                  • Works on 12 volt power                  • High impact scratch &amp; shock resistant plastic                  • Weighs 2.5 lbs                  • Black with B coiled cord</p> <p>• 1800-0 Same as above with 15' straight cord</p>	<p><b>BRINKMANN</b>  <b>Q-Beam® Spot/Flood®</b>                  #1301-0</p> <p>• 92 lights in 1-a 200,000 candle power spot or a 100,000 candle power wide angle flood                  • Fits &amp; operates under water                  • High impact ABS plastic                  • Weighs 8.5 lbs                  • Black E coiled cord</p> <p>• 1300-0 Same as above with 15' straight cord</p>
<p><b>BRINKMANN</b>  <b>Q-Beam® Blue Max™</b>                  #1801-0</p> <p>• The ultimate in hand-held lights                  • Especially treated glass free lens to penetrate fog, haze, smoke, snow                  • Virtually eliminates its own glare                  • 60' coiled cord</p> <p>• 1800-0 Same as above with 15' straight cord</p>	<p><b>BRINKMANN</b>  <b>Q-Beam® Super Spot® Special</b>                  #1400-7</p> <p>• Black high-impact plastic with 200,000 candle power                  • Clear bulb with 8' straight cord/plug</p> <p>• 1402 - Super Spot 2.5 lbs., 15' straight cord, 200,000 CP. Yellow.</p>

## T.V.I. Filters

### Low Pass for Transmitter AV-800

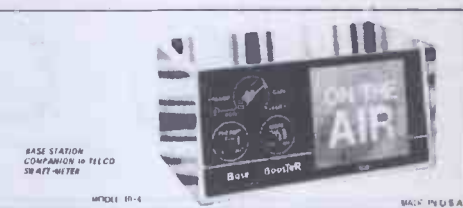


Avanti, Engineering helps you create a "Good Neighbor policy", by eliminating T.V.I. on VHF channels. Easily installed in antenna line via standard SO-239 connectors on each end.

### High Pass for T.V. Receiver AV-811




Attenuates RF energy below 52 MHz. Adjustable notch filter tunes out annoying interference caused by overload of the television receiver. Supplements inadequate T.V. filtering. Easily installed.





Cat. No. 18-250




**Citizens Band**

# Trouble Tape


Clearly plays each major type of CB interference and tells how to eliminate them.

- Fits all cassette players
- No skill required just listen
- Isolate and cure most mobile and base interference

LEN BUCKWALTER 1875



**GC ELECTRONICS**  
DIVISION OF HYDROMETALS, INC.  
ROCKFORD, ILLINOIS U.S.A. 61101



The CB Trouble Tape available from Wintjoy Ltd — see Odds and Ends below.

## National Directory of Handles

At last, the Directory is ready. Problems with distribution are forcing us to offer the Directory on a mail-order only basis. Each handbook-sized issue contains thousands of registered handles all with an individual number and location, all the addresses of the national and local clubs, hundreds of hints and tips to make your life easier and the chance for you to register your handle in the second edition that, hopefully, will be appearing on a regular basis. Full details next month.

## Odds and Ends

Two items of interest from the accessory dealers this month. The first comes from Big Ears and is an automatic antenna matching unit. This motor-driven device will automatically SWR the antenna every time the channel is changed. There are only three connections, the rig plugs into one side, the antenna into the other and a connection is made to positive 12 volts. Installation is kept to an absolute minimum as the unit is held in place with a hefty magnet, a quick twiddle to set it up and your antenna will forever remain perfectly SWRed. Big Ears has a limited supply of these devices, they're called Sylvania Automatch and can be yours for £45.00.

Our second item this month comes from Glyn Hall at Wintjoy, it's called 'CB Trouble Tape'. Basically it is an American cassette with recordings of all of the most common types of interference. There are sections on identifying the cause of the trouble and eliminating them, all easy to understand. Wintjoy are currently offering them for around a fiver, a mite pricey, but then how valuable is your time?

## Missing Child

Cast your minds back to the beginning of last month. You may remember the story of the two year-old child Elizabeth Peck who decided to have a stroll around a forest near her home for a couple of days. Happily she was found, none the worse for her ordeal. The news reports at the time said that local radio amateurs were helping with communication to the search parties. What the media failed to report was the help given by some 60 local Breakers who turned up in response to a plea from the local Fire Brigade. They set up an impressive communications network complete with mobiles and base station, under the supervision of the local constabulary. The Police are now (understandably) reluctant to acknowledge the help given by the CBers. A spokesman from the club said:

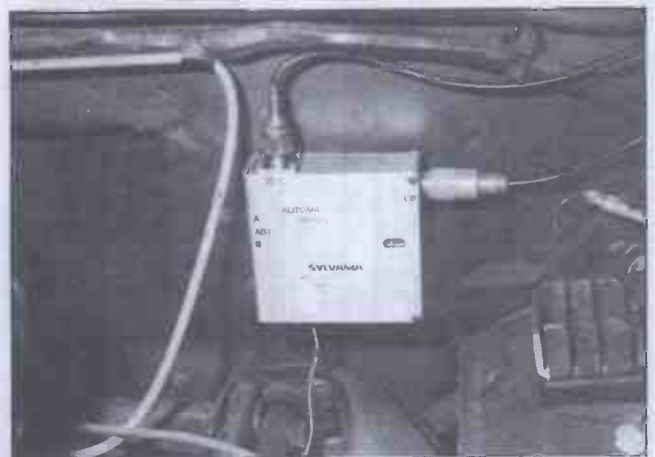
'Our main concern was to help find Elizabeth, not to publicise CB, but the authorities' flat denial of our assistance prompted us to make the truth known'.

We would like to thank publicly Moonraker, Wallaby, Green Turtle, The Mole and all the other members of the South Coast Area Breakers for their prompt and selfless help.

## NATCOLCIBAR

Our last item this month concerns the latest meeting of the Technical Sub-Committee of the National Committee for the Legalisation of Citizens Band Radio. As you may or may not know BOF has been attending these meetings for the past six months. The meeting on the 22nd of August was held to discuss the Green Paper and finalise the alternative specifications that NATCOLCIBAR hope the Government will adopt. To cut a long story short the National Committee have investigated all the possibilities and deduced that an area around 42 MHz is sufficiently free, (remember cheap equipment is available for this frequency).

Their final comment was: the Government Green Paper has absolutely nothing to do with CB. That just about sums it up really! Stay Lucky and see you next month.



The Sylvania 'Auto SWR' in position

HE

## HOBBYPRINTS

If you have never used HOBBYPRINTS before, then you don't know what you've been missing. HOBBYPRINTS are an etch-resistant rub-down transfer. Just place the appropriate HOBBY-PRINT over a clean piece of copper clad PCB material and rub. It's as simple as that. Once the design has been transferred, immerse the board into the Ferric Chloride. 15 minutes later you will be rewarded with a perfect PCB prepared from our original artwork, so you can have no worries about making a mistake. By the way, HOBBYPRINTS are ideal for making PCBs by Ultra-Violet exposure.

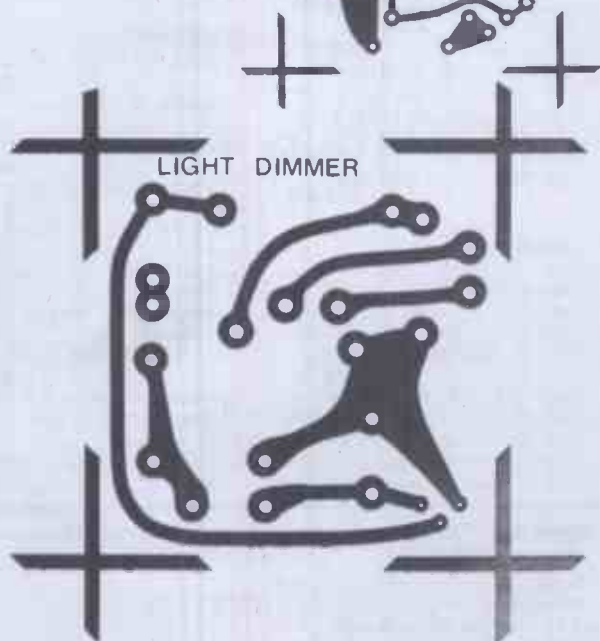
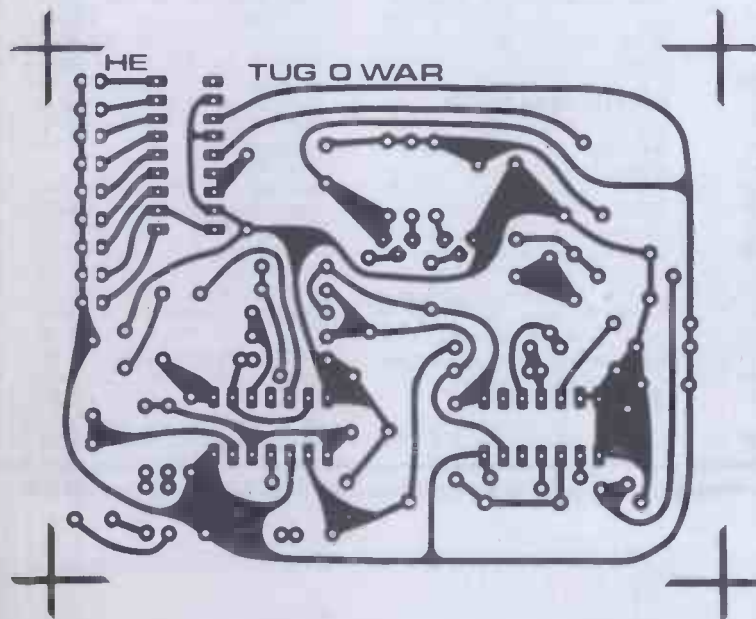
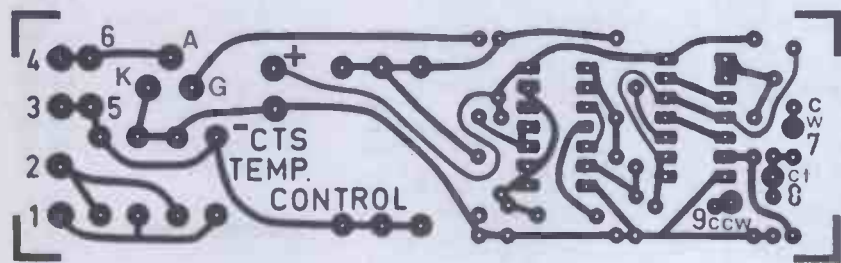
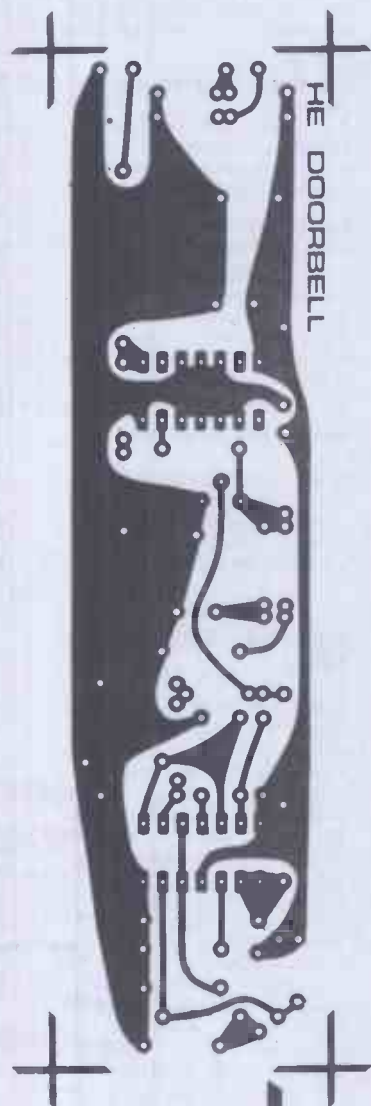
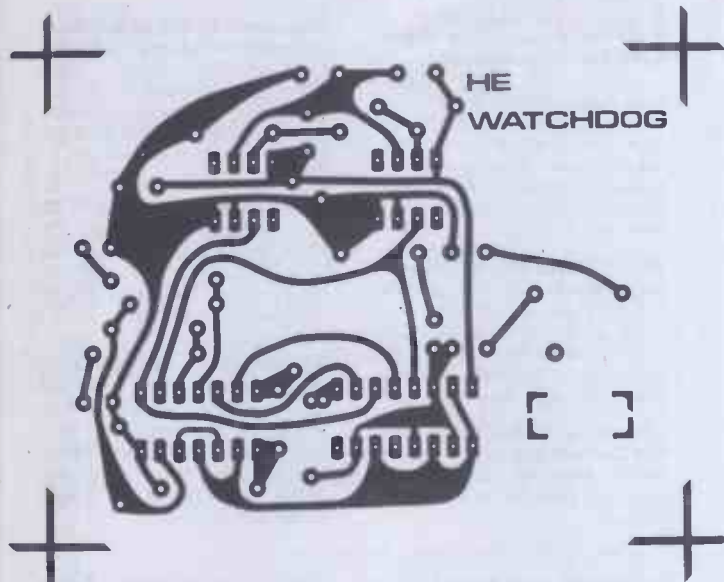
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**FERRANTI - "SIZE 14 x 6 x 3" SLOPING FRONT"** 55 Key ASCII Coded in steel case. Complete with Plug and Cable with circuit to convert to T.T.L. levels. **In good condition at only £26 + VAT, P/P £2.50**

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Full ASCII keyboard (built) £49.00 plus VAT  
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We have produced a mini-rack which accepts MICROKIT 65 and TANGINE. It has an integral power supply, but plug it into the mains and every you get finished in Black/Tangerine/Brushed aluminium. It gives your mini-system the professional finish **£43.00 plus VAT**

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 High quality replacement for most machines record/replay with magnetic brackets. £2.95

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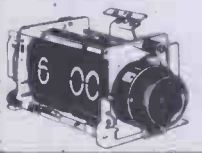
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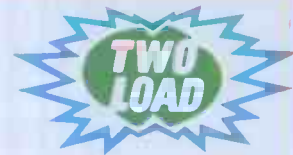


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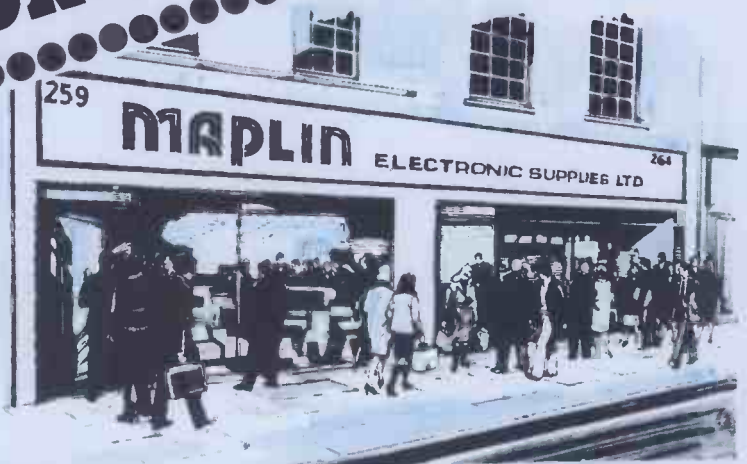
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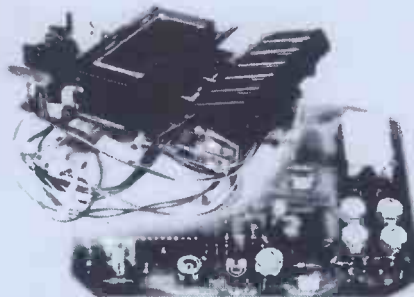
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