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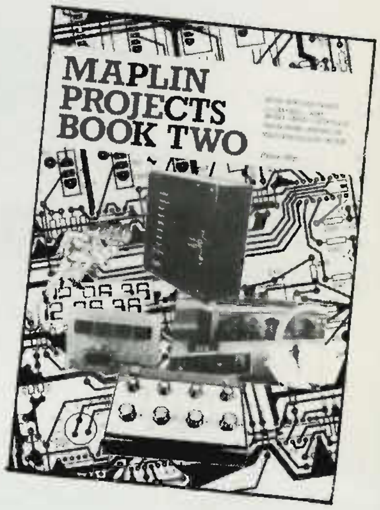

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Cover illustration by Tony Worsfeld

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VIC20 TALK~BACK

by Mark Brighton

- ★ **Allows speech to be easily included in programs**
- ★ **Allophone based system gives unlimited vocabulary**
- ★ **May be used with an unexpanded VIC — does not require large areas of memory**
- ★ **Speech output is direct to TV — no additional amplification needed**

This project is a 'plug-in' speech synthesizer for the VIC20, enabling the computer to 'talk' to the user in response to any programmed input. The synthesizer uses a system where words are put together from allophones, the basic 'building block' sounds of speech. In this way the sixty-four allophones available from this synthesizer can be strung together to form any English word or phrase, thus avoiding the need for several EPROMS each containing a limited vocabulary, as used by some speech synthesis systems.

The synthesizer is under complete program control, and can therefore be used for any application, from remote I/O operations to making games sound more realistic, depending on the program used.

Circuit Description

This circuit is built around the SP-0256 speech processor chip, an N channel MOS device incorporating the following functions:

1. A programmable digital filter which simulates the human voice tract.
2. A 16K ROM which contains the data for the 64 allophones.
3. A micro controller which controls the flow of speech data to the filter and the linking of allophones to produce words.
4. A pulse width modulator. This creates a digital speech output.

The speech processor is used by setting up an address on lines A0 to A5, to define one of 64 speech entry points, and pulsing $\overline{ALD}$ low to speak.

These address lines are connected, via a latch (IC1), to the address lines A0 to A5 on the VIC. The latch is enabled by

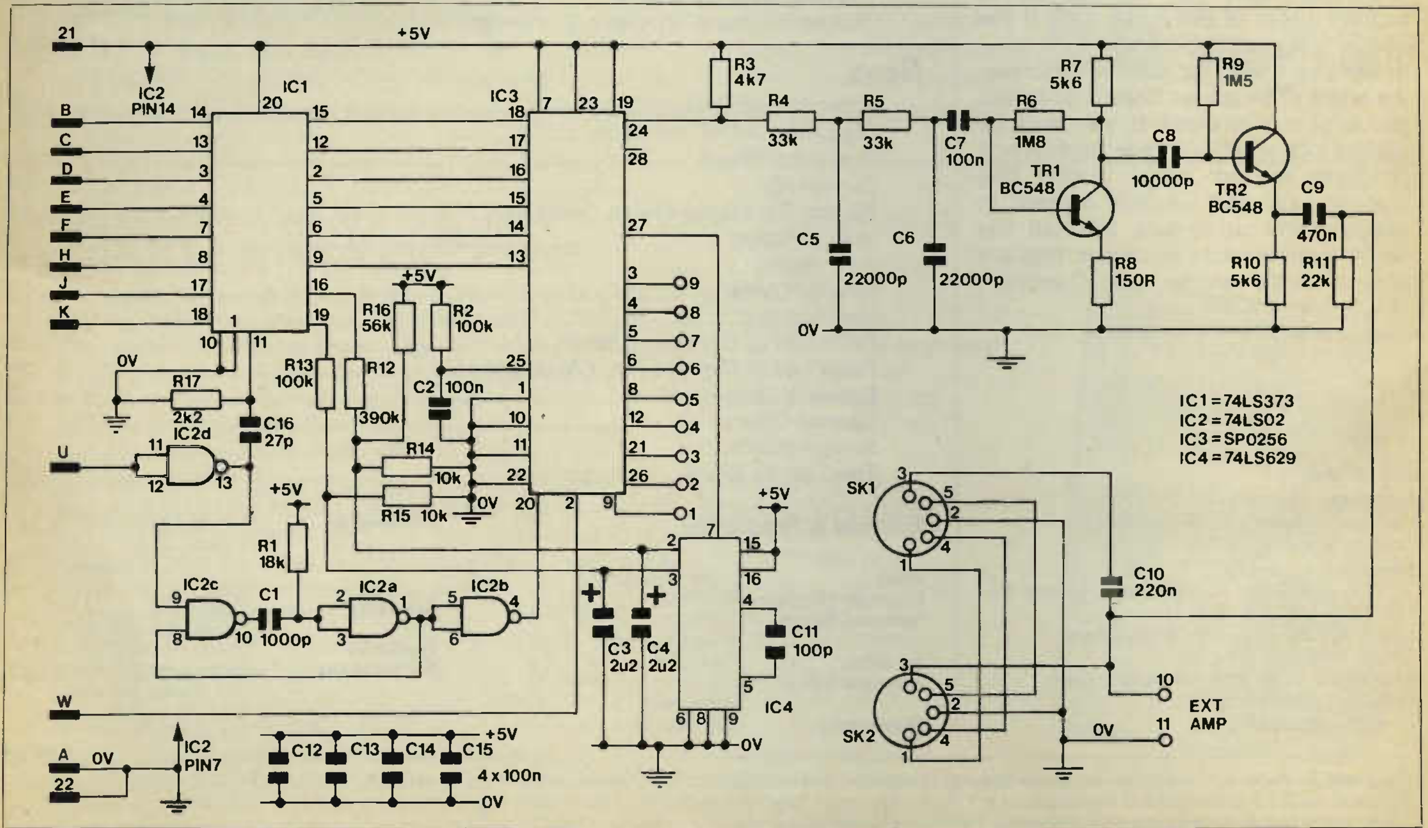
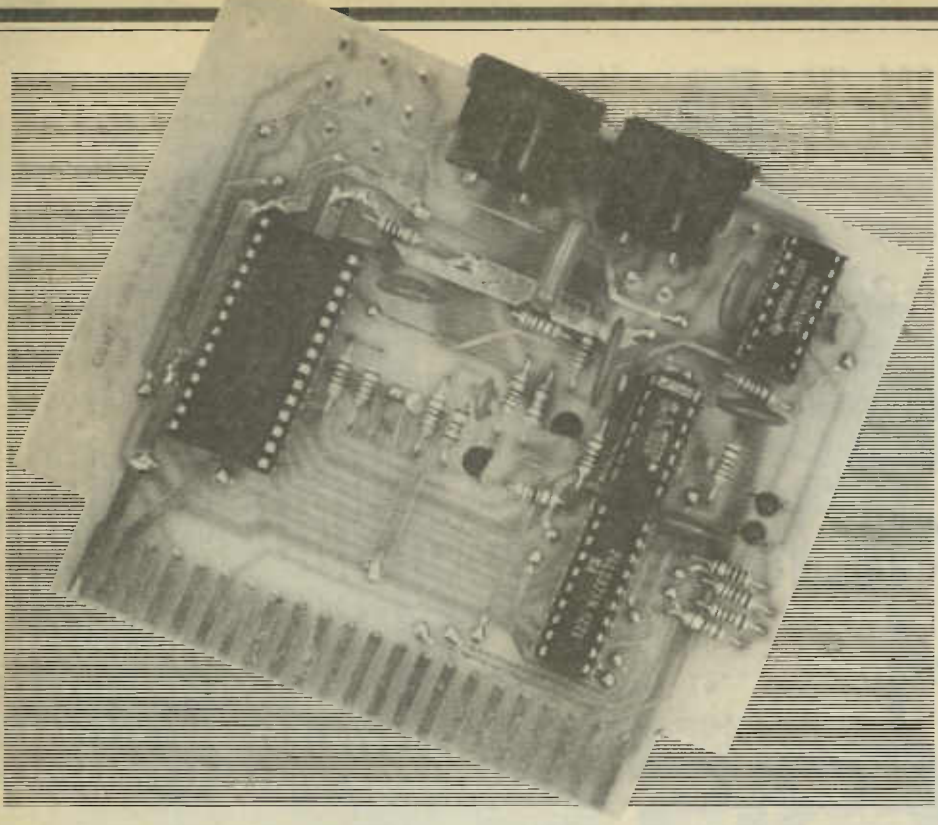


Figure 1. Circuit diagram.



IC2a when a block select pulse (I/O 3) is present, setting the speech entry points between 39936 and 39999.

IC2 forms a monostable that delays the block select pulse which enables the speech processor chip after the address set up on A0 to A5 is latched into IC1.

R5, C5 and C6 form a 5kHz low pass filter that converts the pulse modulated output of IC3 to an analogue signal. This is then amplified by TR1 and TR2. TR2 is a low output impedance emitter follower stage, which drives the VIC modulator.

IC4 is a voltage controlled oscillator, and provides the clock for IC3. The nominal frequency of this oscillator is set by C11 and R16 respectively. C3 and C4 prevent an abrupt change in clock frequency, and hence speech frequency, while R14 and R15 provide a discharge path for the capacitors.

The following status and control signals are provided on the board for ease of use and possible future expansion:

1. Veropin 1 is connected to $\overline{LRQ}$ on IC1, and is a logic 1 output while the speech processor is busy. This signal is

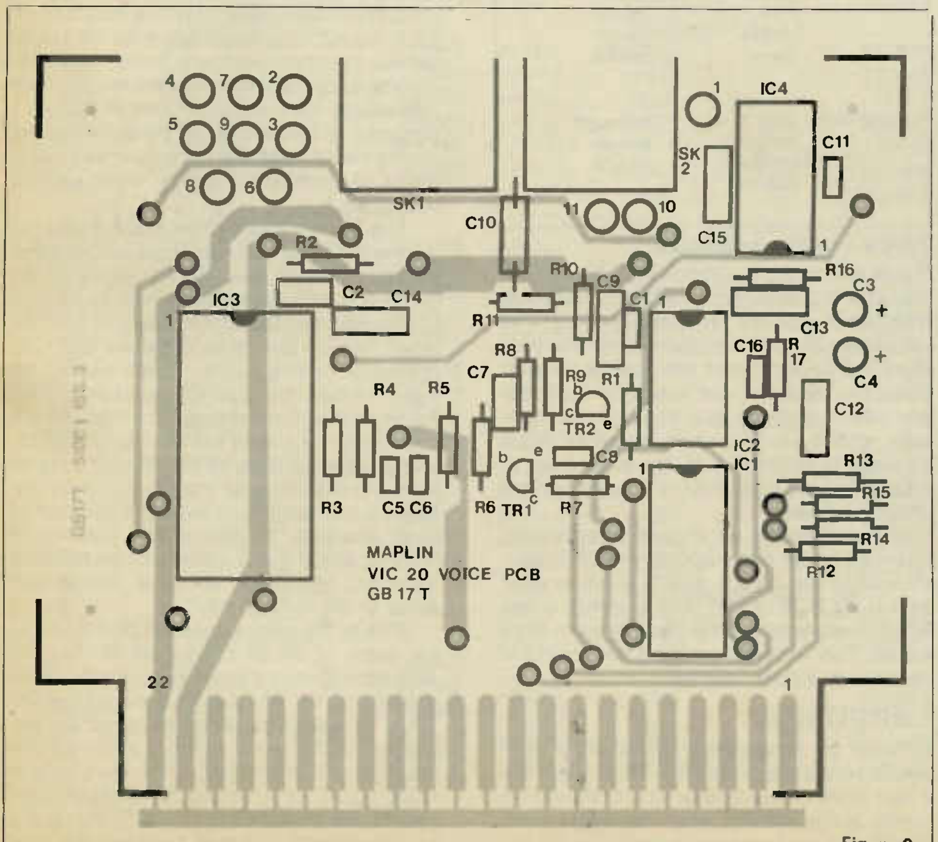


Figure 2.

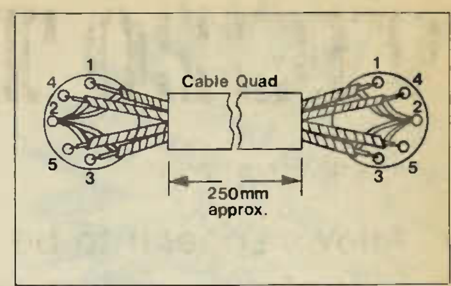


Figure 3.

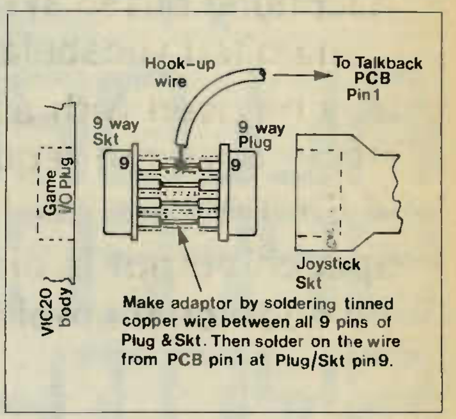


Figure 4.

connected, via PL1, to the paddle port on the VIC.

2. The RESET pin on IC1 is connected to the $\overline{NMI}$ line on the VIC. The chip is therefore reset when the VIC 'restore' key is pressed and an $\overline{NMI}$ pulse is generated.

3. Veropins 2 to 9 are serial address, data and control lines which can be used by an external speech ROM.

Use

To use the speech synthesizer, the correct addresses for each allophone in the phrase to be spoken must be POKEd

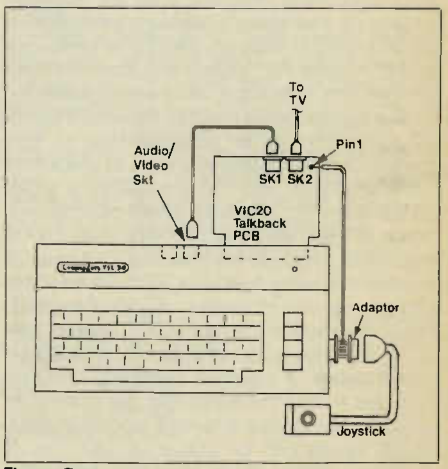
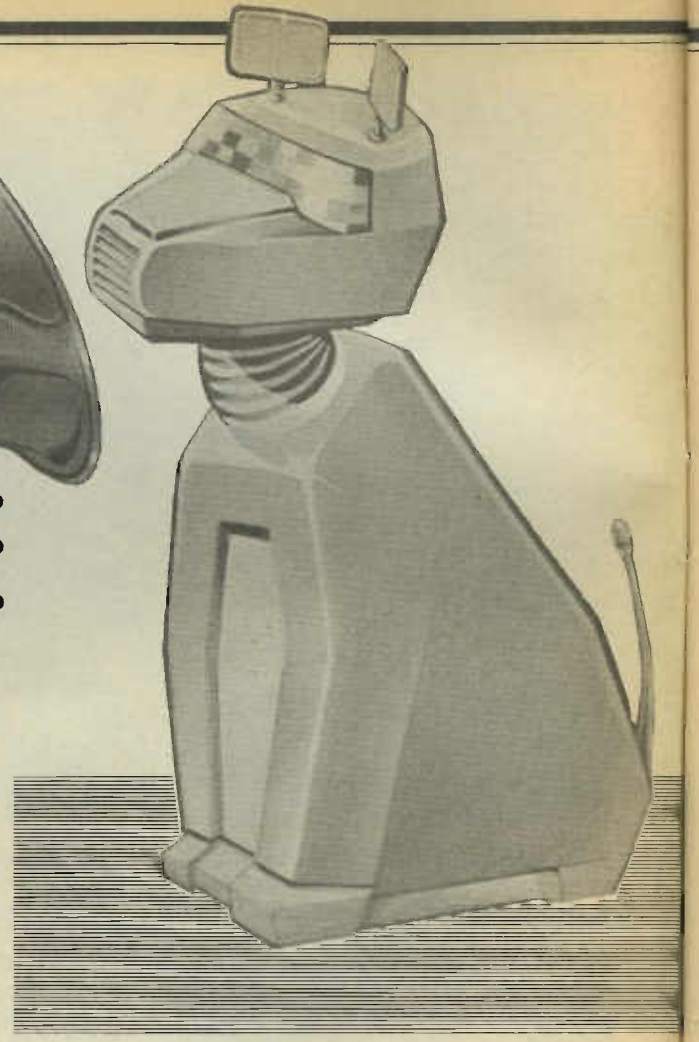


Figure 5.

sequentially with a value between 0 and 255 (the speech chip is linked to the address lines of the VIC, not the data lines, so the value POKEd may be any legal quantity).

One of the easiest ways to do this is to use a data statement where each number corresponds to an offset from the base address, i.e. the address of the first allophone stored in the speech

continued on page 7



ALLOPHONE SPEECH SYNTHESIS TECHNIQUE

by Janet May

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Introduction

The General Instrument allophone speech synthesis technique is easy to use, has a remarkably low bit rate, and allows the user to synthesise any English word by concatenating individual speech sounds. Each allophone requires a six bit address. Assuming that speech contains ten to twelve allophones per second, allophone synthesis would require addressing less than 100 bits per second. Previous techniques have involved synthesising and storing entire words as units. The major disadvantage of this method is that, unless you want to use a very large memory, you are limited to a small vocabulary. For example, pulse code modulation (PCM), which is no more than digital recording, storage, and playback of speech waveforms, requires about 70 thousand data bits per second of speech. Another method, linear predictive coding (LPC), which predicts a speech sample from a weighted combination of previous samples, requires only one to two thousand bits per second to speech. Using this method, approximately 15-20 words can be stored in 16K bits of memory. While these methods require a large memory for a limited vocabulary, their big advantage is relatively high quality speech.

Allophone synthesis, on the other hand, has the major advantage of providing an unlimited vocabulary, since the stored units are not words, but individual speech sounds (allophones). The user merely has to become familiar with the speech sounds of English *(which are different from letters)* and the allophone symbols used to represent them. Another use for allophone synthesis is in a text-to-speech system in which the user inputs a string of text no different from what you are presently reading. The advantage of such a system is that the user does not have to learn the allophone symbols. Two sets of rules would be required: one which converts text to allophone symbols, and a second which converts those symbols to sounds. It is the second set of rules which we have already created and are discussing here.

	One-sound-to-many-letter representation	Many-sound-to-one-letter representation
Vowels	meat feet Pete people penny	vein foreign deism deicer geisha
Consonants	ship tension precious nation	although ghastly cough

Table 1 - Spelling Irregularities

One disadvantage of allophone synthesis, however, is that, although completely understandable, the speech quality is not as good as it is for PCM or LPC. The problem arises when concatenating the allophones to form words. This will be discussed further in the sections to follow.

Language

In order to successfully use a set of allophone sounds to synthesise words there are a few preliminary points which should be made about speech and language. First, there is no one-to-one correspondence between written letters and the sounds of a language; secondly, speech sounds are not discrete units as beads on a string are; and lastly, speech sounds are acoustically different depending on what position in a word they occur, and what sounds precede or follow them.

The first of these is a problem which a child encounters when learning how to read. Each sound in a language may be represented by more than one letter, and conversely, each letter may represent more than one sound. (See the examples in Table 1). Because of these spelling irregularities we must be very careful to remember to think in terms of *sounds* not letters, when dealing with speech.

The second point to be made concerns segmentation of the speech signal. An adult who has learned how to read usually thinks of the acoustic stream of speech as a string of discrete sounds which he calls by their letter names. But, in fact, speech is a continuously varying signal which cannot be easily broken into distinct sound-size units. For example, if one attempts to extract the b sound from the word bat by taking successively larger chunks of the acoustic signal from the beginning of the word, one at first hears a non-speech noise, and then at some point hears ba. In other words, there is no point at which the b sound can be heard in isolation; one hears either a non-speech noise or the syllable ba.

Finally, the most important point to make for users of an allophone set, is that the acoustic signal of a speech sound may differ depending on whether it occurs in word-initial or word-final position; or in the environment of a vowel which is articulated in the front or back of the oral cavity, a long or short vowel, or a voiced or voiceless consonant. For example, the initial p in pop will be acoustically different from the p in spy,

		Labial	Labio-Dental	Inter-Dental	Alveo-Lar	Palatal	Velar	Glottal
Stop:	Voiceless	PP			TT		KK	
	Voiced	BB			DD		GG	
Fricatives:	Voiceless	WH	FF	TH	SS	SH		HH
	Voiced		VV	DH	ZZ	ZH*		
Affricates:	Voiceless					CH		
	Voiced					JH		
Nasals:	(Voiced)	MM			NN		NG*	
Resonants:	(Voiced)	WW			RR,LL	YY		

Labial: Upper and Lower Lips Touch or Approximate
Labio-Dental: Upper Teeth and Lower Lip Touch
Inter-Dental: Tongue Between Teeth
Alveolar: Tip of Tongue Touches or Approximates Alveolar Ridge (just behind upper teeth)
Palatal: Body of Tongue Approximates Palate (roof of mouth)
Velar: Body of Tongue Touches Velum (posterior portion of roof of mouth)
Glottal: Glottis (opening between vocal cords)

*These do not occur in word-initial position in English.
**Examples of these phonemes in word context can be found in Table 5.

Table 2 - Consonant Phonemes of English**

	Front	Central	Back
High	YR		
	IY		UW#
	IH*		UH*#
Mid	EY	ER	OW#
	EH*	AX*	OY#
	XR		
Low	AE*	AW#	AO*#
		AY	OR#
		AR	
		AA*	

* Short Vowels
# Rounded Vowels

Table 3 - Vowel Phonemes of English

	(Silence)	
PA1	PAUSE	10MS
PA2	PAUSE	30MS
PA3	PAUSE	50MS
PA4	PAUSE	100MS
PA5	PAUSE	200MS
	(Short Vowels)	
x/IH/	SiT	70MS
x/EH/	eND	70MS
x/AE/	HaT	120MS
x/UH/	BooK	100MS
x/AO/	auGHT	100MS
x/AX/	SuCCEED	70MS
x/AA/	HoT	100MS
	(Long Vowels)	
/IY/	See	250MS
/EY/	BeiGE	280MS
/AY/	SKy	260MS
/OY/	Boy	420MS
/UW1/	To	100MS
/UW2/	To	260MS
/OW/	Beau	240MS
/AW/	ouT	370MS
/EL/	SADDle	190MS
	(R — Coloured Vowels)	
/ER1/	Fir	160MS
/ER2/	Fir	300MS
/OR/	STore	330MS
/AR/	ALarM	290MS
/YR/	CLear	350MS
/XR/	REPair	360MS
	(Resonants)	
/WW/	wOOL	180MS
/RR1/	rURAL	170MS
/RR2/	BrAIN	120MS
/LL/	lAKE	110MS
/YY1/	yES	130MS
/YY2/	yES	180MS

	(Voiced Fricat.)	
/VV/	vEST	190MS
/DH1/	thEY	290MS
/DH2/	thEY	120MS
/ZZ/	zOO	210MS
/ZH/	AzURE	190MS
	(Voiceless Fricat.)	
x/FF/	fOOD	150MS
x/TH/	thIN	180MS
x/SS/	VEsT	90MS
/SH/	shIP	160MS
/HH1/	hE	130MS
/HH2/	hOE	180MS
/WH/	whIG	200MS
	(Voiced Stop Cons.)	
/BB1/	bUSINESS	50MS (SOFT)
/BB2/	bUSINESS	50MS
/DD1/	COULd	70MS
/DD2/	dO	160MS
/GG1/	gUEST	80MS
/GG2/	gOT	50MS
/GG3/	WIg	160MS
	(Voiceless Stop Cons.)	
/PP/	pOW	210MS
/TT1/	PARt	100MS
/TT2/	tO	140MS
/KK1/	cAN'T	160MS
/KK2/	SkY	190MS
/KK3/	cOMB	120MS
	(Affricate)	
/CH/	chURCH	190MS
/JH/	DOdgE	140MS
	(Nasal)	
/MM/	mILK	180MS
/NN1/	THIn	140MS
/NN2/	nO	190MS
/NG/	AnCHOR	220MS

x — These allophones can be doubled

Table 4. Allophones

and may be different from the final p in pop. Furthermore, the ear will perceive the same acoustic signal differently depending on what sounds precede or follow it. The word cot can be made to sound like cod by lengthening the duration of the O, and conversely, the word cod can be made to sound like cot by shortening the duration of the O.

Phonemes of English

It will be useful to know what the speech sounds of English are. The sounds of a language are called phonemes, and each language has a set of which is slightly different from those of other languages. Table 2 contains a chart of all the consonant phonemes of English, and Table 3 all the vowel phonemes of English.

Consonants are produced by creating a constriction or complete occlusion in the vocal tract which produces an aperiodic sound source. If the vocal cords are vibrating at the same time, as in the case of the voiced fricatives VV, DH, ZZ, and ZH (see Table 4) there are two sound sources: one which is aperiodic and one which is periodic.

Vowels are produced with a relatively open vocal tract and a periodic sound source (unless they are whispered) provided by the vibrating vocal cords. Vowels are classified according to whether the front or back of the tongue is high or low (see Table 3), whether they are long or short, and whether the lips are rounded or unrounded. In English all rounded vowels are produced in or near the back of the mouth (UW, UH, OW, AO, OR, AW).

It will be useful to remember that sounds which have features in common behave in similar ways. For example, the voiceless stop consonants PP, TT, and KK (see Table 2) require 50-80 msec of silence before them and the voiced stop consonants BB, DD and GG require 10-30 msec of silence before them. When you find a particular technique that works well with one sound, try using that same technique with similar sounds. For example, if you decide that KK1 sounds good before a front vowel (IY), use it before other front vowels (YR, IY, IH, EY, EH, XR, AE).

Allophones

So far we have been talking about phonemes, but in fact, a phoneme is an abstraction. It is the name given to a group of similar sounds in a language. Recall the statement that the phoneme PP will be acoustically different depending on whether it occurs in word-initial or word-final position, or after SS. Each of these different PPs are allophones of the phoneme PP. An allophone, therefore, is what occurs in the actual acoustic speech signal. A phoneme is the name of a group of related allophones. It is for this reason that our inventory of English speech sounds is called an allophone set.

How to use the allophone set

The allophone set (see Table 4) contains two or three versions of some phonemes. You may find that you need to use one allophone or a particular phoneme for word - or syllable - initial position and another for word - or syllable - final position. A detailed set of guidelines for using the allophones is given in Table 6. Note that these are suggestions, not rules.

DD2-AO-TT2-ER1	"daughter"
KK3-AX1-LL-AY-DD1	"collide"
SS-SS-IH-SS-TT2-ER1	"sister"
KK1-LL-AW-NN1	"clown"
SS-KK3-WW-XR	"square"
KK3-UH-KK1-IY	"cookie"
LL-EH-TT2-ER	"letter"
LL-IH-TT2-EL	"little"
AX1-NG-KK3-EL	"uncle"
KK1-AX1-MM-PP1-YY1-UW1-TT2-ER	"computer"
EH-KK1-SS-TT2-EH-EH-NN1-TT2	"extent"
TT2-UW2	"two"
AX1-LL-AR-MM	"alarm"
SS-KK3-CR	"score"
FF-ER2	"fir"

Table 5 - Examples of words made from Allophones

Silence

- PA1 (10 ms) — before BB, DD, GG, and JH
- PA2 (30 ms) — before BB, DD, GG, and JH
- PA3 (50 ms) — before PP, TT, KK, and CH, and between words
- PA4 (100 ms) — between clauses and sentences
- PA5 (200 ms) — between clauses and sentences

Short Vowels

- */IH/ — sitting, stranded
- */EH/ — extent, gentlemen
- */AE/ — extract, acting
- */UH/ — cookie, full
- */AO/ — talking, song
- */AX/ — lapel, instruct
- */AA/ — pottery, cotton

Long Vowels

- /IY/ — treat, people, penny
- /EY/ — great, statement, tray
- /AY/ — kite, sky, mighty
- /OY/ — noise, toy, voice
- /UW1/ — after clusters with YY: computer
- /UW2/ — in monosyllabic words: two, food
- /OW/ — zone, close, snow
- /AW/ — sound, mouse, down
- /EL/ — little, angle, gentlemen

R-Colored Vowels

- /ER1/ — letter, furniture, interrupt
- /ER2/ — monosyllables: bird, fern, burn
- /OR/ — fortune, adorn, store
- /AR/ — farm, alarm, garment
- /YR/ — hear, earring, irresponsible
- /XR/ — hair, declare, stare

Resonants

- /WW/ — we, warrant, linquist
- /RR1/ — initial position: read, write, x-ray
- /RR2/ — initial clusters: brown, crane, grease
- /LL/ — like, hello, steel
- /YY1/ — clusters: cute, beauty, computer
- /YY2/ — initial position: yes, yarn, yo-yo

Voiced Fricatives

- /VV/ — vest, prove, even
- /CH1/ — word-initial position: this, then, they
- /CH2/ — word-final and between vowels: bathe, bathing
- /ZZ/ — zoo, phase
- /ZH/ — beige, pleasure

Voiceless Fricatives

- */FF/ —
- */TH/ — These may be doubled for initial position and used singly in final position
- */SS/ —
- /SH/ — shirt, leash, nation
- /HH1/ — before front vowels: YR, IY, IH, EY, EH, XR, AE
- /HH2/ — before back vowels: UW, UH, OW, OY, AO, OR, AR
- /WH/ — white, whim, twenty

Voiced Stops

- /BB1/ — final position: rib; between vowels: fibber; in clusters: bleed, brown
- /BB2/ — initial position before a vowel: beast
- /DD1/ — final position: played, end
- /DD2/ — initial position: down; clusters: drain
- /GG1/ — before high front vowels: YR, IY, IH, EY, EH, XR
- /GG2/ — before high back vowels: UW, UH, OW, OY, AX; and clusters: green, glue
- /GG3/ — before low vowels: AE, AW, AY, AR, AA, AO, OR, ER; and medial clusters: anger; and final position: peg

Voiceless Stops

- /PP/ — pleasure, ample, trip
- /TT1/ — final clusters before SS: tests, its
- /TT2/ — all other positions: test, street
- /KK1/ — before front vowels: YR, IY, IH, EY, EH, XR, AY, AE, ER, AX; initial clusters: cute, clown, scream
- /KK2/ — final position: speak; final clusters: task
- /KK3/ — before back vowels: UW, UH, OW, OY, OR, AR, AO; initial clusters: crane, quick, clown, scream

Affricates

- /CH/ — church, feature
- /JH/ — judge, injure

Nasal

- /MM/ — milk, alarm, ample
- /NM1/ — before front and central vowels: YR, IY, IH, EY, EH, XR, AE, ER, AX, AW, AY, UW; final clusters: earn
- /NN2/ — before back vowels: UH, OW, OY, OR, AR, AA
- /NG/ — string, anger

*These allophones can be doubled.

Table 6. Guidelines for using the Allophones.

Decimal Address	Octal Address	Hex Address	Allophones	Sample Word	Duration
0	000	0	PA1	PAUSE	10MS
1	001	1	PA2	PAUSE	30MS
2	002	2	PA3	PAUSE	50MS
3	003	3	PA4	PAUSE	100MS
4	004	4	PA5	PAUSE	200MS
5	005	5	/OY/	Boy OY	420MS
6	006	6	/AY/	Sky Y	250MS
7	007	7	/EH/	End E	70MS
8	010	8	/KK3/	Comb C	120MS
9	011	9	/PP/	Pow P	210MS
10	012	A	/JH/	Dodge G	140MS
11	013	B	/NN1/	Thin N	140MS
12	014	C	/1H/	Sit I	70MS
13	015	D	/TT2/	To T	140MS
14	016	E	/RR1/	Rural R	170MS
15	017	F	/AX/	Succeed U	70MS
16	020	10	/MM/	Milk M	180MS
17	021	11	/TT1/	Part T	100MS
18	022	12	/DH1/	They TH	290MS
19	023	13	/IY/	See E	250MS
20	024	14	/EY/	Beige EI	280MS
21	025	15	/DD1/	Could ID	70MS
22	026	16	/UW1/	To O	100MS
23	027	17	/AO/	Aught AU	100MS
24	030	18	/AA/	Hot O	100MS
25	031	19	/YY2/	Yes YE	180MS
26	032	1A	/AE/	Hat A	120MS
27	033	1B	/HH1/	He H	130MS
28	034	1C	/BB/	Business BU	80MS
29	035	1D	/TH/	Thin TH	180MS
30	036	1E	/UH/	Book OO	100MS
31	037	1F	/UW2/	Food OO	260MS
32	040	20	/AW/	Out OU	370MS
33	041	21	/DD2/	Do D	160MS
34	042	22	/GG3/	Wig IG	140MS
35	043	23	/VV/	Vest V	190MS
36	044	24	/EG1/	Guest GU	80MS
37	045	25	/SH/	Ship S	160MS
38	046	26	/ZH/	Azure Z	190MS
39	047	27	/RR2/	Brain R	120MS
40	050	28	/FF/	Food F	150MS
41	051	29	/KK2/	Sky K	190MS
42	052	2A	/KK1/	Can't C	160MS
43	053	2B	/ZZ/	Zoo Z	210MS
44	054	2C	/NG/	Anchor N	220MS
45	055	2D	/LL/	Lake L	110MS
46	056	2E	/WW/	Wool W	180MS
47	057	2F	/XR/	Repair R	360MS
48	060	30	/WH/	Whig W	200MS
49	061	31	/YY1/	Yes Y	130MS
50	062	32	/CH/	Church C	190MS
51	063	33	/ER1/	Fir IR	160MS
52	064	34	/ER2/	Fir ERR	300MS
53	065	35	/CW/	Beau AU	240MS
54	066	36	/DH2/	They TH	240MS
55	067	37	/SS/	Vest S	90MS
56	070	38	/NN2/	No N	190MS
57	071	39	/HH2/	Hoe H	180MS
58	072	3A	/OR/	Store OR	330MS
59	073	3B	/AR/	Alarm A	290MS
60	074	3C	/YR/	Clear R	350MS
61	075	3D	/EG2/	Got G	40MS
62	076	3E	/EL/	Saddle L	190MS
63	077	3F	/BB2/	Business B	50MS

Allophone Address Table.

For example, DD2 sounds good in initial position and DD1 sounds good in final position, as in "daughter" and "collide". (See Table 5 for instructions on how to create all the sample words mentioned in this section). One of the differences between the initial and final versions of a consonant is that an initial version may be longer than the final version. Therefore, to create an initial SS, you can use two SSs instead of the usual single SS at the end of a word or syllable, as in "sister". Note that this can be done with TH, and FF, and the inherently short vowels (to be discussed below), but with no other consonants. You will want to experiment with some consonant clusters (strings of consonants such as str, cl) to discover which version works best in the cluster. For example KK1 sounds good before LL as in "clown", and KK2 sounds good before WW as in "square". One allophone of a particular phoneme may sound better before or after back vowels and another before or after front vowels. KK3 sounds good before UH and KK1 sounds good before 1y, as in "cookie". Some sounds (PP, BB, TT, DD, KK, GG, CH and JH) require a brief duration of silence before them. For most of these, the silence has already been added but you may decide you want to add more. Therefore, there are several pauses included in the allophone set varying from 10-200 msec. To create the final sounds in the words "letter" and "little" use the allophones ER and EL. Remember that you must always think about how a word sounds, not how it is spelled. For example, the NG allophone obviously belongs at the ends of the words "sing" and "long", but notice that the NG sound is represented by the letter N in "uncle". And remember that some sounds may not even be represented in words by any letters, as the YY in "computer".

As mentioned earlier there are some vowels which can be doubled to make longer versions for stressed syllables. These are the inherently short vowels IH, EH, AE, AX, AA and UH. For example, in the word "extent" use one EH in the first syllable, which is unstressed and two EHs in the second syllable which is stressed. Of the inherently long vowels there is one, UW, which has a long and short version. The short one, UW1, sounds good after YY in computer. The long version, UW2, sounds good in monosyllabic words like "two". Included in the vowel set is a group called R-coloured vowels. These are vowel + R combinations. For example, the AR in "alarm" and the OR in "score". Of the R-colored vowels there is one, ER, which has a long and short version. The short version is good for polysyllabic words with final ER sounds like "letter", and the long version is good for monosyllabic words like "fir". One final suggestion is that you may want to add a pause of 30-50 msec between word, when creating sentences, and a pause of 100-200 msec between clauses.

VIC20 TALKBACK continued from page 3

chip (this base address has been set at 39936, by using the I/O 3 block select pulse on the edge connector). An example of this method is shown in Listing 1.

A form of tonal inflection is also provided. To raise the tone of a given allophone, add 64 to the offset from the base address. To lower the tone, add 128. Best results will be achieved by experimentation.

```
1     POKE 37139,0 : POKE 37154,127 : REM SET
                         UP DDR FOR PADDLE PORT
5     CHIP = 39936
10    FOR NUMBER = 1 TO 23 :
      READ SPEECH :
      POKE CHIP+SPEECH,0 :
      WAIT 36872,128 :
      NEXT NUMBER
20    POKE 37154,255 : REM RESET DDR FOR
                                KEYBOARD
500   DATA     16,90,73,109,76,75,64,55,9,83,
               114,64,119,76,75,93,79,119,55,
               6,43,51,0
```

Construction

Referring to figure 2 and the parts list, assemble the project as follows: First, bend and insert resistors R1 to R17, and fit capacitors C1 to C16. Insert all veropins and IC sockets, TR1 and TR2. Solder all components into place, clean and inspect the track for dry joints and short circuits, and fit the ICs into the holders. The connector leads are to be used with the plug-in board, and these should be wired to the plugs provided as shown in figures 3 and 4.

Testing

Using a meter switched to resistance, measure between +5V and 0V on the board, to ensure that no shorts exist. With the computer switched off, plug the board into the memory expansion connector, and PL1 into the control port (joystick socket) on the side of the VIC. PL2 is plugged into the modulator socket on the VIC, and PL3 into SK1 on the speech synthesizer board. The VIC modulator is then plugged into SK2 on the synthesizer (see figure 5).

Switch the computer on. If the computer fails to display the 'CBM BASIC' and 'READY' messages switch off immediately and re-check all component placings and connections.

VIC20 TALKBACK PARTS LIST

Resistors: All 0.4W 1% Metal Film

R1	18k		(M18K)
R2,13	100k	2 off	(M100K)
R3	4k7		(M4K7)
R4,5	33k	2 off	(M33K)
R6	1M8		(M1M8)
R7,10	5k6	2 off	(M5K6)
R8	150R		(M150R)
R9	1M5		(M1M5)
R11	22k		(M22K)
R12	390k		(M390K)
R14,15	10k		(M10K)
R16	56k		(M56K)
R17	2K2		(M2K2)

Capacitors

C1	1000pF Ceramic		(WX68Y)
C2,7	100nF Minidisc	2 off	(YR75S)
C3,4	2u2F Tantalum	2 off	(WW62S)
C5,6	22,000pF Ceramic	2 off	(WX78K)
C8	10,000nF Ceramic		(WX77J)
C9	470nF Minidisc		(YR76H)
C10	220nF Polyester		(BX78K)
C11	100pF Ceramic		(WX56L)
C12-15 inc.	100nF Disc Ceramic	4 off	(BX03D)
C16	27pF Ceramic		(WX49D)

Semiconductors

TR1,2	BC548	2 off	(QB73Q)
IC1	74LS373		(YH15R)
IC2	74LS02		(YF02C)
IC3	SP0256		(QY50E)
IC4	74LS629		(WH02C)

Miscellaneous

	14 Pin DIL Skt		(BL18U)
	16 Pin DIL Skt		(BL19V)
	20 Pin DIL Skt		(HQ77J)
	28 Pin DIL Skt		(BL21X)
	Veropin 2141	(1 Pkt)	(FL21X)
	Track Pin	(1 Pkt)	(FL82D)
SK1,2	PC Din Skt 5-Pin A	2 off	(YX91Y)
	PCB		(GB17T)
	D-Range 9-Way Plug		(RK60Q)
	D-Range 9-Way Skt		(RK61R)
	DIN Plug 5-Pin A	2 off	(HH27E)
	Cable Quad	1m	(XR23A)
	Hook-up Wire	1m	(BL00A)

A complete kit of all parts is available for this project.
Order As LK00A (VIC Talkback Kit) Price £24.95

ZX 81 TALK~BACK

by Dave Goodman

- ★ **Add speech to your programs**
- ★ **Allophone set provides unlimited vocabulary**
- ★ **Plugs directly into expansion socket or motherboard**
- ★ **Entry from simple PEEK and POKE in BASIC**
- ★ **Audio output to external amplifier or our 'Sound-on-TV'**

For many years considerable research and development has been done in the field of human speech synthesis. All languages have their own complex speech sounds, or ALLOPHONES, which are strung together to form recognisable words. The SHAW alphabet gives an indication of speech sounds, as many schoolchildren are probably aware.

Simple words like 'cad' use the letters 'see', 'ae', and 'tee'. Stringing these allophones together will produce the sound 'seat', not at all like 'cat', so letters of the alphabet are pronounced differently according to where they are used!

General Instruments' SPO256 Orator-Speech Processor makes use of the allophone system by storing sounds, with instructions, in 16K ROM. A Microtroller control data flow from ROM to a digital filter where speech elements are linked together, along with pitch and amplitude information. The resulting information is pulse width modulated, producing a digital output which has to be low pass filtered to produce recognisable speech.

Sixty-three allophones are available for use, and by concatenating individual sounds, reproduction of entire word lengths is possible. This is very flexible, although speech quality is not as good as systems where complete words are stored.

Circuit Description

Address lines AØ to A15 are decoded by IC1, 2 and 3 to give a memory-mapped 'PORT' address of 16417. This address has not been allocated to the working system of the ZX81, and as it also has a RAM location it is ideal for use in this application. Writing to this address (POKE 16417) places a negative pulse on IC5 pin 20 Address Load input. Data written into IC5, on pins 13 to 18, is then loaded onto the input port, where it is processed to give speech output on pin 24. The circuitry of TR1 forms a low pass filter, to remove any H.F. content from the speech, and the resultant signal is amplified to a usable level of 100-500mV with the output on pin 1 (pin 2 is the 0V or screen). Obviously, the computer can supply data at a far greater rate than it can be processed by IC5, so pin 8 (standby) is used to enable IC6 if the 'PORT' address is read (PEEKed).

With suitable programming IC6 will place DØ to D8 to binary 0 and a software loop will prevent further data being entered to IC5 until the standby output resets. One problem, however, becomes apparent when the system is first switched on; R1 and C7 reset the SPO256 and pin 8 goes low. While the ZX81 CPU is resetting RAM locations, IC6 is enabled and data is prematurely entered, causing the computer to crash. IC4b, C13, and D1 hold IC6 pins 1 and 19 high to prevent this happening. Entering the command NEW can also cause this problem, but not if you are using 1 to 16K RAM. C13 may need to increase in value if larger RAM is used, and this is a subject for experimentation.

Construction

Insert all 48 track pins through the holes marked with a circle, and solder them on both sides of the PCB. Fit resistors R1 to R7; if using the new 1% resistors with 5 band colour codes make sure that the values are correct. Finally, fit all capacitors, noting the polarity marking on C10. Do not insert the ICs yet. Solder all components to the PCB, clean, and inspect your work. Many faults can be cleared by using thinners and a stiff brush to remove all flux and solder splashes from the PCB.

If you do not possess a motherboard, fit a 2 x 23 socket (RK35Q) to the edge connector and solder all pins. Otherwise plug the module into your ZX81.

Testing

Apply power. If all is well the cursor will appear as normal. Use a voltmeter to check that the 0V and +5V rails are correct on the PCB. Switch off and insert the six ICs into their sockets. Reapply power. The cursor should appear again. You will need either an external amplifier or our sound/video project with connections to pins 1 and 2 on the module. Turn the amplifier or TV volume control to an acceptable level and type in POKE 16417, 197 followed by NEWLINE. You should hear the allophone 'oy' and a continuous 'e' sound. Type POKE 16417, Ø NEWLINE and the sound will cease. Thus far, all should be well. Now enter program 1 and run it. Various prompts and directions appear during the program run and allophone sounds, not words, will be heard. Run the program several times to familiarise yourself with each sound and code number.

Using the Talkback

If you refer to the Sinclair Manual page 178, you will see that address 16417 is not used by the working system. Fortunately this address, being part of the memory map, has a location in RAM which makes it ideal for use a a 'PORT'. Data POKEd to this address is read by the SPO256 chip, so the numbers entered must range from 192 to 255 to suit.

Table 1 gives a list of numbers and their equivalent allophone sound. Also shown is a list of ZX81 characters corresponding to each number and allophone. If a word, like COMPUTER, is phonetically split into a series of vowels

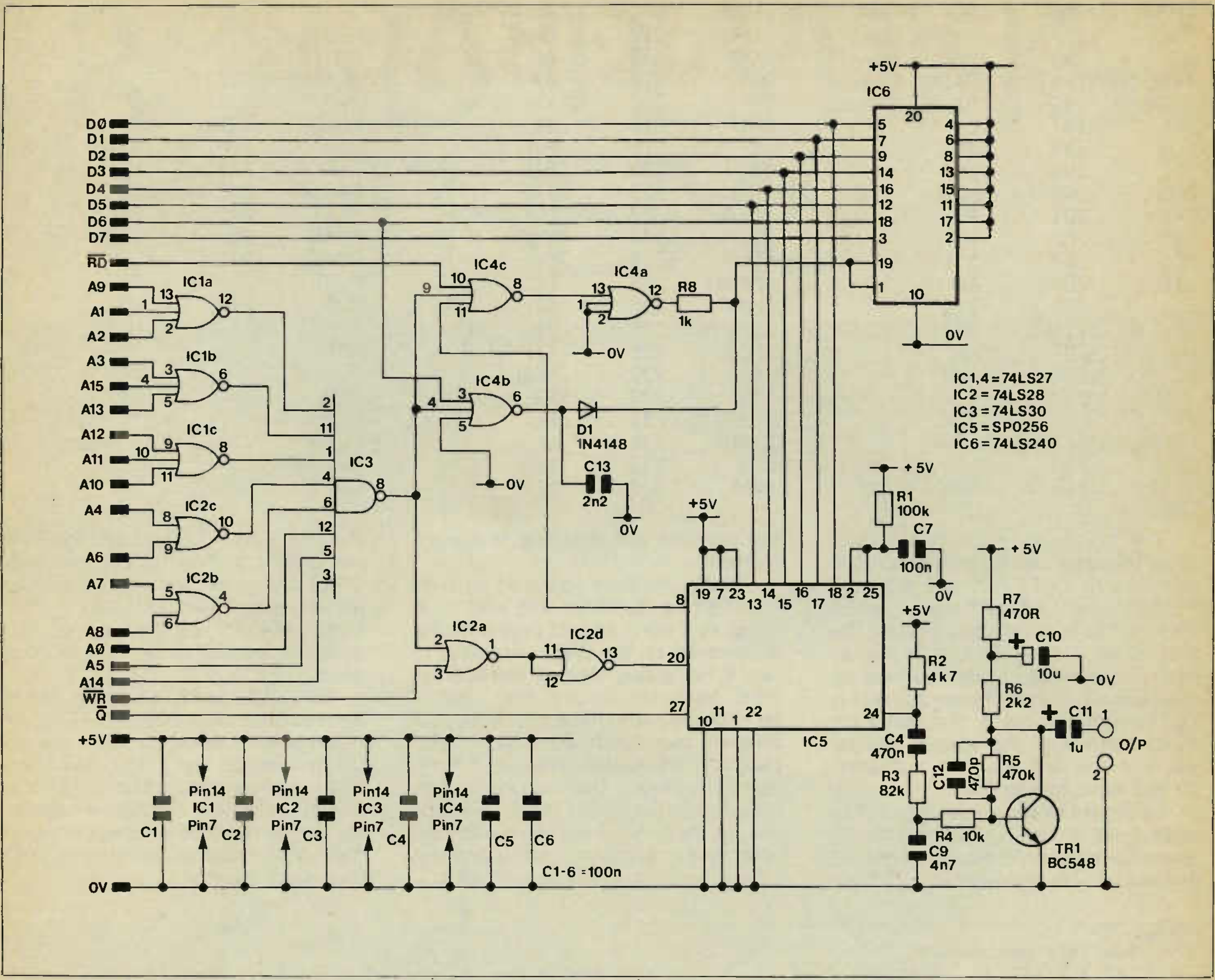


Figure 1. Circuit diagram.

and consonants the allophone equivalent will be something like this:

WORD	ALLO-PHONE	CODE	CHR$
C	KER	233	DIM
O	AA	216	**
M	MM	208	SQR
P	PP	201	TAN
U	YUH	241	LET
	OOW	214	CHR$
T	TT2	205	LN
ER	ERR	241	POKE

The SP0256 has 63 allophones, five of which are pauses of different duration, which leaves 58 to span the range of the English language. Because of this limitation compromises have to be made with pronunciation, but in practise it is not a real problem as long as you do not mind your computer speaking with an American accent!

The letter c in computer does not sound like 'see', but 'k' as in kite. A short pause, e.g. code 194 (50ms) inserted between C and computer enhances the C, as can be heard in program 2. If you ran the test program, you will have heard each allophone spoken, and be already familiar with the sounds available, so now enter program 2.

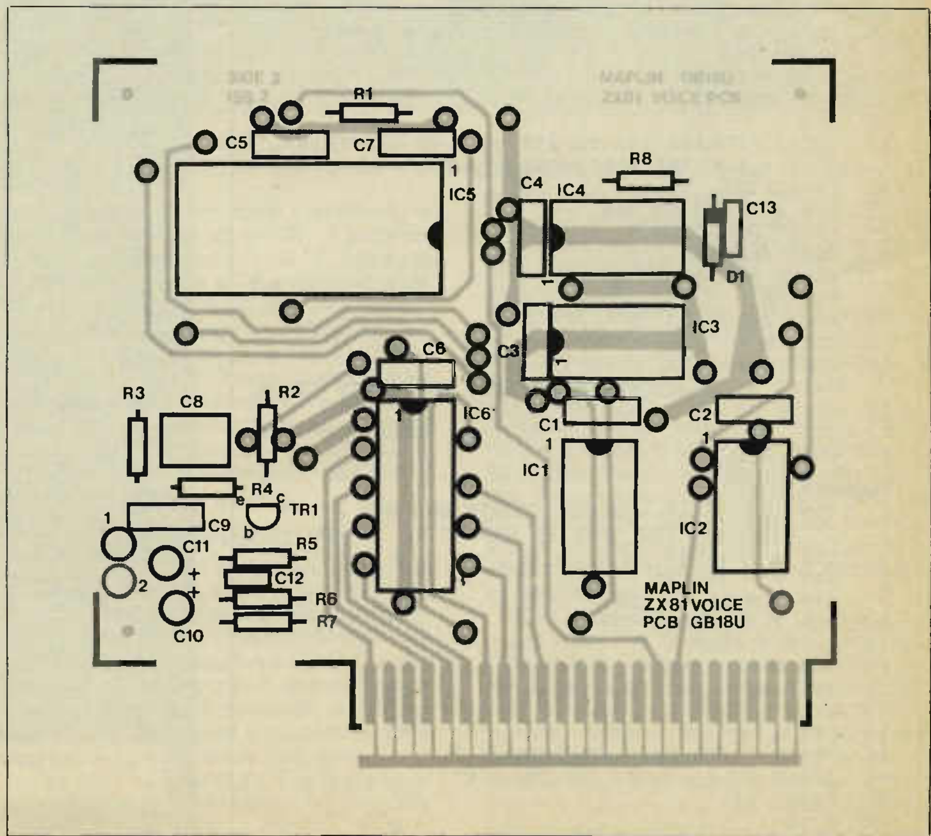


Figure 2. PCB artwork and legend.

CHR$	CODE	ALLOPHONE	CHR$	CODE	ALLOPHONE			
""	192	PAUSE 10ms	CHR$	214	OOW	FOR	235	ZER
AT	193	PAUSE 30ms	NOT	215	AO	GOTO	236	NA
TAB	194	PAUSE 50ms	**	216	AA	GOSUB	237	LL
CODE	196	PAUSE 200ms	OR	217	YE	INPUT	238	WW
VAL	197	OY	AND	218	AE	LOAD	239	RE
LEN	198	AY	<=	219	HH1	LIST	240	WH
SIN	199	EH	>=	220	BU	LET	241	YUH
COS	200	KK3	<>	221	TH	PAUSE	242	CH
TAN	201	PP	THEN	222	UO	NEXT	243	ERE
ASN	202	JH	TO	223	UOO	POKE	244	ERR
ACS	203	NN	STEP	224	OU	PRINT	245	UO
ATN	204	1H	LPRINT	225	DD2	PLOT	246	DH2
LN	205	TT2	LLIST	226	GG	RUN	247	SS
EXP	206	RR1	STOP	227	VE	SAVE	248	NNN
INT	207	AX	SLOW	228	GU	RAND	249	HER
SQR	208	MM	FAST	229	SSH	IF	250	OR
SGN	209	TT1	NEW	230	SZ	CLS	251	AR
ABS	210	DH1	SCROLL	231	R	UNPLOT	252	YR
PEEK	211	IY	CONT	232	FF	CLEAR	253	GGG
USR	212	EY	DIM	233	KER	RETURN	254	EL
STR$	213	DD1	REM	234	KU	COPY	255	BB

TABLE 1

The technique used in this program relies on placing allophone code numbers as CHR$ in line 1 after the REM statement. Altogether there are 18 CHR$ in this line, including pauses. The first address after REM is 16514, so each character has its own address up to 16532. The value of each address is POKEd into variable A, this being the PORT address of the speech processor, and line 1 is scanned, a character at a time, by line 10.

A software loop is set up by line 25 to allow time for each allophone to be spoken before continuing with the next instruction. Try removing line 25 from the program and listening to the difference.

Maybe you have your own routines for POKEing numbers into port locations, so I won't go into programming techniques on the ZX81. Needless to say, if using this method the address must be found for the first character to be read after REM, otherwise your program may crash. Some of the allophone CHR$ must be entered in command word mode. One way of doing this is to first enter THEN (shift CHR$) to change the cursor from L to K, and then enter the command word. Step the cursor back to THEN and RUBOUT. Step the cursor forward past the command word, and continue with the next CHR$. Always add a space (192 or "") at the end of the character string or insert POKE 16417,Ø at the end of your program, otherwise speech will continue.

FOR-NEXT or PAUSE delays can be entered after the POKE 16417 command to slow down speech if you find that it talks too fast. Use codes 192 to 196 to add pauses between allophones where required. Previous sounds spoken can then be emphasised to suit the word formation, and speech made more intelligible.

Program 1.

```
1    REM TEST PROGRAM
2    LET A = 197
3    LET PORT = 16417
4    PRINT "PRESS NEWLINE "
5    IF INKEY$ = " " THEN GOTO 5
6    PRINT "ALLOPHONE ""OY"" WILL BE SPOKEN "
7    PAUSE 250
8    POKE PORT,A
9    POKE PORT,0
10   CLS
11   PRINT "NUMBER 197 TO 255 WILL BE DISPLAYED,
        AND THE ALLOPHONE SPOKEN."
12   PAUSE 500
13   FOR A = 197 TO 255
14   PRINT AT 10,14;A
15   POKE PORT,A
16   FOR B = 0 TO 10
17   NEXT B
18   POKE PORT,192
19   NEXT A
20   POKE PORT,192
21   PRINT AT 15,0;"PRESS NEWLINE TO REPEAT TESTS"
22   INPUT A$
23   CLS
24   GOTO 11
```

Program 2.

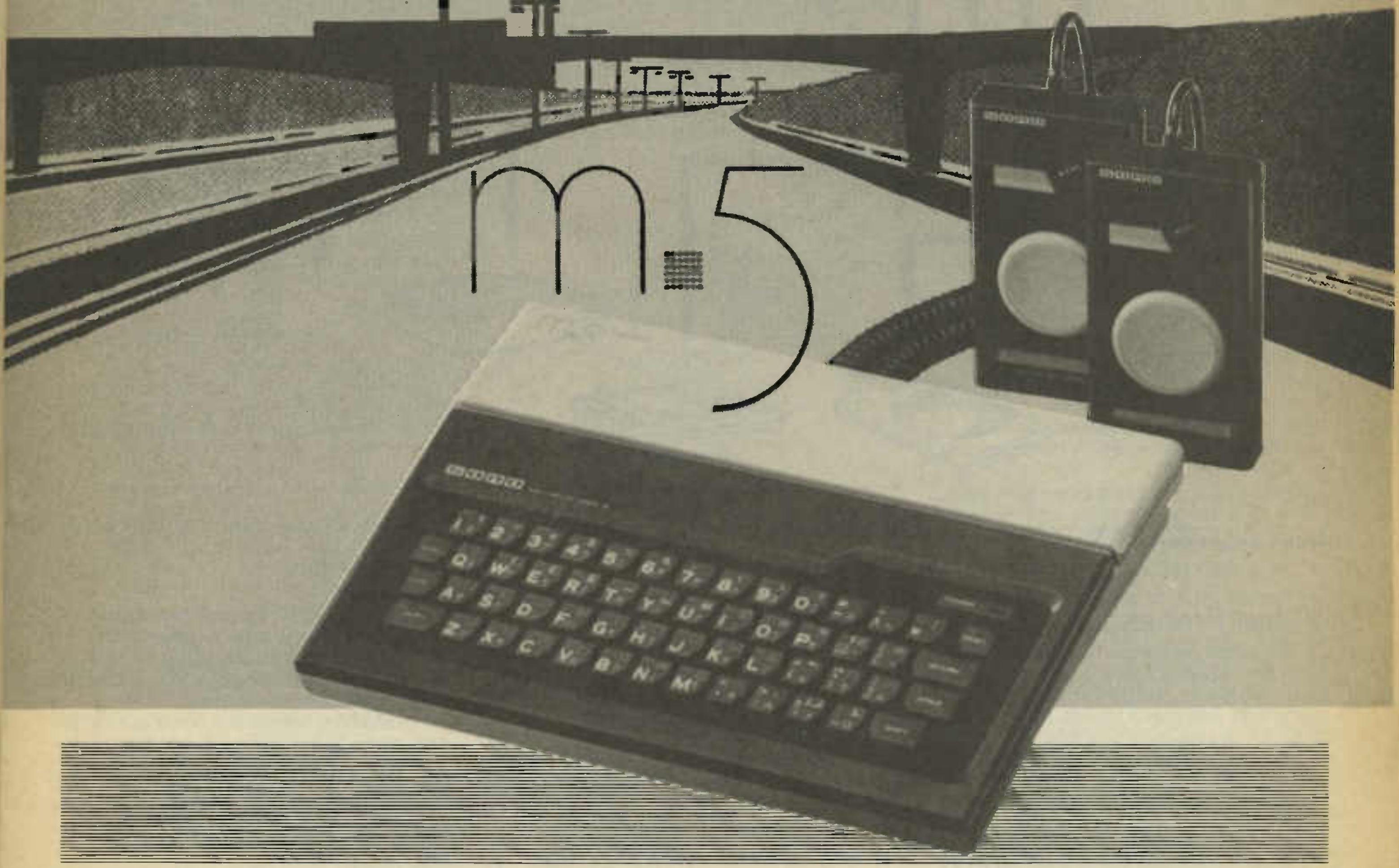
```
1    REM LEN "" AT AND SQR "" TAB USR DIM AT **
        SQR TAN LET CHR$ LN NEXT ""
3    LET A = 16417
5    LET B = 16514
7    REM NUMBER OF CHR$
10   FOR C = B TO (B+17)
15   POKE A,PEEK C
20   REM WORD LENGTH
25   IF PEEK A=0 THEN GOTO 25
30   NEXT C
35   CLS
40   PRINT " ""I AM A COMPUTER"" "
45   PRINT AT 18,0;"PRESS NEWLINE"
50   INPUT A$
60   GOTO 1
```

ZX81 TALKBACK PARTS LIST

Resistors — all 0.4W 1% metal film			
R1	100k		(M100K)
R2	4k7		(M4K7)
R3	82k		(M82K)
R4	10k		(M10K)
R5	470k		(M470K)
R6	2k2		(M2K2)
R7	470R		(M470R)
R8	1k		(M1K)
Capacitors			
C1-7 inc	100nF Disc Ceramic	7 off	(BX03D)
C8	470nF Polycarbonate		(WW49D)
C9	4n7F Polycarbonate		(WW26D)
C10	10uF 35V PC Electrolytic		(FF04E)
C11	1uF 35V Tantalum		(WW60Q)
C12	470pF Ceramic		(WX64U)
C13	2n2F Ceramic		(WX72P)
Semiconductors			
D1	1N4148		(QL80B)
TR1	BC548		(QB73Q)
IC1,4	74LS27	2 off	(YF18U)
IC2	74LS28		(YF19V)
IC3	74LS30		(YF20W)
IC5	SP0256		(QY50E)
IC6	74LS240		(YF87U)
Miscellaneous			
	14-pin DIL skt	4 off	(BL18U)
	20-pin DIL skt		(HQ77J)
	28-pin DIL skt		(BL21X)
	ZX81 voice pcb		(GB18U)
	Veropin 2141	1 pkt	(FL21X)
	Track Pin	1 pkt	(FL82D)

A set of parts is available to build the ZX81 Talkback.
Order As LK01B Price £24.95

ROAD TESTING THE M5



Within the last two years we have seen an explosion in the numbers of home computers competing for the money in our pockets. This year there will doubtless be many more. Most of them will be variations on the same theme, but one that we've been looking at recently really does seem to have something extra. It comes from the Japanese business microcomputer manufacturer Sord and is called the M5. It is in its graphics capabilities that the M5 really stands out, and we will look at that in depth later.

The M5 is a neat, lightweight and compact unit which has had to forego a full-size keyboard to remain compact. The keyboard has moving rubber keys, but they do have a nice feel and are as large as possible in the space provided. The worst thing about the keyboard is that the designers have seen fit to place the space and return keys next to each other, which can cause a lot of confusion at first.

Keyboard Functions

Fortunately the M5 boasts an excellent on-screen editor which allows you to move the cursor anywhere on the screen then change, add or delete characters at the desired point. As with most computers, each key (of which there are 55) has several functions.

Upper and lower case characters, a direct function call to BASIC, a graphics symbol and, because it is a Japanese machine, it also has a Japanese character set. The keyboard has 50 Japanese characters known as the "goju on", these are the fifty basic forms in the Japanese "alphabet" which has a total of 112 forms (a lot less than Chinese!) and the characters are displayed in the style known as Katakana. Since typing gobbledegook in Japanese has, however, a somewhat limited fascination, we'll move onto other things.

Making Connections

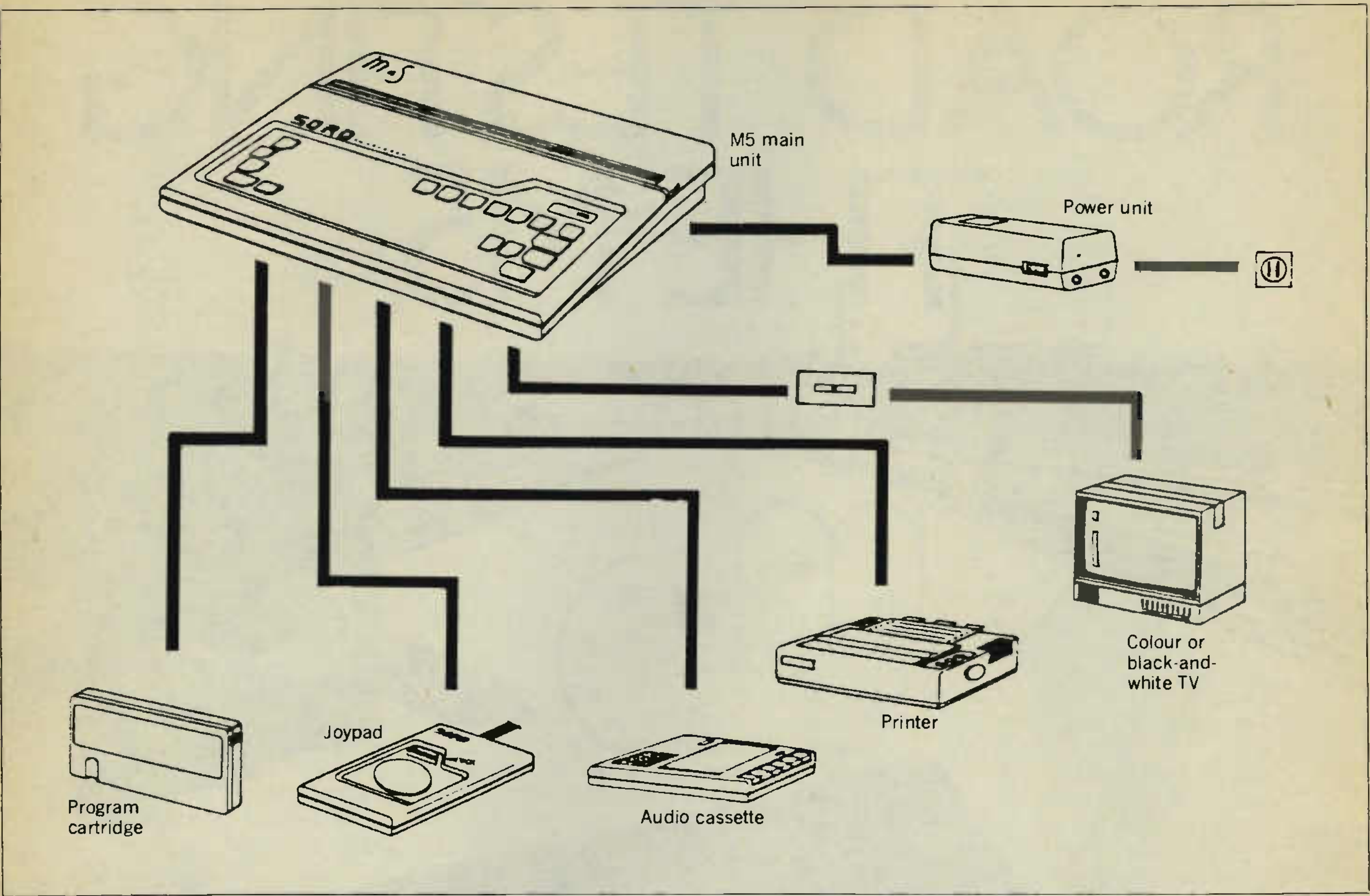
Along the back of the computer are two sockets for joysticks, a socket for a cassette recorder, an input socket for the power unit, a socket for connection to a standard UK PAL UHF TV set, and separate sockets for sound for connection to your hi-fi and composite video for connection to a monitor. In addition there is an 8-bit parallel output socket for a electronics type printer or disk drive.

But one of the most exciting features of this computer is found by flipping open the lid along the top rear of the unit. Here is unveiled the socket into which cartridge programs can be plugged in. However, unlike most such sockets, this one has 56 internal lines connected to it giving access to just about every function in the computer. This means that just about everything you can think of can be added on to the computer, ranging from a Prestel interface to second processors or use as an intelligent terminal on a time sharing computer.

Inside the M5

Inside the computer we find a Z80A processor running at around 3.58 MHz and 8K of ROM in which are the monitor program and the standard character sets. Only 4K of RAM is supplied with the machine, but this should not be compared directly with the amount of RAM supplied in other machines as we shall see.

The reason is the amazing graphics capability of this machine. It has a separate processor to control the video display and this has its own completely separate RAM (VRAM) and a massive 16K of it at that. This VRAM is not part of the memory that can be directly addressed by the Z80 and therefore whether you are using hi-res or lo-res graphics the amount of RAM available to the main processor is the same, unlike any other home computer we know of.



System configuration diagram.

Video Processor

The video processor is a very powerful chip, the TMS9918A which has 16-bit internal architecture, and, whilst even the Commodore 64 has only 8 sprites, this chip can generate no less than 32 at one time. At the same time a backdrop screen can be used and a further multicolour screen on which text or graphics may be displayed can be generated.

A sprite is a graphic symbol created by the program designer and is drawn on an 8 x 8 or 16 x 16 matrix. Sprites can be made bigger by combining them. Up to 32 sprites can be displayed at any one time and several of them may be moving at any one time.

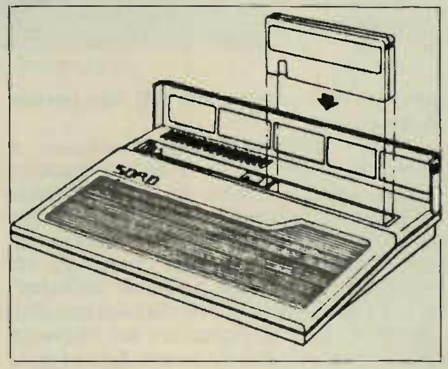
The sprite screens are numbered 0 to 31 and move in front of and behind one another depending on their priority. For example a missile drawn on screen 6 will disappear behind clouds on screen 5, but will move in front of clouds drawn on screen 7. An image larger than the screen can be created by using several screens and colours. The program could control this composite as one image.

Any image can be made to move automatically simply by specifying the start and end positions and the length of time during which this process will occur. The monitor is flagged whenever images on different screens collide and this can be detected by the program.

Behind the 32 sprite screens is a background plane which can be used in one of four modes. In Graphic 1 mode the screen has 32 x 24 positions where 8 x 8 characters can be specified. 256 different patterns are possible using 32 colours and in this mode characters can also be displayed. In multi-colour mode there are 64 x 48 positions where 4 x 4 characters can be displayed in 16 colours.

Text Mode

In text mode, 960 characters can be displayed in 24 rows of 40 columns. Each character is 6 x 8 dots, but only a single colour may be used and, in this mode, sprites cannot be used. In Graphics 2 mode you have complete control of every individual pixel and there are 256 x 192 (49,152) of them.

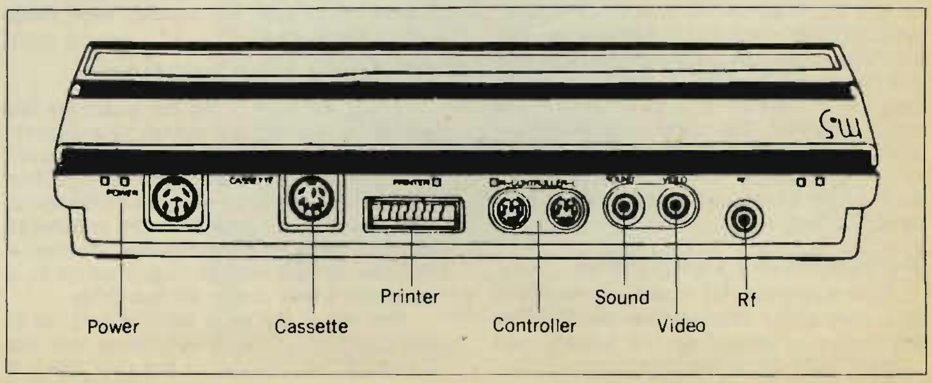


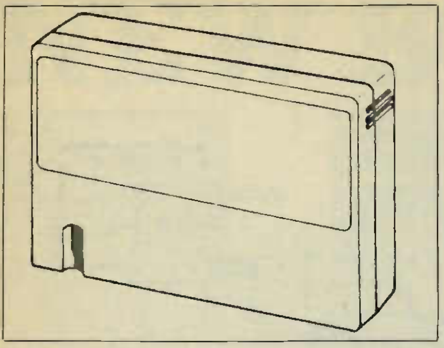
This background plane might be used for example to show a river or mountain as a background to a cartoon since the sprites can be used to create complete animated pictures, just as in a cartoon.

In addition, behind this plane is a backdrop plane. In this plane only one colour can be used in the example above, this plane would be blue and would look like the sky behind the river and mountain. Thus a whole image is made up of a combination of the 32 sprites, the background plane and the backdrop plane.

A Complete Cartoon

In a typical example the leaves of a tree are drawn in green on sprite screen 0 and the trunk of the tree is brown on screen 1. A car is drawn on screens 2 to 5; the tyres in black on screens 2 and 5 and the body of the car in two parts in blue on screens 3 and 4. Clouds are drawn on screens 6, 7 and 8. On the background plane is drawn grass in green, a grey road and mountains in brown. Now the car can be made to move smoothly along the road and





Program cartridge.

pass behind the tree, whilst the clouds in the sky move across, passing in front of and behind each other, just like a real animated cartoon.

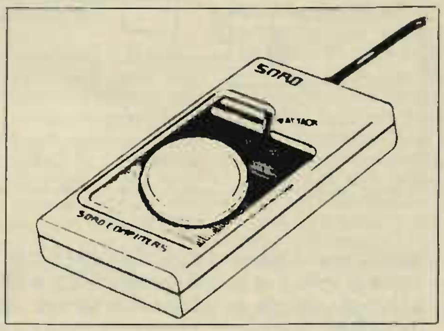
And the most exciting thing is the ease with which it can all be done. Everything described above can be executed from the special Graphics BASIC once you've got the hang of the machine. The excellent documentation allows even a novice programmer to achieve this kind of animation. You could even create your own complete cartoon stories!

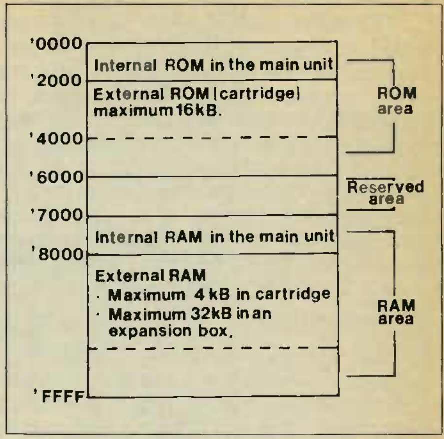
Creating Sounds

Of course no cartoon would be complete without a musical backing and the M5 has a very comprehensive sound source. The Texas Instruments 76489 is the IC we used in our Sound Generator for the ZX81 published in issue 5 of this magazine. The chip contains 3 tone generators with a five octave range each and a noise generator with three pitch levels. Envelope control of all four generators is available, which means that this computer contains a mini-synthesiser.

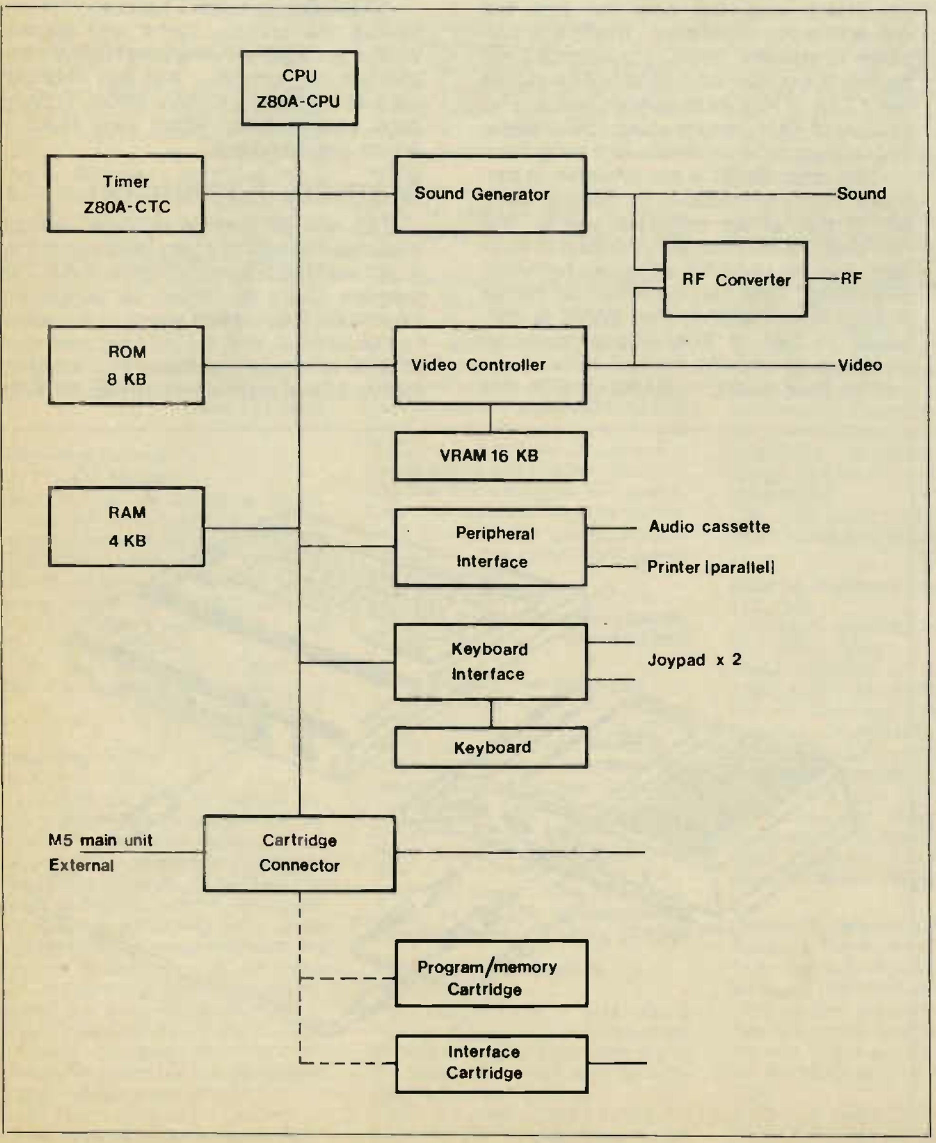
Three note chords can be generated and individual notes can be made to sound like particular instruments, violin, piano, etc., by controlling the envelope. This kind of control of the noise channel permits all kinds of sound effects, e.g. gunshots, explosions, car engines etc. In fact the sound generation possibilities with the M5 are very comprehensive indeed.

The sound output is to both the TV speaker and to a separate output for connection to a hi-fi setup. The documentation we had (not the ones to be supplies with the unit unfortunately) hinted at the possibility of





'00	CTC: Timer, clock and interrupt vector occurrance.
'10	VDP: Display controller.
'20	SGC: Sound generator.
'30	KB: Keyboard, joypad.
'40	PDT: Printer (output data).
'50	COM: Cassette tape player, printer.
'60	EXIOA:
'70	EXIOB: For optional interface (extra).
'80 'FF	Not defined



obtaining a voltage on this output instead of sound that could be used like a D/A converter to control robots.

Monitor Functions

The monitor program is contained in the first 8K of memory in ROM. Programs can make calls to the monitor or to the 768 bytes of RAM used by the monitor and I/O. The monitor controls a real-time clock which can be used as an event timer. Programs can have full use of this clock for incrementing, decrementing and controlling what happens at given times. In addition a program itself can be activated at a specified time. This timer is accurate to about 3 seconds an hour.

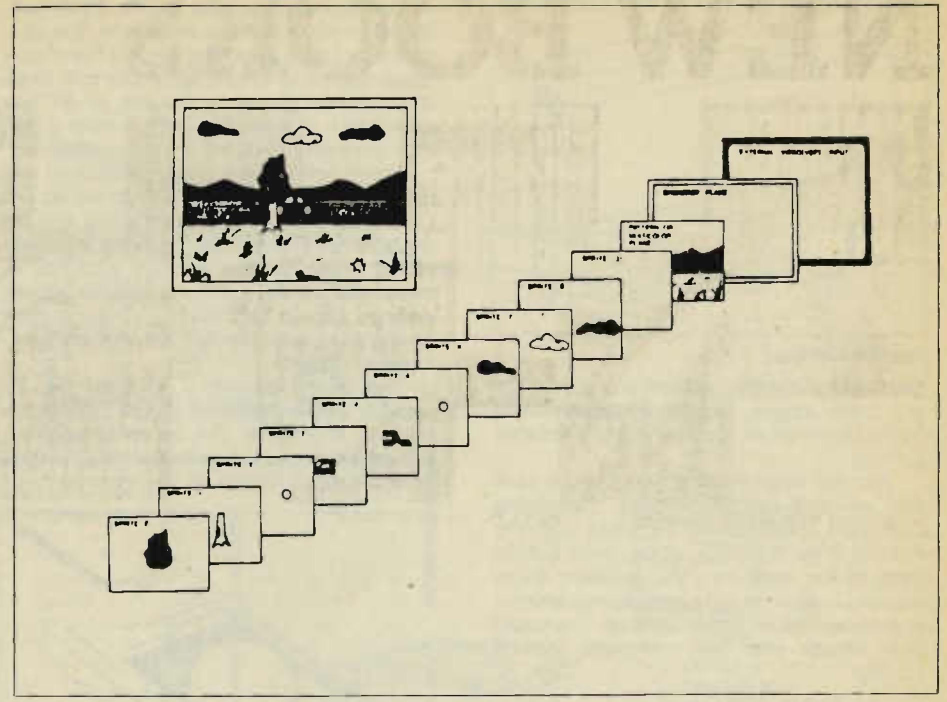
Other monitor functions include control of the video processor sprites and a collision register. It controls the graphic display at 256 x 192 points, and also supports several keyboard modes, including direct function calls to BASIC, for 26 of the most commonly used functions. The keyboard is scanned under control of the monitor, as are the joystick ports, though these two functions are independent.

The monitor controls the parallel output port to which a printer may be attached. Alternatively the output could be used as an 8-bit parallel switch, possibly in conjunction with the real-time clock for process control.

Graphics Capabilities

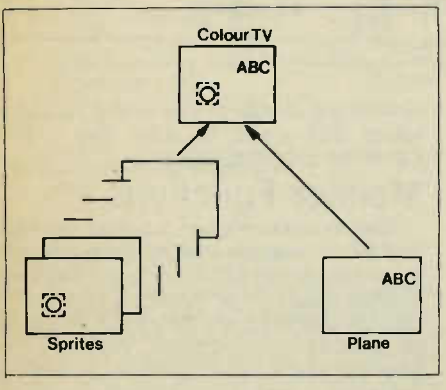
As always though, it is the graphics capability that is exceptional in this machine. By using the monitor and its registers, a view port can be set up on the screen. Here the TV screen acts like a window on a large scene and can be scrolled across the screen in any direction. It is also possible to control the right and left halves of the screen separately. In addition to all this the various modes: text, graphic, multicolour can be called and mixed during a single screen and then the whole image displayed one screen at a time allowing jitter-free animation and games whose graphics really are on a par with the arcade machines.

The monitor also controls read from and write to the cassette tape. Any audio cassette recorder can be used with the M5 and the cable supplied plugs into the back of the computer. The three plugs on the other end of the cable connect to the earphone, microphone and remote sockets on the cassette recorder. Data transfer to the cassette recorder proceeds at an exceptionally fast rate. Speeds up to 3200 Baud are possible and the starting and stopping of the tape is under the computer's control.



Controllers

Two joysticks, or rather I should say joypads, can be connected to the M5. As with most computers these have to be purchased separately. Joypads, the manufacturers claim, are much easier to use than joysticks since they are less tiring in use and the smaller movements involved make them quicker. They are like a large round button on a flat box. Simply touching the edge of the button in the desired direction is all that is required. Movement can be controlled in eight directions as with a joystick. The fire button is just to the left above the movement button. Certainly they can be controlled with one hand unlike a joystick and are a lot less cumbersome. In addition a left-handed person will find them just as easy to use as a right-hander.



Software Availability

Another major advantage with this machine is the large amount of ready-made software that will be available. Fifty different programs will be available when the machine is launched and CGL are promising to have 200 different titles available before the end of 1983. Of the first fifty, thirty will be games and twenty will be educational, business and utility programs.

The games should be first class since Sord have signed an agreement with one of the leading manufacturers of arcade games to reproduce their titles under licence. A very powerful Visicalc-type program called FALC will be available too. Most of the programs will be in cartridge form, but some will be on cassette.

The cartridges which plug into the 56-way edge connector, are about the size of an audio cassette tape. They may contain up to 16K of ROM and many will also contain up to 4K of RAM. The M5 is supplied with the BASIC -I cartridge and one game cartridge.

Programming Languages

BASIC-I is an introductory integer BASIC which can be used to learn the fundamentals of programming the M5. In saying that, don't go away with the idea that it is a very limited BASIC. That is not the case. It contains most of the functions found in other BASIC's at this level, but it does not permit floating point maths, and it does not give complete access to the graphics or sound functions in the M5, although simple functions for games are included.

In BASIC-I a variable name can be 256 characters long, but only the first two characters are significant. When this cartridge is inserted, BASIC-I is automatically booted. It is contained in 8K of ROM and uses the 3.25K of free RAM as work space. This amount of RAM permits about 150 program instructions to be written in one program.

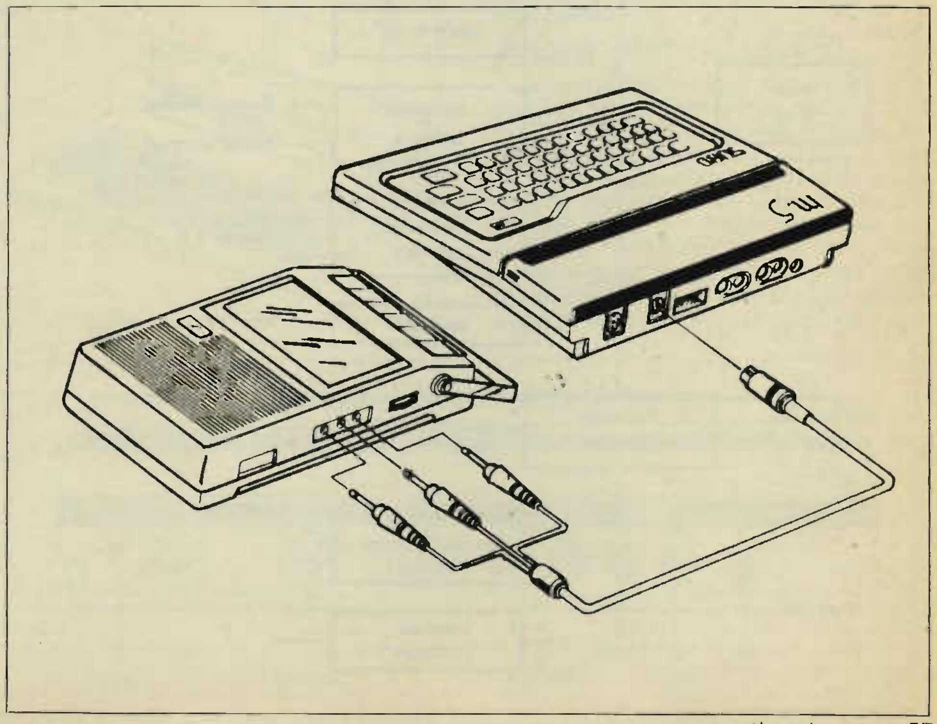
Two other BASIC's are available in cartridge. One is BASIC-F, a floating point BASIC that allows extended use of real numbers. Various numeric values and functions can be used for advanced technical processing. Data can be shown in graphs directly from BASIC-F. This BASIC is contained in 16K of ROM and contains an additional 4K of RAM.

The third BASIC is BASIC-G. With this BASIC, the sprites, background plane, backdrop plane and monitor can all be controlled directly. BASIC-G is ideal for creating games and animated sequences and will be easy to use once BASIC-I has been mastered.

BASIC-G has special functions for controlling the sprites, sound and joypads. Writing good games programs requires imagination and creativity and can help children develop these powers. BASIC-G brings good programming within easy reach of novice programmers.

Memory Expansion

CGL will be making available memory expansion boards at a very reasonable cost. A 32K expansion board will allow about 3000 program steps. It should be possible to expand the RAM so that all possible memory can be utilised. With BASIC-I a maximum of 35.25K is directly addressable, though a further 12K of memory addresses are avail-



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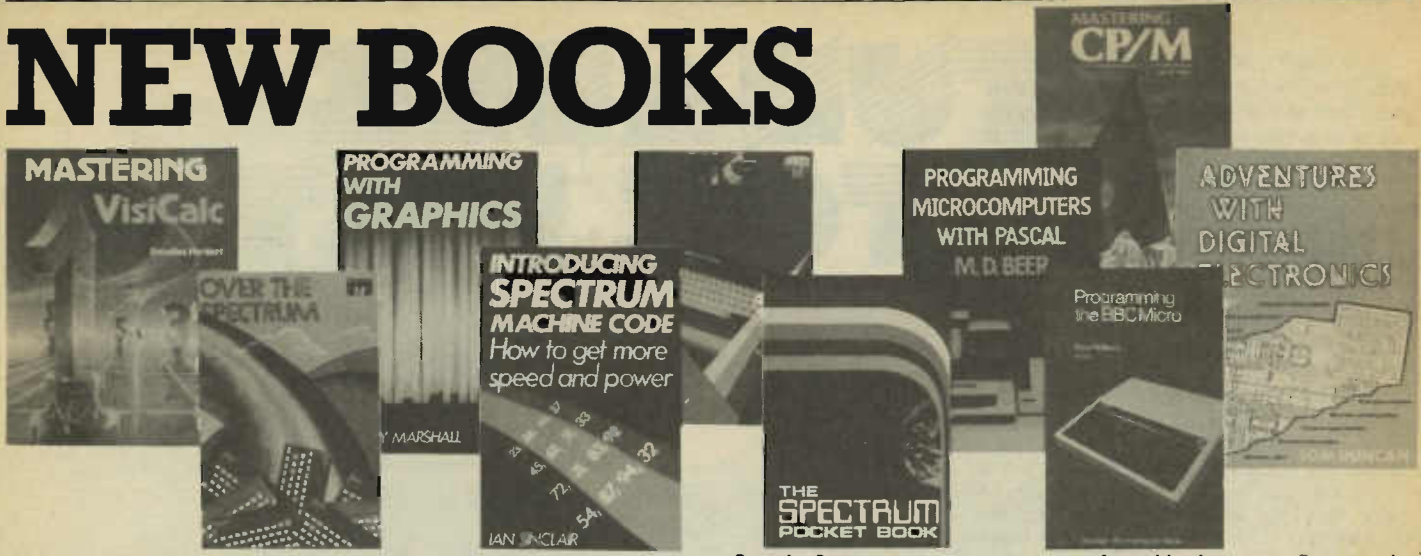
NEW BOOKS



Adventures With Digital Electronics
by Tom Duncan
This book is a follow-up to Adventures With Microelectronics, and should provide a stepping-stone to discovery of microprocessors. The first part deals with logic gates, multivibrators, flip-flops, counters, shift registers, memories, adders, magnitude comparators, code converters, and displays. Part 2 gives construction details for eight devices, and an explanation of how they work and things to try. There is no soldering in any of the projects.
1983. 64 pages. 189 x 245mm.
Order As WK10L (Book JM875)
Price £4.25*NV*

Practical Design of Digital Circuits
by Ian Kampel
This book should instruct the reader with no previous knowledge of digital electronics in the practical aspects of digital design, only familiarity with basic electronic principles being assumed. It covers the principles of digital electronics, the wide range of devices available, how to use these devices in cost-effective designs (including two examples), and microprocessors, showing them to be particularly versatile and sophisticated devices.
1983. 300 pages. 215 x 136mm.
Order As WK14Q (Book NB1183)
Price £11.05*NV*

Mastering Visicalc
by Douglas Hergert
Whether you are a new or experienced user of Visicalc, this book will show you how simple it is to learn this important spreadsheet program. Based on the idea of learning by using, this is the complete guide to Visicalc, for business, science and personal applications.
1983. 216 pages. 228 x 177mm.
Order As WK05F (Mastering Visicalc)
Price £12.95*NV*

Mastering CP/M
by Alan R. Miller
This book explains techniques for using, altering, and adding features to the CP/M operating system. It will give you a complete understanding of the CP/M modules, particularly the BIOS and BDOS. Macros, the powerful tools for developing and organising assembly language programs, are clearly presented. For advanced CP/M users and systems programmers, this book will enable you to explore the subtleties of CP/M, and to enhance the power of CP/M commands. Included is a comprehensive set of reference appendices.
1983. 398 pages. 227 x 150mm.
Order As WK09K (Mastering CP/M)
Price £14.50*NV*

Hart's Dictionary of BASIC
by W. A. Hart
A complete programming dictionary, from ABS to ZER, with over 800 different commands, statements, and operators in plain English. This book also gives you sections on: A systematic approach to translating BASIC programs; PEEK, POKE and memory map comparisons for the popular machines — PET, Tandy TRS-80, VIC, Sharp MZ-80K, Apple II, ZX81 and the BBC Micro; and free membership of a BASIC swap club.
1983. 160 pages. 210 x 144mm.
Order As WK06G (BASIC Dictionary)
Price £6.95*NV*

VIC Innovative Computing
by Clifford Ramshaw
This book contains listings for thirty games in a specially designed, easy-to-read format, as well as program structures, opening new dimensions in programming your standard VIC 20.
1983. 152 pages. 211 x 140mm.
Order As WK12N (VIC Innovative Computing) Price £6.95*NV*

The Spectrum Games Companion
by Bob Maunder
This book is aimed at the games player and programmer alike. Twenty-one games are included, with clear instructions on entry and play. Each program is explained fully, with complete details on how it was designed and written. Also shown is how to set up and use the Spectrum and how to create your own games. Later sections cover number games, word games, board games, simulation games, dice games, card games and grid games.
1983. 122 pages. 210 x 147mm.
Order As WK08J (Spectrum Games Companion) Price £5.95*NV*

Understanding Your Spectrum
by Dr Ian Logan
This book aims to explain, in simple terms, how the Spectrum works; to teach Z80 machine code from first principles; and to give details of 'monitor entry points' so that efficient programs can be written. There is also a special section on ROM operation.
1983. 190 pages. 211 x 140mm.
Order As WK13P (Understanding Your Spectrum) Price £7.95*NV*

The Spectrum Pocketbook
by Trevor Toms
This book includes 6 programs, a number of hints and tips on how to get the best out of your Spectrum, and all the information you need to write machine code effectively.
1983. 160 pages. 210 x 144mm.
Order As WK07H (Spectrum Pocket Book) Price £7.50*NV*

Over the Spectrum
With the full listing of over 30 programs for your Spectrum, this book will show you how to use the computers facilities to the maximum. Utilities, business programs, educational programs, plus programming tips, hints on extending the graphics capabilities and many of the functions are fully explained, making this a definitive book for Spectrum Users.
1983. 164 pages. 211 x 138mm.
Order As WK18U (Over the Spectrum)
Price £6.95*NV*

Introducing Spectrum Machine Code
by Ian Sinclair
This book has been written for the complete novice, and you are carefully shown what to do in easy stages. Using machine code will enable your Spectrum to use ZX81 cassettes, allow you to renumber a whole set of lines quickly, send serial printer signals to the cassette output, etc. It will enable you to really master the Spectrum, and open up a fascinating range of extra facilities.
1983. 150 pages. 233 x 154mm.
Order As WK19V (Book GP2082)
Price £8.95*NV*

Programming with Graphics
by Garry Marshall
This book covers the three major methods of graphics production, block, pixel, and line. It also considers topics such as colour movement and three-dimensional drawing, and the appendix summarises the graphics capabilities of various micros, although the book itself is machine independent.
1983. 120 pages. 233 x 155mm.
Order As WK20W (Book GP2021)
Price £6.75*NV*

Machine Intelligent Programs for the 16K ZX81
by Graham Charlton, Mark Harrison, and Dilwyn Jones
These programs will turn your T/S 1000 or ZX81 into an intelligent entity that will play a board game with you, discuss your problems, try your luck at dice, work out the value of resistors, compile an address book, or calculate exam results. You will find that your computer becomes an ally, opponent, or assistant.
1983. 154 pages. 197 x 123mm.
Order As WK21X (Book IP20)
Price £5.25

Games ZX Computers Play
edited by Tim Hartnell
This is a collection of 30 great ZX programs from the National ZX Users' Club, written by some of the most talented young programmers in the country. There are fifteen programs for the Spectrum and fifteen for the ZX81.
1983. 168 pages. 196 x 126mm.
Order As WK22Y (Book IP13)
Price £3.25*NV*

Assembly Language Programming for the BBC Microcomputer
by Ian Birnbaum
This book assumes no prior knowledge of assembly language programming, and takes the reader from the basics to complex implementation. It is also designed as a potential textbook for a structured approach to computer science, and contains some 73 listings, many of which are helpful utilities, such as a full machine code monitor, a suite of machine code sorting programs, a high resolution screen copy and a program compactor.
1983. 304 pages. 234 x 153mm.
Order As WK11M (Book MM585)
Price £9.50*NV*

Programming the BBC Micro
by Peter Williams
This book concentrates on the programming and application of the machine, assuming little or no knowledge on the reader's part. It covers functions, subroutines, procedures, program development, and program libraries. Features of BBC BASIC as applied to graphics, words, numbers, random numbers, and the machine's sound facility are also shown, as are machine code, hex, assembly language programming, interfacing and file handling. The final chapters deal with hardware, error code, ASCII codes, and the 6502 instruction set.
1983. 168 pages. 216 x 137mm.
Order As WK15R (Book NB1302)
Price £7.25*NV*

Programming Languages for Micros
by Garry Marshall
This deals with the common programming languages available for microcomputers — BASIC, Pascal, Lisp, Cobol, Forth, Comal, FORTRAN, Pilot, C, as well as some more specialised ones such as Prolog and Logo. It explains what each language is intended for, how to use it, and its main areas of application. Sample programs are given.
1983. 126 pages. 215 x 138mm.
Order As WK16S (Book NB1185)
Price £6.75*NV*

Programming Microcomputers with Pascal
by M. D. Beer
This book is an informal introduction to Pascal, and is built around the problems and applications of concern to the scientist and engineer. It deals with the way data are stored and manipulated, how to control the operation of a program, how to split it into manageable proportions, storage of data in files, structured programming, top-down design, and the special problems of programming control systems.
1983. 242 pages. 233 x 152mm.
Order As WK17T (Book GP1619)
Price £7.50*NV*

TUNABLE SCRATCH FILTER

by Robert Penfold

Worn or dusty records produce a continuous "crackle" of background noise in use, and as this noise is largely at high frequencies it tends to stand out from the wanted signal and is consequently very obtrusive. However, due to its mainly high frequency composition the "surface noise" as it is often called, can be virtually eliminated using a filter which attenuates high frequency signals. Obviously there is some loss of the wanted signal at high frequencies and not just the noise is removed, but this loss is far less noticeable than the reduction in noise and a very worthwhile improvement in the subjective quality is obtained.

An ordinary treble tone control can be used to provide suitable filtering, but results are less than optimum with the low attenuation rate of 6dB per octave provided by normal tone controls giving a relatively low level of noise reduction, plus a larger loss of the wanted signal than is really necessary. Much better results can be obtained using an active filter which has a flat response almost up to the cut-off frequency, with a high attenuation rate of about 12 to 24dB. per octave above this point.

Even with a filter of this type results may often be less than optimum since the cut-off frequency is not usually variable. The frequency chosen must then be a compromise which inevitably gives less than maximum noise reduction with some programme sources, and unnecessary attenuation of the main signal with other sources. Ideally it should be possible to adjust the cut-off frequency to optimize results, but using conventional C-R filters this would require a four gang potentiometer for a stereo 12dB. per octave filter, or an eight gang component for a stereo 24dB. per octave type! Also, mismatching between the gangs of the potentiometer could result in irregularities in the frequency responses of the filters, and a mismatch between the cut-off frequencies of the two channels.

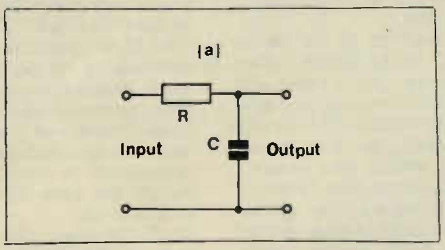


Figure 1a. Conventional R-C low pass filter.

Switched Capacitor Filter

These problems can be overcome using a relatively new type of filter called a "switched capacitor" filter. An ordinary C-R lowpass filter uses the arrangement shown in Figure 1(a), and here the resistor restricts the rate at which the input signal can charge and discharge the capacitor. At low frequencies where only a low rate of charge and discharge are necessary to permit the output to follow the input signal accurately the filter has no significant effect, but at high frequencies the capacitor cannot charge and discharge with sufficient rapidity to keep up with changes in the input voltage. Thus the signal is attenuated and the lowpass filter action is provided.

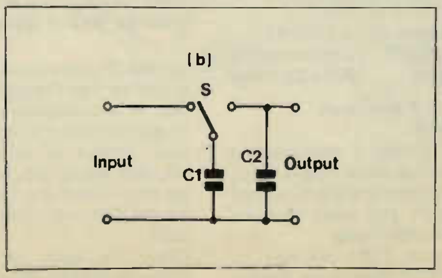


Figure 1b. Switched capacitor equivalent.

A switched capacitor filter works in a similar manner, but the rate at which the filter capacitor can be charged and discharged by the input signal is controlled by a switch and a low value capacitor rather than by a resistor. Figure 1(b) shows the basic arrangement used.

C1 is first connected by switch S to the input and C1 is instantly charged to the input potential. C1 is then connected by S to C2, and C1 discharges into C2 but only partially charges it towards the input potential since C1 is much lower in value than C2. This process continues with C1 repeatedly charging to the input potential and then transferring its charge to C2. If the switching action is very rapid C2 quickly takes up a charge potential practically equal to the input voltage due to the numerous burst of current it receives from C1, and provided the input potential only changes slowly S and C1 will be able to maintain the charge on C2 at almost the input potential. At high frequencies, as was the case with the C-R filter, the transfer of current from the input to the filter capacitor is inadequate and the amplitude of the output signal is much

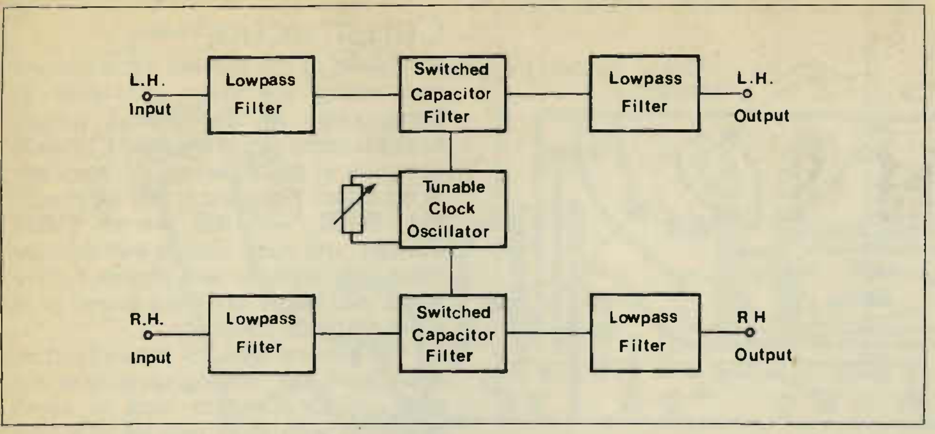
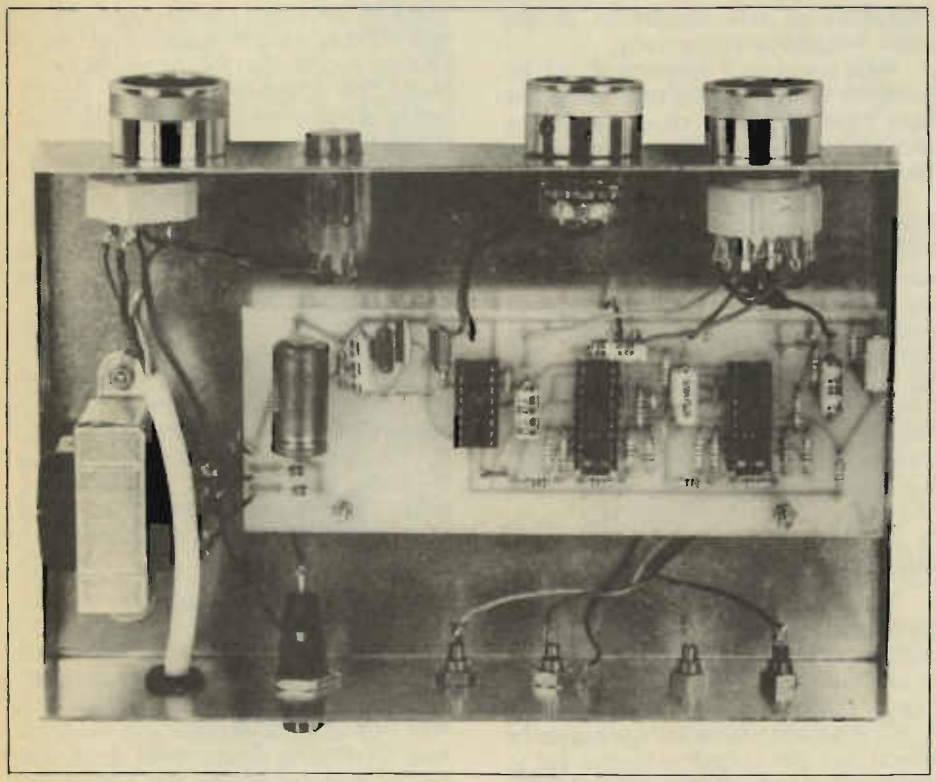


Figure 2. Block diagram of the Tunable Scratch Filter.



Internal view of the scratch filter.

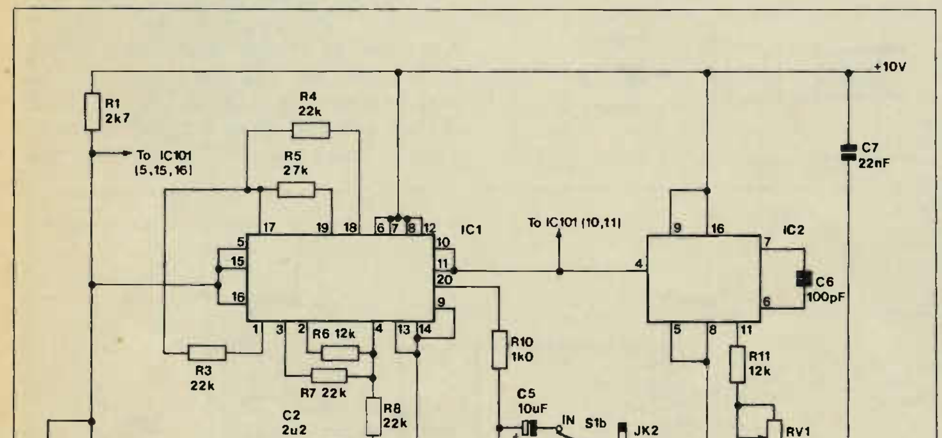


Figure 3. Circuit diagram of the Tunable Scratch Filter.

lower than that of the input signal.

The effective resistance provided by S and C1 depends on the value of C1 and on the switching frequency of S. In a practical circuit S would be formed by f.e.t.s. which would be on the same chip as C1 and C2 (with the latter normally being replaced by an integrator). It would, of course, be possible to produce conventional passive or active filters on a single chip, but the high resistor values that would be needed would make a device very expensive, and the cut-off frequency of the filter would be preset. Using a switched capacitor filter the effective resistance of S and C1 (and therefore the cut-off frequency of the filter) can be controlled by the clock frequency used to control S. Furthermore, the filters can be constructed with a high degree of precision so that a number of filters controlled by a common clock oscillator will have cut-off frequencies matched to typically within about 1%.

Block Diagram

The switched capacitor filted used in this project is the National Semiconductors MF10CN, and this has an input operational amplifier followed by a form of mixer circuit and two switched capacitor filters in series. This enables the device to be used in various operating modes so that highpass, notch, and bandpass functions can be obtained in addition to straight forward lowpass filtering, although in this application it is obviously used in a lowpass mode. The MF10CN actually contains two filters of the type described above, and these can either be used as separate second order filters, or connected in series to provide a fourth order (24dB. per octave) filter.

Figure 2 shows the block diagram of the "Tunable Scratch Filter", and the clock oscillator is at the heart of the unit. This has an operating frequency which is variable from about 150 to 750kHz, and the cut-off frequency of the MF10CN is one fiftieth of the clock frequency. This gives the filter a cut-off frequency which is continuously adjustable from about 3kHz to 15kHz. The clock signal is used to control two MF10CN switched capacitor filters having a 24dB. per octave attenuation rate, one device being used in each stereo channel. The two channels have responses that are accurately matched and they are tuned by a single gang potentiometer.

A simple lowpass filter is used at the input of each channel, and this is done merely to prevent stray coupling of radio frequency signals into the switched capacitor filters where heterodynes could be produced by an interaction with the clock signal. A simple lowpass filter is also used at the output of each channel to reduce breakthrough of the clock signal. The clock signal only breaks through at about 10mV. at the output of an MF10CN, but the output filter reduces this to less than 1mV. and makes quite sure that this signal cannot cause any problems with the equipment that is fed from the output of the unit.

The Circuit

The circuit diagram of the scratch filter is shown in Figure 3. The clock oscillator uses IC2 which is a CMOS 4046BE phase locked loop, but it is employed here as a simple oscillator which has its operating frequency set by timing components C6, R11, and RV1. The latter is the tuning control of course. The 4046 is ideal for this application since its output levels are compatible with the MF10CN, it will operate from the same 10 volt supply as the MF10CN, and it will operate reliably at the quite high maximum frequency needed here.

IC1 is the filter device for the right hand channel, and this has pins 5, 15, and 16 biased to half the supply voltage by R1, R2, and C1. Pins 5 and 15 are unused inputs of the device, but they must be biased correctly or the circuit will not function properly. Pin 15 connects to the non-inverting input of the operational amplifier used at the input of each section of the device, and these amplifiers are used in the standard inverting mode. R8 and R7 set the input impedance and voltage gain of the amplifier at the input of the first stage at 22k and unity respectively. R3 and R4 perform the same function in the second section of IC1, and R3 is direct coupled to the output of the first filter section. R5 and R6 control the Qs of the filter sections, and these could be given a value of 22k to set both filters at a Q value of one. However, better results are obtained by giving the first filter section a lower value and a lower Q, and the second section a higher value and Q. This gives the first section a response that gives a rather gradual introduction of the attenuation, while the second section has a peak in the response followed by an abrupt introduction of the full attenuation rate. The combination of the two responses produces the excellent overall response shown in Figure 4. This is with RV1 set for a cut-off frequency of 5kHz, but the shape of the response remains unaltered at other cut-off frequencies.

R9 and C3 are the input lowpass filter, and the output lowpass filtering is provided by R10 and C4. C2 and C5 are D.C. blocking capacitors. Pins 7, 8, 13, and 14 of IC1 are merely supply pins, and there are control terminals which also connect to one or other of the supply rails. Pin 9 is the "level shift" terminal and is connected to the negative supply rail for use with a single supply and a CMOS (or TTL) clock signal. Internal switches of the device are controlled by a voltage applied to pin 6, and for the mode of operation utilized here it must be taken to the positive supply. Pin 12 is also taken to the positive supply rail, and this gives a cut-off frequency at one fiftieth of the clock frequency. Taking pin 12 to half the supply voltage sets the cut-off

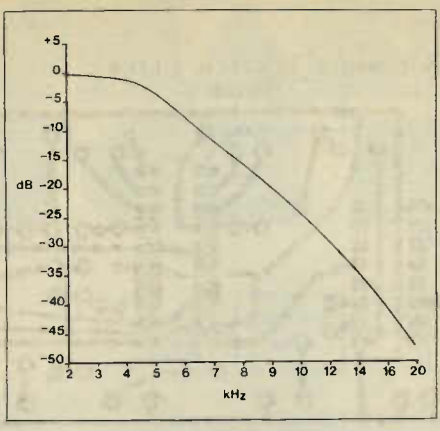


Figure 4. Frequency response of the filter when set for a 5kHz cut-off (-3dB).

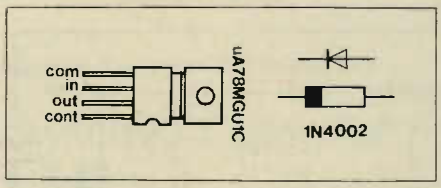
frequency at one hundredth of the clock frequency incidentally.

With some hi-fi systems it will be possible to bypass the unit using the tape monitor switch or some similar facility, but S1 can be used to bypass the unit if no other method is possible.

Note that Figure 3 only shows the filter for the right hand channel, but the circuit for the other channel is identical apart from the component identification numbers (which have one hundred added to the corresponding component number for the right hand channel). R1, R2, and C1 are used to bias the left hand channel as well as the right hand one, the clock oscillator is common to both channels, and a further two poles of S1 are used to bypass the right hand channel.

Mains Power Supply

The unit requires a stable, well smoothed 10 volt supply, and the supply current is only about 25mA. This is provided by the simple mains power supply circuit which is shown in Figure 5. IC3 is an adjustable voltage regulator which has the output potential set at nominally the required level by R12 and R13.



Construction

Details of the printed circuit board and wiring are given in Figure 6. Construction of the printed circuit board is quite straight forward, but use Veropins at points where connections to off-board component will be made. IC1, IC101, and IC2 are all CMOS devices, and these should therefore be fitted into sockets, and should not be fitted into place until the board is in other respects complete.

The general layout of the unit can be seen from the photographs, and for ease of construction and to avoid problems with stray pick-up of mains hum it is recommended that a radically different layout should not be used. Mains transformer T1 is mounted using ¼in 6BA bolts, and a soldertag fitted on one of these mounting bolts provides a chassis connection for the mains earth lead. The completed printed circuit board is mounted on the base panel of the case using 1in 6BA bolts with ½in spacers to keep the underside of the board well clear of the case. LP1 is a snap-fit into a 12mm diameter hole, and this must be the correct size if LP1 is to fit into place properly. The entrance hole for the mains lead is fitted with a small grommet which protects the cable.

Once everything has been fitted into the case the final wiring can be completed, and this is all quite easy, but be careful not to make any errors in the wiring to T1, S2, FS1, and the mains lead. Check this wiring very thoroughly when the unit has been completed and before switching it on.

Using The Unit

Ideally the unit should be wired between the preamplifier and power amplifier stages of the hi-fi amplifier, and many amplifiers have a tape monitor facility or something of this nature that will enable the filter to be used in this way. An alternative way of using the unit is to feed the input from the record deck via a suitable pre-amplifier, and then feed the output of the filter to a high level input (tape, tuner, aux., etc.) of the amplifier. The audio noise output of the filter is about 300uV, and this gives a signal to noise ratio of more than 60dB. provided the

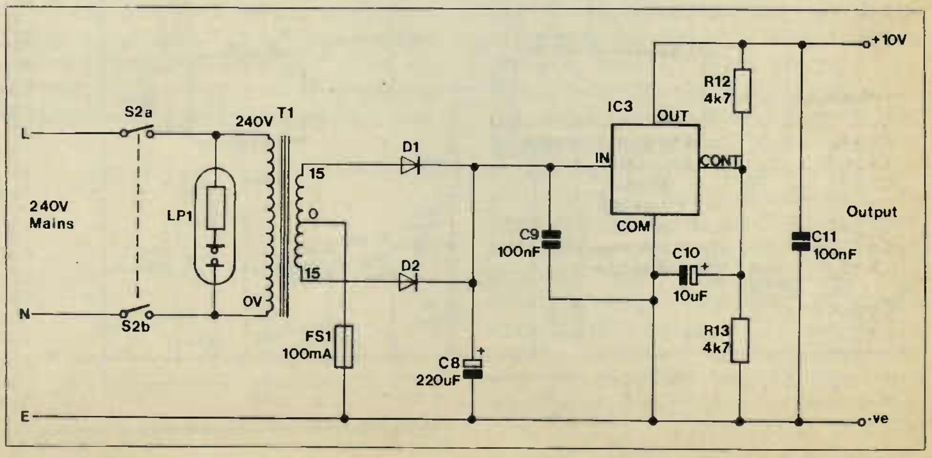


Figure 5. Circuit diagram of the mains power supply.

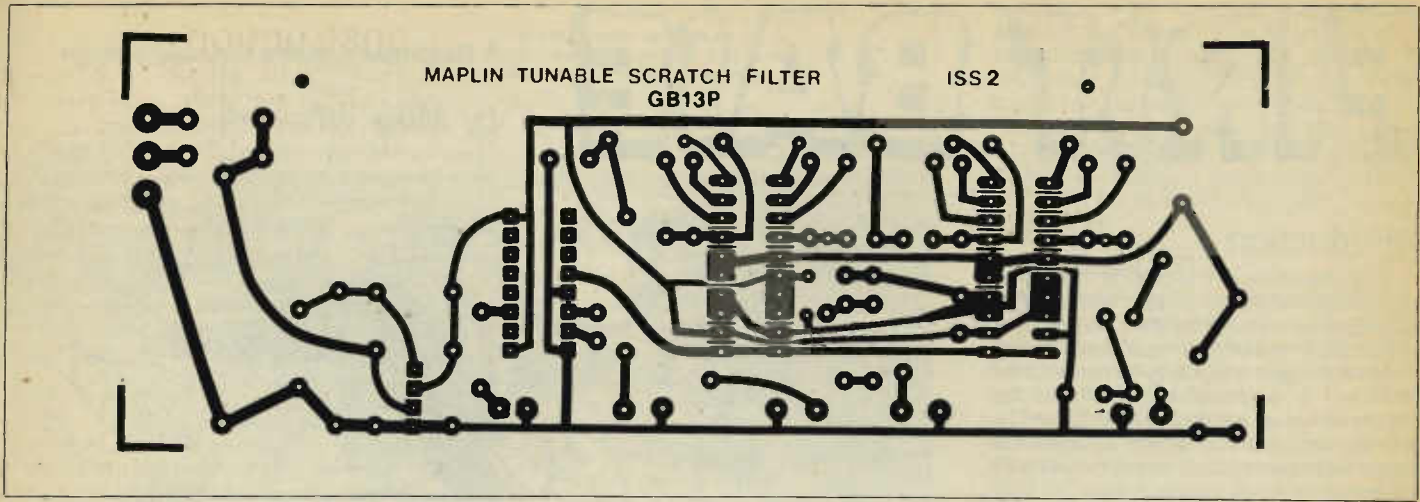


Figure 6. Legend and artwork.

unit is used to process a reasonably high level signal. It will not work properly if fed direct from the output of a pick-up since it would be handling a very low level signal and would give a very poor signal to noise ratio.

The filter can be used to good effect with tuners and cassette decks to combat noisy F.M. reception, or to reduce tape "hiss" when playing a non-Dolbyised cassette. When used in this way the unit can simply be connected between the tuner or cassette deck and the amplifier, with S1 being used to bypass the filter when it is not needed.

The best setting for RV1 is found by trial and error, and it should be set for the highest cut-off frequency that gives good noise reduction. In most cases there is a well defined setting at which the offending noise becomes practically eliminated as RV1 is gradually backed-off from its highest setting. It should be borne in mind that a filter of this type is not suitable for combatting the large noise spikes produced by badly scratched records as these produce strong signals at quite low frequencies, and not just at high frequencies.

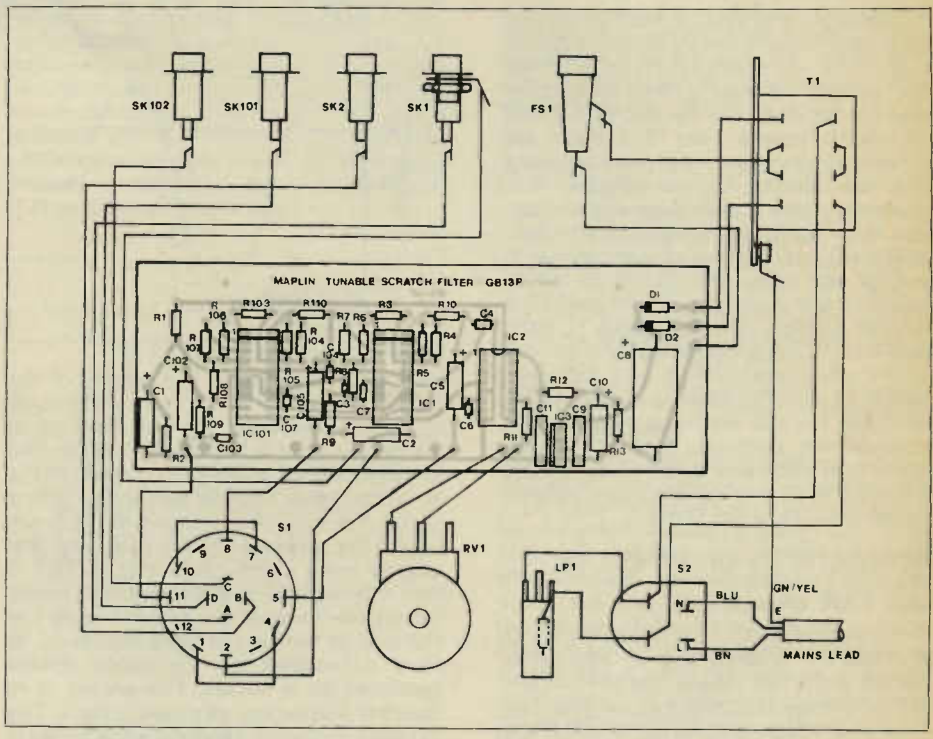


Figure 7. Wiring diagram.

PARTS LIST FOR TUNABLE SCRATCH FILTER

Resistors — All 0.4W 1% Metal Film

R1,2	2k7	2 off	(M2K7)
R3,4,7,8,103, 104,107,108	22k	8 off	(M22K)
R5,105	27k	2 off	(M27K)
R6,11,106	12k	3 off	(M12K)
R9,109	2k2	2 off	(M2K2)
R10,110	1k	2 off	(M1K)
R12,13	4k7	2 off	(M4K7)
RV1	100k lin pot		(FW05F)

Capacitors

C1,5,10,105	10uF 25V axial electrolytic	4 off	(FB22Y)
C2,102	2u2 63V axial electrolytic	2 off	(FB15R)
C3,103	1nF ceramic	2 off	(WX68Y)
C4,104	4n7F ceramic	2 off	(WX76H)
C6	100pF ceramic		(WX56L)
C7,107	22nF ceramic		(WX78K)
C8	220uF 25V axial electrolytic		(FB62S)
C9,11	100nF polyester	2 off	(BX76H)

Semiconductors

D1,2	1N4002	2 off	(QL74R)
IC1,101	MF10CN	2 off	(QY35Q)
IC2	4046BE		(QW32K)
IC3	uA78MGU1C		(WQ78K)

Miscellaneous

S1	Rotary 4 pole 3 way		(FF76H)
S2	Rotary mains switch		(FH57M)
SK1,101,2,102	Threaded phono sockets	4 off	(YW06G)
T1	Mains transformer 15V 6VA		(WB15R)
FS1	100mA quickblow fuse 20mm		(WR00A)
LP1	Mains panel neon		(RX82D)
	Printed circuit board		(GB13P)
	Case Type TP3		(LH45Y)
	Control knobs	3 off	(HB34M)
	20mm Safuseholder		(RX96E)
	20 pin DIL socket	2 off	(HQ77J)
	16 pin DIL socket		(BL19V)
	Grommet small		(FW59P)
	Cabinet feet		(FW19V)
	13A mains plug		(RW67X)
	Min mains cable	2m	(XR01B)
	Hook-up wire black		(BL00A)
	Veropins type 2145		(FL24B)
	Bolt ¼in 6BA	2 off	(BF05F)
	Bolt 1in 6BA	2 off	(BF07H)
	Nut 6BA	4 off	(BF18U)
	Tag 6BA		(BF29G)
	Spacer 6BA × ½in	2 off	(FW35Q)

A complete kit of parts excluding the case is available for this project. **Order As LK04E (Scratch Filter Kit) Price £24.90**

FIRST BASE

A Beginner's guide to Logic Design

by Mike Wharton

Introduction

This new series will explain to the novice some of the rudiments of Logic design using integrated circuits. Rather than simply being a theoretical approach, the series will look at practical designs which may be made up on Veroboard or a breadboard. Many of the circuits will use commonly available TTL devices, and this first article outlines the design of a simple 5 volt supply for use with the experiments during the series.

Power Supply

Before you can venture forth on making any project in electronics you need a supply of electrons, you need lots of them, and they must be kept moving! Common sources are cells and batteries, like the zinc-carbon and alkaline-manganese ones, but these are becoming more and more expensive, have a fairly low capacity, and are definitely non-returnable when empty! Many schools possess very rugged low-voltage power supply units (psu), which allow the mains supply to be used with safety. These units are able to deliver several amperes at a voltage which is variable between zero and about 17 volts. Such psu's are fine for lighting bulbs, driving motors and copper-plating Sir's door keys during Chemistry lessons, but sensitive electronic circuits like to be supplied with more refined electrons. This article describes how regulated power supply units operate and how to construct one suitable for the projects in this series.

Smoothing, or, when is DC not DC?

You may know that the 'mains' supply in this country is described as Alternating Current (AC); this means that the current, and the voltage, is constantly changing. This is not on an irregular basis, but smoothly and regularly 50 times every second. If you think that sounds fast it is really quite slow compared to radio frequency (RF) voltages which may alternate at anything up to many millions of times per second. So, we have this alternating supply, and a graph of the mains voltage against time would look like Fig. 1. Since the supply voltage alternates 50 times each second, its frequency is 50 hertz, hertz being the units used for describing frequency named after Heinrich Hertz, but that's another story. The voltage of 240 volts marked on Fig. 1 is the value used to describe the mains voltage, i.e. 240 volts AC. Some of you will have recognised the curve shown in Fig. 1 as a sinewave, and that the value of 240V is the Root Mean Square value, or RMS for short. If you didn't know that don't worry, use it to impress your friends; it's actually the value of Direct Current (DC) needed to produce the same heating effect in a resistance. You may well be wondering what all this has to do with our little DC power supply unit, and it's this: AC is great for getting the electrons from the Power Station into our homes, because it means that transformers can be used to step up the voltage for transmission, and then back down again. The heart of most psu's is a transformer which reduces the lethal 240V mains to a safer 20V or so. However, AC is not much good for powering circuits designed to operate on DC, since the polarity of the supply changes every half cycle, and polarity sensitive components like transistors would be zapped on the first negative wave. The simplest way to convert AC into a sort of DC is to block these negative half waves with a diode. A simple circuit, shown in Fig. 2, will block the negative half waves, and the slightly more complicated ones in Figs. 3 and 4 will produce the waveforms shown alongside. However, you couldn't really call the outputs from any of these circuits DC, at least it's nothing like the steady voltage produced by a battery. The answer is to connect a capacitor, as shown in Fig. 5. This is called a reservoir capacitor and it serves to store up electrons and let them out in a more even stream, rather like a full-size water reservoir. The resistor marked as the Load in Fig. 5 represents the circuit being supplied with current by the psu; it may be just a resistor, but it's more likely to be a transistor radio, or even a whole computer, the effect is just the same. The reservoir capacitor is charged up by the current from the diode rectifiers, then, as this falls back to zero, the capacitor is able to maintain a flow of current through the Load until it is charged again on the next half-cycle. The larger the Load, that is the smaller the resistance, so the more rapidly it will empty the reservoir, and hence it needs to have a fairly high value of capacitance. For small loads, taking just a few milli-amps of current, then values around 1000uF to 4700uF will suffice, but where larger currents are involved, such as in a computer, values of 20,000uF to 33,000uF (20 to 33 milli-farads) are needed.

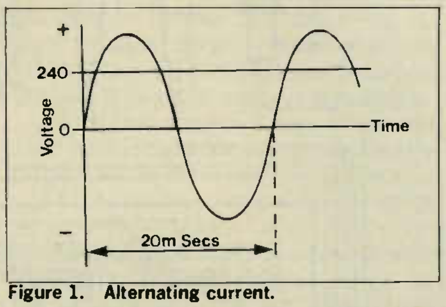


Figure 1. Alternating current.

All this may seem sufficient to produce a fairly respectable output, but, as Fig. 6 shows, it is still far from perfect. The output from our evolving design contains what is called 'ripple' (unfortunately, not the raspberry type!). What is needed is some clever device which can compensate for the variations in the waveform, to let more current through when it falls and block it off when it rises. Although the ripple may not have a very large value, often less than half a volt, it will make its presence felt in many circuits in no uncertain manner.

Zener Diode to the Rescue!

Possibly the simplest way of producing a constant voltage from one which varies is to use a zener diode. The characteristics of this device are shown in Fig. 7. In the forward biased direction it behaves like most other

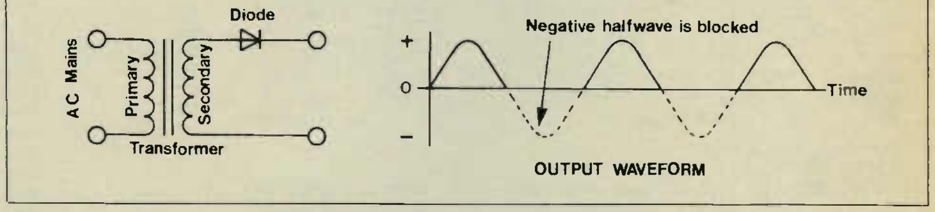


Figure 2. Simple diode rectifier circuit.

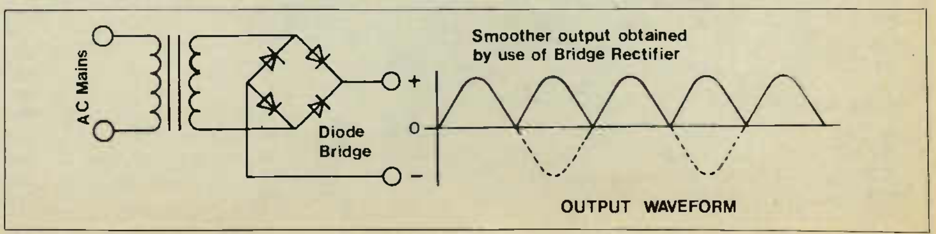


Figure 3. Bridge rectifier circuit.

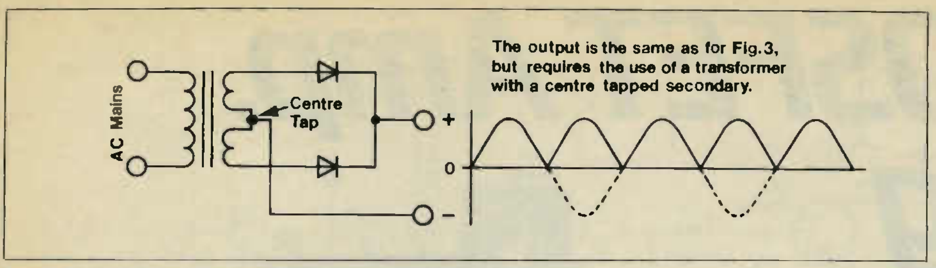


Figure 4. Full wave rectifier circuit.

diodes, nothing remarkable in that; however, in the reverse direction, the current passed remains very small until a certain voltage is reached, the zener voltage, then whoosh. . . a very large current will pass. To use such a device a resistance is needed in series to limit the current to a safe value, so that the diode doesn't get too hot and burn out. The zener voltage can be arranged during manufacture to be any value, and a quick look at page 277 of the Maplin catalogue will show that they are made with certain preferred values, rather like resistors. A very simple design, using a zener diode connected to the rest of the components used so far, is given in Fig. 8. This will produce a 'regulated' output, but there is a snag (there had to be a snag, life is never that easy!). Such an arrangement is only able to supply a limited current, and probably much less than any power supply unit worth the name. Ohm's Law will tell you the maximum current you can draw before the output voltage falls below the zener voltage. Suppose we want a 5 volt supply to run our home computer, and so we would choose a 5V zener diode. Suppose also that having spent all the pocket money on the computer we can only afford a zener diode able to dissipate 400 milli-watts, about the cheapest available. This gives us a zener current of:—

$I = P/V$

therefore, $I = 0.4/5$ which gives a zener current of 80 milli-amps. If our un-regulated supply produces 9 volts DC, the value of the series resistor will then have to be:—

$R = V/I$

so, $R = (9-5)/0.08$ ohms

$= 4/0.08$ ohms

therefore, $R = 50$ ohms.

So, you may well be asking, where's the snag? So far we have not taken any current by an external load; if we attach a load resistance which will pass 50 milli-amps then this current will be diverted from the zener diode, so that the total current remains 80mA, and the voltage dropped by the resistor is still 4V. However, if we try to take more than 80mA there will be nothing left for the zener (sighs!) and the voltage dropped by the resistor will be more than 4V; zip goes our regulated supply of 5 volts, for these currents are only a small fraction of that required by even a modest computer. This type of circuit is only suitable for providing a constant voltage for critical parts of a design, such as oscillators, where it helps to maintain frequency stability, and only a small current is taken. One solution to our problem would be to use a zener diode with a larger power dissipation, but, I can hear you say, there must be a better way that doesn't turn all our expensive electrons into heat before they have a chance to do any useful work.

Head them off at the Pass!

The zener diode is very good at providing a constant reference voltage, but what it really needs is more muscle. This is usually arranged by using the zener to control a power transistor, such as the 2N3055, in an arrangement known as a Series Pass circuit shown in Fig. 9. Here, the original zener diode circuit is used to provide base current for the series pass transistor, which then amplifies the current available to the external load. This type of circuit is able to provide a fairly constant voltage output under varying load conditions. To go back for a moment to the example of the home computer, which may require several amperes, the transistor will drop the 4 volts, assuming the 9 volts remains the same, but pass a current which depends on the load resistance. The point to note is that although power dissipation in the zener is no longer a problem, you must take care that the limits of the power transistor are not exceeded, and this will normally be mounted on a heat sink if large currents are involved.

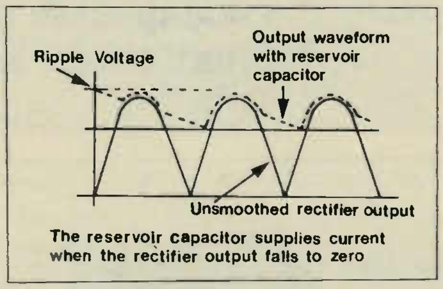


Figure 6.

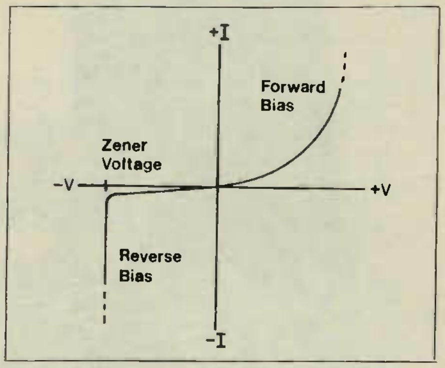


Figure 7. Zener diode characteristics.

A Practical Design

All of the above theory can be put together to produce the design shown in Fig. 10. There is nothing remarkable about the design, and many will recognise it from similar commercial designs. The capacitor connected across the zener is to ensure that the base current to the power transistor is as smooth as possible, since small variations here will be amplified and make matters worse rather than better. The appearance of a couple of extra transistors in the final design also requires some explanation. Transistor TR1 is the power transistor, which is supplied with base current from the zener diode via TR2; this arrangement permits a lower zener current to be used, and TR2 is needed to increase the base current to the power transistor. Transistor TR3 is included with R3 to provide some degree of short circuit protection. When the voltage developed across R3 due to the passage of load current increases beyond about 0.6 volts, TR3 will start to conduct and divert base current away from TR1 thus limiting the load current to around 2 amps. Finally, D5 is included to indicate that the unit is switched on.

Construction

The power supply unit may be constructed on Veroboard, remembering to mount the power transistor, TR1 on a suitable heat sink. A better alternative is to use a printed circuit board.

Also, it is worth bearing in mind that since mains voltages are present at the input side of the transformer, great care must be taken to ensure that it is impossible to touch any of the 'live' parts. For this reason it is a very good idea to mount the unit in a proper project box which can be earthed, otherwise you are in danger of defeating the whole object of the exercise, which is to remove the hazard of mains voltages! This should also be borne in mind if it is necessary to investigate any reasons why the unit does not function as intended; the golden rule here is make certain the mains is disconnected before probing with your fingers. A voltmeter applied to the output should indicate between 4.5 and 5.5 volts at worst, and should be close to the 5 volts required for TTL work if the unit has been put together correctly. If the voltmeter reading is outside these limits then switch off immediately and check your work; things to look out for are solder bridges across tracks on the circuit board, components incorrectly placed and the electrolytic capacitors the 'wrong way round'.

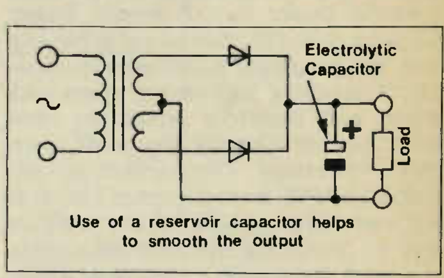


Figure 5. Use of reservoir capacitor to smoothe the output.

If the metal box specified is used, then the power transistor may be mounted on the rear of the case along with an insulating mica washer; again, remember to use wire of adequate size and rating for those connections which carry the high currents.

Having successfully completed the power supply unit you will then be in a position to commence the experiments on logic design without any fear of destroying the integrated circuits due to inappropriate supply voltages.

continued on page 25

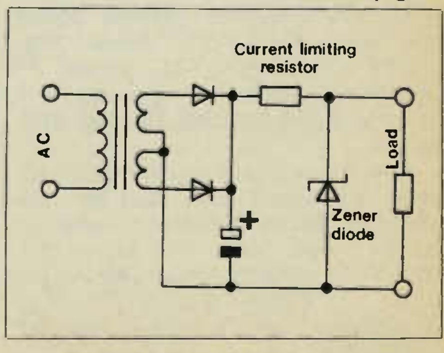
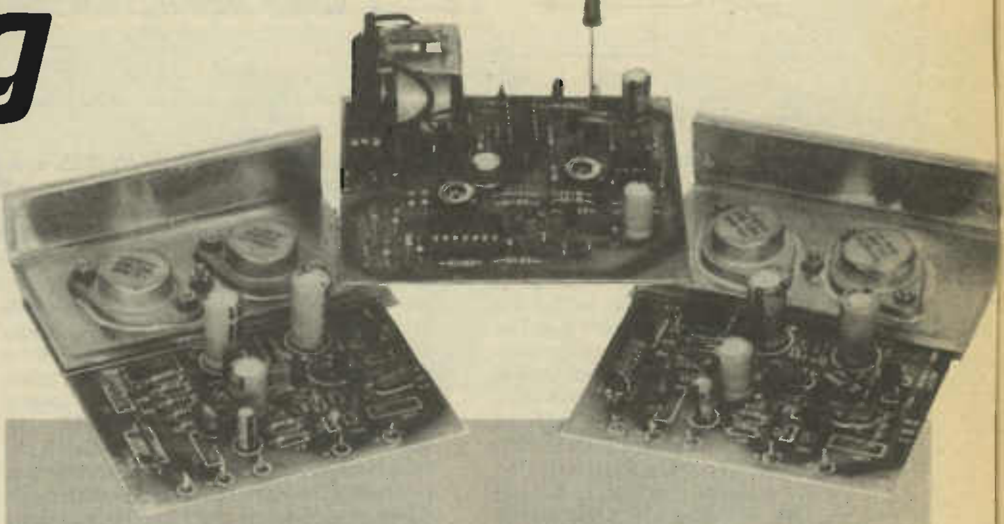


Figure 8. Use of a zener diode to provide a constant voltage output.

75W MOSFET Amp. Bridging Module

by Dave Goodman



- Increases power output to 400W
- 'Anti Thump' delay at switch on
- Loudspeaker protection
- Short circuit and offset protection

The Maplin MOSFET power amplifier has proved an extremely popular project, and many requests have been received for increased power output levels. Power Bridging is an effective way of achieving this, but of course loudspeakers capable of handling high power levels cost more, and therefore protection from any possible damage becomes even more necessary. This system senses voltage offsets from the amplifier, and will switch the speaker out of circuit, as well as producing the inverted signals required for bridging two amplifiers together.

Power Bridging

Power bridging is a system where the output of two power amplifiers can be combined to provide a larger total output into a common speaker load (see figure 1).

If we assume that signal A is exactly 180 degrees out-of-phase with signal B, and that amplitude V of A and B is the same, then the combined signal amplitude across the speaker load in figure 1 will be 2V.

It is usual to express amplifier power ratings as RMS or peak output levels, and for the purposes of standardisation I will refer to RMS power (that being the most commonly used) throughout this article.

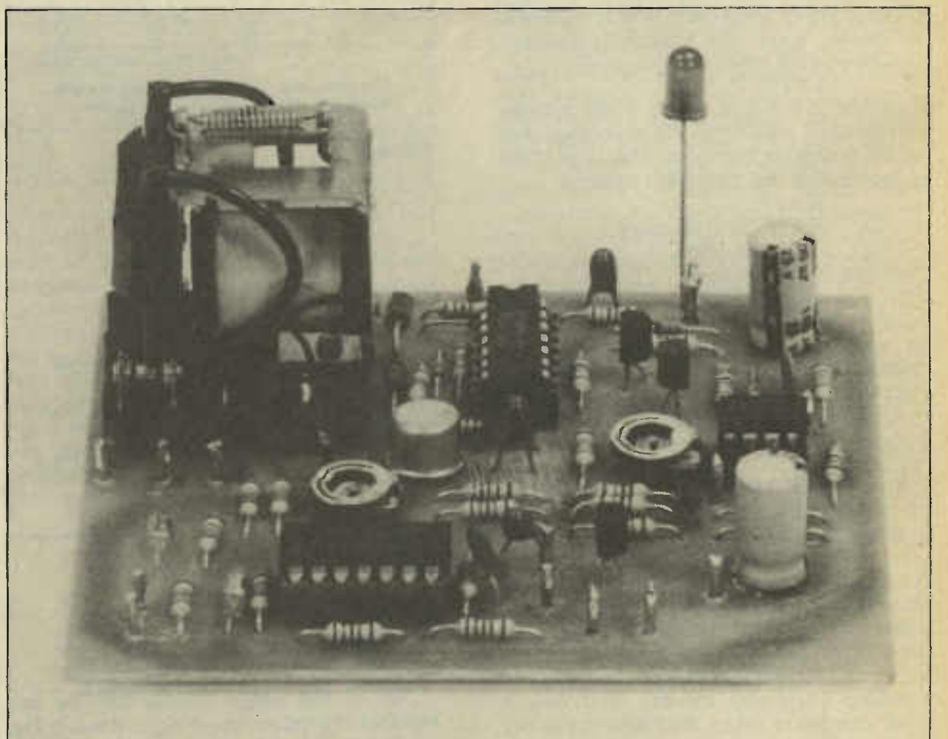
The expression used for calculating power into a given load is $W(Av) = \frac{(V_{RMS})^2}{R}$, where W = RMS power and V = the RMS value of voltage measured across loudspeaker R.

Unfortunately the average power calculation does not consider true voltage and current RMS values, so calculations using this expression will be some 20% lower than the true RMS figures.

Now that we have an expression for power developed in a load for one amplifier, the two amplifiers shown in figure 1 will have the expression

$$W = \frac{(V_{RMS}(AMP1) - V_{RMS}(AMP2))^2}{R}$$

because the load R is common to both amplifiers and W is the total power from both amplifiers.



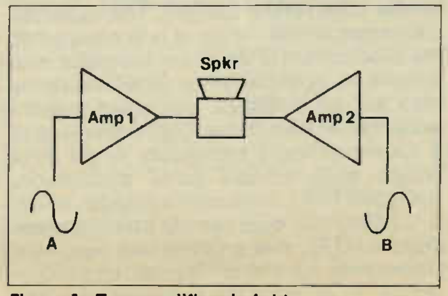


Figure 1. Two amplifiers in bridge.

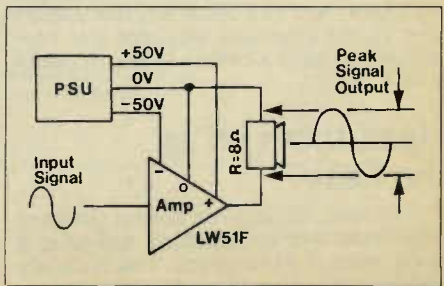


Figure 2. Typical connections to a single amplifier.

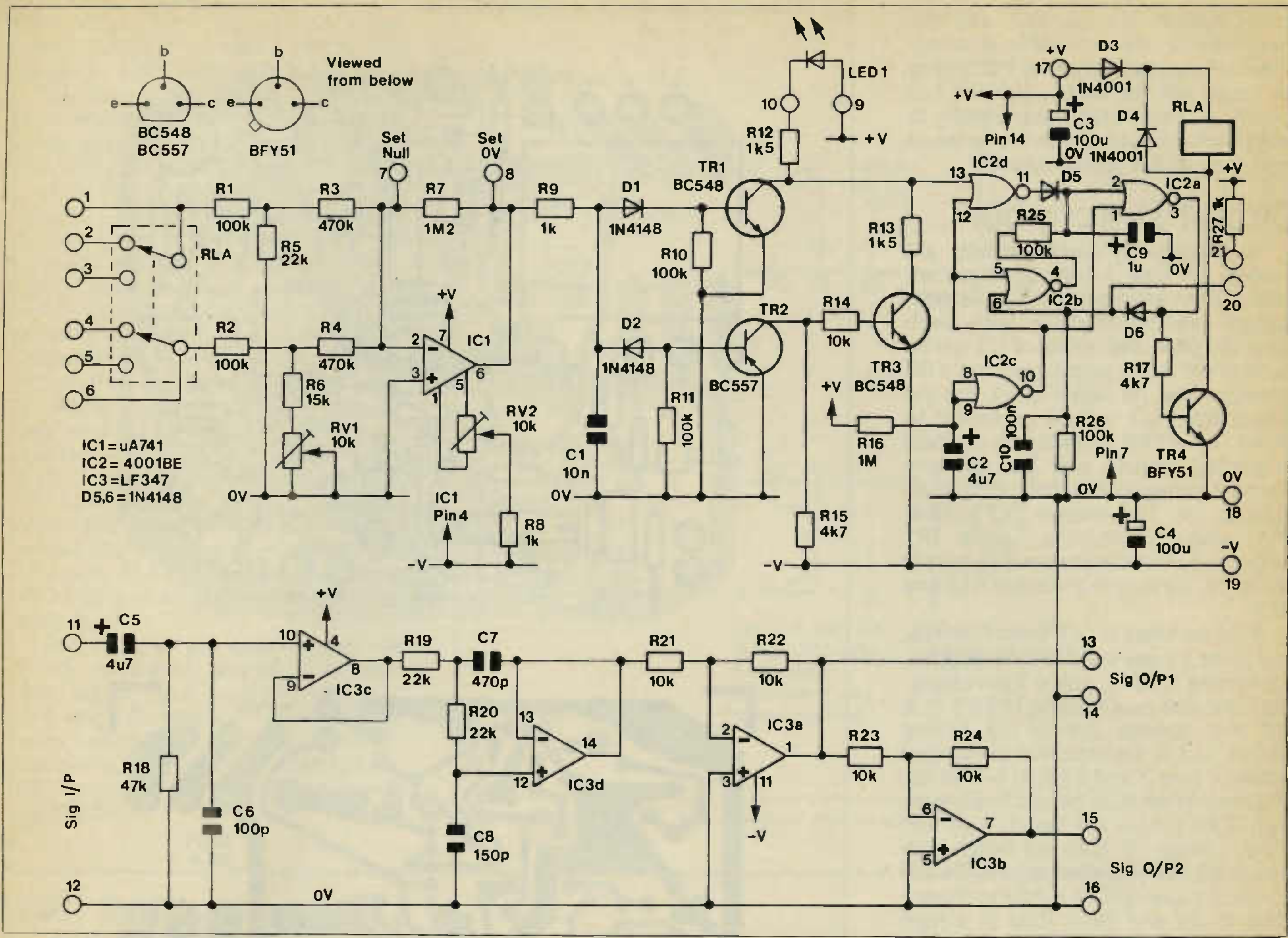


Figure 3. Circuit diagram.

To understand these formulae in real terms it is necessary to convert the peak voltage across the load into RMS volts which can be calculated from

$$V_{(RMS)} = \frac{V_{(PK)}}{2} \times 0.707$$

Given a power supply of +50V (or 100V DC) connected to a MOSFET power amplifier (LW51F) and an 8 ohm speaker as in figure 2, full drive at 1% distortion at 1kHz would develop 100V peak or $\frac{100}{2} \times 0.707 = 35.35$V RMS signal across R. Therefore the average RMS power would be $\frac{(35.35)^2}{2}$, or 156 Watts.

This magical figure works only in theory, and in fact losses due to heat, output stage inefficiency, and supply regulation would reduce this figure to a more realistic 100W RMS.

Connecting a second MOSFET amplifier as in figure 1, and referring to the expression $W = \frac{(V(AMP1) + V(AMP2))^2}{2}$ the RMS power output will be $W = \frac{(35.35 + 35.35)^2}{8} = 624$ Watts, or a realistic 400W.

All the above formulae show that bridging two amplifiers together doubles their combined power output, or quadruples a single amplifier output. Power supplies used for bridging must be capable of delivering 8 to 10 Amps at a well regulated 100 volts (+50V) if high

PARTS LIST FOR MOSFET BRIDGE

Resistors — All 0.4W 1% Metal Film unless specified

R1,2,10,11,25,26	100k	6 off	(M100K)
R3,4	470k	2 off	(M470K)
R5,19,20	22k	3 off	(M22K)
R6	15k		(M15K)
R7	1M2 (½W 5%)		(B1M2)
R8,9,27	1k	3 off	(M1K)
R12,13	1k5	2 off	(M1K5)
R14,21,22,23,24	10k	5 off	(M10K)
R15,17	4k7	2 off	(M4K7)
R16	1M		(M1M)
R18	47k		(M47K)
RV1,2	10k Hor sub-min preset	2 off	(WR58N)
Capacitors			
C1	10nF disc ceramic		(BX00A)
C2,5	4u7F 16V Tantalum	2 off	(WW64U)
C3,4	100uF 25V PC electrolytic	2 off	(FF11M)
C6	100pF ceramic		(WX56L)
C7	470pF polystyrene		(BX32K)
C8	150pF polystyrene		(BX29G)
C9	1uF 35V tantalum		(WW60Q)
C10	100nF disc ceramic		(BX03D)
Semiconductors			
D1,2,5,6	1N4148	4 off	(QL80B)
D3,4	1N4001	2 off	(QL73Q)
TR1,3	BC548	2 off	(QB73Q)
TR2	BC557		(QQ16S)
TR4	BFY51		(QF28F)
IC1	uA741		(QL22Y)
IC2	4001BE		(QX01B)
IC3	LF347		(WQ29G)
Miscellaneous			
RLA	Power relay 12V		(FX48C)
LED1	Red LED		(WL27E)
	14-pin DIL skt	2 off	(BL18U)
	8-pin DIL skt		(BL17T)
	Printed Circuit Board		(GA17T)
	Veropin 2141	1 Pkt	(FL21X)

A complete set of parts is available for this project.
Order As LK03D. **Price £9.95**

power outputs are required, and this may make transformers difficult to find. Alternatively, two separate PSUs may be used, one for each amplifier, but they must track each other closely to avoid signal amplitude errors between amplifiers at full power outputs.

Circuit Description

Both amplifier signal outputs are present on pins 1 and 6, which are mixed, then amplified by IC1. As both signals are out-of-phase with each other the expected output of IC1 will be close to 0V. If one signal input has a DC offset, or has no signal at all, the the output from IC1 will be presented to either TR1 or TR2. TR1 will only conduct to positive signals, and TR2 will only conduct to negative signals, with reference to 0V. TR3 inverts TR2 output, and, when conducting, pulls TR1 collector down from the positive supply rail to 0V, via potential divider R12 and R13.

IC2a switches to C/R timer C2/R16, and gives a three second turn-on delay, preventing IC2a, b, and d from changing state, and thus holding TR4 off. RLA will not operate during the timing period and a loudspeaker connected between pins 3 and 5 (RLA) will be out of circuit. When IC2c output finally goes high IC2b output will switch high and slowly charge C9. IC2a will switch high before C9 has fully charged, and D6 will conduct, causing IC2b output to change state to 0V and latch IC2a in a high state.

TR4 will now turn on and RLA will operate, presenting the loudspeaker to both amplifier outputs. If a fault condition turns on TR1 or TR3, IC2d output will switch high and D5 will conduct. IC2a output goes low and RLA will be released. IC2b then switches high, latching IC2a and holding TR4 off until reset by connecting pins 20 and 21 together. IC3c is a high impedance unity gain input buffer and IC3d is a low pass filter.

Our MOSFET amp has a large power bandwidth of some 70 to 100kHz or more, and for audio use it is not desirable to reproduce high power levels at these frequencies, so a low pass filter, IC3d has been added with a cut off frequency of 25kHz and a slope characteristic of 12dB per octave. This prevents h.f. signals from being amplified by reducing their level above the cut off point. IC3a is a unity gain buffer producing a signal output at pin 13 in phase with the pin 11 input signal, while IC3b inverts and produces a unity gain signal 180 degrees out-of-phase with the input, at pin 15. The two signal outputs are then connected to both MOSFET amp inputs (figure 5).

Construction

Insert all six diodes, noting that D3 and D4 are different from the others. They all have a band on one end, which must align with the band on the legend. Insert all resistors and both preset potentiometers, followed by all the

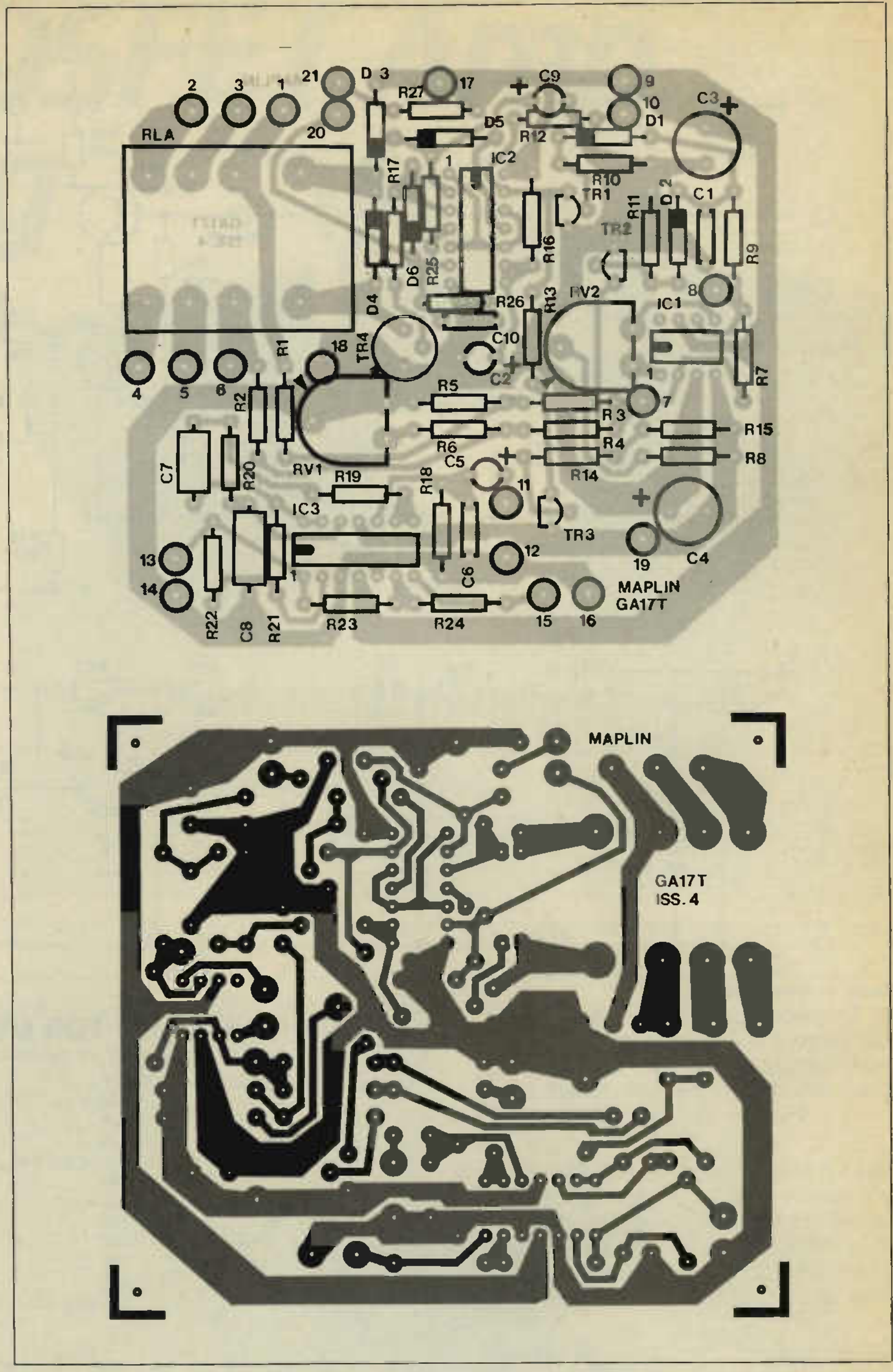


Figure 4. Legend and artwork.

capacitors. C3 and C4 are electrolytics, while C2, 5, and 9 are tantalum beads, and they all have polarity markings at one end. Mount the four transistors and three IC sockets, followed by the 21 vero pins. The relay is fitted last, and goes directly into the PCB. Bend the terminals over their track pads to hold in place. Solder all connections carefully and clean excess flux etc. from the board. Inspect the track face, looking for bad joints or short circuits, then fit all three ICs in their sockets.

Test and Use

Connect LED 1 between pins 9 and 10. The anode (positive) leg is usually the longest, and goes to pin 9. Turn RV1 and RV2 wipers so that their centres line up with the arrows on the legend. The indicators have been added for guidance purposes only, and are not final adjustment positions.

Temporarily connect pin 13 to pin 1 and pin 15 to pin 6. You will need a 50Hz signal source for setting up the null point and also a voltmeter, or preferably an oscilloscope.

Connect a +12V to +15V power supply to pins 17, 18, and 19 as shown in figure 5, and switch on. RLA should operate after about three seconds. Place a DC voltmeter between 0V and pin 8. Adjust RV2 for a reading of 0V.

Set the voltmeter to read 1V AC, and connect between 0V and pin 11. Also connect a signal source to pin 11 and 12V, and adjust the signal to 50Hz and about 1V RMS (3V pk on a scope). If you are unable to do this don't worry, as adjustments can be made further on, when using the complete system. Remove the meter lead from pin 11 and reconnect to pin 8. Adjust RV1 for the lowest possible voltage, which will appear as a dip in the reading.

If using a scope, adjust RV1 for null or 0V, whichever is the least. Switch off power and remove connections from pins 1, 6, 13, and 15, and the voltmeter.

Wire the bridging module to both MOSFET amps as shown in figure 5, but do not connect a speaker yet. Use screened lead for all signal connections. Connect power supplies and switch on. Apply a music signal, or whatever you intend to normally use the system for. Remove signal wire from pin 13, and RLA will release. It can be reset by briefly shorting pins 20 and 21 together. LED 1 also acts as a peak level indicator, coming on if signal levels reach clipping point at the output. RLA will also operate if this happens. Reconnect signal wire to pin 13 and remove the other input wire from pin 15. Again, RLA will release. Reconnect pin 15 to your amplifier and all will be ready to go.

The module pre-amp stages are exactly unity gain, and up to a maximum signal input level of about 10V RMS can be handled, although the power amps would complain! Their maximum input for full output is 1.2V RMS, and levels greater than this will clip the output.

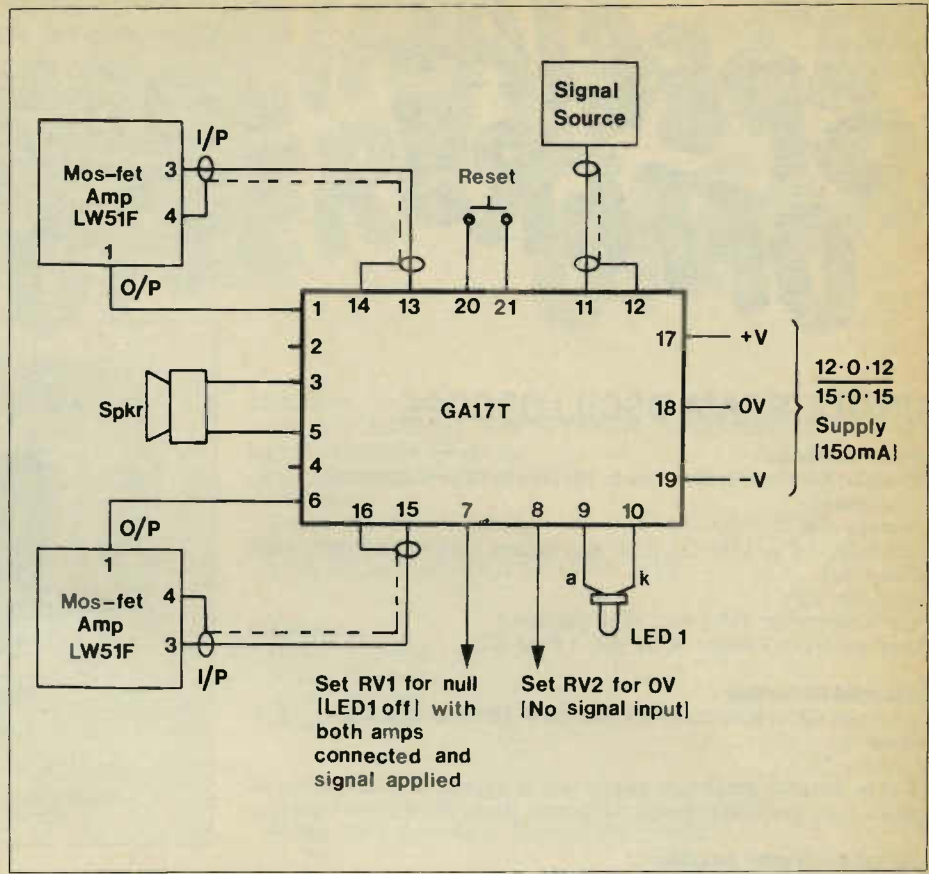


Figure 5. Connections for two amplifiers and bridge module.

FIRST BASE continued from page 21

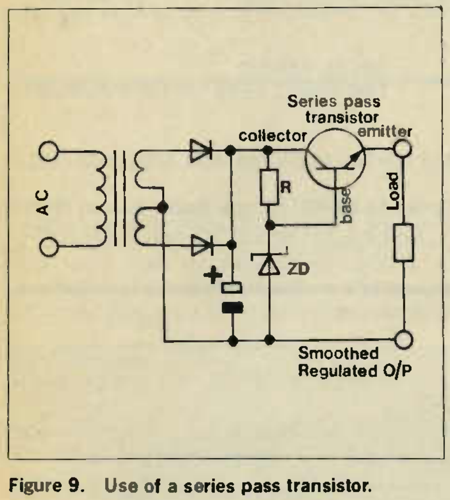


Figure 9. Use of a series pass transistor.

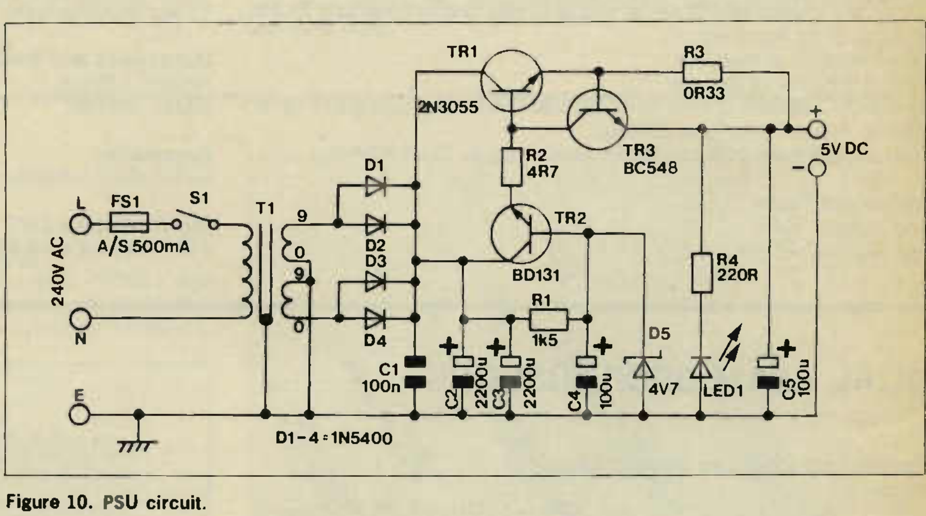


Figure 10. PSU circuit.

P.S.U. PARTS LIST

Resistors — All 0,4W 1% metal film unless specified.

R1	1k5		(M1K5)
R2	4R7 (½W 5%) carbon		(B4R7)
R3	0.33R (3W) wirewound		(WO.33R)
R4	220R		(M220R)

Capacitors

C1	100nF disc ceramic		(BX03D)
C2,3	2200uF 16V PC electrolytic	2 off	(FF6DQ)
C4,5	100uF 10V PC electrolytic	2 off	(FF10L)

Semiconductors

D1-4 inc	1N5400	4 off	(QL81C)
D5	BZY88C6V2		(QH09K)
LED 1	Red LED		(WL27E)
TR1	2N3055		(BL45Y)
TR2	BD131		(QF03D)
TR3	BC548		(QB73Q)

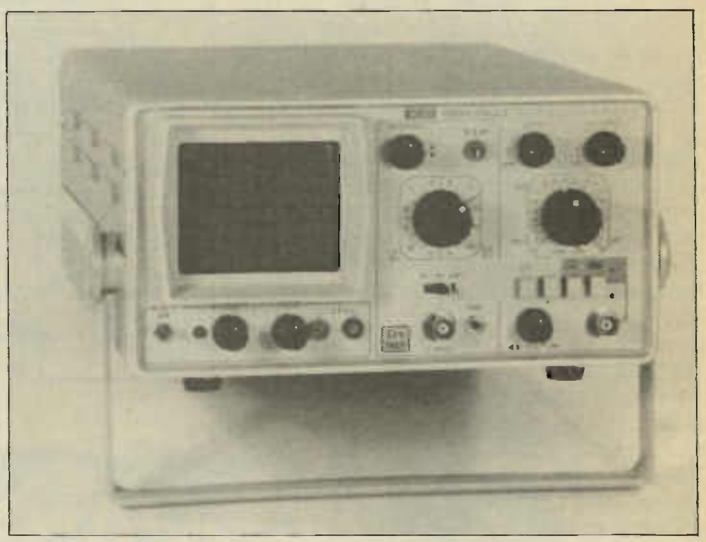
Miscellaneous

T1	TR 9V 1½A		(WB03D)
FS1	500mA A/S		(WR18U)
S1	Std Toggle SPST		(FH10L)
	Safe fuseholder 20		(RX96E)
	Kit T03		(WR24B)
	Wire to suit		

SPECIAL OFFERS

To go with our article on oscilloscopes and their uses we are selling not only our scopes at a very special price, but we are cutting the cost of our probes too! For the next three months only we are offering £10 off our single beam and £16 off our double beam scopes, and reducing our probes to just £12.75, saving you almost £3. These are prices you may never see again!

SINGLE-BEAM OSCILLOSCOPE



Vertical Deflection
Deflection Coefficient: 5mV/div to 20V/div in 12 calibrated steps (1, 2, 5 sequence).
Accuracy: 3%
Bandwidth: DC — 15MHz (-3dB) AC coupled 10Hz — 15MHz (-3dB) AC coupled.
Rise Time: 23ns
Input Impedance: 1MΩ and 35pF (approx.)
Maximum Input Voltage: 400V (DC + Peak AC)

Horizontal Deflection
Sweep Speeds: 0.5us/div to 200ms/div in 18 calibrated steps (1, 2, 5 sequence).
Accuracy: 5%
Variable: Extends maximum sweep rate to approx. 200ns/div continuously variable between calibrated steps.

External Horizontal Amplifier
Deflection Coefficient: 400mV/div within 10%
Bandwidth: 4Hz — 1MHz (-3dB)
Input Impedance: 1MΩ and 35pF (approx.)
X-Y Operation: Input via external trigger socket

Triggering
Modes: Automatic or manual level selection. Automatic operation minimizes trigger adjustments and provides bright base line in the absence of an input signal.
Slope: Positive or negative
Source: Internal or external
Sensitivity, Internal: 0.5 div from 10Hz to 1MHz decreasing to 1 div at 20MHz. Typical 0.4 div at 20MHz.
External: 0.5 from 10Hz to 1MHz decreasing to 1V at 20MHz

Component Tester
Test Voltage: 8.6V
Test Current: 28mA max.

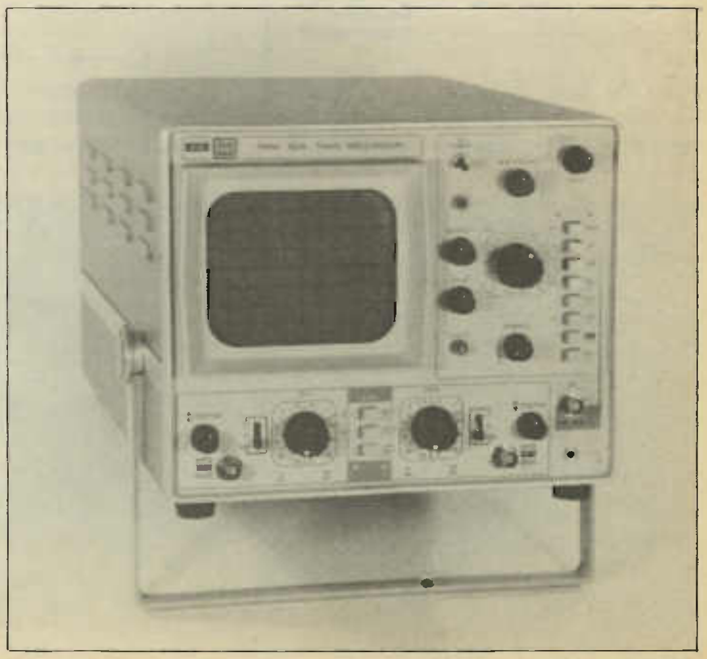
Display
95mm diagonal flat faced rectangular CRT P31 Phosphor 1KV accelerating potential 8 x 10 div display area non illuminated red line graticule on greenish blue filter. Each div is 0.66cm.
Calibrator: Output provided, 1KHz at 200mV p-p, for probe compenation. All Accuracies claimed at 25°C.
Trace Rotate: Control located on back panel allows 5° of adjustment.
Power Requirements: 110V/220V/230V/240V 47Hz — 65Hz 18VA.

Dimensions and Weight
Height: 125mm
Width: 240mm
Depth: 335mm
Nett weight: 4.6kg without accessories

Accessories
Included Accessories: Instruction Manual. Input Lead, and power cord.

Our usual price £167.90. Order As SP99H (Single Beam Scope) Price £157.90, and save £10.

DUAL BEAM OSCILLOSCOPE



Vertical Deflection (two identical channels)
Bandwidth:
DC—15MHz (-3 dB) DC coupled, 10Hz — 15MHz (-3 dB) AC coupled.
Rise Time: 23ns or less.
Deflection Coefficient:
5mV/div to 20V/div in 12 calibrated steps (1, 2, 5 sequence)
Accuracy: 3%.
Display Modes:
Channel 1 only CH1 & CH2 alternate or chopped mode (250KHz)
Algebraic addition CHI + CHII, Algebraic Substraction CHI — CHII, CHII Invert and X—Y.
Input Impedance: 1MΩ and 35pF (approx.)
Max. Input Voltage: 400V (DC + Peak AC)
Internal Trigger signal: CHI or CHII signal

Horizontal Deflection
Sweep Speeds:
0.5u s/div to 0.2 s/div in 18 calibrated steps in (1, 2, 5 sequence)
Accuracy: 5%.
Variable:
Uncalibrated continuously variable between steps, extends fastest speed to 200ns/div (approx).

SPECIAL OFFERS SPECIAL OFFERS SPECIAL OFFERS

X—Y Operation: Horizontal Input via CHII (CHI) operates as Y.
Deflection Coefficient: Same as CHII.
Bandwidth: DC—1MHz (-3dB).
Input Impedance: Same as CHII.

Triggering
Modes:
Automatic or normal with level selection. Automatic operation minimizes trigger adjustment and is useful above 30Hz. With no input automatic triggering provides a bright base line at all sweep rates.
Source: CHI or CHII, Line or Ext, and TV (frame).
Slope: Positive or Negative.
Sensitivity:
0.5 div deflection or IV pp external signal up to 20MHz in Auto mode 2 div deflection or 3V pp external signal from 10Hz to 20Hz in normal mode. Typical 1 div at 35MHz in AUTO at normal mode.

Component Tester
Test Voltage: 8.6V
Test Current: 28mA max.
Test Frequency: Line Frequency.

Display
130 mm flat faced Mono accelerator CRT with P31 Phosphor.
Z Modulation:
20V pp signal up to 1MHz modulates at normal intensity.
Graticule:
8 x 10 div blue non-illuminated. Vertical and horizontal centre lines marked in 5 minor divisions per major division.

Calibrator:
Amplifier Calibrator 0.2V at External socket accurate within 2%, output resistance 50 ohms.
All accuracies claimed at 25°C.
Trace Rotate:
Control located on rear panel allows 5° of adjustment.
Power Requirements:
110V/220V/230V/240V 47—65Hz 23VA

Dimensions
Height: 215 mm
Depth: 425 mm
Width: 265 mm
Weight: 8.5 kg

Accessories
Included Accessories:
Power Cord, Instruction Manual, Input Leads.

Note:
The component tester may be used to check components in circuit. Under these conditions it is recommended that the display obtained is compared with that obtained for a circuit known to be functional.

Our usual price £286. Order As SP00A (Dual Beam Scope) Price £270, and save £16.

PROBE FOR OSCILLOSCOPES

A very high quality probe suitable for use with almost any oscilloscope. Probe has a slide switch on body for immediate selection of either times 10 or times 1 or ground for instant position reference.

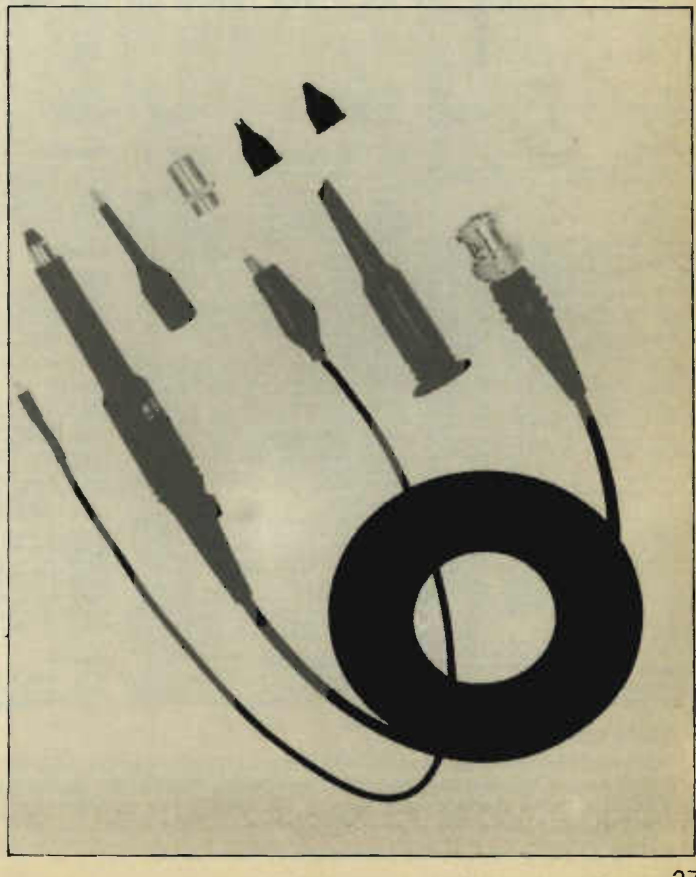
Specification

Bandwidth:	DC to 70MHz
Rise time:	<5ns
Overshoot:	<3%
Switch functions:	10:1 attenuation, ±1% with 'scope of 1MΩ input resistance. 1:1 attenuation with bandwidth of 10MHz approx.
Reference position, tip ground via 9MΩ, 'scope input grounded.	
Input capacitance:	12pF typical, depending on 'scope input capacitance.
Compensation range:	May be used with 'scopes of up to 45pF input capacitance by adjusting trimmer in probe body. Trim tool supplied.
Working voltage:	500V DC, 350V AC rms.

The probe is supplied with an ultra-flexible screened lead fitted, and an earth lead with crocodile clip attached. Lead is 1.2m approx. long.

Supplied in strong seal-top plastic wallet with accessories: retractable sprung hook with fully insulating sleeve, insulating tip, IC test tip, trimming tool and BNC adaptor.

Our usual price £15.63. Order As SP01B (scope probe BNC) Price £12.75, and save £2.88.



PRICE LIST

All prices shown in this price list are valid from 14th February 1983 to 14th May 1983

Please note new telephone number for Sales Only (0702) 552911

Prices shown in this list include VAT at 15% where applicable. Items marked *NV* are rated at 0% and the price shown applies both to inland and export orders. Overseas customers should add up the total cost of all items except those marked *NV* and deduct 13% to arrive at the total price excluding VAT. Alternatively multiplying the total price (except *NV* items) by 0.87 will give the total price excluding VAT. Please add extra for carriage on all overseas orders. Carriage will be charged at cost.

Although postage charges to customers living in the Republic of Ireland and in the UK, but not on the UK mainland, are the same as to mainland addresses we regret that we must levy an additional charge of £5 on each order containing any items marked "Delivery by Carrier".

Will customers from the Republic of Ireland please add 40p and then 35% to the cost of their order now that the Irish pound is not equivalent to sterling, to cover the rate difference and negotiation fees. We will refund any difference; please state cheque or credit note. Alternatively if you pay by bank draft drawn in pounds sterling on a London bank, then you need add nothing extra. Bank drafts drawn in pounds sterling on a London bank should be readily available from your local bank.

All prices are for the unit quantity shown in the catalogue (unless shown otherwise on this list) i.e. each, per pack, per metre etc. All prices include postage and packing. There is a 50p handling charge which must be paid on all orders having a total value of under £5.00.

The price list is intended for use with our 1983 catalogue and applies to all mail orders. Prices in our shop are generally lower on heavy items as mail order prices include postage and packing costs.

Copies of manufacturers' data sheets are available for most IC's — price 40p each.

NYA	Not yet available
NA	Not available
DIS	Discontinued
TEMP	Temporarily out of stock
OOP	Out of print
FEB	Out of stock, new stock expected in month shown
†	While stocks last
NV	Indicates that item is zero rated for VAT purposes
*	See Amendments to Catalogue

TRADE QUANTITIES

The letter in brackets after the price indicates the minimum quantity of that item you can buy and qualify for a trade price. If you buy less than the quantity shown then the price is that shown. If you want to buy the quantity shown or more of that item, then please contact us for a trade price. If no trade quantity is shown, then the price shown is the best price we can offer regardless of the quantity. Trade quantities shown for wires or cables of any type is in metres, not reels or parts of metres. Trade quantities for nuts, bolts, washers, Hiatts etc. refers to the number of packs, i.e. to qualify for a trade price on Tag 2BA for example (trade quantity 500), you will need to order 500 packs which is equal to 5000 tags.
Most items in the price list have a letter in brackets after the price which indicates the trade quantity as follows:

(A)	Trade quantity	5
(B)	Trade quantity	10
(C)	Trade quantity	25
(D)	Trade quantity	50
(E)	Trade quantity	100
(F)	Trade quantity	250
(G)	Trade quantity	500
(H)	Trade quantity	1000

Prices charged will be those ruling on the day of despatch

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XF12N	Maplin Poster	£1.00*NV* (D)
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XQ23A	Mushkiller FM234T	£16.50 (A)
XQ24B	Mushkiller FM235T	£17.60 (A)
XQ25C	Mushkiller FM244T	£17.80 (A)
XQ27E	Mushkiller FM264T	£24.50 (A)
XQ28F	Mushkiller FM284T	£30.50 (A)
XQ29G	Trucolour TC10 Grp A	£10.50 (A)
XQ30H	Trucolour TC10 Grp B	£9.40 (B)
XQ31J	TrucolourTC10 GrpC/D	£9.94 (B)
XG23A	Trucolour TC10 Grp E	£9.94 (B)
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XQ41U	Extragain XG8 GrpC/D	£21.50 (A)
XQ42V	Extragain XG8 Wdbnd	£21.95 (A)
XQ43W	ExtragainXG14 GroupA	£35.50 (A)
XQ44X	ExtragainXG14 GroupB	£36.35 (A)
XQ45Y	ExtragainXG14 GrpC/D	£34.85 (A)
XQ46A	Extragain XG14 Wdbnd	£35.95 (A)
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Page 22		
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BW43W	Mast Bracket Type 2	£2.55 (C)
XQ53H	Mast Bracket Type 3	£8.50 (B)
XQ54J	Mast Bracket Type 8	£12.75 (A)
BW44X	Mast Bracket Type 14	£4.65 (C)
BW45Y	Loft Bracket EM4	£2.65 (C)
XQ55K	Lashing Kit Type 4	£9.85 (B)
XQ56L	Lashing Kit Type 6	£15.95 (A)
XQ57M	Lashing Kit Type 7	£14.90 (A)
XQ58N	Lashing Kit Type 9	£12.24 (A)
XQ60Q	Mast D	£3.75 (C)
XQ61R	Mast E	£7.45 (B)
XQ62S	Mast G	£15.95 (A)
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BW46A	Masthead UP1300/W	£10.90 (A)
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XX09K	AC Adaptor BR300	£4.45 (C)
HF27E	Clips PP9	14p (G)
HF28F	PP3 Clip	9p (H)
RK43W	Heavy Duty Clips	19p (F)
YR59P	1.5V Batt Box	16p (G)
YR60Q	3V Batt Box	15p (G)
YR61R	4.5V Batt Box	30p (F)
HF29G	6v Batt Box	22p (G)
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RH05F	Book BP7	50p*NV*
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RH21X	Book BP27	65p*NV*
RH53H	Book BP160	MAY
XW53H	Book NB454	£3.96*NV*
XW63T	Book JM671	£2.75*NV* (C)
WA51F	Book BP107	£2.45*NV*
WA55K	Book BP113	£2.45*NV*
RL19V	Book NB126	£4.82*NV*
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XW64U	Book NB449	£4.84*NV*
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RR06G	Book NB209	£7.46*NV*
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RL33L	Book NB188	£7.84*NV*
XW87U	Book AG530	£4.25*NV*
WA24B	Undrstdng Communctns	£4.95*NV*
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RH11M	Book BP14	£2.15*NV*
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FW82D HD Strap Handle £1.55 (D)
LH08J Recess Handle 43p (F)
LH11M Heavy Duty Handle £2.94 (C)
YL05F Flip Handle £4.95 (C)
YX00A Cab Corners Small 20p (G)

FX04E Cab Corner Large 12p (G)
FX94C Corner Two-Side 29p (F)
FX95D Corner Three-Side 36p (F)
BK25C Cab Corner/Foot Lge 62p (E)
BK26D Cab Corner/Foot Sm. 40p (F)

HB20W Flexihinge 8p (H)
YL24B Small Hinge £1.55 (D)
YL04E Lift off Hinge £2.21 (D)
YL25C Lockable Catch £1.94 (D)
YL06G Butterfly Catch £4.79 (C)

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XY17T Laminate Japan Teak £3.75 (C)
XY18U Laminate Penang W/Nu £3.75 (C)
XY19V Laminate Alum Small £1.59 (D)
•XY20W Laminate Alum Large £2.44 (C)
RY06G Acoustic Wadding 65p (E)

RY00A Black Tygan 45in £1.96 (D)
RY01B Black Tygan 22 1/2in 98p (E)
RY02C Brown Tygan 45in £1.96 (D)
RY03D Brown Tygan 22 1/2in 98p (E)
RY04E Covering Cloth 50in £1.06 (D)

RY05F Covering Cloth 25in 53p (E)

CABLES

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BL77J Wire-Wrap Black £1.85 (G)
BL82D Wire-Wrap Red £1.85 (G)
BL83E Wire-Wrap White £1.85 (G)
BL85G Bell Wire Black 50p (H)
BL86T Bell Wire Blue 50p (H)

BL87U Bell Wire Brown 50p (H)
BL88V Bell Wire Green 50p (H)
BL89W Bell Wire Grey 62p (H)
BL90X Bell Wire Orange 62p (H)
BL91Y Bell Wire Pink 62p (H)

BL92A Bell Wire Red 62p (H)
BL93B Bell Wire Violet 62p (H)
BL94C Bell Wire White 62p (H)
BL95D Bell Wire Yellow 62p (H)
BL46A L/C Wire Black £1.25 (H)

BL47B L/C Wire Blue £1.25 (H)
BL48C L/C Wire Brown £1.25 (H)
BL49D L/C Wire Green £1.25 (H)
BL50E L/C Wire Grey £1.25 (H)
BL51F L/C Wire Orange £1.25 (H)

BL52G L/C Wire Pink £1.25 (H)
BL53H L/C Wire Red £1.25 (H)
BL54J L/C Wire Violet £1.25 (H)
BL55K L/C Wire White £1.25 (H)
BL56L L/C Wire Yellow £1.25 (H)

BL00A Wire 10M Black 35p (H)
BL01B Wire 10M Blue 35p (H)
BL02C Wire 10M Brown 35p (H)
BL03D Wire 10M Green 35p (H)
BL04E Wire 10M Grey 35p (H)

BL05F Wire 10M Orange 35p (H)
BL06G Wire 10M Pink 35p (H)
BL07H Wire 10M Red 35p (H)
BL08J Wire 10M Violet 35p (H)
BL09K Wire 10M White 35p (H)

BL10L Wire 10M Yellow 35p (H)
XL10L Wire 11C £3.75
YR00A Bicol Green/Red 34p (H)
YR01B Bicol Green/Yellow 34p (H)
YR04E Bicol Orange/Black 34p (H)

YR05F Bicol Orange/Red 34p (H)
YR06G Bicol Pink/Black 34p (H)
YR07H Bicol Purple/Red 34p (H)
YR08J Bicol Red/Black 34p (H)
YR09K Bicol Red/Blue 34p (H)

YR12N Bicol White/Black 34p (H)
YR14Q Bicol Yellow/Black 34p (H)
YR16S Bicol Yellow/Red 34p (H)
XR32K Wire 3202 Black 17p (G)
XR33L Wire 3202 Blue 17p (G)

XR34M Wire 3202 Brown 17p (G)
XR35Q Wire 3202 Green 17p (G)
XR36P Wire 3202 Red 17p (G)
XR37S Wire 3202 White 17p (G)
XR38R Wire 3202 Grn/Yllw 17p (G)

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XR57M HC Wire Black 38p (G)
XR58N HC Wire Green 38p (G)
XR59P HC Wire Red 38p (G)
XR40T Extra Flex Black 20p (G)
XR41U Extra Flex Blue 20p (G)

TRADE QUANTITIES

The letter in brackets after the price indicates the minimum quantity of that item you can buy and qualify for a trade price. See table at start of price list. If you buy less than the quantity shown then the price is that shown. If you want to buy the quantity shown or more of that item, then please contact us for a trade price. If no trade quantity is shown, then the price shown is the best price we can offer regardless of the quantity.
Trade quantities shown for wires or cables of any type is in metres, not reels or parts of metres. Trade quantities for nuts, bolts, washers, Hiatts etc. refers to the number of packs, i.e. to qualify for a trade price on Tag 2BA for example (trade quantity 500), you will need to order 500 packs which is equal to 5000 tags.

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XR43W	Extra Flex Green	20p (G)
XR44X	Extra Flex Red	20p (G)
XR45Y	Extra Flex Yellow	20p (G)
XR68Y	Min Extra Flex Black	15p (G)
XR69A	Min Extra Flex Red	15p (G)
XR22Y	EHT Wire	32p (G)
BL11M	Strappg Wire 16swg	82p (E)
BL12N	Strappg Wire 18swg	87p (E)
BL13P	Strappg Wire 20swg	95p (E)
BL14Q	Strappg Wire 22swg	94p (E)
BL15R	Strappg Wire 24swg	96p (E)
BL16S	EC Wire 14 swg	70p (E)
BL24B	EC Wire 16 swg	79p (E)
BL25C	EC Wire 18 swg	88p (E)
BL26D	EC Wire 20 swg	89p (E)
BL27E	EC Wire 22 swg	93p (E)
BL28F	EC Wire 24 swg	£1 05 (D)
BL29G	EC Wire 26 swg	£1 07 (D)
BL39N	EC Wire 28 swg	£1.07 (D)
BL40T	EC Wire 30 swg	£1 10 (D)
BL41U	EC Wire 32 swg	£1.12 (D)
BL42V	EC Wire 34 swg	£1.16 (D)
BL43W	EC Wire 36 swg	£1.25 (D)
BL44X	EC Wire 38 swg	£1.25 (D)
BL60Q	EC Wire 40 swg	£1.50 (D)
BL61R	EC Wire 42 swg	£1 49 (D)
BL62S	EC Wire 44 swg	£2 20 (C)
BL63T	EC Wire 48 swg	£4 95 (C)
XR39N	Zip Wire	14p (G)
XR60Q	HD Loudspeaker Cable	36p (G)
YG08J	Litz Speaker Leads	£6.84 (B)
XR06G	Ribbon Cable 10-Way	60p
XR07H	Ribbon Cable 20-Way	£1 20
XR67X	Ribbon Cable 30 Way	£1 80 (D)
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XR65V	IDC Cable 12-Way	£2 28
RK30H	Flexicable 7-way	54p (G)
RK31J	Flexicable 10-way	65p (G)
XR47B	Twn Mains DS Black	28p (G)
XR00A	Twn Mains DS White	18p (G)
XR61R	Twin 6A Mains Orange	49p (E)
XR62S	Twin 6A Mains White	49p (E)
XR01B	Min Mains Black	35p (E)
XR02C	Min Mains White	36p (E)
XR03D	C6A Mains Black	56p (E)
XR04E	C6A Mains White	56p (E)
XR05F	C6A Mains Orange	70p (E)
XR09K	HD Mains Black	99p (E)
XR10L	HD Mains White	80p (E)
XR11M	HD Mains Orange	90p (E)
XR24B	Cotton Mains	94p (E)
BL71N	Stretchflex 1A	£1 05 (D)
BL72P	Stretchflex 6A	£4 95 (C)
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XR48C	4 Core Mains	£1.05 (E)
XR49D	1.0mm TE Cable	43p (E)
XR50E	1 5mm TE Cable	48p (E)
XR51F	2 5mm TE Cable	65p (E)
XR52G	6mm TE Cable	£1.75 (E)
XR53H	1mm Trpl & ECC Cbl	74p (E)
XR15R	Min Screened	15p (G)
XR12N	Cable Single Black	19p (G)
XR13P	Cable Single Grey	19p (G)
XR14Q	Cable Single White	19p (G)
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XR16S	Single Mic Cable	42p (G)
XR18U	Low Noise Scnd	42p (G)
XR19V	Low C Cable	55p (G)
XR63T	UR67 RF Cable	£1 95 (D)
XR08J	Twin Mic Cable	82p (E)
XR20W	Lapped Pair	21p (G)
XR21X	Cable Twin	29p (G)
XR23A	Cable Quad	38p (G)
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XR25C	Multi-Core 4 Way	60p (E)
XR26D	Multi Core 6 Way	65p (E)
XR27E	Multi-Core 9 Way	86p (E)
XR28F	Multi-Core 15-Way	£1.25 (E)
XR46A	Multi Core 25-Way	£1 74 (E)
XR54J	Multi Core 36-Way	£2.31 (E)
XR66W	4 Wire Phone Cable	21p (G)
XR55K	7-Core Trailer Cable	£1.19 (E)
BH30H	Scr Strtchflx Blck	£1.80
BH31J	Scr Strtchflx Blue	£1 65 (D)
BH34M	Scr Stretchflex Red	£1.80 (D)
HQ49D	Twin Stretchflex	£2 40 (C)
XR30H	Standard Co-Ax	48p (G)
XR29G	Low Loss Co-Ax	50p (G)
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XR31J	Bal Feeder	19p (G)
YR19V	Marker A0	14p (G)
YR20W	Marker A1	14p (G)
YR21X	Marker A2	14p (G)
YR22Y	Marker A3	14p (G)
YR23A	Marker A4	14p (G)
YR24B	Marker A5	14p (G)
YR25C	Marker A6	14p (G)
YR26D	Marker A7	14p (G)
YR27E	Marker A8	14p (G)
YR28F	Marker A9	14p (G)
YR29G	Marker B0	14p (G)
YR30H	Marker B1	14p (G)
YR31J	Marker B2	14p (G)
YR32K	Marker B3	14p (G)
YR33L	Marker B4	14p (G)
YR34M	Marker B5	14p (G)
YR35Q	Marker B6	14p (G)
YR36P	Marker B7	14p (G)
YR37S	Marker B8	14p (G)
YR38R	Marker B9	14p (G)
YR39N	Marker C0	14p (G)
YR40T	Marker C1	14p (G)
YR41U	Marker C2	14p (G)
YR42V	Marker C3	14p (G)
YR43W	Marker C4	14p (G)
YR44X	Marker C5	14p (G)
YR45Y	Marker C6	14p (G)
YR46A	Marker C7	14p (G)
YR47B	Marker C8	14p (G)
YR48C	Marker C9	14p (G)
BF86T	Heat Shrink CP 16	55p (E)
BF87U	Heat Shrink CP 24	65p (E)
BF88V	Heat Shrink CP 32	30p (F)
BF89W	Heat Shrink CP 48	32p (F)
BF90X	Heat Shrink CP 64	34p (F)
YR17T	Heat Shrink CP95	50p (E)
YR18U	Heat Shrink CP127	£1 10 (E)
BL66W	Ht-Resist Sleeve Blk	12p (G)
BL69A	Ht-Resist Sleeve Grn	12p (G)
BL70M	Ht-Resist Sleeve Red	12p (G)
BH00A	Systoflex 1mm Black	6p (H)
BH01B	Systoflex 1mm Blue	6p (H)
BH02C	Systoflex 1mm Green	6p (H)
BH03D	Systoflex 1mm Red	6p (H)
BH04E	Systoflex 1mm White	8p (H)

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BH05F	Systoflex 1mm Yellow	8p (H)
BH06G	Systoflex 2mm Black	9p (H)
BH07H	Systoflex 2mm Blue	9p (H)
BH08J	Systoflex 2mm Green	9p (H)
BH09K	Systoflex 2mm Red	9p (H)
BH10L	Systoflex 2mm White	11p (H)
BH11M	Systoflex 2mm Yellow	11p (H)
BH12N	Systoflex 4mm Black	15p (H)
BH13P	Systoflex 4mm Blue	15p (H)
BH14Q	Systoflex 4mm Green	15p (H)
BH15R	Systoflex 4mm Red	15p (H)
BH16S	Systoflex 4mm White	24p (H)
BH17T	Systoflex 4mm Yellow	24p (H)
BH42V	Systoflex 6mm Black	17p (H)
BH43W	Systoflex 10mm Black	24p (H)
BL65V	Lacing Cord	£1 10 (H)
BL57M	Spirawrap 1/8in	18p (G)
BL58N	Spirawrap 1/4in	21p (F)
BL59P	Spirawrap 1/2 in	46p (F)
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BF91Y	Tie-Wrap 92	2p (H)
BF92A	Tie-Wrap 140	3p (H)
BF93B	Tie Wrap 186	4p (H)
BF94C	Cable Tie Base	19p (G)
RK59P	Re-Usable Cable Tie	2p (H)
BH26D	Safix 4	12p (G)
BH27E	Safix 8	10p (G)
BH28F	Safix 12	14p (G)
LR44X	Cable P Clip 3/16in	3p (H)
LR45Y	Cable P Clip 1/4in	3p (H)
LR46A	Cable P Clip 5/16in	3p (H)
LR04E	Cable P Clip 3/8in	3p (H)
BH18U	Hiatt Rd 2.3/4mm	25p (G)
BH19V	Hiatt Rd 3 1/2mm	29p (F)
BH20W	Hiatt Rd 4mm	29p (F)
BH21X	Hiatt Rd 5mm	29p (F)
BH22Y	Hiatt Rd 6mm	32p (F)
BH23A	Hiatt Rd 7mm	32p (F)
BH24B	Hiatt Rd 8mm	34p (F)
BH36P	Hiatt Rd 9mm	37p (F)
BH25C	Hiatt Flat 4mm	32p (G)
BH37S	Hiatt Flat 5mm	32p (F)
BH38R	Hiatt Flat 7mm	36p (F)
BH39N	Hiatt Flat 9mm	32p (F)
BH40T	Hiatt Flat 10mm	38p (F)
BH41U	Hiatt Flat 14mm	45p (F)
CAPACITORS		
Page 86		
WX35Q	Ceramic 1.8	8p (H)
WX36P	Ceramic 2.2	8p (H)
WX37S	Ceramic 2 7	8p (H)
WX38R	Ceramic 3.3	8p (H)
WX39N	Ceramic 3 9	8p (H)
WX40T	Ceramic 4 7	8p (H)
WX41U	Ceramic 5 6	8p (E)
WX42V	Ceramic 6.8	8p (H)
WX43W	Ceramic 8 2	8p (H)
WX44X	Ceramic 10	8p (H)
WX45Y	Ceramic 12	8p (H)
WX46A	Ceramic 15	8p (H)
WX47B	Ceramic 18	8p (H)
WX48C	Ceramic 22	8p (H)
WX49D	Ceramic 27	8p (H)
WX50E	Ceramic 33	8p (H)
WX51F	Ceramic 39	8p (H)
WX52G	Ceramic 47	8p (H)
WX53H	Ceramic 56	8p (H)
WX54J	Ceramic 68	8p (H)
WX55K	Ceramic 82	8p (H)
WX56L	Ceramic 100	8p (H)
WX57M	Ceramic 120	8p (H)
WX58N	Ceramic 150	8p (H)
WX59P	Ceramic 180	8p (H)
WX60Q	Ceramic 220	8p (H)
WX61R	Ceramic 270	8p (H)
WX62S	Ceramic 330	8p (H)
WX63T	Ceramic 390	8p (H)
WX64U	Ceramic 470	8p (H)
WX65V	Ceramic 560	8p (H)
WX66W	Ceramic 680	8p (H)
WX67X	Ceramic 820	8p (H)
WX68Y	Ceramic 1000	8p (H)
WX69A	Ceramic 1200	8p (H)
WX70M	Ceramic 1500	8p (H)
WX71N	Ceramic 1800	8p (H)
WX72P	Ceramic 2200	8p (H)
WX73Q	Ceramic 2700	8p (H)
WX74R	Ceramic 3300	8p (H)
WX75S	Ceramic 3900	8p (H)
WX76H	Ceramic 4700	8p (H)
WX77J	Ceramic 10,000	8p (H)
WX78K	Ceramic 22,000	8p (H)
YY24B	Monocap 0 001uF	28p (F)
YY25C	Monocap 0 0022uF	28p (F)
YY07H	Monocap 0.0047uF	28p (F)
YY08J	Monocap 0 01uF	28p (F)
YY09K	Monocap 0.022uF	34p (F)
YY10L	Monocap 0 047uF	36p (F)
YY11M	Monocap 0.1uF	43p (F)
YR73Q	Minidisc 0.01uF	5p (H)
YR74R	Minidisc 0.047uF	5p (H)
YR75S	Minidisc 0.1uF	7p (H)
YR76H	Minidisc 0.47uF	15p (G)
BX00A	Disc 0 01uF	10p (G)
BX01B	Disc 0 022uF	10p (G)
BX02C	Disc 0.047uF	12p (G)
BX03D	Disc 0.1uF	12p (G)
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BX05F	HV Disc 10	14p (G)
BX06G	HV Disc 47	19p (G)
BX07H	HV Disc 100	22p (G)
BX10L	HV Disc 470	11p (G)
BX12N	HV Disc 1000	11p (G)
BX13P	HV Disc 2200	11p (G)
BX14Q	HV Disc 4700	22p (G)
BX15R	HV Disc 10,000	19p (G)
HY18U	1000V Disc 4700pF	26p (F)
BX16S	Feed Thro Cap	8p (H)
WX02C	Mica 5pF	27p
WX03D	Mica 10pF	27p
WX05F	Mica 22pF	27p
WX07H	Mica 33pF	28p
WX09K	Mica 47pF	28p
WX11M	Mica 68pF	28p
WX12N	Mica 82pF	28p
WX13P	Mica 100pF	28p
WX14Q	Mica 120pF	28p
WX15R	Mica 150pF	28p
WX16S	Mica 180pF	28p
WX17T	Mica 220pF	28p
WX19V	Mica 330pF	49p
WX21X	Mica 470pF	49p
WX23A	Mica 680pF	51p
WX25C	Mica 1000pF	56p
WX31J	Mica 4700pF	£1 25
BX24B	Polystyrene 22	13p (G)
BX25C	Polystyrene 33	8p (H)

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BX26D	Polystyrene 47	8p (H)
BX27E	Polystyrene 68	8p (H)
BX28F	Polystyrene 100	8p (H)
BX29G	Polystyrene 150	8p (H)
BX30H	Polystyrene 220	8p (H)
BX31J	Polystyrene 330	8p (H)
BX32K	Polystyrene 470	8p (H)
BX33L	Polystyrene 560	8p (H)
BX34M	Polystyrene 680	8p (H)
BX35Q	Polystyrene 1000	8p (H)
BX36P	Polystyrene 1500	8p (H)
BX37S	Polystyrene 2200	8p (H)
BX38R	Polystyrene 3300	8p (H)
BX39N	Polystyrene 4700	8p (H)
BX40T	Polystyrene 5600	10p (G)
BX41U	Polystyrene 6800	10p (G)
BX92A	Polystyrene 10,000	14p (G)
BX93B	Polystyrene 22,000	19p (G)
BX94C	Polystyrene 47,000	25p (F)
BX95D	Polystyrene 100,000	49p (F)
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BX46A	1% Polysty 100	27p (F)
BX47B	1% Polysty 150	27p (F)
BX48D	1% Polysty 220	27p (F)
BX50E	1% Polysty 270	29p (F)
BX51F	1% Polysty 330	29p (F)
BX52G	1% Polysty 390	29p (F)
BX53H	1% Polysty 470	29p (F)
BX54J	1% Polysty 560	29p (F)
BX55K	1% Polysty 750	29p (F)
BX56L	1% Polysty 1000	29p (F)
BX57M	1% Polysty 1200	29p (F)
BX58N	1% Polysty 1500	29p (F)
BX59P	1% Polysty 1800	29p (F)
BX60Q	1% Polysty 2200	29p (F)
BX61R	1% Polysty 2700	29p (F)
BX62S	1% Polysty 3300	29p (F)
BX63T	1% Polysty 3900	29p (F)
BX64U	1% Polysty 4700	37p (F)
BX65V	1% Polysty 5600	37p (F)
BX66W	1% Polysty 6800	37p (F)
BX85G	1% Polysty 8200	37p (F)
BX86T	1% Polysty 10,000	42p (F)
BX87U	1% Polysty 22,000	48p (F)
WW22Y	Carbonate 0.001	9p (H)
WW23A	Carbonate 0.0015	9p (H)
WW24B	Carbonate 0.0022	9p (H)
WW25C	Carbonate 0.0033	9p (H)
WW26D	Carbonate 0.0047	9p (H)
WW27E	Carbonate 0.0068	9p (H)
WW28F	Carbonate 0.0082	9p (H)
WW29G	Carbonate 0.01	9p (H)
WW30H	Carbonate 0.012	9p (H)
WW31J	Carbonate 0.015	9p (H)
WW32K	Carbonate 0.018	9p (H)
WW33L	Carbonate 0.022	9p (G)
WW34M	Carbonate 0.027	11p (G)
WW35Q	Carbonate 0.033	11p (G)
WW36P	Carbonate 0.039	11p (G)
WW37S	Carbonate 0.047	11p (G)
WW38R	Carbonate 0.056	11p (G)
WW39N	Carbonate 0.068	12p (G)
WW40T	Carbonate 0.082	12p (G)
WW41U	Carbonate 0.1	11p (G)
WW42V	Carbonate 0.12	11p (G)
WW43W	Carbonate 0.15	14p (G)
WW44X	Carbonate 0.18	14p (G)
WW45Y	Carbonate 0.22	16p (G)
WW46A	Carbonate 0.27	16p (G)
WW47B	Carbonate 0.33	20p (G)
WW48C	Carbonate 0.39	22p (G)
WW49D	Carbonate 0.47	25p (F)
WW50E	Carbonate 0.56	27p (F)
WW51F	Carbonate 0.68	27p (F)
WW52G	Carbonate 0.82	27p (F)
WW53H	Carbonate 1	27p (F)
BX70M	Polyester 0.01uF	8p (H)
BX71N	Polyester 0.015uF	8p (H)
BX72P	Polyester 0.022uF	8p (H)
BX73Q	Polyester 0.033uF	8p (H)
BX74R	Polyester 0.047uF	9p (H)
BX75S	Polyester 0.068uF	9p (H)
BX76H	Polyester 0.1uF	9p (H)
BX77J	Polyester 0.15uF	15p (G)
BX78K	Polyester 0.22uF	13p (G)
BX79L	Polyester 0.33uF	18p (G)
BX80B	Polyester 0.47uF	21p (G)
BX81C	Polyester 0.68uF	34p (F)
BX82D	Polyester 1uF	38p (F)
BX83E	Polyester 1.5uF	56p (E)
BX84F	Polyester 2.2uF	64p (E)
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WW15R	Mylar 0.001	5p (H)
WW16S	Mylar 0.0022	5p (H)
WW17T	Mylar 0.0047	5p (H)
WW18U	Mylar 0.01	6p (H)
WW19V	Mylar 0.022	6p (H)
WW20W	Mylar 0.047	8p (H)
WW21X	Mylar 0.1	10p (G)
WW83E	Mylar 0.22	16p (G)
FF53H	IS Cap 0.01uF	23p (G)
FF54J	IS Cap 0.022uF	25p (F)
FF55K	IS Cap 0.047uF	28p (F)
FF56L	IS Cap 0.1uF	45p (F)
FF57M	IS Cap 0.22uF	45p (F)
FF58N	IS Cap 0.47uF	78p (E)
YY29G	Minelect 0.1uF 50V	13p (G)
YY30H	Minelect 0.47uF 50V	13p (G)
YY31J	Minelect 1uF 50V	14p (G)
YY32K	Minelect 2.2uF 50V	15p (G)
YY33L	Minelect 4.7uF 35V	21p (G)
YY34M	Minelect 10uF 16V	13p (G)
*YY35Q	Minelect 10uF 40V	16p (G)
YY36P	Minelect 22uF 16V	18p (G)
YY37S	Minelect 47uF 10V	22p (G)
RK50E	Minelect 100uF 6.3V	22p (G)
WW54J	Tant 0.1uF 35V	13p (G)
WW55K	Tant 0.15uF 35V	16p (G)
WW56L	Tant 0.22uF 35V	16p (G)
WW57M	Tant 0.33uF 35V	18p (G)
WW58N	Tant 0.47uF 35V	17p (G)
WW59P	Tant 0.68uF 35V	17p (G)
WW60Q	Tant 1.0uF 35V	18p (G)
WW61R	Tant 1.5uF 35V	18p (G)
WW62S	Tant 2.2uF 35V	18p (G)
WW63T	Tant 3.3uF 35V	19p (G)
WW64U	Tant 4.7uF 16V	18p (G)
WW65V	Tant 4.7uF 35V	19p (G)
WW66W	Tant 6.8uF 16V	21p (G)
WW67X	Tant 6.8uF 35V	24p (F)
WW68Y	Tant 10uF 16V	25p (F)
WW69A	Tant 10uF 25V	28p (F)
WW70M	Tant 22uF 16V	36p (F)
WW72P	Tant 22uF 16V	39p (F)
WW73Q	Tant 22uF 25V	65p (E)
WW74R	Tant 33uF 10V	32p (F)
WW75S	Tant 47uF 10V	57p (E)
WW76H	Tant 47uF 16V	75p (E)
WW78K	Tant 100uF 3V	35p (F)
WW79L	Tant 100uF 10V	£1 25 (D)

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FF00A	PC Elect 0 47uF 100V	11p (G)
FF01B	PC Elect 1uF 100V	11p (G)
FF02C	PC Elect 2 2uF 63V	10p (G)
FF03D	PC Elect 4.7uF 63V	10p (G)
FF04E	PC Elect 10uF 35V	10p (G)
FF05F	PC Elect 10uF 63V	11p (G)
FF06G	PC Elect 22uF 16V	10p (G)
FF07H	PC Elect 22uF 63V	12p (G)
FF08J	PC Elect 47uF 25V	12p (G)
FF09K	PC Elect 47uF 63V	14p (G)
FF10L	PC Elect 100uF 10V	10p (G)
FF11M	PC Elect 100uF 25V	12p (G)
FF12N	PC Elect 100uF 63V	22p (G)
FF13P	PC Elect 220uF 16V	12p (G)
FF14Q	PC Elect 220uF 63V	33p (F)
FF15R	PC Elect 470uF 16V	20p (G)
FF16S	PC Elect 470uF 25V	25p (F)
FF59P	PC Elect 470uF 63V	56p (E)
FF17T	PC Elect 1000uF 16V	27p (F)
FF18U	PC Elect 1000uF 25V	33p (F)
FF60Q	PC Elect 2200uF 16V	42p (F)
FB11M	Axial 0 47uF 250V	21p (G)
FB12N	Axial 1uF 63V	8p (H)
FB13P	Axial 1uF 450V	25p (F)
FB14Q	Axial 1 5uF 63V	10p (G)
FB15R	Axial 2.2uF 63V	10p (G)
FB16S	Axial 2 2uF 450V	30p (F)
FB17T	Axial 3 3uF 63V	10p (G)
FB18U	Axial 4.7uF 63V	12p (G)
FB19V	Axial 4.7uF 450V	33p (F)
FB20W	Axial 6 8uF 40V	15p (G)
FB21X	Axial 6.8uF 63V	16p (G)
FB22Y	Axial 10uF 25V	9p (H)
FB23A	Axial 10uF 63V	11p (G)
FB24B	Axial 10uF 100V	18p (G)
FB25C	Axial 10uF 450V	45p (F)
FB26D	Axial 15uF 16V	9p (H)
FB27E	Axial 15uF 40V	11p (G)
FB28F	Axial 15uF 63V	16p (G)
FB30H	Axial 22uF 25V	11p (G)
FB31J	Axial 22uF 63V	16p (G)
FB32K	AXial 22uF 100V	24p (F)
FB33L	Axial 22uF 450V	55p (E)
FB34M	Axial 33uF 6 3V	10p (G)
FB35Q	Axial 33uF 16V	11p (G)
FB36P	Axial 33uF 40V	12p (G)
FB38R	Axial 47uF 10V	10p (G)
FB39N	Axial 47uF 25V	13p (G)
FB41U	Axial 47uF 63V	17p (G)
FB42V	Axial 47uF 100V	32p (F)
FB43W	Axial 47uF 450V	85p (E)
FB44X	Axial 68uF 6.3V	15p (G)
FB45Y	Axial 68uF 16V	16p (G)
FB48C	Axial 100uF 10V	11p (G)
FB49D	Axial 100uF 25V	14p (G)
FB50E	Axial 100uF 40V	18p (G)
FB51F	Axial 100uF 63V	22p (G)
FB52G	Axial 100uF 100V	52p (E)
FB53H	Axial 100uF 250V	85p (E)
FB54J	Axial 150uF 6 3V	21p (G)
FB56L	Axial 150uF 25V	15p (G)
FB58N	Axial 150uF 63V	32p (F)
FB60Q	Axial 220uF 10V	12p (G)
FB61R	Axial 220uF 16V	14p (G)
FB62S	Axial 220uF 25V	18p (G)
FB63T	Axial 220uF 40V	27p (F)
FB64U	Axial 220uF 63v	32p (F)
FB65V	Axial 220uF 100V	55p (E)
FB67X	Axial 330uF 10V	14p (G)
FB68Y	Axial 330uF 25V	20p (G)
FB69A	Axial 330uF 63V	44p (F)
FB71N	Axial 470uF 10V	22p (G)
FB72P	Axial 470uF 16V	26p (F)
FB73Q	Axial 470uF 25V	30p (F)
FB74R	Axial 470uF 63V	55p (E)
FB75S	Axial 470uF 100V	89p (E)
FB77J	Axial 680uF 16V	30p (F)
FB78K	Axial 680uF 25V	38p (F)
FB79L	Axial 680uF 40V	68p (E)
FB80B	Axial 1000uF 6 3V	29p (F)
FB81C	Axial 1000uF 10V	25p (F)
FB82D	Axial 1000uF 16V	32p (F)
FB83E	Axial 1000uF 25V	40p (F)
FB84F	Axial 1000uF 63V	£1.00 (D)
FB85G	Axial 1500uF 6 3V	32p (F)
FB86T	Axial 1500uF 10V	38p (F)
FB87U	Axial 1500uF 16V	42p (F)
FB89W	Axial 2200uF 10V	40p (F)
FB90X	Axial 2200uF 25V	57p (E)
FB91Y	Axial 2200uF 40V	98p (E)
FB92A	Axial 2200uF 63V	£1 54 (D)
FB93B	Axial 3300uF 6 3V	58p (E)
FB94C	Axial 3300uF 25V	94p (E)
FB95D	Axial 4700uF 10V	60p (E)
FB96E	Axial 4700uF 25V	£1.25 (D)
RK26D	Axial 4700uF 40V	£1.40 (D)
Page 91		
FB97F	Reversolytic 1uF	25p (F)
FB01B	Reversolytic 2 2uF	25p (F)
FB02C	Reversolytic 3 3uF	25p (F)
FB03D	Reversolytic 4.7uF	25p (F)
FB06G	Reversolytic 10uF	25p (E)
FB08J	Reversolytic 22uF	35p (E)
FB09K	Reversolytic 33uF	39p (E)
FB10L	Reversolytic 47uF	39p
RK83E	Reversolytic 100u	69p (E)
FF19V	Can 1000uF 100V	£1 86 (D)
FF20W	Can 1500uf 63V	£1.95 (D)
FF21X	Can 2200uF 40V	£1.86 (D)
FF22Y	Can 2200uF 63V	£3 25 (C)
FF24B	Can 3300uF 40V	£2.15 (C)
FF25C	Can 3300uF 63V	DIS
FF26D	Can 4700uF 25V	£1 45 (D)
FF27E	Can 4700uF 40V	£4.35 (C)
FF28F	Can 4700uF 63V	£3 85 (C)
FF29G	Can 4700uF 100V	£5 35 (B)
FF30H	Can 6800uF 40V	£4 85 (C)
FF31J	Can 10,000uF 25V	£4 95 (C)
FF32K	Can 10,000uF 63V	£5 45 (B)
FF33L	Clip Can 25	15p (G)
FF34M	Clip Can 35	22p (G)
FF35Q	Clip Can 40	19p (G)
FF36P	Clip Can 50	55p (F)
FF37S	Horiz Clip 25	18p (G)
FF38R	Horiz Clip 35	18p (G)
†WL68Y	Trimmer 5.5pF	30p (F)
WL69A	Trimmer 10pF	30p (F)
WL70M	Trimmer 22pF	26p (F)
WL72P	Trimmer 65pF	29p (F)
WL71N	Trimmer 40pF	19p (G)
WL73Q	Trimmer 500pF	33p (F)
YQ24B	AM Varitune	£1 32 (C)
Page 92		
FF39N	Vari O	£4.62 (C)
FF40T	DG Vari	£6 95 (B)
FF41U	Twin OO	£7.16 (B)
FF42V	SW Trim 10pF	£5 23 (B)
FF43W	SW Trim 15pF	£5.23 (B)
FF44X	SW Trim 25pF	£5.23 (B)

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FF45Y	SW Trim 50pF	£5.23 (B)
FF46A	SW Trim 60pF	£6.15 (B)
FF48C	SW Trim 100pF	£6.10 (B)
FF49D	SW Trim 150pF	£6.76 (B)
FF50E	Dilecon 300pF	£4 45 (C)
FF51F	Dilecon 500pF	£4.35 (C)
FY77J	FS Crystal 100kHz	£4 55 (C)
HX62S	FS Crystal 1MHz	£5 95 (B)
FY78K	FS Crystal 10MHz	£2.95 (C)
FY79L	MP Crystal 1MHz	£4 45 (C)
FY80B	MP Crystal 2MHz	£2 20 (C)
FY81C	MP Crystal 2 4576MHz	£3.35 (C)
FY82D	MP Crystal 4MHz	£1.80 (D)
FY83E	MP Crystal 6 144MHz	£1 25 (D)
FY84F	MP Crystal 18 432MHz	£2 65 (C)
HX30H	MCR Crys Brown Pairs	£2 96 (C)
HX31J	MCR Crystal Red Pair	£2.96 (C)
HX32K	MCR Crys Orange Pair	£2 96 (C)
HX33L	MCR Crys Yellow Pair	£2.96 (C)
HX34M	MCR Crystal Green Pr	£2 96 (C)
HX35Q	MCR Crys Blue Pair	£2.96 (C)
FY85G	Colour TV Crystal	£1.20 (D)
Page 93		
FY86T	Crystal 50HzX 2.16	£3.15 (C)
FY87U	Crystal 1H X 2.22	£3.15 (C)
HX60Q	Crystal Socket 25u	26p (G)
HX61R	Crystal Socket 6u	45p (F)
HX99H	Ceramic Fltr 10.7MHz	60p (E)
CAR ACCESSORIES		
Page 94		
HW18U	Car Aerial Pull Up	£1 99 (D)
LH99H	Windscreen Aerial	£2 69 (C)
XX37S	Car Aerial Booster	£6 95 (B)
HW12N	Car Accessory Plug	45p (F)
YB68Y	Car Lighter Ext Lead	£2 25
YW59P	Car Power Lead	£2 70 (C)
FQ73Q	Map Light	69p (E)
HW22Y	12V Inspection Lamp	£1 60 (D)
HQ30H	Wiper Control	£9.65 (B)
Page 95		
WY09K	Demister	£6 95 (B)
FQ78K	Car Ammeter	£2 95 (C)
HQ35Q	Charger Ammeter	£1 47 (D)
HW16S	Car Flash 4 Lamp	£1.63 (D)
HW17T	Car Flash 6 Lamp	£1 55 (D)
HW01B	Supp Cap Small Lucar	59p (E)
HW03D	Supp Cap Spade	DIS
FQ87U	Supp Cap 3uF	£1 12 (D)
FQ88V	Plug-Top Supp Strt	38p (F)
FQ89W	Plug-Top Supp Ang	50p (E)
FQ90X	In Line Plug Supp	25p (F)
FQ91Y	Suppressor Choke	84p (E)
YL02C	Magnilamp	95p (E)
FY01B	Tyre Pressure Gauge	£1 95 (D)
XB44X	Car Speakers Shelf	£6 75 (B)
XG26D	Slim Line Car Spkers	£10 95 (A)
Page 96		
XY73Q	10W Shelf Spkrs	£18.25 (A)
XQ75S	10W Car Stereo Spkrs	£13.95 (A)
XG27E	15W Shelf Speakers	£15.95 (A)
XG25C	20W Shelf Speakers	£26.95 (A)
AF00A	Booster Amp	£17 99 (A)
AF01B	Booster Equaliser	£37 50 (A)
Page 97		
YX85G	Speed Sensor	£11 93 (A)
YX86T	Flow Sensor	£16.90 (A)
COMMUNICATIONS		
Page 98		
AF46A	CB Model GT 868	£49.95 (A)
XG10L	12V 3A Power Unit	£16 95 (A)
YK29G	Ext CB Speaker	£7 45 (B)
YL42V	Filter Choke	£1 99 (D)
YK30H	Noise Filter System	£10.95 (A)
YB00A	Low Pass RF Filter	£3.95 (C)
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YL43W	TVI Filter	£5 25 (B)
YL44X	CB Aerial Converter	£7 25 (B)
YQ73Q	CB/Radio Aerial Cplr	£5 49 (B)
YB01B	RF Antenna Switch	£6.34 (B)
YQ74R	CB Aerial Matcher	£5 25 (B)
XG13P	1 5m CB Aerial	£13 95 (A)
YG41U	27MHz Rubber Duck	£4 75 (C)
YG15R	2m Rubber Duck	£4.75 (C)
Page 100		
YG16S	Mag Mount	£8 50 (B)
HL94C	30W Dummy Load	£6 75 (B)
YK00A	2m Scanning Receiver	£54 95 (A)
WY11M	Compact PA Amp	£22.70 (A)
WY12N	10W PA Amp	£29 95 (A)
Page 101		
XY81C	40W PA Amp	£65.50 (A)
XY82D	60W PA Amp	£106.75 (A)
XQ72P	Megaphone	£49.95 (A)
XY76H	Pistol Grip Megphone	£49.95 (A)
XQ73Q	Car PA 8W	£8.25 (B)
XQ74R	Car PA 15W	£12 95 (A)
Page 102		
LB72P	Intercom 2-Station	£9 60 (B)
RK81C	FM Door Phone Set	£46.50 (A)
XY77J	4-Channel FM Intrcom	£29.95 (A)
XG18J	PB Telephone	£21.90 (B)
XG19V	Set 4 PB Telephones	£69 99 (A)
AF09K	AM Radio	£1.95 (C)
AF10L	AM/FM Radio	£4 95 (C)
COMPUTERS		
Page 103		
AF02C	Atari 800 with 16K	£399.00
AF55K	Atari 800 48K RAM	£440.00
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AF36P	Atari 400 with 16K	£249.90
AF37S	Atari 400 with 48k	£299.00
AF28F	Atari 410 Cass Rcdr	£50.00
AF06G	Atari 810 Disk Drive	£299.95
AF04E	Atari 822 Therm Prtr	£199.95
HY24B	Printer 822 Paper	£4 95
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AF41U	400 Cent I/F	£59 95
AF42V	800 Cent I/F	£59.95
AF29G	Atari 850 Interface	£135 00
AF43W	Versawriter	£199 95 (A)
AF08J	16K Memory Module	£55 00 (A)
AF44X	48K RAM Memry Module	£99 95 (A)
AF45Y	Atari 400 48K Upgrad	£75.00 (A)
AC37S	Game Joysticks	£13.95
AC53H	Single Game Joystick	£7.50
AC30H	Games Paddles	£13.95
AC45Y	Le Stick	£24 95 (B)

TRADE QUANTITIES

The letter in brackets after the price indicates the minimum quantity of that item you can buy and qualify for a trade price. See table at start of price list. If you buy less than the quantity shown then the price is that shown. If you want to buy the quantity shown or more of that item, then please contact us for a trade price. If no trade quantity is shown, then the price shown is the best price we can offer regardless of the quantity.
Trade quantities shown for wires or cables of any type is in metres, not reels or parts of metres. Trade quantities for nuts, bolts, washers, Hiatts etc. refers to the number of packs, i.e. to qualify for a trade price on Tag 2BA for example (trade quantity 500), you will need to order 500 packs which is equal to 5000 tags.

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YG44X	Conversation French	£39.95
YG45Y	Conversation German	£39.95
YG46A	Conversation Spanish	£39.95
YG47B	Conversation Italian	£39.95
YG49D	Touch Typing	£15.95
YG56L	States & Capitals	£9.95
YG57M	Euro Country & Caps	£8.95
BG00A	Kids 1 Cassette	£11.75 (B)
BG01B	Kids 1 Disk	£11.75 (B)
BG02C	Kids 2 Cassette	£11.75 (B)
BG03D	Kids 2 Disk	£11.75 (B)
YG43W	Inv To Prog 1	£21.52 (A)
BQ67X	Inv To Prog 2	£22.95 (A)
BQ68Y	Inv To Prog 3	£22.95 (A)
BQ57M	Basic Animation Cass	£14.50 (A)
BQ58N	Basic Animation Disk	£11.95 (A)
BQ59P	PM Graphics Cass	£21.25 (A)
BQ60Q	PM Graphics Disk	£21.25 (A)
BQ51F	Display Lists Cass	£14.50 (A)
BQ52G	Display Lists Disk	£14.50 (A)
BQ53H	Scrolling Cassette	£14.50 (A)
BQ54J	Scrolling Disk	£14.50 (A)
BQ55K	Page Flipping Cass	£14.50 (A)
BQ56L	Page Flipping Disk	£14.50 (A)
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BG04E	Sounds & Music Cass	£14.50 (A)
BG05F	Sounds & Music Disk	£14.50 (A)
BG06G	Tricky Tutorial Cass	£69.95 (A)
BG07H	Tricky Tutorial Disk	£69.95 (A)
YL39N	Visicalc	£119.95 (A)
YG42V	APC Word Processor	£99.95 (A)
BQ99H	Text Wizard Disk	£75.00 (A)
BG08J	Mini Word Procr Cass	£14.50 (B)
BG09K	Mini Word Procr Disk	£14.50 (A)
YG51F	Graph-It	£13.95 (A)
YG52G	Statistics Cassette	£13.95 (A)
BQ65V	Financial Manager	£49.00 (A)
BQ66W	Mortgage & Loan	£13.95 (A)
BG11M	Bob's Business Cass	£10.59 (B)
BG12N	Bob's Business Disk	£10.59 (B)
BQ14Q	Galactic Empire	£14.50 (A)
BG75S	Galaxy Cassette	£14.95 (A)
BG76H	Galaxy Disk	£18.95 (A)
BG77J	Galaxy Log Pad	NYA
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BQ21X	Rescue Rigel Cass	£20.75 (A)
BQ80B	Rescue Rigel Disk	£20.75 (A)
BQ22Y	Datestones Ryn Cass	£13.80 (A)
BQ82D	Datestones Ryn Disk	£13.80 (A)
BQ24B	Star Warrior Cass	£28.95 (A)
BQ79L	Star Warrior Disk	£27.45 (A)
BG95D	Voyager 1 Cassette	£14.95 (A)
BG96E	Voyager 1 Disk	£18.95 (A)
BQ23A	Invasion Orion Cass	£17.25 (A)
BQ81C	Invasion Orion Disk	£17.25 (A)
BG89W	Planet Miners Cass	£11.95 (A)
BG90X	Planet Miners Disk	£15.95 (A)
BQ83E	Crush Crumble Cass	£20.75 (A)
BQ84F	Crush Crumble Disk	£20.75 (A)
BQ91Y	Mission: Asteroid	£17.19 (A)
BQ25C	Wizard and Princess	£21.79 (A)
BQ92A	Ulysses Gold Fleece	£20.64 (A)
Page 109		
KB04E	Goodcode Cavern Disk	£21.95 (A)
BQ94C	Zork I Disk	£29.95 (A)
BQ95D	Zork II Disk	£29.95 (A)
BQ78K	Ali Baba 40 Thieves	£25.95 (A)
BQ85G	Temple Apshai Cass	£27.45 (A)
BQ86T	Temple Apshai Disk	£27.45 (A)
BQ87U	Upper Reaches Cass	£13.80 (A)
BQ88V	Upper Reaches Disk	£13.80 (A)
BQ89W	Curse of Ra Cass	£13.80 (A)
BQ90X	Curse Of Ra Disk	£13.80 (A)
BG73Q	Empire Ovr-Mind Cass	£21.95 (A)
BG74R	Empire Ovr-Mind Disk	£25.95 (A)
BG79L	Lords Of Karma Cass	£14.95 (A)
BG80B	Lords Of Karma Disk	£18.95 (A)
BQ33L	Analog Adventure	£16.95 (A)
BQ00A	Adventure Land	£17.95 (A)
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BQ01B	Pirate Adventure	£17.95 (A)
BQ02C	Mission Impossible	£17.95 (A)
BQ03D	Voodoo Castle	£17.95 (A)
BQ04E	The Count	£17.95 (A)
BQ05F	Strange Odyssey	£17.95 (A)
BQ06G	Mystery Fun House	£17.95 (A)
BQ07H	Pyramid of Doom	£17.95 (A)
BQ08J	Ghost Town	£17.95 (A)
BQ09K	Savage Island 1	£17.95 (A)
BQ10L	Savage Island II	£17.95 (A)
BQ11M	Golden Voyage	£17.95 (A)
BQ93B	Softporn Adventure	£20.64 (A)
BQ96E	Deadline	£34.95 (A)
YG53H	Energy Czar	£9.95
YG55K	Kingdom	£9.95
BG65V	Space Shuttle Mod 1	£18.95 (A)
BQ98G	Shattered Alliance	£29.95 (A)
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KB00A	Legionnaire Cassette	£25.95 (A)
BG63T	Battle Shiloh Cass	£28.95 (A)
BQ97F	Battle Shiloh Disk	£28.95 (A)
BG71N	Dnieper Line Cass	£18.95 (A)
BG72P	Dnieper Line Disk	£21.95 (A)
BG93B	Tanktics Cassette	£17.45 (A)
BG94C	Tanktics Disk	£21.95 (A)
BG83E	NA Convoy Raider Css	£11.95 (A)
BG84F	NA Convoy Raider Dsk	£15.95 (A)
KB01B	Tigers in Snow Cass	£28.95 (A)
KB02C	Tigers in Snow Disk	£28.95 (A)
BG81C	Midway Campaign Cass	£11.95 (A)
BG82D	Midway Campaign Disk	£15.95 (A)
BG68Y	B1 Nuke Bomber Cass	£11.95 (A)
BG69A	B1 Nuke Bomber Disk	£15.95 (A)
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BG87U	Nukewar Cassette	£11.95 (A)
BG88V	Nukewar Disk	£15.95 (A)
BG85G	Conflict 2500 Cass	£11.95 (A)
BG86T	Conflict 2500 Disk	£15.95 (A)
YG66W	Star Raiders	£29.95
BG97F	Shootout Galaxy Cass	£14.95 (A)
BG98G	Shootout Galaxy Disk	£18.95 (A)
YG60Q	Asteroids	£29.95
YG70M	Space Invaders	£29.95
YG64U	Missile Command	£29.95
BQ69A	Caverns Of Mars	£24.50
KB20W	Shamus Cassette	£34.95
KB21X	Shamus Disk	£34.95
BQ63T	K-razy Shoot Out	£34.95 (A)
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BG51F	K-Razy Kritters	£34.95 (A)
BG52G	K-Star Patrol	£34.95 (A)
BG33L	Pathfinder Disk	£27.95 (A)

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BG22Y	Crossfire Cassette	£20.64 (A)
BG23A	Crossfire Disk	£20.64 (A)
BG24B	Protector Cassette	£27.50 (A)
BG25C	Protector Disk	£27.50 (A)
KB12N	Choplifter Disk	£27.50
BG18U	Threshold Disk	£27.54 (A)
BG34M	Deluxe Invaders Disk	£27.95 (A)
BQ62S	Galactic Chase Cass	£16.95 (A)
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HH35Q	DIN Socket 5-pin B	18p (G)
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YX91Y	PC DIN Skt 5-pin A	25p (F)
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RK60Q	D-Range 9 Way Plug	79p (E)
BK58N	D-Range 15-Way Plug	£1.45
YQ48C	D-Range 25-Way Plug	£1.49 (C)
RK61R	D-Range 9 Way Skt	99p (D)
BK59P	D Range 15-Way Skt	£1 60 (D)
YQ49D	D-Range 25W Socket	£2 35 (C)
RK62S	D-Range 9 Way cover	99p (E)
BK60Q	D-Range 15 Way cover	99p (D)
YQ50E	D-Range 25-Way Cover	£1.32 (D)
WQ14Q	PCB Conns 45	7p (H)

TRADE QUANTITIES

The letter in brackets after the price indicates the minimum quantity of that item you can buy and qualify for a trade price. See table at start of price list. If you buy less than the quantity shown then the price is that shown. If you want to buy the quantity shown or more of that item, then please contact us for a trade price. If no trade quantity is shown, then the price shown is the best price we can offer regardless of the quantity.

Trade quantities shown for wires or cables of any type is in metres, not reels or parts of metres. Trade quantities for nuts, bolts, washers, Hiatts etc. refers to the number of packs, i.e. to qualify for a trade price on Tag 2BA for example (trade quantity 500), you will need to order 500 packs which is equal to 5000 tags.

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WQ15R	PCB Conns Vertical	7p (H)
WQ16S	PCB Conns Horizontal	7p (H)
RK63T	D Range 9 Way Latch	28p (F)
BK61R	D Range 15 Way Latch	28p (F)
YQ51F	D-Range Latch	28p (F)
RK35Q	PC Edgeconn 2x23-way	£2.39 (C)

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FL83E	Edge Conn 108	52p (E)
FL84F	Edge Conn 116	£1.08 (D)
FL85G	Edge Conn 124	£1.29 (D)
FL86T	Edge Conn 132	£1.95 (D)
FL87U	Edge Conn 140	DIS
FL91Y	Edge Conn Feet G	15p (G)
FL92A	Edge Conn Feet H	14p (G)
FL93B	Edge Conn Feet L	DIS
FL30H	Edge Conn Silver	£1.99 (D)
YR57M	Card Frame Edge Conn	£3.95 (C)
YR58N	Edge Conn End Bkt	26p (F)
YX33L	Multicon Plug 2-way	15p (G)
YX34M	Multicon Plug 4-way	20p (G)
YX35Q	Multicon Plug 9-way	29p (F)
YX36P	Multicon Plug 15-way	43p (F)
YX37S	Multicon Plug 24-way	58p (E)
YX38R	Multicon Plug 36-way	78p (E)
YX39N	Multicon Skt 2-way	18p (G)
YX40T	Multicon Skt 4-way	19p (G)
YX41U	Multicon Skt 9-way	27p (F)
YX42V	Multicon Skt 15-way	51p (E)
YX43W	Multicon Skt 24-way	59p (E)
YX44X	Multicon Skt 36-way	68p (E)
YX45Y	Multicon Plug Pin	3p (H)
YX46A	Multicon Skt Pin	3p (H)

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HL01B	Octal Ch Plug	75p (E)
HL00A	Octal Ch Skt	50p (E)
HL02C	8-way Plug	95p (E)
HL03D	8-way Socket	99p (E)
RK65V	Minicon Latch Pl 2w	13p (G)
BX96E	Minicon Latch Pl 3w	23p (G)
YW11M	Minicon Latch Pl 4w	22p (G)
FY93B	Minicon Latch Pl 5w	26p (F)
YW12N	Minicon Latch Pl 6w	29p (F)
YW13P	Minicon Latch Pl 8w	29p (F)
RK66W	Minicon Latch Pl 10w	70p (E)
YW14Q	Minicon Latch Pl 12w	48p (F)
BH61R	Minicon Latch Pl 17w	78p (E)
FY92A	RA Lch Minicn Pl 2w	26p (F)
YW15R	RA Lch Minicn Pl 3w	31p (F)
FY91Y	RA Lch Minicn Pl 4w	33p (F)
RK67X	RA Lch Minicn Pl 5w	29p (F)
FB99H	RA Lch Minicn Pl 6w	40p (F)
YW18U	RA Lch Minicn Pl 8w	52p (E)
RK68Y	RA Lch Minicn Pl 10w	45p (F)
YW19V	RA Lch Minicn Pl 12w	74p (E)
HB59P	Mncn Ltch Hsg 2way	8p (H)
BX97F	Mncn Ltch Hsg 3-way	11p (G)
HB58N	Mncn Ltch Hsg 4way	10p (G)
BH66W	Mncn Ltch Hsng 5-way	11p (G)
BH65V	Mncn Ltch Hsng 6-way	13p (G)
YW23A	Mncn Ltch Hsng 8-way	15p (G)
FY94C	Mncn Ltch Hsng 10way	18p (G)
YW24B	Mncn Ltch Hsng 12way	17p (G)
RK69A	Mncn Ltch Hsng 17way	25p (F)
YW26D	Minicon Skt 3-way	24p (F)
YW27E	Minicon Skt 4-way	30p (F)
YW28F	Minicon Skt 6-way	36p (F)
YW29G	Minicon Skt 8-way	50p (E)
YW30H	Minicon Skt 12-way	65p (E)
YW31J	Polarcon 0.1in	6p (H)
YW25C	Minicon Terminal	3p (H)
YW95D	IDC Con 3-way	20p (G)
YW96E	IDC Con 4-way	26p (F)
YW97F	IDC Con 6-way	38p (F)
YW98G	IDC Con 8-way	50p (E)
YW99H	IDC Con 12-way	88p (E)
YX49D	IDC Insertion Tool	£1.98 (D)

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HL04E	Wafercon Plug 3-pin	12p (G)
HL05F	Wafercon Plug 4-pin	14p (G)
HL06G	Wafercon Plug 6-pin	19p (G)
HL07H	Wafercon Plug 8-pin	19p (G)
HL08J	Wafercon Plug 12-pin	29p (F)
HL09K	Wafercon Skt 3-way	11p (G)
HL10L	Wafercon Skt 4-way	10p (G)
HL11M	Wafercon Skt 6-way	16p (G)
HL12N	Wafercon Skt 8-way	17p (G)
HL13P	Wafercon Skt 12-way	25p (F)
HL14Q	Wafercon Terminal	3p (H)
YW32K	Polarcon 0.2in	8p (H)
RK72P	3 way PC Terminal	29p (F)
RK73Q	4 way PC Terminal	37p (F)
RK38R	8-Way PC Terminal	55p (E)
RK74R	12 way PC Terminal	98p (E)
†YW40T	Compactboard	£13.50 (A)
YY22Y	CB Pin Blue	37p (F)
YY23A	CB Pin Red	37p (F)
YY26D	CT Pin White	£1.33 (D)
YY27E	AT Pin Black	£1.33 (D)
YB08J	Large Patchboard	£111.00 (A)
HH39N	Multi-position Plug	67p (E)
HH38R	Universal Plug	85p (E)
HH60Q	Std Power Plug 2.1	14p (G)
HH61R	Long Pwr Plug 2.1	16p (G)
HH62S	Std Power Plug 2.5	15p (G)
HH63T	Long Pwr Plug 2.5	15p (G)
HH85G	Power Skt 2.1	20p (G)
HH86T	Power Skt 2.5	22p (G)
RK37S	PC Mtg Power Socket	28p (F)
HH87U	Cassette Skt Nivico	39p (F)
HH88V	Cassette Skt Paros	46p (F)
HL17T	USA Mains Plug	28p (G)
HL18U	Flat Pin M/S	27p (F)
HL19V	Flat Pin Conn	31p (F)

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HL16S	Eurosocket	69p (E)
HL15R	Europlug	48p (F)
HL42V	Euro Facility Outlet	89p (E)
HL43W	Euro Facility Plug	94p (D)
BW99H	Euroconn Lead	£1.75 (D)
RW56L	Cas Lead Crown	60p (E)
RW57M	Cas Lead Hitachi	60p (E)
RW58N	Cas Lead Nat Pan	60p (E)
RW59P	Cas Lead Nivico	60p (E)
RW60Q	Cas Lead Dtake-Drion	60p (E)
RW61R	Cas Lead Paros	65p (E)
RW62S	Cas Lead Philips	75p (E)
RW63T	Cas Lead Sanyo	60p (E)
RW64U	Cas Lead Sharp	60p (E)
RW65V	Cas Lead Sony	60p (E)
RW66W	Cas Lead Telefunken	65p (E)
YX62S	Cassette Lead OS219	60p (E)

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YX63T	Cassette Lead 955	60p (E)
WY16S	Euroboard 4-way	£7.35 (B)
WY17T	Euroboard 6-way	£10.75 (A)
HL20W	Mains Plug P429	64p (E)
HL44X	Mains Socket P646	£1.49 (D)

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HL23A	Mains Socket P430SE	£1.15 (D)
HL45Y	Mains Plug P649	£1.15 (D)
HL46A	Mains Socket P650	£1.10 (D)
HL47B	Mains Plug SA2403	£1.56 (D)
HL48C	Mains Socket SA2404	94p (E)
HL27E	Mains Plug SA2190	49p (F)
HL28F	Mains Socket SA1862	52p (E)
HL49D	Mains Socket SA2111	99p (C)
HL30H	Mains Plug SA2019A	£1.48 (D)
HL31J	Mains Socket SA2020	£1.36 (D)
HL33L	Mains Plug SA2367	£1.55 (D)
HL34M	Mains Socket SA2368	93p (E)
HL36P	Mains Plug P635	£1.05 (D)
HL37S	Mains Socket P636	£1.29 (D)
HL39N	Mains Plug P551	£2.97 (C)

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HL40T	Mains Socket P552	98p (E)
HL50E	Sleeve 8037	12p (G)
RK71N	Video Kopy Kit	£11.95 (A)
HL51F	Boot 9455	35p (F)
HL52G	Boot 8878	38p (F)
RK84F	Video Lead 1	£2.94 (E)
RK85G	Video Lead 2	£1.95 (D)
RK70M	Video Lead 3	£2.45 (C)
RK86T	Video Lead 4	£1.15 (D)
RK87U	Video Lead 5	£2.15 (C)
RK88V	Video Lead 6	£1.65 (D)

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RW04E	Adaptor E	45p (F)
RW01B	Adaptor B	45p (F)
YW38R	Adaptor W	59p (E)
YW39N	Adaptor X	56p (E)
RW07H	Adaptor H	38p (F)
RW03D	Adaptor D	40p (F)
RW11M	Adaptor M	39p (F)
RW06G	Adaptor G	46p (F)
RW08J	Adaptor J	37p (F)
RW00A	Adaptor A	38p (F)
YW34M	Adaptor S	55p (E)
YW35Q	Adaptor T	£1.25 (D)
RW05F	Adaptor F	40p (F)
RW09K	Adaptor K	40p (F)
RW02C	Adaptor C	45p (F)
YW37S	Adaptor V	£1.55 (D)
RW12N	Adaptor N	38p (F)
YW33L	Adaptor R	£1.28 (D)
HL53H	Adaptor P	£1.30 (D)
YW36P	Adaptor U	99p (E)
RK55K	Adaptor Y	42p (F)
RK56L	Adaptor Z	48p (F)
RW27E	Dinpak P	60p (E)
RW26D	Dinpak N	£1.20 (D)
RW45Y	Dinpak 273	£1.45 (D)
RW44X	Dinpak 262	75p (E)
RW47B	Dinpak 275	95p (E)
RW25C	Dinpak M	£1.55 (D)
RW46A	Dinpak 274	£1.50 (D)
RW15R	Dinpak B	£1.55 (D)
RW14Q	Dinpak A	£1.10 (D)
RW43W	Dinpak 254	£1.10 (D)
RW16S	Dinpak C	£1.10 (D)
RW22Y	Dinpak J	69p (E)

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RW23A	Dinpak K	65p (E)
RW24B	Dinpak L	87p (E)
RW18U	Dinpak E	82p (E)
RW19V	Dinpak F	95p (E)
RW17T	Dinpak D	£1.42 (D)
RW20W	Dinpak G	£1.34 (D)
RW49D	Dinpak 280	£1.55 (D)
RW48C	Plugpak 279	89p (E)
RW50E	Plugpak 282	89p (E)
RW51F	Plugpak 283	£1.85 (D)
RW28F	Plugpak Q	65p (E)
RW31J	Plugpak T	£2.25 (C)
RW34M	Plugpak X	£2.48 (C)
RW35Q	Plugpak HD Guitar	£4.45 (C)
RK58N	Plugpak Y	£1.55 (D)
RK27E	Plugpak Z	96p (E)
RK57M	Plugpak W	£1.45 (D)

ELECTRICAL

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HF01B	Terminal Block 5A	35p (F)
HL54J	Terminal Block 15A	69p (E)
HL55K	Terminal Block 30A	£1.10 (D)
HL56L	Terminal Block Conn	£1.47 (D)
HL57M	5 Amp Plug Nylon	59p (E)
RW67X	13 Amp Plug Nylon	59p (E)
HL58N	Rubber 13A Plug	99p (E)
HL59P	15A Plug Nylon	99p (E)
HL60Q	Kettle Connector	£1.94 (D)
HL61R	Flex Connector	£1.40 (D)
HL62S	Mains Adaptor 2-way	£2.20 (C)
HL63T	Mains Adaptor 3-way	£2.95 (C)
HL64U	Shaver Adaptor	£1.15 (D)

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HL65V	Junction Box Small	£1.50 (D)
HL66W	Junction Box Lge	99p (E)
HL67X	Junction Box RM	£1.75 (D)
HL68Y	Single Skt Unswtched	£1.96 (D)
HL69A	Dble Skt Unswitched	£3.75 (C)
HL71N	Single Sw Socket	£2.60 (C)
HL72P	Double Sw Socket	£5.20 (B)
HL73Q	Trailing Skt Single	£1.75 (D)
HL74R	Trailing Dble Skt	£3.45 (C)
RW68Y	Dis Board 4-way	£8.75 (B)
HL76H	Cooker Switch	£8.45 (B)
HL78K	Shaver Skt Isolated	£18.75 (A)
HL79L	Shaver Socket	82p (E)
HL82D	Flex Outlet Unswchd	£3.95 (C)

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HL83E	Switched Flex Outlet	£4.38 (C)
HL86T	Blanking Plate	85p (E)
HL87U	20A Plateswitch	£3.20 (C)
HL88V	20A Water Htr Switch	£4.85 (C)
HL89W	Light Swch ST Single	£1.28 (D)
HL90X	Light Swch DT Single	£1.49 (D)
HL91Y	Light Swch Dual	£2.39 (C)
HL92A	Light Switch Triple	£3.25 (C)
FQ10L	250W Rotary Dimmer	£8.22 (B)
FQ12N	250W Push Dmr Sngl	£9.24 (B)
XX35Q	Remote Control Dmmr	£29.45 (A)

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XX36P	Dmmr Control Box	£15.75 (A)
FQ15R	Security Dimmer	£16.95 (A)
FQ16S	Auto Security Switch	£15.32 (A)
YB09K	Fl Pattress 16mm Sgl	96p (E)

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YB10L	Fl Pattress 25mm Sgl	70p (E)
YB11M	Fl Pattress 25mm Dbl	£1.06 (D)
YB12N	Fl Pattress 35mm Dbl	£1.34 (D)
YB13P	Steel Pattress 47mm	£2.62 (C)
YB14Q	Sur Patt 20mm Sngl	78p (E)
YB15R	Sur Patt 29mm Sngl	98p (E)
YB16S	Sur Patt 29mm Dble	£1.65 (D)
YB17T	Sur Patt 47mm Dble	£3.68 (C)
YB18U	Conversion Pattress	£2.62 (C)
FQ00A	Ceiling Switch 1-way	£2.65 (C)
FQ02C	Lampholder 702	59p (E)
FQ04E	Lampholder 252 1/2in	65p (E)
LB63T	Bayonet L/Hldr	64p (E)
FQ05F	Ceiling Rose	£1.12 (D)
FQ07H	Starter 80W	25p (F)
YB19V	Time Switch	£16.95 (A)
WY23A	Timetouch	£24.80 (A)

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YB20W	Room Thermostat	£8.25 (B)
XY08J	Extn Lead 5A	£13.80 (A)
XY09K	Extn Lead 13A	£17.95 (A)

HARDWARE

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BF00A	Bolt 2BA 1/2in	33p (F)
BF01B	Bolt 2BA 1in	85p (E)
BF02C	Bolt 4BA 1/4in	25p (F)
BF03D	Bolt 4BA 1/2in	28p (F)
BF04E	Bolt 4BA 1in	30p (F)
LR52G	Bolt 4BA 1.1/2in	33p (F)
BF05F	Bolt 6BA 1/4in	12p (G)
BF06G	Bolt 6BA 1/2in	14p (G)
BF07H	Bolt 6BA 1in	43p (F)
LR53H	Bolt 6BA 1.1/2in	63p (E)
BF08J	Bolt 8BA 1/4in	28p (F)
BF09K	Bolt 8BA 1/2in	24p (F)
LR54J	C/S Screw 2BA 1/2in	14p (G)
LR55K	C/S Screw 4BA 1/4in	14p (G)
BF10L	C/S Screw 4BA 1/2in	17p (G)
BF11M	C/S Screw 4BA 1in	32p (F)
LR56L	C/S Screw 6BA 1/4in	9p (H)
BF12N	C/S Screw 6BA 1/2in	19p (G)
LR57M	C/S Screw 6BA 1in	35p (F)
LR00A	C/S Screw 8BA 1/2in	29p (F)
BF14Q	Panel Screw	3p (H)
LR75S	C/S Panel Screw	5p (H)
BF16S	Nut 2BA	19p (G)
BF17T	Nut 4BA	19p (G)
BF18U	Nut 6BA	12p (G)
BF19V	Nut 8BA	12p (G)
BF20W	Washer 2BA	12p (G)
BF21X	Washer 4BA	9p (H)
BF22Y	Washer 6BA	9p (H)
BF23A	Washer 8BA	9p (H)
LR76H	Cup Washer	2p (H)
BF24B	Shake 2BA	9p (H)
BF25C	Shake 4BA	9p (H)
BF26D	Shake 6BA	9p (H)
LR01B	Shake 8BA	8p (H)
BF27E	Tag 2BA	12p (G)
BF28F	Tag 4BA	9p (H)
BF29G	Tag 6BA	13p (G)
LR02C	Tag 8BA	11p (G)
BF30H	Pozi Screw M5 6mm	23p (G)
BF31J	Pozi Screw M5 12mm	33p (F)
BF32K	Pozi Screw M5 25mm	54p (F)
BF33L	Pozi Screw M4 6mm	25p (F)
BF34M	Pozi Screw M4 12mm	32p (F)
BF35Q	Pozi Screw M4 25mm	27p (F)
BF36P	Pozi Screw M3 6mm	13p (G)
LR57M	Pozi Screw M3 9mm	13p (G)
BF37S	Pozi Screw M3 12mm	15p (G)
BF38R	Pozi Screw M3 25mm	27p (F)
LR58N	Pozi Screw M3 40mm	33p (F)
BF39N	Pozi Screw M2.5 6mm	15p (G)
BF40T	Pozi Screw M2.5 12mm	18p (G)
BF41U	Pozi Screw M2 6mm	29p (F)
BF46A	Isobolt M5 12mm	55p (E)
BF48C	Isobolt M4 6mm	26p (F)
BF49D	Isobolt M4 12mm	33p (F)
BF50E	Isobolt M4 25mm	57p (E)
BF51F	Isobolt M3 6mm	20p (G)
HY30H	Isobolt M3 9mm	12p (G)
BF52G	Isobolt M3 12mm	26p (F)
BF53H	Isobolt M3 25mm	35p (F)
BF54J	Isobolt M2.5 6mm	19p (G)
BF55K	Isobolt M2.5 12mm	24p (F)
BF56L	Isonut M5	20p (G)
BF57M	Isonut M4	20p (G)
BF58N	Isonut M3	15p (G)
BF59P	Isonut M2.5	14p (G)
LR59P	Isonut M2	10p (G)
BF60Q	Isowasher M5	15p (G)
BF61R	Isowasher M4	10p (G)
BF62S	Isowasher M3	9p (H)
BF63T	Isowasher M2.5	9p (H)
LR60Q	Isowasher M2	7p (H)
BF42V	Isoshake M5	12p (G)
BF43W	Isoshake M4	9p (H)
BF44X	Isoshake M3	9p (H)
BF45Y	Isoshake M2.5	9p (H)
LR61R	Isoshake M2	9p (H)

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LR62S	Isotag M5	18p (G)
LR63T	Isotag M4	20p (G)
LR64U	Isotag M3	12p (G)
LR65V	Isotag M2.5	12p (G)
LR66W	Isotag M2	9p (H)
BF68Y	Slf-Tpr No.8 x 3/8in	22p (G)
BF69A	Slf-Tpr No.8 x 1/2in	22p (G)
LR67X	Slf-Tpr No.6 x 3/8in	20p (G)
BF67X	Slf-Tpr No.6 x 1/2in	22p (G)
BF65V	Slf-Tpr No.6 x 3/4in	30p (F)
BF66W	Slf-Tpr No.4 x 1/2in	16p (G)
BF64U	Slf-Tpr No.2 x 3/16"	12p (G)
LR68Y	Slf-Tpr No.2 x 1/4in	16p (G)
BF70M	Nyl 2BA 1/2in	86p (E)
BF71N	Nyl 2BA 1in	95p (E)
BF72P	Nyl 4BA 1/2in	39p (F)
BF73Q	Nyl 4BA 1in	55p (E)
BF74R	Nyl 4BA 1.1/2in	£1.05 (D)
BF75S	Nyl 6BA 1/2in	50p (E)
BF76H	Nyl 6BA 1in	60p (E)
BF77J	Nyl 8BA 1/2in	60p (E)
BF78K	Nyl Nut 2BA	94p (E)
BF79L	Nyl Nut 4BA	94p (E)
BF80B	Nyl Nut 6BA	49p (E)
BF81C	Nyl Nut 8BA	55p (E)
BF82D	Nyl Washer 2BA	18p (G)
BF83E	Nyl Washer 4BA	18p (G)
BF84F	Nyl Washer 6BA	18p (G)

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BF85G	Nyl Washer 8BA	32p (F)
WH18U	Nyl C/S Scw M3 x12mm	6p (H)
WH19V	Nylon Nut M3	4p (H)
BF15R	Spring Clip	4p (H)
YW94C	Batten Clip	4p (H)
LB99H	Blk Wdscrw No 4 1/2"	15p (G)
BH44X	Plas Fixing	12p (G)
YL23A	Hand Wheel Bolt	35p (F)
FW10L	Spade 2BA	28p (F)
FW11M	Spade 4BA	23p (G)
FW13P	Studding 2BA	32p (F)
FW14Q	Studding 4BA	34p (F)
FW15R	Studding 6BA	30p (F)
FW30H	4BA Spacer 1/8in	38p (F)
FW31J	4BA Spacer 1/4in	48p (F)
FW32K	4BA Spacer 1/2in	52p (E)
FW33L	6BA Spacer 1/8in	35p (F)
FW34M	6BA Spacer 1/4in	38p (F)
FW35Q	6BA Spacer 1/2in	49p (F)
LR69A	8BA Spacer 1/8in	32p (F)
LR70M	8BA Spacer 1/4in	36p (F)
LR71N	Thrded Spcr 4BA	78p (E)
LR72P	Thrded Spcr 6BA	59p (E)

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FW16S	Standoff Short	8p (H)
FW17T	Standoff Medium	8p (H)
FW18U	Standoff Long	8p (H)
LR03D	Terry Clip 1/2in	10p (G)
LR73Q	Terry Clip 1.1/2in	26p (F)
FW59P	Grommet Small	2p (H)
FW60Q	Grommet Large	2p (H)
LR47B	SR Grommet 3P-4	6p (H)
LR48C	SR Grommet 5M-3	7p (H)
LR49D	SR Grommet 6W-1	10p (G)
LR50E	SR Grommet 7K-2	26p (F)
LR51F	Sealing Grommet	8p (H)
BL74R	Flexigrommet A	24p (F)
BL75S	Flexigrommet B	29p (F)
BL76H	Flexigrommet C	31p (F)
FW36P	Hole Plug 1/4in	10p (G)
FW37S	Hole Plug 3/8in	12p (G)
HB22Y	Quickstick Pads	9p (H)
HB21X	Velcromounts	15p (G)
LQ12N	Sealing Strip	79p (E)

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LH12N	Aly Sheet 18 swg	£1.59 (D)
LH13P	Aly Sheet 16 swg	£3.85 (C)
WH48C	Mains Warning Label	15p (G)
XX31J	PCB Guides	25p (F)
YX88V	P7 Paper Roll	46p (F)
YX89W	P7 Ink Cassette	£2.75 (C)
XH39N	Transfer 1/8in Black	£1.35 (D)
XH40T	Transfer 1/8in Red	£1.56 (D)
XH41U	Transfer 1/8in White	£1.56 (D)
XH42V	Transfer 1/4in Black	£1.56 (D)
XH43W	Transfer 1/4in Red	£1.45 (D)
XH44X	Transfer 1/4in White	£1.35 (D)
XH45Y	Panel Transfer Black	£1.56 (D)
XH46A	Panel Transfer Red	£1.56 (D)
XH47B	Panel Transfer White	£1.35 (D)

KNOBS

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RW75S	Knob BK12	16p (G)
RX99H	Knob RN92	28p (F)
RW87U	Knob KB4	22p (G)
RW86T	Knob KB3	45p (F)
RX09K	Knob R78	58p (E)
HB23A	Knob K1	29p (F)
HB24B	Knob K2	39p (F)
HB19V	Knob RK401	95p (E)
HB57M	Knob RK403	£1.55 (D)
RW88V	Knob M1	38p (F)
RW89W	Knob M2	36p (F)
RW90X	Knob M3	26p (F)
RX00A	Knob M4	45p (F)
RX10L	Knob R81	45p (F)
RX11M	Knob 82	55p (E)

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RW78K	Knob F10	35p (F)
HB26D	Knob F11	31p (F)
RX01B	Knob NK2	45p (F)
RX02C	Knob PK2	45p (F)
YX01B	Knob K7A	24p (F)
YX02C	Knob K7B	27p (F)
YX03D	Knob K7C	32p (F)
YX04E	Knob K7D	49p (F)
HB28F	Knob R51	52p (E)
HB29G	Knob R52	53p (E)
RX07H	Knob R76	55p (E)
RX08J	Knob R77	64p (E)
HB30H	Knob R53	69p (E)
HB31J	Knob R54	96p (E)
YR64U	Knob K8A	43p (F)
YR65V	Knob K8B	56p (E)
YR66W	Knob K8C	72p (E)
RK89W	Knob K10A	45p (F)
RK90X	Knob K10B	59p (E)
RK91Y	Knob K10C	75p (E)
HB34M	Knob K105L	95p (E)
HB35Q	Knob K106L	£1.74 (D)
HB32K	Knob K105	59p (E)
HB33L	Knob K106	95p (E)
HB36P	Knob K15	55p (E)
HB38R	Knob K30	78p (E)

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HB39N	Knob K44	69p (E)
HB40T	Knob K45	79p (E)
HB41U	Knob K46	£1.15 (D)
RX16S	Collet Knob Black	41p (F)
WL45Y	15mm Collet Cap Blk	5p (H)
WL46A	15mm Collet Cap Blue	5p (H)
WL47B	15mm Collet Cap Grn	5p (H)
WL48C	15mm Collet Cap Grey	5p (H)
WL49D	15mm Collet Cap Red	5p (H)
WL50E	15mm Collet Cap Yllw	5p (H)
WL51F	15mm Collet Pntr Blk	5p (H)
WL52G	15mm Collet Pntr Blu	5p (H)
WL53H	15mm Collet Pntr Grn	5p (H)
WL54J	15mm Collet Pntr Gry	5p (H)
WL55K	15mm Collet Pntr Red	5p (H)
WL56L	15mm Collet Pntr Ylw	5p (H)
RX18U	15mm Collet Nut Cvr	13p (G)
RX19V	15mm Collet Indctr	18p (G)
RX20W	15mm Collet Skirt	24p (G)
RX21X	15mm Collet Stator	24p (F)
WL43W	3/8in Nut	16p (G)
WL44X	10mm Nut	16p (G)
YG40T	Low-Cost Collet Knob	27p (F)
QY00A	LC Cap Black	5p (H)
QY01B	LC Cap Blue	5p (H)
QY02C	LC Cap Green	5p (H)
QY03D	LC Cap Grey	5p (H)
QY04E	LC Cap Red	5p (H)

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QY05F	LC Cap White	5p (H)
QY06G	LC Cap Yellow	5p (H)
RX22Y	Slide Knob A	15p (G)
YG09K	Slide Knob B	21p (G)
YG10L	Slide Knob C Black	20p (G)
YG11M	Slide Knob C Chrome	29p (F)
RX24B	Slide Knob F Blk	17p (G)
RX25C	Slide Knob F Blue	17p (G)
RX26D	Slide Knob F Green	17p (G)
RX27E	Slide Knob F Grey	17p (G)
RX28F	Slide Knob F Red	17p (G)

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RX29G	Spindle Coupler	59p (E)
RX30H	Ext Spindle	74p (E)
RX38R	Nylon Rod	14p (G)
RX46A	Cord Drive Steel	£1.51 (D)
RX31J	Brass Bush	29p (E)
BL73Q	Drive Cord	7p (H)
RX43W	Cord Drum Small	92p (D)
RX94C	Cord Drum Large	£1.05 (D)
RX44X	Flywheel	£3.68 (C)
HB45Y	Aluminium Dial	£6.60 (B)
RX42V	Ball Drive	£2.71 (C)
HB42V	Mini Ball Drive	£1.95 (D)
RX39N	Vernier Dial Small	£2.35 (C)
RX40T	Vernier Dial Medium	£2.95 (C)
RX41U	Vernier Dial Large	£3.84 (C)
HB46A	White Pointer	38p (F)
HB47B	Ball Drive Pointer	62p (E)
HB48C	Spring Short	9p (H)
HB49D	Spring Medium	9p (H)
HB50E	Spring Long	9p (H)
RX95D	Pulley 1/2in	14p (G)

MICROPHONES

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LB92A	Phone Coil	95p (E)
LB93B	Crystal Mic In Plas	50p (E)
HY33L	Crystal Mic In Metal	84p (E)
LB68Y	Lapel Mic	£1.28 (D)
YB31J	Cassette Mic Jacks	£1.95 (D)
YB32K	Cassette Mic DIN	£2.75 (C)
YB33L	Electret Cssette Mic	£2.95 (C)
WF35Q	Dynamic Ball Mic	£9.93 (B)
LH87U	Dynamic Stereo Mics	£10.25 (A)
WF05F	Communications Mic	£5.75 (B)

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YW70M	Diff Comm Mic	£8.25 (B)
RK03D	Power Mic DM313P	£11.75 (A)
YW77J	Mic Hldr Screw-Fix	28p (F)
YW78K	Mic Hldr Adhesive	49p (F)
YW79L	Mic Hldr Magnetic	52p (E)
RK04E	Power Mic DM311P	£13.95 (A)
XY72P	Base Station Mic	£29.30 (A)

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XG11M	Base Stn Mic DX357	£33.50 (A)
XG12N	Base Stn Mic BSA610A	£33.50 (A)
LB69A	Tie-Clip Mic	£6.45 (B)
YW71N	UM Tie-Clip Mic	£12.45 (A)
YB35Q	Eletret Mic EM507	£11.98 (A)

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WF34M	Electret Mic Dual-Z	£16.75 (A)
YB36P	Unisound Mic EM82D	£19.17 (A)
YB37S	Unisound Mic EM83D	£20.85 (A)
WY06G	Super Cardioid Mic	£23.55 (A)
WY07H	Stereo Electret Mic	£19.75 (A)
YB38R	Unisnd Dyn DM-31011	£35.45 (A)

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LB94C	Screen S15	£6.58 (B)
LB95D	Mic Unit U15	£10.75 (A)
BK01B	FM Mic	£19.50 (A)
BK02C	FM Mic Adaptor	£19.50 (A)
LB35Q	Mic Windshield	45p (F)
RK92A	Universal Mic Holder	£1.85 (D)
RK93B	Tapered Mic Holder	£1.45 (D)
YW72P	Gsneck Mic Stand 8in	£2.21 (D)
LH88V	Gsneck Mic Stnd 13in	£2.95 (C)
WF36P	Gsneck Mic Stnd 19in	£3.45 (C)
YW73Q	Plastic Gsneck Base	65p (E)
YW74R	Metal Gsneck Base	£3.25 (C)
WF37S	Bkt For Gsnk Stand	£1.95 (D)
YW75S	Cast Base Mic Stand	£3.85 (C)
YW76H	Extra Hgt Mic Stand	£6.95 (B)

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LB96E	Table-Top Mic Stand	£2.25 (C)
XB45Y	5-Foot Mic Stand	£13.45 (A)
XB46A	Boom Arm	£12.65 (A)

MUSIC & EFFECTS

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LB97F	Pre-Amp EQ2S	£3.45 (C)
YB39N	Pre-Amp CS5	£8.43 (B)
XB30H	Mono Mic Mixer	£8.65 (B)
YK55K	Stereo Mixer MM2	£10.75 (A)
XB29G	Stereo Mixer	£22.88 (A)

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AF60Q	Graphic Eqlizr GE206	£59.95 (A)
AF27E	GE1305 Equaliser	£77.50 (A)
AF59P	Graphic Eq. GE909	£124.50 (A)
LB66W	Mini-Phaser	£19.77 (A)
YB30H	Fuzz Box	£15.25 (A)

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XB41U	Fuzz-Wah Pedal	£29.50 (A)
XB34M	Vibra Chorus	£57.30 (A)
YB88V	Mini Compressor	£21.20 (A)
XB33L	Echo Chamber	£67.33 (A)
LB67X	Echo Chamber Tape	£4.99 (C)
XY80B	BBD Echo Machine	£72.50 (A)

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YB40T	Cry Guitar Pick-Up	£3.93 (C)
YB42V	Steel Mag Pick-up	£8.45 (B)
YL08J	Pickup Transl.AJ21	£27.95 (A)
YL09K	Pickup Transl.AJ51	£19.95 (A)
YL07H	Pickup Switch	£3.24 (C)
LB98G	Strap Button	55p (E)
LB60Q	Guitar Strings Steel	£1.72

OPTO

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RX86T	MES Batten Hldr	21p (G)
RX57M	Holder MES Amber	£1.45 (D)
RX58N	Holder MES Blue	DIS
RX59P	Holder MES Clear	£1.45 (D)
RX60Q	Holder MES Green	£1.45 (D)

TRADE QUANTITIES

The letter in brackets after the price indicates the minimum quantity of that item you can buy and qualify for a trade price. See table at start of price list. If you buy less than the quantity shown then the price is that shown. If you want to buy the quantity shown or more of that item, then please contact us for a trade price. If no trade quantity is shown, then the price shown is the best price we can offer regardless of the quantity.

Trade quantities shown for wires or cables of any type is in metres, not reels or parts of metres. Trade quantities for nuts, bolts, washers, Hiatts etc. refers to the number of packs, i.e. to qualify for a trade price on Tag 2BA for example (trade quantity 500), you will need to order 500 packs which is equal to 5000 tags.

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RX61R	Holder MES Red	£1.45 (D)
RX76H	Dmd LES Lhldr Blue	35p (F)
RX77J	Dmd LES Lhldr Green	35p (F)
RX78K	Dmd LES Lhldr Red	35p (F)
RX79L	Dmd LES Lhldr White	35p (F)
RX80B	Dmd LES Lhldr Yellow	35p (F)
RX67X	Flt-Tp LES Lhldr Blu	35p (F)
RX68Y	Flt-Tp LES Lhldr Grn	35p (F)
RX69A	Flt-Tp LES Lhldr Red	35p (F)
FF66W	Fluted Lhldr Amber	30p (F)
FF67X	Fluted Lhldr Clear	30p (F)
FF68Y	Fluted Lhldr Green	30p (F)
FF69A	Fluted Lhldr Red	30p (F)
YY00A	LES Cover Amber	8p (H)
YY01B	LES Cover Blue	8p (H)
YY02C	LES Cover Green	8p (H)
YY03D	LES Cover Purple	8p (H)
YY04E	LES Cover Red	8p (H)
YY05F	LES Cover White	8p (H)
YY06G	LES Cover Yellow	8p (H)
BK52G	Min Neon Red	30p
BK53H	Min Neon Green	30p
BK54J	Min Neon Amber	30p
RX82D	Pan Neon Amber	29p (F)
RX83E	Pan Neon Red	82p (F)
BK51F	Pan Neon Green	33p
RX81C	Square Neon Red	33p (F)
RX98G	Square Neon Green	33p (F)
BK55K	Chrome Neon Red	55p
BK56L	Chrome Neon Green	55p

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RX70M	Wire Neon	14p (G)
WQ13P	Wire Bulb 12V	30p (F)
WL74R	LES Bulb 6V	17p (G)
WL75S	LES Bulb 12V	15p (G)
RX84F	Neon Bulb	99p (E)
WL76H	Bulb MES 3.5V	35p (F)
WL77J	Bulb MES 6V 0.24W	36p (F)
WL78K	Bulb MES 6V 0.6W	31p (F)
WL79L	Bulb MES 6.5V	27p (F)
WL80B	Bulb MES 12V 1.2W	28p (F)
WL81C	Bulb MES 12V 2.2W	29p (F)
WL82D	Bulb MES 24V	36p (F)
LQ10L	Portable Lamp	£6.95 (B)
XY71N	Caravan Lamp	£9.65 (B)
LQ11M	12V Tube	£1.38 (D)
LL15R	240V Inspection Lamp	£5.60 (B)
HB52G	Pygmy Bulb Blue	90p (E)
HB53H	Pygmy Bulb Green	90p (E)
HB54J	Pygmy Bulb Red	90p (E)
HB55K	Pygmy Bulb White	70p (E)
HB56L	Pygmy Bulb Yellow	90p (E)
WF25C	Spot Lamp Amber	£2.85 (C)
WF26D	Spot Lamp Blue	£2.85 (C)
WF27E	Spot Lamp Clear	£1.84 (C)
WF28F	Spot Lamp Green	£2.85 (C)
WF29G	Spot Lamp Red	£2.85 (C)
WF30H	Spot Lamp Violet	£2.85 (C)
YY80B	Spot Holder	£3.96 (C)
XB31J	BC Clip-On Hdr Sngl	TEMP
XB32K	BC Clip-On Hdr Twin	TEMP

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WF22Y	Gooseneck Lamp	£5.32 (B)
YK39N	Alarm Beacon	£18.45 (A)
WL32K	Mini LED Red	10p (G)
WL33L	Mini LED Green	19p (G)
WL34M	Mini LED Orange	17p (F)
YY38R	Mini LED Yellow	19p (G)
YY39N	Mini LED Clip	2p (H)
WL27E	LED Red	12p (G)
WL28F	LED Green	19p (G)
WL29G	LED Orange	33p (F)
WL30H	LED Yellow	17p (G)
YY40T	LED Clip	2p (H)
QW96E	Square LED Red	36p (F)
YH60Q	Square LED Green	36p (F)
YH61R	Square LED Yellow	40p (F)
YH62S	Square LED Clip	7p (H)
YY41U	Large LED Red	£1.49 (D)
YY42V	Large LED Clip	21p (G)
YY45Y	Shape LED R1 Red	20p (G)
YY46A	Shape LED R1 Green	25p (F)
YY47B	Shape LED R1 Orange	37p (F)
YY48C	Shape LED R1 Yellow	27p (F)
YY49D	Shape LED S2 Red	20p (G)
YY50E	Shape LED S2 Green	27p (F)
YY51F	Shape LED L3 Red	21p (G)
YY52G	Shape LED L3 Green	26p (F)
YY53H	Shape LED L3 Yellow	26p (F)
YY54J	Shape LED T4 Red	22p (G)
YY55K	Shape LED T4 Green	26p (F)
YY56L	Shape LED T4 Yellow	26p (F)
YY57M	Shape LED A5 Red	23p (G)
YY58N	Shape LED A5 Green	27p (F)

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YH53H	Cliplite Amber	16p (G)
YH54J	Cliplite Clear	16p (G)
YH55K	Cliplite Green	16p (G)
YH56L	Cliplite Red	16p (G)
YH57M	Cliplite Yellow	16p (G)
YY61R	Multicolour LED	TEMP
QR54J	Rect Multicolour LED	75p (E)
YY59P	Chrome LED Small	49p (F)
QY46A	Chrome LED Small Gn	53p (F)
YY60Q	Chrome LED Large Red	54p (E)
QY47B	Chrome LED Large Gn	56p (E)
QY48C	Black Bezel LED Red	38p (F)
QY49D	Black Bezel LED Gn	47p (F)
BY65V	Red Bargraph Dsply	£3.25 (C)
YG33L	Green Bargraph Dsply	£3.22 (C)
YG34M	Ornge Bargraph Dsply	£2.95 (C)
YG35Q	Yllow Bargraph Dsply	£3.35 (C)
FR36P	7-Seg Red Type 1	£1.07 (D)
FR38R	7-Seg Red Type 4	£1.25 (D)

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FR39N	"1/2" Display Type 1	99p (E)
FR41U	"1/2" Display Type 4	£1.07 (D)
BK03D	Vertisocket Type 1	£1.15 (D)
BK04D	Vertisocket Type 2	£2.45 (C)
BY66W	DD Display Type A	£1.98 (D)
BY67X	DD Display Type AF	50p (E)
BY68Y	DD Display Type C	£1.98 (D)
XX08J	4-Dig Dspy Cmn Cath	£2.69 (C)
BY70M	4 Dig Dis Cmn Anode	£1.50 (D)

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HQ36P	Mult Cmn Cath Disply	£3.45 (C)
FR32K	Filter Amber	85p (E)
FR33L	Filter Green	£1.20 (D)
FR34M	Filter Red	85p (E)
FR35Q	Filter Yellow	65p (E)
FY89W	Lqd Crystal Display	£4.82 (C)

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WL35Q	Opto-Isolator	69p (E)
YY62S	Dual Opto-Isolator	£1.58 (D)
YY63T	Quad Opto-Isolator	£2.96 (C)
WQ70M	Darlington Isolator	74p (E)
YY64U	SCR Isolator	£2.12 (C)
QQ10L	Triac Isolator	£1.55 (D)
YY65V	Infra-Red Source	38p (F)
YY66W	Infra-Red Sensor	31p (F)

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RK22Y	Solar Panel 6V	£7.95 (B)
RK23A	Solar Panel 9V	£8.95 (B)
RK24B	Solar Panel 12V	£10.60 (A)
YH70M	IR Emitter TIL38	49p (F)
YH71N	Photodiode TIL100	98p (E)
BL23A	Solar Cell MS4A	£2.95 (C)
QF30H	BPX25	£4.20 (C)

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HQ61R	MEL 12	38p (F)
YQ62S	Xenon Tube	£2.40 (C)
YQ63T	Trigger Transfmr	49p (F)
XR56L	1mm Light Guide	67p (E)
XL11M	Laser Tube	£124.00 (A)
HY19V	5KV Laser PCB	£4.80 (C)
HQ63T	Lens	£2.30 (C)
HQ64U	Lensholder	£1.12 (E)

ORGAN

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QL02C	SAM77	£1.20 (D)

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XB10L	DMO2	£14.82 (A)
XB11M	DMO2T	£15.82 (A)

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XL08J	Short Spring Line	£5.53 (B)
FB98G	Rubber Coupling	66p (E)
XB84F	Long Spring Line	£11.13 (A)
XB85G	MES Driver Module	£6.95 (B)
YL17T	Reverb PSU Module	£4.73 (C)
XB17T	Mld Kbd 49-Note C-C	£23.40 (A)
XB13P	KB Mounting Strip	39p (F)

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XB14Q	Keyboard 48-Note	£23.94 (A)
XB15R	Keyboard 49-Note	£27.50 (A)
XB16S	Keyboard 61-Note	£28.95 (A)
XY92A	Twin Kbd & Frame	£49.90 (A)
XY97F	Kbd Separator	£1.95 (D)
BH62S	Spacer Block	4p (H)
BH63T	Keyboard Spacer	2p (H)
XB94C	Contact Block 1WG	29p (F)
XB01B	Contact Block GJ	45p (F)
XB02C	Contact Block GB2	78p (E)
XB03D	Contact Block GC3	DIS
QY07H	Contact Springs	8p (H)
XB00A	Gold Wire	£1.10 (D)

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XB04E	Earth Bar	23p (G)
FL66W	Stop Tab Black	75p (E)
FL67X	Stop Tab Blue	75p (E)
FL68Y	Stop Tab Green	75p (E)
FL69A	Stop Tab Grey	75p (E)
FL70M	Stop Tab Ivory	75p (E)
FL71N	Stop Tab Maroon	75p (E)
FL72P	Stop Tab Orange	75p (E)
FL73Q	Stop Tab Red	75p (E)
FL74R	Stop Tab White	75p (E)
FL75S	Stop Tab Yellow	75p (E)
BR05F	S Tab Acc Del Trem	£1.10 (D)
BR47B	S Tab BassGuitar	£1.10 (D)
BR67X	S Tab Bourdon 8'	£1.10 (D)
BR06G	S Tab Cello 16'	£1.10 (D)
BR07H	S Tab Clarinet 8'	£1.10 (D)
BR08J	S Tab Clarion 4'	£1.10 (D)
BY00A	S Tab Clavichord	£1.10 (D)
BY01B	S Tab D/B to Rotor	£1.10 (D)
BY02C	S Tab Dly Vbrato Acc	£1.10 (D)
BY03D	S Tab Dly Vbrto Solo	£1.10 (D)
BR09K	S Tab Diapason 8'	£1.10 (D)
BR68Y	S Tab Diapason 16'	£1.10 (D)
BR10L	S Tab Drawbars Acc	£1.10 (D)
BR11M	S Tab Drawbars Solo	£1.10 (D)
BR12N	S Tab Dulciana 8'	£1.10 (D)
BR13P	S Tab Flute 1'	£1.10 (D)
BR14Q	S Tab Flute 2'	£1.10 (D)
BR15R	S Tab Flute 2.2/3'	£1.10 (D)
BR16S	S Tab Flute 4'	£1.10 (D)
BR17T	S Tab Flute 5.1/3'	£1.10 (D)
BR18U	S Tab Flute 8'	£1.10 (D)
BR19V	S Tab Flute 16'	£1.10 (D)
BR20W	S Tab French Horn 8'	£1.10 (D)
BR21X	S Tab Gedeckt 8'	£1.10 (D)
BY05F	S Tab Gedeckt 16'	£1.10 (D)
BY06G	S Tab Honky Tonk	£1.10 (D)
BR22Y	S Tab Horn 8'	£1.10 (D)
BY07H	S Tab Mixture 16'	£1.10 (D)
BR23A	S Tab Oboe 8'	£1.10 (D)
BR24B	S Tab Octave 4'	£1.10 (D)
BR25C	S Tab Pedal Sustain	£1.10 (D)
BY08J	S Tab Piano	£1.10 (D)
BY09K	S Tab Presets Cancel	£1.10 (D)
BY10L	S Tab Prsts to Rotor	£1.10 (D)
BY11M	S Tab Reed 4'	£1.10 (D)
BR26D	S Tab Reverb	£1.10 (D)
BY12N	S Tab Rotor Fast	£1.10 (D)
BY13P	S Tab Rotor To Main	£1.10 (D)
BR27E	S Tab Salicet 4'	£1.10 (D)
BR28F	S Tab Salicional 8'	£1.10 (D)
BR29G	S Tab Saxophone 16'	£1.10 (D)
BR30H	S Tab Solo Del Trem	£1.10 (D)
BR31J	S Tab String 4'	£1.10 (D)
BR32K	S Tab String 8'	£1.10 (D)
BR33E	S Tab Sub Bass 16'	£1.10 (D)
BY14Q	S Tab Sustain Acc	£1.10 (D)
BY15R	S Tab Sustain Solo	£1.10 (D)
BR34M	S Tab Tremulant	£1.10 (D)
BR35Q	S Tab Trumpet 8'	£1.10 (D)
BR36P	S Tab Tuba 16	£1.10 (D)
BY16S	S Tab Vibrato	£1.10 (D)
BR37S	S Tab Vox Anglica 8'	£1.10 (D)
BR38R	S Tab Vox Humana 8'	£1.10 (D)
BH49D	Tablet Rocker Grey	96p (E)
BH50E	Tablet Rocker Orange	96p (E)
BH51F	Tablet Rocker Red	96p (E)
BY17T	Mar Ky Tab Cello 16'	£3.45
BY18U	Mar Key Tab Clar 8'	DIS
BY19V	Mar Ky Tab Clrion 4'	DIS
BY20W	Mar Key Tab Clav	£3.45
BY21X	Mar Ky Tb D/B to Rtr	£3.45
BY22Y	Mr Ky Tb Dly Vbr Acc	£3.45
BY23A	Mr Ky Tb Dly Vbr Slo	£3.45
BY24B	Mar Key Tab Diap 8'	DIS

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BY25C	Mar Key Tab Diap 16'	DIS
BY26D	Mar K Tab Dbar Acc	£3.45
BY27E	Mar K Tab Dbar Solo	£3.45
BY28F	Mar Key Tab Dulc 8'	£3.45
BY29G	Mar Key Tab Flute 1'	£3.45
BY30H	Mar Key Tab Flute 2'	£3.45
BY31J	Mr Ky Tb Flte 2.2/3'	DIS
BY32K	Mar Key Tab Flute 4'	DIS
BY33L	Mr Ky Tb Flte 5.1/3'	DIS
BY34M	Mar Key Tab Flute 8'	DIS
BY35Q	Mar Ky Tab Flute 16'	£3.45
BY36P	Mr Ky Tb Frch Hrn 8'	£3.45
BY37S	Mar Key Tab Gedkt 8'	£3.45
BY38R	Mr Key Tab Gedkt 16'	£3.45
BY39N	Mar Key Tab Hnky Tnk	£3.45
BY40T	Mar Key Tab Horn 8'	DIS
BY41U	Mar Key Tab Mix 16'	DIS
BY42V	Mar Key Tab Oboe 8'	£3.45
BY43W	Mar Key Tab Octve 4'	DIS
BY44X	Mar Key Tab Pdl Sus	£3.45
BY45Y	Mar Key Tab Piano	£3.45
BY46A	Mr Ky Tb Prsts Cncl	£3.45
BY47B	Mr Ky Tb Prsts To Rr	£3.45
BY48C	Mar Key Tab Reed 4'	DIS
BY49D	Mar Key Tab Reverb	£3.45
BY50E	Mar Key Tab Rtr Fst	£3.45
BY51F	Mr Ky Tb Rtr To Main	£3.45
BY52G	Mar Ky Tab Salict 4'	DIS
BY53H	Mar Key Tab Salic 8'	£3.45
BY54J	Mar Key Tab Sax 16'	DIS
BY55K	Mar Key Tab Strng 4'	£3.45
BY56L	Mar key Tab Strng 8'	£3.45
BY57M	Mar Ky Tb Sb-Bss 16'	£3.45
BY58N	Mar Key Tab Sus Acc	£3.45
BY59P	Mar Key Tab Sus Solo	£3.45
BY60Q	Mar Key Tab Trmpt 8'	DIS
BY61R	Mar Key Tab Tuba 16'	£3.45
BY62S	Mar Key Tab Vibrato	£3.45
BY63T	Mar K Tab Vox Ang 8'	£3.45
BY64U	Mar K Tab Vox Hum 8'	DIS
FL76H	Key Tab	90p (E)
BR46A	ST Strip	£1.35 (D)
XX13P	KT Strip	£1.50 (D)
BR41U	Drawbar Red	£1.35 (D)
BR42V	Drawbar White	£1.35 (D)
BR98G	Drawbar Blue	£1.55 (D)
BR99H	Drawbar Green	£1.55 (D)
XB18U	Contact Pedal Board	£24.50 (A)

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XB19V	Free-Stdg Pedalboard	£63.00 (A)
XB99H	Pdl Unit Front Panel	£2.95 (C)
XB96E	32-Note Pdlbd	£135.41 (A)
	Carr in UK with XB96	£14.30
XB21X	Piano Pedal	£11.85 (A)
XB20W	Swell Pedal	£8.50 (B)
XY89W	Switched Swell Pedal	£11.45 (A)
XY98G	Swell Pdl Hsg & Trim	£3.75 (C)
XY28F	Remote Foot Control	£11.20 (A)

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XY99H	Roll Top	£19.50 (A)
XG00A	Roll Top Guides (pr)	£2.50 (C)
XG01B	Music Stand	£4.75 (C)
XB95D	Organ Stool	£29.50 (A)

PANEL METERS

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RW74R	Level Meter	£4.35 (C)
LB80B	Sig Strength Meter	£1.95 (D)
LB79L	Tuning Meter	£1.95 (D)
RW73Q	VU Meter V41	£2.20 (C)
YQ47B	Dual VU Meter	£3.90 (C)
RK21X	Quick Ft Mtr 50-0-50	£2.95 (C)
RK05F	Qck Ft Mtr 100-0-100	£2.95 (C)
RK06G	Quick Fit Meter 50uA	£2.95 (C)
RK07H	Quick Fit Mtr 100uA	£2.95 (C)
RK08J	Quick Fit Mtr 500uA	£2.95 (C)
RK09K	Quick Fit Meter 1mA	£2.95 (C)
RK10L	Quick-Fit Meter 5mA	£2.95 (C)
RK11M	Quick-Fit Meter 10mA	£2.95 (C)
RK12N	Quick-Fit Meter 50mA	£2.95 (C)
RK13P	Quick-Fit Meter 100mA	£2.95 (C)
RK14Q	Quick-Ft Meter 500mA	£2.95 (C)
RK15R	Quick-Fit Meter 1A	£2.95 (C)
RK16S	Quick-Fit Meter 5A	£2.95 (C)
RK17T	Quick-Fit Meter 25V	£2.95 (C)
RK18U	Quick-Fit Meter 50V	£2.95 (C)
RK19V	Quick-Fit Meter VU	£2.95 (C)
RK20W	Punch 27.5mm	£6.58 (B)

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RW98G	2inPn Mt 100-0-100uA	£6.65 (B)
RW99H	2inPn Mt 500-0-500uA	£6.65 (B)
RW91Y	2in Pan Meter 50uA	£6.45 (B)
RW92A	2in Pan Meter 100uA	£6.45 (B)
RW93B	2in Pan Meter 500uA	£6.45 (B)
RW94C	2in Pan Meter 1mA	£6.45 (B)
RW95D	2in Pan Meter 5mA	£6.45 (B)
RW96E	2in Pan Meter 10mA	£6.45 (B)
†RX32K	2in Pan Meter 50mA	£6.65 (B)
RX33L	2in Pan Meter 100mA	£6.20 (B)
RX34M	2in Pan Meter 500mA	£5.99 (B)
RX35Q	2in Pan Meter 1A	£6.20 (B)
RX36P	2in Pan Meter 50V	£6.65 (B)
RX37S	2in Pan Meter 300V	£5.90 (B)
†RX52G	2in Pan Meter 'S'	£6.65 (B)
RX53H	2in Pan Meter 'VU'	£6.65 (B)
RX54J	Large Panel Meter	£7.59 (B)
RX92A	Meter MI 15v	£6.95 (B)
RX88V	Meter MI 300V	£7.96 (B)
RX89W	Meter MI 1A	£7.38 (B)
RX90X	Meter MI 5A	£6.95 (B)
RX91Y	Meter MI 15A	£7.65 (B)
RX93B	Meter MI 25A	£7.95 (B)

PCB EQUIPMENT

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FL02C	SRBP 0.1in Type 3	£1.10 (D)
FL06G	Vero 14354	20p (F)
FL07H	Vero 10345	£1.05 (D)
FL08J	Vero 10346	89p (E)
FL09K	Vero 10347	£1.30 (D)
FL10L	Vero 10348	£1.05 (D)
FL53H	Vero 10401	£3.65 (C)
FL17T	Verostrip	£1.39 (D)
FL19V	DIP Board	£4.35 (C)
HQ48C	Vero V-Q Board	£2.10 (D)
FL25C	Tool 2022	£1.62 (D)
FL26D	Tool 2150	£2.10 (D)
FL27E	Tool 2151	£1.95 (D)
FL20W	Pin 2140	65p (E)
FL21X	Pin 2141	55p
FL23A	Pin 2144	58p (E)
FL24B	Pin 2145	69p (E)

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FL80B	Pin 0266 Pk of 10	25p (F)
FL81C	Pin 1657 Pk of 10	38p (F)
RK94C	Verowire Kit	£5.60 (B)
HY16S	Verowire Pen	£4.95 (C)
HY17T	Verowire Spool	99p (E)
FY33L	Verowire Comb	8p (H)
FL82D	Track Pin	85p (E)
FL28F	4-Way Tag	12p (G)
FL29G	Mounting Strip	32p (F)
FL11M	Tag Board	94p (E)
YL11M	Vero Plugblock	£4.38 (C)
HQ84F	Verobloc Bracket	68p (E)
BK62S	Engineer Design Sht	59p (F)
BK63T	Verobloc Kit	£5.95 (C)

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YR83E	Eurobreadboard	£6.75 (B)
YR84F	Prof Plugblock	£6.95 (B)
XX42V	MP Urobreadboard	£21.75 (A)
YR85G	Bus-Strip Plugblock	£2.95 (C)
YR86T	Plugblck Contct Strp	28p (F)
YR87U	Plugblock PCB	£1.85 (D)
XB43W	Seno Etch System	£6.99 (B)

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XY10L	UV Exposure Box	£42.40 (A)
BW19V	Photo-Etch PCB	£2.94 (C)
XX12N	Etch Crystals	£1.49 (D)
BW20W	Phot-Etch Drftg Pk	£1.95 (D)
WF10L	Etcher Fluid	£2.52 (C)
HX02C	PCB Pen	£1.35 (D)
HX03D	Resist Remover	88p (E)
HX00A	PCB SRBP Smll Single	48p (F)
WF38R	PCB SRBP Med Single	96p (E)
WF39N	PCB SRBP Lrg Single	£1.25 (D)
HX01B	PCB F.Glass Sm Sngl	85p (E)
WF40T	PCB F.Glass Med Sngl	£1.75 (D)
WF41U	PCB F.Glass Lrg Sngl	£2.75 (C)
WF42V	PCB F.Glass Med Dble	£1.39 (D)

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HX04E	Polish Block	£1.40 (D)
XB90X	Fixircuit	£9.52 (B)
XG20W	CM100 PCB Kit	£69.95 (A)
RK40T	Film FPF012	£9.95 (B)
RK41U	Etching Kit CM100E	£4.95 (C)
RK42V	PCB006 Pack	£7.95 (B)
XG21X	Chemicals Kit CM100C	£16.95 (A)
BW21X	Track Tape 31	£1.24 (E)
BW22Y	Track Tape 40	£1.24 (E)
BW23A	Track Tape 50	£1.24 (E)
BW24B	Track Tape 62	£1.32 (D)
BW25C	Track Tape 80	£1.39 (D)
BW26D	Track Tape 100	£1.32 (D)
BW27E	Track Tape 125	£1.96 (D)
BW28F	Track Tape 150	£1.92 (D)
BW29G	Track Tape 200	£1.96 (D)
BW30H	Pad 075	£1.55 (D)
BW31J	Pad 100	£1.55 (D)
BW32K	Pad 125	£1.64 (D)
BW33L	Pad 150	£1.49 (D)
BW34M	Pad 200	£1.64 (D)
BW35Q	Pad 300	£1.50 (D)
BW36P	Pad 400	£2.55 (C)
BW37S	Pad 500	£3.95 (C)
BW38R	Pad 600	£5.64 (B)

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BW40T	IC Pads 200	£4.65 (C)
BW41U	Drafting Template	94p (E)
HX45Y	Transfer Sheet 1	42p (F)
HX46A	Transfer Sheet 2	42p (F)
HX47B	Transfer Sheet 3	42p (F)
HX48C	Transfer Sheet 4	42p (F)
HX49D	Transfer Sheet 5	42p (F)
HX63T	Transfer Sheet 6	42p (F)
HX64U	Transfer Sheet 7	42p (F)
HX65V	Transfer Sheet 8	42p (F)
HX66W	Transfer Sheet 9	42p (F)
HX67X	Transfer Sheet 10	42p (F)
HX68Y	Transfer Sheet 11	42p (F)
HX83E	Transfer Sheet 12	42p (F)
HX84F	Transfer Sheet 13	42p (F)
HX44X	Transfer Kit	£3.75 (C)

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BH64U	Minicon Pl 17way	46p (F)
BH67X	Rt-Angle Mncn Pl 15W	65p (E)
BX98G	Jumper Cable 17-way	£3.65 (C)
YK06G	Pedalboard Cableform	£2.98 (C)
HY31J	Steel Washer 4BA	11p (G)
XY94C	Matinee Front Panel	£17.95 (A)
XY95D	Matinee Mtlwk Kit	£9.50 (B)
XY96E	End Cheek Set	£6.75 (B)
YK04E	Matinee PSU Bkt	£1.60 (D)
YK05F	Pot Mntg Brkt	79p (E)
FH86T	Reset Spring	3p (H)
HB60Q	Latchbrkt 5 way	27p (F)
HY26D	Latch Brkt 16 way	72p (E)
HY27E	Reset Bar 15way	35p (F)
HY28F	Latchbrkt 9way	39p (F)
HY29G	Reset Bar 6way	16p (G)
QY15R	2716/M2	£10.50 (A)
GA18U	Matinee PSU PCB	£2.10 (C)
XY86T	Matinee Main PCB	£50.00 (A)
XY88V	Matinee Contact pcb	£7.30 (B)
XY91Y	Matinee Organ Kit	£299.95 (A)
	Carriage with XY91Y	£15.00
XY93B	Matinee Cabinet Kit	£99.50 (A)
	Carriage with XY93B	£20.00
XG05F	Matinee Module Kit	£399.95 (A)
	Carr in UK With XG05	£15.00
XX43W	Matinee Dem Cassette	£1.99 (D)
XH55K	Matinee Book	£2.50NV (C)

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BR45Y	AS314	33p (F)
BR88V	Mk/Space Adptr Kit	£3.95 (C)
YL20W	Mstr Tuning Module	£18.20 (A)
BB00A	Divider Board 'A'	£4.35 (C)
BB01B	Divider Board 'B'	£3.28 (C)
BB02C	Tone Board 'A'	£4.45 (C)
BB03D	Tone Board 'B'	£1.98 (C)
BB07H	Control Board 'A'	£4.25 (C)
BB08J	Control Board 'B'	£2.98 (C)
BB09K	Sawtooth Board 'A'	£4.35 (C)
BB10L	Sawtooth Board 'B'	£5.49 (B)
BB77J	Divider MO & Frq Gen	£4.95 (C)
BB78K	Pedal PCB 'B'	£3.87 (C)
BB79L	32-Note Pedal Voice	£4.82 (C)
BB80B	Pedal Diode PCB	£1.65 (D)
HQ72P	Auto Ogn Gen/Clk PCB	£3.95 (C)
HQ73Q	Auto Ogn Crd Cdr PCB	£3.95 (C)
HQ74R	Auto Ogn Auto St PCB	£6.32 (B)
HQ75S	Auto Ogn PA/PSU PCB	£4.35 (C)
YL00A	Organ Mixer PCB	£3.25 (C)
YL18U	2G05 PSU PCB	£1.35 (D)
YL21X	32 Note Pdl PSU PCB	£2.95 (C)
XX38R	Downbeat Indictr PCB	£2.20 (C)
BB11M	Gate Board	48p (F)
BB04E	Tone Board 'C'	£4.90 (C)
BB05F	Tone Board 'D'	£4.82 (C)
BB06G	Tone Board 'E'	£4.96 (C)
BB12N	Pedal PCB 'A'	£2.20 (C)
BB15R	Mother Board 'A'	£10.30 (A)
BB13P	A/B Switch Board	£1.68 (D)
BB14Q	MES Amp Board 'A'	72p (E)
XH00A	MES51	15pNV
XH02C	MES52	15pNV
XH04E	MES53	35pNV
XH31J	MES54	30pNV
XH33L	MES55	30pNV

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XF11M	Stereo Synth Book	£2.00NV (C)
BB41U	Synth Mixer PCB	£3.95 (C)
BB44X	Synth VCA PCB	£1.48 (D)
BY87U	Synth Preset Mtg Bd	68p (E)
BY88V	Synth 1979 Kybd Cont	£6.64 (B)
BY89W	Synth Binary Encoder	£8.24 (B)
BB40T	Synth PSU Mk.II PCB	£4.99 (C)
BY90X	Synth Smpl & Nse PCB	£4.20 (C)
BB43W	Synth Trns Gen 1 PCB	£3.20 (C)
BB45Y	Synth Trns Gen 2 PCB	£3.36 (C)
BY81C	Synth Trns Rept PCB	£1.38 (D)
BY82D	Synth Rvrb & Phs PCB	£3.20 (C)
BY83E	Synth VC Pn & AncPCB	£8.36 (B)
BB38R	Synth Oscillator PCB	£4.39 (C)
BB48C	Synth Ext I/P's PCB	£1.54 (D)
BB65V	3600 VCF PCB	£2.20 (C)
BB64U	4600 Hinge	63p (E)
BB63T	Synth Ext I/P's Bkt	64p (E)
BB49D	Synth Dscltr Mtg Bkt	67p (E)
BB52G	Synth Mixer Chassis	£2.10 (C)
BB51F	Synth Pwr Sply Htsnk	£1.30 (D)
BB56L	Synth Mixer Mtg Bkt	16p (G)
BB61R	Synth VCF Mtg Bkt	64p (E)
BB58N	Synth Trns 1/Env Bkt	85p (E)
BB59P	Synth Trns 2 Mtg Bkt	£1.20 (D)
BB60Q	Synth VCA Mtg Bkt	52p (E)
BF95D	Joylever PCB	99p (E)
XQ01B	5600 Front Panel	£13.50 (A)
	Carr in UK with XQ01	£9.00
BY84F	5600 Rear Panel	£4.55 (C)
XQ02C	5600 Cabinet	£55.23 (A)
	Carr in UK with XQ02	£9.00
XB79L	Teak 5600 Cabinet	£55.70 (A)
	Carr in UK with XB79	£7.00
LW53H	5600S Synth Kit	£599.95 (A)
	Carr in UK with LW53	£20.00

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BY86T	3800 Interface PCB	£2.62 (C)
BB47B	Synth Otpt Stge PCB	£6.34 (B)
XQ03D	3800 Front Panel	£11.98 (B)
BB67X	3600 VCF Mtg Bkt	59p (E)
BF96E	3800 Sp Ext.I/P.Bkt	55p (E)
BF98G	3800 VCA Bkt	55p (E)
BF99H	3800 Intface Mtg Bkt	55p (E)
BY85G	3800 Rear Panel	£4.56 (C)
XQ04E	3800 Cabinet	£49.60 (A)
	Carr in UK with XQ04	£9.00
LW54J	3800 Synth Kit	£336.75 (A)
	Carr in UK with LW54	£20.00
YQ46A	Synth Demo Tape	£4.50 (A)
XF41U	Synth Guide Book	£2.00NV (C)
XF42V	5600S Patch Chart	7pNV (H)
XF43W	3800 Patch Chart	7pNV (H)

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QY17T	2716/M3	£14.95 (A)
RK32K	Sequencer Key Print	65p (E)
GA65V	Sequencer PSU PCB	£1.35 (D)
YQ56L	Sequencer Main PCB	£4.99 (C)
YQ57M	Seq Display PCB	£1.65 (D)
YQ58N	Seq Keyboard PCB	£2.35 (C)
YQ59P	Seq Interface PCB	£2.10 (C)
LW66W	Sequencer Kit	£125.00 (A)
XH59P	Sequencer Leaflet	40pNV (F)

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XG08J	Spectrum Front Panel	£14.95 (A)
XX46A	Spectrm Joystk Panel	£2.25 (C)
XY90X	Spectrum Bus Bar Set	£2.20 (C)
GA03D	Spectrum PSU PCB	£2.40 (C)
GA09K	24-Way Contact PCB	£2.80 (C)
GA10L	25-Way Contact PCB	£2.87 (C)
GA36P	Spectrum VCO PCB	£4.75 (C)
GA53H	Spectrum LFO PCB	£2.50 (C)
GA55K	Spectrum Cntrllr PCB	£1.82 (D)
GA57M	Spectrum VCF PCB	£2.64 (C)
GA59P	Spectrum Shaper PCB	£2.95 (C)
LW60Q	Spectrum Synth Kit	£167.50 (A)
XH56L	Spectrum Synth Book	£1.00NV (D)
XH18U	MES22	25pNV
BY78K	Piano PSU/Voice PCB	£4.45 (C)
BY79L	Piano Top Oct PCB	£4.95 (C)
BY80B	Piano Two-Oct PCB	£5.98 (B)
XQ06G	Piano Cabinet Black	£49.95 (A)

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XH20W	MES25	25pNV
BB16S	Drgn/Gtar Bass PCB	£10.50 (A)
GA32K	Hexadrum Pcb	£2.60 (C)
LW85G	Hexadrum Kit	£18.95 (A)
GA05F	Syntom PCB	£1.18 (D)
BH60Q	Syntom Front Panel	£1.10 (D)
LW86T	Syntom Kit	£10.90 (A)

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GA35Q	Synwave PCB	£1.10 (D)
BX99H	Synwave Front Panel	£1.46 (D)
LW87U	Synwave Kit	£10.25 (A)
GA54J	Synclock PCB	£1.65 (D)
XX44X	Synclock Front Panel	£1.50 (D)
LW55K	Synclock Kit	£19.75 (A)
LW88V	Volume Pedal Kit	£21.45 (A)

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GA52G	Auto Swell PCB	£1.35 (D)
LW89W	Auto Swell Kit	£10.90 (A)
GA24B	Guitar Tuner PCB	£1.45 (D)
YL26D	Guitar Tuner Frt Pan	£1.10 (D)
LW90X	Guitar Tuner Kit	£10.75 (A)
GA48C	Harmony Gen PCB	£2.25 (C)
LW91Y	Harmony Gen Kit	£15.45 (A)

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GA00A	D.I.Box PCB	£1.10 (D)
GA41U	Combo Amp PCB	£5.75 (B)
XG03D	Combo Amp Frnt Panel	£3.35 (C)
LW92A	Combo-Amp Kit	£89.90 (A)

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RK25C	Stereo Amp Heatsink	£1.25 (D)
XG16S	Stereo Amp Woodwork	£6.25 (B)
XG15R	Stereo Amp Chassis	£5.95 (B)
GA71N	Stereo Amp PCB	£4.92 (C)
GA78K	Stereo Amp Sw PCB	68p (E)
LW71N	25W Stereo Amp Kit	£55.20 (A)
RK36P	Switch Panel	£1.20 (D)
GA97F	Stereo Amp IR Decodr	£2.75 (C)
GA99H	Sto Amp IR Contrller	£1.40 (D)
LW77J	Amp Remote Cntrl Kit	£27.90 (A)

TRADE QUANTITIES

The letter in brackets after the price indicates the minimum quantity of that item you can buy and qualify for a trade price. See table at start of price list. If you buy less than the quantity shown then the price is that shown. If you want to buy the quantity shown or more of that item, then please contact us for a trade price. If no trade quantity is shown, then the price shown is the best price we can offer regardless of the quantity.

Trade quantities shown for wires or cables of any type is in metres, not reels or parts of metres. Trade quantities for nuts, bolts, washers, Hiatts etc. refers to the number of packs, i.e. to qualify for a trade price on Tag 2BA for example (trade quantity 500), you will need to order 500 packs which is equal to 5000 tags.

1983 Catalogue Page No.		VAT inclusive PRICE

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XH48C	MES33	40pNV (F)
FL94C	HiFi Amp Sel Mthr PC	£4.20 (C)
FL95D	HiFi Amp Sel PCB	£3.47 (C)
FL96E	HiFi Amp Eql Mthr PC	£2.99 (C)
FL97F	HiFi Amp Eql PCB	£1.97 (D)
FL98G	HiFi Amp Pk Det PCB	£1.97 (D)
FL99H	HiFi Amp PSU PCB	£2.15 (C)
XX32K	H/Phones Skt Brckt	59p (E)
XY21X	HiFi Amp Chassis	£22.10 (A)
XY22Y	HiFi Amp Screen	£1.85 (D)
XY23A	HiFi Amp Frt Panel	£10.99 (B)
XY24B	HiFi Amp Cover Black	£6.95 (B)

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LR13P	HQ Mixer PCB No.2	£1.96 (D)
LR14Q	HQ Mixer PCB No.3	£1.55 (D)
LR15R	HQ Mixer PCB No.4	£1.39 (D)
LR34M	HQ Mixer PCB No.24	£1.98 (D)

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LR16S	HQ Mixer PCB No.5	£1.10 (D)
LR35Q	HQ Mixer PCB No.25	£1.60 (D)
LR21X	HQ Mixer PCB No.6	99p (E)
LR22Y	HQ Mixer PCB No.7	£1.75 (D)
LR23A	HQ Mixer PCB No.8	£1.60 (D)

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LR24B	HQ Mixer PCB No.9	£1.78 (D)
LR42V	HQ Mixer PCB No. 29	£2.95 (C)
LR25C	HQ Mixer PCB No.10	£1.85 (D)
LR26D	HQ Mixer PCB No.14	£1.87 (D)

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GA68Y	Quadramix PCB	£1.15 (D)
YQ18U	Tone Con PCB	£1.55 (D)
YQ06G	Stereophoner PCB	£1.10 (D)
YQ19V	LM380 Amp PCB	£1.98 (D)
YQ20W	20W Amp PCB	£1.50 (D)

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HQ68Y	50W Hi-Fi PCB	£2.96 (C)

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LW35Q	50W Amp Kit	£14.95 (A)
GA29G	MOSFET Amp Mtg Bkt	£1.15 (D)
GA28F	75W MOSFET Amp PCB	£1.80 (D)
LW51F	75W MOSFET Amp Kit	£11.49 (A)

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LW32K	150W Power Amp Kit	£18.60 (A)

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GA08J	Woofer PCB	£2.00 (C)
LW40T	Tuner Metalwork Kit	£43.90 (A)

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LW41U	Tuner PSU Module	£23.95 (A)
LW42V	Tuner Switching Mod	£16.20 (A)
LW45Y	TV Sound Tuner	£44.80 (A)
LW44X	Tuner Head FD811U14	£23.79 (A)
YQ00A	IF Tuner Mono Module	£9.50 (B)
YQ10L	12/30V PSU Module	£6.70 (B)

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LW43W	Tuner IF Module	£18.98 (A)
LW48C	Stereo Tuner Kit	£161.00 (A)
LW46A	AM Tuner	£17.95 (A)
XF22Y	Tuner Schedule	FREE

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XH21X	MES37	25pNV (F)
XX03D	10 Channel G.E. PCB	£1.95 (D)
BX74R	10-Chl Eqlsr Mtwrk	£10.45 (A)
XB75S	10-Chl Eqlsr Wwrk	£8.50 (B)
GA30H	Compander PCB	£3.20 (C)
GA31J	Compander PSU PCB	£1.60 (D)
GA43W	Noise Gate Pcb	£1.30 (D)

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XY32K	Cassette Mechanism	£14.95 (A)
XY34M	Stereo Tape Module	£17.20 (A)
XH51F	MES30	20pNV
YQ30H	Tape Switch Board	42p
YQ33L	Tape Switch Bracket	51p
YQ31J	Tape PSU PCB	39p
XY35Q	Cassette Parts Kit	£11.90 (A)
XY36P	Cassette Recrder Kit	£39.95 (A)

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XF04E	MES41	40pNV
LB76H	Disco Front Panel	£12.50 (A)
XY26D	Heatsink Mtg Plate	£3.95 (C)
XY27E	Heatsink Cover	£6.45 (B)
BB18U	Heatsink DR2	74p (E)
XB77J	Disco Cabinet	£48.44 (A)
	Carr in UK with XB77	£8.00
BB81C	Disco Pre-Amp Tn PCB	£4.45 (C)
BB19V	Disco PSU PCB	£1.95 (D)
BB20W	150W Amp Board	£2.35 (C)
BB26D	Motor Switch PCB	£1.15 (D)
BB27E	Light Mod Bd	£5.81 (B)
BB22Y	FET-Ceramic PU Bd	£1.69 (D)
BB24B	Disco Fader Bd	£2.20 (C)
BB25C	VUM & HP Amp Bd	£2.35 (C)
XH23A	MES42	25pNV
XB37S	Sound To Light Case	£12.50 (A)

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GA42V	Partylite Pcb	£2.25 (C)
LW93B	Partylite Kit	£8.45 (B)
YQ21X	Snd/Light Conv PCB	£2.10 (C)
GA25C	Power Control pcb	£1.15 (D)
GA58N	The Bomb PCB	£1.55 (D)

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GA04E	Stopwatch PCB	£2.95 (C)
LW65V	Stopwatch Kit	£34.95 (A)
FY94C	Minicn Ltch Hsng 10way	18p (G)
HQ85G	Minicon Plug 10-Way	47p (F)
GA64U	Timer Front Panel	£3.85 (C)
GA61R	Timer Main PCB	£2.80 (C)
GA62S	Timer Switch Board	£3.85 (C)
GA63T	Timer Relay PCB	£1.10 (D)
LW94C	Universal Timer Kit	£39.95 (A)

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QY25C	2716/M4	£10.50 (A)
GB04E	E.L.C.Board	£2.95 (C)
GB05F	Connect PCB	£3.80 (C)
GB06G	T/E Motherboard	£12.75 (A)
GB07H	T/E PSU PCB	£4.50 (C)
LW80B	Digi-Tel ELC Kit	£24.95 (A)
LW81C	Digi-Tel Connect Kit	£9.95 (B)
LW82D	Digi-Tel Main Kit	£67.50 (A)

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XG06G	Burglar Alarm Box	£12.50 (A)
XG07H	Ext Horn Box	£14.50 (A)
GA44X	Burglr Alrm PSU PCB	£2.40 (C)
GA45Y	Burglr Alrm Main PCB	£6.75 (B)
GA46A	Break Contact PCB	£1.95 (D)
GA47B	Ext Horn PCB	£1.60 (D)
LW57M	Burglar Alarm Kit	£44.95 (A)
LW59P	Break Contact Kit	£2.99 (C)
LW58N	Ext Horn Kit	£29.95 (A)
GA81C	Channel/PSU PCB	£1.85 (D)
GA82D	Extra Channel PCB	£1.35 (D)
LW73Q	RTX3 Doppler Kit	£39.95 (A)
LW74R	Radar Ch/PSU Module	£15.40 (A)
LW75S	Radar Extr Ch Module	£4.90 (C)

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GB00A	Ultrasonic Xvr PCB	£1.60 (D)
GB01B	Ultrasonic IF PCB	£1.60 (D)
LW83E	Usonic Xceiver Kit	£12.65 (A)
LW84F	Usonic Interface Kit	£2.50 (C)
XF44X	Magnum Booklet	50pNV (E)
YQ44X	Magnum 1 PCB	£2.95 (C)
YQ45Y	Magnum 2 PCB	£2.95 (C)
YQ72P	Magnum Mode Chng PCB	£1.65 (D)
GA79L	Multi-circuit Board	£1.25 (D)

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LW50E	Electronics For All	£14.95 (A)
XG09K	Train Control Case	£12.50 (A)
XX47B	Train Cnrl Front Pnl	£3.75 (C)
GA72P	Train Common PCB	£2.90 (C)
GA73Q	Train Control PCB	£2.20 (C)
GA74R	Train Receiver 1 PCB	£1.35 (D)
GA75S	Train Receiver 2 PCB	£1.35 (D)
LW61R	Train Common/PSU Kit	£27.50 (A)
LW62S	Train Control Kit	£6.75 (B)
LW63T	Train Rcvr1 ML926Kit	£6.90 (B)
LW64U	Train Rcvr2 ML926Kit	£6.99 (B)
LW68Y	Train Rcvr1 ML927Kit	£6.99 (B)
LW69A	Train Rcvr2 ML927Kit	£6.99 (B)

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GA84F	Remote Data Ltch PCB	£2.10 (C)
GA85G	Data Encoder PCB	£2.49 (C)
GA86T	Data Decoder PCB	£2.45 (C)
GA87U	IR Tx PCB	£1.25 (D)
GA88V	IR Rx PCB	£1.25 (D)
GA89W	27MHz Tx PCB	98p (E)
XH26D	MES71	30pNV
BB82D	Keyboard PCB	£7.72 (B)
BB83E	VDU Logic PCB	£10.96 (A)
BB98G	VDU PSU PCB	£2.98 (C)
XY12N	VDU Front Panel	£7.90 (B)
XX05F	UHF Mod No 2	£4.99 (C)

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XH58N	Keytop Print ZX81	25p (F)
XG17T	ZX81 Keyboard Case	£4.95 (C)
GA83E	ZX81 Ext Keyboard PCB	£2.95 (C)
LW72P	ZX81 Keyboard Kit	£21.90 (D)
XG22Y	ZX81 Keyboard	£29.95
GA90X	I/O Port PCB	£2.25 (C)
LW76H	ZX81 I/O Port Kit	£9.25 (B)
GB08J	ZX81 Extendiboard	£2.32 (C)

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XF03D	MES26	£1.28NV
BB28F	RC Coder PCB	£1.95 (D)
BB29G	RC Xmitter PCB	£1.99 (D)
BB30H	RC Receiver PCB	£1.45 (D)
BB31J	RC Interface PCB	£1.55 (D)
BB32K	RC Decoder PCB	£1.35 (D)
BB33L	RC Relay Drive PCB	99p (E)
BB34M	RC Servo Drive PCB	82p (E)
BB35Q	RC Servo Amp PCB	92p (E)
BB36P	RC Tone Gen PCB	85p (E)
BB37S	RC Tone Decoder PCB	85p (E)
YQ03D	McM Encoder PCB	£1.10 (D)
YQ04E	McM Receiver PCB	£2.32 (D)
YQ05F	McM Rcvr Dcdr PCB	£1.05 (D)
YQ07H	McM Transmitter PCB	£1.95 (D)
YQ08J	McM Elect Ig/Cnv PCB	£1.60 (D)
XH27E	MES16	15pNV
XX40T	Ignition PCB	£1.30 (D)
XX41U	Ign Mtg Plate	£1.28 (D)
GA22Y	Strobe Main pcb	£2.20 (C)
GA23A	Strobe HT pcb	£1.20 (D)
YQ09K	McM Flasher PCB	£1.10 (D)

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GA26D	Dig Tacho Main PCB	£1.75 (D)
GA27E	Dig Tacho Dsply PCB	£1.25 (D)
GA19V	Batt Mon PCB	£1.20 (D)
GA98G	Car Burglar Alrm PCB	£1.10 (D)
LW78K	Car Burglr Alarm Kit	£6.95 (B)
GA40T	Car Aerial Bster Pcb	£1.35 (D)

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GA76H	MPG Meter Main PCB	£2.45 (C)
GA77J	MPG Meter Disply PCB	£1.75 (D)
LW67X	MPG Meter Kit	£44.95 (A)
RK39N	Freq Cnt Front Panel	£1.99 (D)
GB02C	Freqency Counter PCB	£4.95 (C)
GB03D	Freq Ctr Display PCB	£1.85 (D)
LW79L	Freqency Counter Kit	£85.00 (A)
BB72P	Sine/Square Gen PCB	£3.12 (C)
BB73Q	Audio Osc Frt Panel	£1.98 (D)
XH24B	MES15	15pNV

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XF11M	Stereo Synth Book	£2.00NV (C)
XF13P	MES12B	FREE
XF37S	MES12C	FREE
XH24B	MES15	15pNV
XF14Q	MES15B	FREE
XH27E	MES16	15pNV
XF15R	MES16B	FREE
XH18U	MES22	25pNV
XF18U	MES22B	FREE
XH06G	MES24	FREE
XH20W	MES25	25pNV
XF20W	MES25B	FREE
XF03D	MES26	£1.28NV
XH13P	MES27	FREE
XH51F	MES30	20pNV
XH48C	MES33	40pNV (F)
XF21X	40W Amp Schedule	FREE
XF22Y	Tuner Schedule	FREE
XF25C	MES35B	FREE
XH21X	MES37	25pNV (F)
XF06G	MES37B	FREE
XF04E	MES41	40pNV
XF05F	Disco Schedule	FREE
XH23A	MES42	25pNV
XF23A	MES42B	FREE
XH00A	MES51	15pNV
XH01B	MES51B	FREE
XH02C	MES52	15pNV
XH03D	MES52B	FREE
XH04E	MES53	35pNV
XH05F	MES53B	FREE
XH31J	MES54	30pNV
XH32K	MES54B	FREE
XH33L	MES55	30pNV
XH34M	MES55B	FREE
XH26D	MES71	30pNV
XF26D	MES71B	FREE
GA11M	Continuity Testr PCB	£1.32 (D)
XF46A	E&MM April 1981	£1.00NV
XF47B	E&MM May 1981	£1.00NV
XF48C	E&MM June 1981	£1.00NV
XF49D	E&MM July 1981	£1.00NV
XF50E	E&MM August 1981	£1.00NV

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XF52G	E&MM October 1981	£1.00NV
XF53H	E&MM November 1981	£1.00NV
XF54J	E&MM December 1981	£1.10NV
XF55K	E&MM January 1982	£1.10NV
XF56L	E&MM February 1982	£1.10NV
XF57M	E&MM March 1982	£1.10NV
XF58N	E&MM April 1982	£1.10NV
XF59P	E&MM May 1982	£1.10NV
XF60Q	E&MM June '82	£1.10NV
XF61R	E&MM July 1982	£1.10NV
XF62S	E&MM August 1982	£1.10NV

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XF63T	E&MM September 1982	£1.10NV
XF64U	E&MM October 1982	£1.10NV
XH61R	E&MM Projects Vol 1	£1.00NV (D)
XA00A	Maplin Mag Subscrptn.	60pNV
XA01B	Projects Book One	60pNV (E)
XA02C	Projects Book Two	60pNV (E)
XA03D	Projects Book Three	60pNV (E)
XA04E	Projects Book Four	60pNV (E)

PROTECTION

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RX96E	Safuseholder 20	45p (F)
RX97F	Safuseholder 1.1/4in	£1.96 (D)
RX49D	Chassis F/H 20mm	11p (G)
RX50E	Chassis F/H 1.1/4 in	17p (G)
WH49D	Fuse Clip	3p (H)
RX51F	F/H Car	10p (G)
WR93R	Fuse 20mm 50mA	6p (H)
WR00A	Fuse 20mm 100mA	6p (H)
WR94C	Fuse 20mm 150mA	6p (H)
WR01B	Fuse 20mm 250mA	6p (H)
WR02C	Fuse 20mm 500mA	6p (H)
WR03D	Fuse 20mm 1A	8p (H)
WR04E	Fuse 20mm 1.5A	8p (H)
WR05F	Fuse 20mm 2A	8p (H)
WR06G	Fuse 20mm 3A	8p (H)
WR07H	Fuse 20mm 5A	7p (H)
WR18U	Fuse A/S 500mA	12p (G)
WR19V	Fuse A/S 1A	12p (G)
WR20W	Fuse A/S 2A	12p (G)
WR95D	Fuse 1 1/4 50mA	4p (H)
WR08J	Fuse 1 1/4 100mA	6p (H)
WR96E	Fuse 1 1/4 150mA	8p (H)
WR09K	Fuse 1 1/4 250mA	7p (H)
WR10L	Fuse 1 1/4 500mA	6p (H)
WR11M	Fuse 1.1/4 1A	8p (H)
WR12N	Fuse 1.1/4 1.5A	8p (H)
WR13P	Fuse 1 1/4 2A	8p (H)
WR14Q	Fuse 1.1/4 3A	8p (H)
WR15R	Fuse 1.1/4 5A	9p (H)
WR16S	Fuse 1.1/4 10A	9p (H)
WR17T	Fuse 1.1/4 15A	12p (G)
HQ31J	Plug Fuse 2A	15p (G)
HQ32K	Plug Fuse 3A	14p (G)
HQ33L	Plug Fuse 5A	15p (G)
HQ34M	Plug Fuse 13A	14p (G)
BK21X	Thermal Breaker 1A	£2.35 (C)
BK22Y	Thermal Breaker 3A	£1.35 (D)
BK23A	Thermal Breaker 5A	£1 35 (D)
BK24B	Thermal Breaker 12A	£1 35 (D)
BK20W	Thermal Breaker 15A	£1.35 (D)

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HB51F	Fuse Wire	30p (F)
HW04E	RF Supp Choke 1A	29p (F)
HW05F	RF Supp Choke 2A	32p (F)
HW06G	RF Supp Choke 3A	39p (F)
YR90X	R C Network	£1.39 (D)
HW13P	Mains Trans Supp	65p (E)
HW07H	Delta Cap	97p (E)
YW46A	Door Contact Reed	£1.49 (D)
YW50E	Window Foil	£1.25 (D)
YW51F	Foil Terms	65p (E)
YW49D	BA Junction Box	59p (E)
YW47B	Surface BA Reed	£1 95 (D)
YW48C	Door Loop	£1.75 (D)
YB91Y	Pressure Mat	£3.55 (C)

RECORD & VIDEO

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XQ00A	Autochanger	£22.50 (A)
XB23A	Rim Drive Turntable	£29.90 (A)
XB25C	Belt Drive Turntable	£34.50 (A)

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FQ17T	Cartridge Slide MP60	£2 68 (C)
FQ18U	Cartridge Slide 710	DIS
FQ19V	Crtndge Slide BDS95	DIS
LB75S	Drive Wheel BSR	£1.55 (D)
YW58N	BSR Drive Belt	£2 20 (C)
LB76H	Dr Wheel Garrard Lrg	£2 55 (C)
FQ30H	Dr Wheel Garrard Sm.	£2 85 (C)
†FQ31J	Spindle Man Short	72p (E)
FQ32K	Spindle Man Long	DIS
†FQ33L	Spindle Auto Short	£4.50 (C)
FQ35Q	CB Weight SP25IV	£3 95 (C)
FQ36P	Garrard Drive Belt	£2.50 (C)
XX34M	Headshell	£3 50 (C)
YX76H	Drive Belt 46mm	98p (E)
YX77J	Drive Belt 57mm	98p (E)
YX78K	Drive Belt 66mm	98p (E)
RK99H	Dnve Belt 71mm	£1.00 (D)
YX79L	Dnve Belt 76mm	98p (E)
YX80B	Drive Belt 90mm	98p (E)
HR01B	Ctrdg BSR X5M	£3 65 (C)
HR02C	Ctrdg BSR X5H	£3 65 (C)

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HR04E	Ctrdg BSR SX6M	£4.25 (C)
HR05F	Ctrdg BSR SX6H	£4 49 (C)
HR09K	Ctrdg BSR SC12M	£3 75 (C)
HR10L	Ctrdg BSR SC12H	£3.65 (C)
YX83E	Ctridge Philips GP215	£4 55 (C)
FY75S	Ctrdg Rigonda 2SB	£4.45 (C)
HR12N	Ctrdg Sono 3509	£4.95 (C)
HR13P	Ctrdg Sono 3549	£5.95 (B)
HR14Q	Ctrdg Sono 3559	£5.25 (B)
HR17T	Ctrdg Sono V100	£5.98 (B)
YX82D	Cartridge QLM36	£21.40 (A)

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HR15R	Ctrdg Goldring G850	£5.70 (B)
HR16S	Ctrdg Goldnng G800	£8.75 (B)
FQ38R	Ctrdg Goldring G800H	£9 49 (B)
FQ39N	Ctrdg Goldring G800E.	£11.95 (A)
FQ40T	Ctrdg Tenorel T2001D	£4.85 (C)
FQ41U	Cdg Tenorel T2001ED	£11 29 (A)
RK98G	Tenorel TMC10 Cart	£39.95 (A)
BK64U	TMC10 Replacement	£19 95

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HR25C	Stylus GP91SC DD	£1.85 (D)
BK05F	Stylus Sanyo ST26	£5.50
BK07H	Stylus ATN3400	£4 95 (C)
HR31J	Stylus GP104 DD	£1 85 (D)
HR66W	Stylus Acos SM6	£4 95 (C)
•BK08J	Stylus ATN71	£5.50
YX06G	Stylus ADC RSQ30	£7.96 (B)
BK09K	Stylus ATN3710	£4.95
BK10L	Stylus Toshiba N501	£5.50 (B)
YX09K	Stylus AT70	£4 95 (C)
BK19V	Stylus D5107AL	£4.95 (C)
HR68Y	Stylus VM8	£5.50 (B)
HR39N	Stylus BSR TC8 D	£1.50 (D)
HR71N	Stylus BSR ST4 DD	£1.85 (D)
HR42V	Stylus BSR ST10	£1.85 (D)
HR45Y	Stylus BSR ST15	£1.85 (D)
HR47B	Stylus BSR ST17 DD	£1.85 (D)
HR74R	Stylus BSR ST21	£1.85 (D)
BK11M	Stylus Hitachi E100	£5.50 (B)
BK12N	Stylus JVC DT31	£5.50 (B)
YX12N	Stylus Garrard GA150	£10 50 (A)
HR76H	Stylus D110E	£5.50 (B)
HR77J	Stylus D110H	£2.95 (C)
HR48C	Stylus D110SR	£1.95 (D)
HR49D	Stylus D120SR	£2.45 (C)
HR78K	Stylus Hitachi ST101	£5.40 (C)
HR79L	Stylus Hitachi ST103	£6.75 (B)
YX13P	Stylus Hitachi ST104	£4.95 (C)
YX14Q	Stylus JVC DT21S	DIS
FQ54J	Stylus JVC DT33	£4.95 (C)
BK14Q	Stylus Trio STY111	£4 95 (C)
HR81C	Stylus LV65977D	£1.50 (D)
HR83E	Stylus NP EPS36	£2.25 (C)
HR84F	Stylus NP EPS52	£4.95 (C)
YX16S	Stylus NP EPS53	£5.50 (B)
YX17T	Stylus Philip AG3306	£1.85 (D)
HR87U	Sty Philips GP200DD	£1.85 (D)
HR89W	Stylus Philips GP205	£1.25 (D)
YX18U	Stylus Philips GP213	£1.85 (D)
HR90X	Styl Philips GP400	£5.10 (B)
YX19V	Styl Philps GP400Mk2	£4.95 (C)
YX20W	Styl Philps GP401Mk2	£6.75 (B)
BK15R	Stylus EPC207	£5.35 (B)
HR51F	Stylus BF40D	£1 85 (D)
HR96E	Stylus DM500/7	£4 95 (C)
YX22Y	Stylus Sanyo ST10J	£4.95 (C)
HR95D	Stylus Sansui SN28	£4 95 (C)
YX23A	Stylus Sansui SN41	£4 95 (C)
YX24B	Stylus Sanyo ST7D	£4.95 (C)
HR97F	Stylus Sanyo 2611	£4.95 (C)
FQ48C	Stylus Sony ND128	£2.20 (C)
YX25C	Stylus Sharp STY101	£4.95 (C)
HR98G	Stylus Sharp 706	£4.95 (C)
HR99H	Stylus Sharp 717	£4.95 (C)
BK16S	Stylus PN12	£5.50 (B)
HR61R	Stylus Sonotone V100	£4.95 (C)
YX26D	Stylus Sonotone V101	£4.95 (C)
FQ45Y	Stylus 2509	£1 85 (D)
HR60Q	Stylus 9TAHC DD	£1.85 (D)
HR53H	Stylus KS40A DD	£1.85 (D)
BK17T	Stylus Sony ND114	£5.50 (B)
BK18U	Stylus ND200	£6 75 (B)
YX27E	Stylus Sony XL15	£4.35 (C)
YX28F	Stylus Sony ND126	£4.95 (C)
FQ49D	Stylus Sony ND133	£5.50 (B)
FQ50E	Stylus Sony ND134	£5.50 (B)
FQ51F	Stylus N2001D	£2.95 (C)
FQ52G	Stylus N2001ED	£6.75 (B)
YX30H	Stylus Tetrad 51	£2 25 (C)
FQ53H	Stylus Toshiba N3C	£2 20 (C)
YX31J	Stylus Toshiba N55	£4.95 (C)
YX32K	Stylus Toshiba N58	£4.95 (C)
YX21X	Stylus Toshiba N550	£4 95 (C)

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YB47B	Record Care kt C106	£4.95 (C)
LX06G	Cleaning Arm C100	£3.25 (C)
YW81C	Cleaning Cloth C104	78p (E)
FR48C	Dust-Off C101	99p (E)
YW82D	Cleaner C92	£4.65 (C)
YX93B	Stylus Microscope	£2.45 (C)
YW83E	Stylus Brush C103	12p (G)
FR46A	Stylus Cleaner C95	80p (E)
YB55K	Cleaning Kit C116	£2.42 (C)
FR52G	Anti-Stat Fluid 69S	49p (F)
LX10L	Anti-Stat Mat C119	£1.95 (D)
LX04E	Anti Stat Gun	£5.25 (B)
FR49D	Stylus Balance PX1	£2.45 (C)
FR50E	Gram Speed Indicator	9p (H)

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YW86T	Cassette Kit C115	£1.85 (D)
RK95D	Tape Head Care Kit.	£2.75 (C)
YB56L	Cassette Kit C107	£4.25 (C)
•BK28F	Deluxe Head Cleaner	£3 25 (C)
RB04E	Cass Head Clnr C118	£1.25 (D)
YW87U	Cleaning Stick C109	23p (G)
YW88V	Tape Cleaning Fluid	58p (E)
FR54J	Cassette Clnr Tape	55p (E)
YW89W	Cassette Cln & Demag	£2.25 (C)
FR62S	Straight Demagnetzer	£3.64 (C)
FQ62S	Curved Demagnetiser	£3.85 (C)
BK27E	Elec Head Demag	£8.95 (B)
YW91Y	Splicing Block	£1.85 (D)

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YW90X	Cassette Splicer	£4.25 (C)
LX17T	Splicing Tape	65p (E)
RB03D	Cassette Case	26p (G)
FR60Q	Index Cards	£1.40 (D)
RB01B	Cassette Fast Winder	£2.75 (C)
FR59P	Test Cassette 53	£4 98 (C)
YG25C	Cassette Tape C60	61p (E)
YG26D	Cassette Tape C90	65p (E)
RB07H	Rota-Rack	£2.45 (C)
LH91Y	Cassettebox	£4.65 (C)
LH92A	Videocassettebox	£9.68 (B)
RK96E	VHS Head Cleaner	£9 75 (B)
RK97F	Betamax Head Cleaner	£10.95 (A)

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FQ63T	GF Cassette Head	£12.80 (A)
FQ64U	Mono Cassette Head	£3 64 (C)
FQ66W	Cassette Erase Head	£1.99 (C)
FQ65V	Stereo Cassette Head	£4.48 (B)
FQ69A	Tape hd Four-Trck RP	£16.95 (A)
FQ70M	Tpe Hd Four Trk Eras	£8.85 (B)
FQ71N	2-Head Bracket	£4.65 (C)
FQ72P	3-Head Bracket	£5.39 (B)

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U	Micro Res	3p (H)
B	Econ Res 1R to 8R2	2p (H)
B	Econ Res 1M2 to 10M	2p (H)
M	M1R to 8R2 (1%)	12p (H)
M	M10R to 1M (1%)	2p (H)
M	M1M2 to M10M (1%)	12p (H)

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S	Std Res	3p (H)
C	1W Res	5p (H)
XL05F	Colour Wheel	25p (F)
X	See M	
T	See M	
W	W/W Min	29p (F)

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L	7W W/W	29p (F)
H	10W W/W	35p (F)
P	25 W/W Res	£1.65 (D)
V	HV Res 1M-33M	12p (G)
V	HV Res 47M	25p (F)
BL64U	Constantan 28 swg	£3.35 (C)
YY12N	Resnet 100R	85p (E)
YY13P	Resnet 220R	85p (E)
YY14Q	Resnet 470R	85p (E)
YY15R	Resnet 1k	85p (E)
YY16S	Resnet 2k2	93p (E)
YY17T	Resnet 4k7	85p (E)
YY18U	Resnet 10k	85p (E)
YY19V	Resnet 22k	85p (E)
YY20W	Resnet 47k	85p (E)
YY21X	Resnet 100k	85p (E)
WR52G	Hor S-Min Prest 100R	10p (G)
WR53H	Hor S-Min Prest 220R	10p (G)
WR54J	Hor S-Min Prest 470R	10p (G)
WR55K	Hor S-Min Prest 1k	10p (G)
WR56L	Hor S-Min Prest 2K2	10p (G)
WR57M	Hor S Min Prest 4k7	10p (G)
WR58N	Hor S-Min Prest 10k	10p (G)
WR59P	Hor S-Min Prest 22K	10p (G)
WR60Q	Hor S-Min Prest 47k	10p (G)
WR61R	Hor S-Min 100k	10p (G)
WR62S	Hor S-Min Prest 220k	10p (G)
WR63T	Hor S Min Prest 470k	10p (G)
WR64U	Hor S-Min Preset 1M	10p (G)
WR65V	Vrt S-Min Prest 100R	11p (G)
WR66W	Vrt S-Min Prest 220R	11p (G)
WR67X	Vrt S-Min Prest 470R	11p (G)
WR68Y	Vrt S-Min Prest 1k	11p (G)
WR69A	Vrt S-Min Prest 2k2	11p (G)
WR70M	Vrt S-Min Prest 4k7	11p (G)
WR71N	Vrt S-Min Prest 10k	11p (G)
WR72P	Vrt S-Min Prest 22k	11p (G)
WR73Q	Vrt S-Min Prest 47k	11p (G)
WR74R	Vrt S-Min Prest 100k	11p (G)
WR75S	Vrt S-Min Prest 220k	11p (G)
WR76H	Vrt S-Min Prest 470k	11p (G)
WR77J	Vert S-Min Prest 1M	11p (G)

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WR78K	Hor Skeleton 100R	14p (G)
WR79L	Hor Skeleton 220R	14p (G)
WR80B	Hor Skeleton 470R	28p (F)
WR81C	Hor Skeleton 1k	26p (F)
WR82D	Hor Skeleton 2k2	26p (F)
WR83E	Hor Skeleton 4k7	26p (F)
WR84F	Hor Skelton 10k	26p (F)
WR85G	Hor Skeleton 22k	26p (F)
WR86T	Hor Skeleton 47k	26p (F)
WR87U	Hor Skeleton 100k	27p (F)
WR88V	Hor Skeleton 220k	26p (F)
WR89W	Hor Skeleton 470k	26p (F)
WR90X	Hor Skeleton 1M	26p (F)
WR91Y	Hor Skeleton 2M2	26p (F)
WR92A	Hor Skeleton 4M7	26p (F)
WW00A	Vrt Skeleton 100R	26p (F)
WW01B	Vrt Skeleton 220R	26p (F)
WW02C	Vert Skeleton 470R	26p (F)
WW03D	Vrt Skeleton 1k	26p (F)
WW04E	Vrt Skeleton 2k2	26p (F)
WW05F	Vrt Skeleton 4k7	26p (F)
WW06G	Vrt Skeleton 10k	26p (F)
WW07H	Vrt Skeleton 22k	29p (F)
WW08J	Vrt Skeleton 47k	26p (F)
WW09K	Vrt Skeleton 100k	26p (F)
WW10L	Vrt Skeleton 220k	26p (F)
WW11M	Vrt Skeleton 470k	24p (F)
WW12N	Vrt Skeleton 1M	28p (F)
WW13P	Vrt Skeleton 2M2	28p (F)
WW14Q	Vrt Skeleton 4M7	24p (F)
WR38R	Cermet 100R	98p (E)
WR39N	Cermet 500R	98p (E)
WR40T	Cermet 1k	98p (E)
WR41U	Cermet 5k	98p (E)
WR42V	Cermet 10k	98p (E)
WR43W	Cermet 50k	98p (E)
WR44X	Cermet 100k	98p (E)
WR45Y	Cermet 1M	98p (E)
WR46A	15-Turn Cermet 500R	£1.20 (D)
WR47B	15-Turn Cermet 1k	£1.20 (D)
WR48C	15-Turn Cermet 5k	£1.20 (D)
WR49D	15-Turn Cermet 10k	96p (D)
WR50E	15-Turn Cermet 50k	£1.20 (D)
WR51F	15-Turn Cermet 100k	£1.42 (D)
BW06G	Edge Control Pot	65p (E)
BW07H	Edge Knob Small Blk	8p (H)
BW08J	Edge Knob Small Grey	8p (H)
BW09K	Edge Knob Large Blk	8p (H)
BW10L	Edge Knob Large Grey	8p (H)
FW00A	Pot Lin 1k	45p (F)
FW01B	Pot Lin 4k7	45p (F)
FW02C	Pot Lin 10k	45p (F)
FW03D	Pot Lin 22k	45p (F)
FW04E	Pot Lin 47k	45p (F)
FW05F	Pot Lin 100k	45p (F)
FW06G	Pot Lin 220k	45p (F)
FW07H	Pot Lin 470k	45p (F)
FW08J	Pot Lin 1M	45p (F)
FW09K	Pot Lin 2M2	45p (F)
FW21X	Pot Log 4k7	45p (F)
FW22Y	Pot Log 10k	45p (F)
FW23A	Pot Log 22k	45p (F)
FW24B	Pot Log 47k	45p (F)
FW25C	Pot Log 100k	45p (F)
FW26D	Pot Log 220k	45p (F)
FW27E	Pot Log 470k	45p (F)
FW28F	Pot Log 1M	45p (F)
FW29G	Pot Log 2M2	45p (F)

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FW41U	Sw Pot Lin 4k7	£1.12 (D)
FW42V	Sw Pot Lin 10k	£1.12 (D)
FW43W	Sw Pot Lin 22k	£1.12 (D)
FW44X	Sw Pot Lin 47k	£1.12 (D)
FW45Y	Sw Pot Lin 100k	£1.12 (D)
FW46A	Sw Pot Lin 220k	£1.12 (D)
FW47B	Sw Pot Lin 470k	£1.12 (D)
FW48C	Sw Pot Lin 1M	£1 12 (D)
FW49D	Sw Pot Lin 2M2	£1.12 (D)
FW62S	Sw Pot Log 4k7	£1.12 (D)
FW63T	Sw Pot Log 10k	£1.12 (D)
FW64U	Sw Pot Log 22k	£1.12 (D)
FW65V	Sw Pot Log 47k	£1 12 (D)
FW66W	Sw Pot Log 100k	£1.12 (D)
FW67X	Sw Pot Log 220k	£1 12 (D)
FW68Y	Sw Pot Log 470k	£1.12 (D)
FW69A	Sw Pot Log 1M	£1.12 (D)
FW70M	Sw Pot Log 2M2	£1.12 (D)
FW50E	W/W Pot 10R	£2.15 (C)
FW51F	W/W Pot 25R	£1 99 (D)
FW52G	W/W Pot 50R	£1.99 (D)
FW71N	W/W Pot 100R	£2.55 (C)
FW72P	W/W Pot 250R	£1 98 (D)
FW73Q	W/W Pot 500R	£1 85 (D)
FW93B	W/W Pot 1k	£1.85 (D)
FW96E	W/W Pot 2K5	59p (E)
FW94C	W/W Pot 5k	99p (E)
FW95D	W/W Pot 10k	£2.29 (C)
FX18U	W/W Pot 50k	£2.79 (C)

TRADE QUANTITIES

The letter in brackets after the price indicates the minimum quantity of that item you can buy and qualify for a trade price. See table at start of price list. If you buy less than the quantity shown then the price is that shown. If you want to buy the quantity shown or more of that item, then please contact us for a trade price. If no trade quantity is shown, then the price shown is the best price we can offer regardless of the quantity.

Trade quantities shown for wires or cables of any type is in metres, not reels or parts of metres. Trade quantities for nuts, bolts, washers, Hiatts etc. refers to the number of packs, i.e. to qualify for a trade price on Tag 2BA for example (trade quantity 500), you will need to order 500 packs which is equal to 5000 tags.

1983 Catalogue Page No.		VAT inclusive PRICE
FW84F	Dual Pot Lin 4k7	£1.24 (D)
FW85G	Dual Pot Lin 10k	£1.24 (D)
FW86T	Dual Pot Lin 22k	£1.24 (D)
FW87U	Dual Pot Lin 47k	£1.24 (D)
FW88V	Dual Pot Lin 100k	£1.24 (D)
FW89W	Dual Pot Lin 220k	£1.24 (D)
FW90X	Dual Pot Lin 470k	£1.24 (D)
FW91Y	Dual Pot Lin 1M	£1.24 (D)
FW92A	Dual Pot Lin 2M2	£1.24 (D)
FX08J	Dual Pot Log 4k7	£1.24 (D)
FX09K	Dual Pot Log 10k	£1.24 (D)
FX10L	Dual Pot Log 22k	£1.24 (D)
FX11M	Dual Pot Log 47k	£1.24 (D)
FX12N	Dual Pot Log 100k	£1.24 (D)
FX13P	Dual Pot Log 220k	£1.24 (D)
FX14Q	Dual Pot Log 470k	£1.24 (D)
FX15R	Dual Pot Log 1M	£1.24 (D)
FX16S	Dual Pot Log 2M2	£1.24 (D)
FX40T	L/S Control 20R	55p (E)
FX97F	L/S Control 50R	55p (E)
FX98G	L/S Control 100R	55p (E)
FX99H	L/S Control 200R	55p (E)
YG04E	Rheostat 50R	£4.90 (C)
YG05F	Rheostat 100R	£4.90 (C)
YG06G	Rheostat 150R	£4.90 (C)
YG07H	Rheostat 200R	£4.90 (C)

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FX32K	Slide Pot Lin 5k	79p (E)
FX33L	Slide Pot Lin 10k	79p (E)
FX34M	Slide Pot Lin 25k	79p (E)
FX35Q	Slide Pot Lin 50k	79p (E)
FX36P	Slide Pot Lin 100k	79p (E)
FX37S	Slide Pot Lin 250k	79p (E)
FX38R	Slide Pot Lin 500k	79p (E)
FX53H	Slide Pot Log 5k	79p (E)
FX54J	Slide Pot Log 10k	79p (E)
FX55K	Slide Pot Log 25k	79p (E)
FX56L	Slide Pot Log 50k	79p (E)
FX57M	Slide Pot Log 100k	79p (E)
FX58N	Slide Pot Log 250k	79p (E)
FX59P	Slide Pot Log 500k	79p (E)
FX7EH	Dual Slide Lin 5k	£1.25 (D)
FX77J	Dual Slide Lin 10k	£1.25 (D)
FX80B	Dual Slide Lin 100k	£1.25 (D)
HB02C	Dual Slide Log 10k	£1.25 (D)
HB04E	Dual Slide Log 50k	£1.25 (D)
HB05F	Dual Slide Log 100k	£1.25 (D)
HB07H	Dual Slide Log 500k	£1.25 (D)
FX07H	Slide Bezel	49p (F)
XB09K	Joystick Pot	£6.38 (B)
HQ50E	2-Axis Joystick	£3.25 (C)
XB06G	Joystick Mtg Plate	£1.66 (D)

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FX87U	Thermistor KR152CW	98p (E)
FX21X	Thermistor VA1055S	51p (E)
FX22Y	Thermistor VA1056S	38p (F)
FX42V	Thermistor VA1066S	41p (F)
FX43W	Thermistor VA1067S	39p (F)
FX62S	Thermistor R53	£5.95 (B)
WH23A	Thermistor G16	£5.40 (B)
WH24B	Thermistor G23	£5.35 (B)
HB10L	LDR ORP12	£1.35 (D)
HB11M	LDR ORP60	£1.72 (D)
HB09K	LDR RPY58A	£1.18 (D)

SEMICONDUCTORS

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QB00A	AA119	11p (G)
QB01B	AC126	36p (F)
QB02C	AC127	38p (F)
QB03D	AC128	42p (F)
QB04E	AC141	39p (F)
QB05F	AC142	42p (F)
QB06G	AC176	34p (F)
QB07H	AC187	29p (F)
QB08J	AC188	37p (F)
QB10L	ACY19	77p (E)
QB11M	ACY20	75p (E)
BL30H	AD140	£1.55 (D)
BL31J	AD149	£1.35 (D)
BL32K	AD161	61p (E)
BL33L	AD161/2MP	£1.22 (D)
BL34M	AD162	61p (E)
QQ00A	ADC0804LCN	£4.45 (C)
QB19V	AF139	65p (E)
QB20W	AF239	88p (E)
BR45Y	AS314	33p (F)
QB21X	AY-1-0212	£8.20 (B)
HQ52G	AY-1-1320	£4.99 (C)
HQ51F	AY-1-5050	£1.99 (D)
YY98G	AY-3-1270	£8.30 (B)
YY89W	AY-3-1350	£5.95 (B)
WQ18U	AY-3-1015D	£5.98 (B)
WQ19V	AY-5-2376	£9.95 (B)
QB27E	BA102B	29p (F)
QQ12N	BA243	DIS
QQ13P	BAR28	15p (G)
QB28F	BAX13	12p (H)
QB29G	BAX16	7p (H)
QB31J	BC107B	14p (G)
QB32K	BC108C	16p (G)
QB33L	BC109C	16p (G)
QB34M	BC117	24p (F)
QB35Q	BC119	39p (F)
QB36P	BC139	40p (F)
QB37S	BC140	34p (F)
QB38R	BC141	37p (F)
QB39N	BC142	34p (F)
QB40T	BC143	34p (F)
QB44X	BC154	27p (F)
QB48C	BC160	43p (F)
QB49D	BC161	36p (F)
QB50E	BC168C	11p (G)
QB51F	BC169C	11p (G)
QB52G	BC177	20p (G)
QB53H	BC178	20p (G)
QB54J	BC179	20p (G)
QB55K	BC182L	11p (G)
QB56L	BC183L	11p (G)
QB57M	BC184L	11p (G)
QB58N	BC204	15p (G)
QB59P	BC209C	14p (G)
QB60Q	BC212L	11p (G)
QB61R	BC213L	11p (G)
QB62S	BC214L	10p (G)
QB63T	BC301/5	40p (F)
QB64U	BC301/5/302/5MP	89p (E)
QB65V	BC302/5	36p (F)
QB66W	BC327	15p (G)
QB67X	BC328	15p (G)
QB68Y	BC337	15p (G)
QB69A	BC338	15p (G)
QB70M	BC441	38p (F)
QB71N	BC441/461MP	79p (E)
QB72P	BC461	43p (F)
QQ14Q	BC547	11p (G)
QB73Q	BC548	14p (G)
QQ15R	BC549	12p (G)

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QQ16S	BC557	11p (G)
QQ17T	BC558	11p (G)
QQ18U	BC559	11p (G)
QB74R	BC650	29p (F)
QF00A	BCY70	18p (G)
QF01B	BCY71	18p (G)
QF03D	BD131	49p (F)
QF04E	BD131/2MP	£1.19 (D)
QF05F	BD132	50p (E)
QF06G	BD135	36p (F)
QF75S	BD136	24p (F)
QF07H	BD139	40p (F)
QF08J	BD140	40p (F)
WH15R	BD711	68p (E)
WH16S	BD712	68p (E)
QF09K	BF115	38p (F)
QF10L	BF167	38p (F)
QF11M	BF180	38p (F)
QF15R	BF200	32p (F)
QF16S	BF244	32p (F)
QF17T	BF258	33p (F)
QF18U	BF259	39p (F)
QF19V	BF337	40p (F)
QQ19V	BF494	25p (F)
QQ20W	BF495	23p (F)
QF20W	BFW10	£1.43 (D)
QF21X	BFX29	33p (F)
QF22Y	BFX30	35p (F)
QF23A	BFX84	34p (F)
QF24B	BFX85	31p (F)
QF25C	BFX87	32p (F)
QF26D	BFX88	36p (F)
QF27E	BFY50	30p (F)
QF28F	BFY51	29p (F)
QF29G	BFY52	31p (F)
QF31J	BRY39	48p (F)
QF32K	BSX20	26p (F)
QF33L	BSX21	29p (F)
QF35Q	BT109	£1.49 (D)
QF37S	BU205	£1.95 (D)
QF39N	BU208	£2.99 (C)
QF41U	BY126	21p (G)
QF42V	BY127	14p (G)
QF43W	BY164	76p (E)
QF44X	BY206	30p (F)
QF45Y	BZX61C4V7	16p (G)
QF46A	BZX61C5V1	16p (G)
QF47B	BZX61C5V6	16p (G)
QF48C	BZX61C6V2	16p (G)
QF49D	BZX61C6V8	16p (G)
QF50E	BZX61C7V5	16p (G)
QF51F	BZX61C8V2	16p (G)
QF52G	BZX61C9V1	16p (G)
QF53H	BZX61C10	16p (G)
QF54J	BZX61C11	16p (G)
QF55K	BZX61C12	16p (G)
QF56L	BZX61C13	16p (G)
QF57M	BZX61C15	16p (G)
QF58N	BZX61C16	16p (G)
QF59P	BZX61C18	16p (G)
QF60Q	BZX61C20	16p (G)
QF61R	BZX61C22	16p (G)
QF62S	BZX61C24	16p (G)
QF63T	BZX61C27	16p (G)
QF64U	BZX61C30	16p (G)
QF65V	BZX61C33	16p (G)
QF66W	BZX61C36	16p (G)
QF67X	BZX61C39	16p (G)
QF68Y	BZX61C43	16p (G)
QF69A	BZX61C47	16p (G)
QF70M	BZX61C51	16p (G)
QF71N	BZX61C56	16p (G)
QF72P	BZX61C62	16p (G)
QF73Q	BZX61C68	16p (G)
QF74R	BZX61C75	16p (G)
QH00A	BZY88C2V7	9p (H)
QH01B	BZY88C3V0	9p (H)
QH02C	BZY88C3V3	9p (H)
QH03D	BZY88C3V6	9p (H)
QH04E	BZY88C3V9	9p (H)
QH05F	BZY88C4V3	9p (H)
QH06G	BZY88C4V7	9p (H)
QH07H	BZY88C5V1	9p (H)
QH08J	BZY88C5V6	9p (H)
QH09K	BZY88C6V2	9p (H)
QH10L	BZY88C6V8	9p (H)
QH11M	BZY88C7V5	8p (H)
QH12N	BZY88C8V2	9p (H)
QH13P	BZY88C9V1	9p (H)
QH14Q	BZY88C10	9p (H)
QH15R	BZY88C11	9p (H)
QH16S	BZY88C12	9p (H)
QH17T	BZY88C13	9p (H)
QH18U	BZY88C15	9p (H)
QH19V	BZY88C16	9p (H)
QH20W	BZY88C18	9p (H)
QH21X	BZY88C20	9p (H)
QH22Y	BZY88C22	9p (H)
QH23A	BZY88C24	9p (H)
QH24B	BZY88C27	8p (H)
QH25C	BZY88C30	9p (H)
QH26D	CA3046	72p (E)
YH58N	CA3080E	87p (E)
QH27E	CA3089E	£2.70 (C)
QH28F	CA3130T	£1.10 (D)
QH29G	CA3140T	99p (E)
WQ20W	CA3189E	£1.95 (D)
QH21X	CA3240E	£1.38 (D)
YG37S	CL8960	£31.26 (A)
QH30H	C106D	42p (F)
WQ22Y	C116D	99p (E)
WQ23A	C126D	£1.63 (D)
WQ24B	C206D	£1.40 (E)
WQ25C	C226D	64p (E)
QL14Q	C246D	£1.24 (D)
QQ01B	DAC0801LCN	£2.45 (C)
QQ21X	DV1202W	£8.35 (B)
QQ22Y	DV1205W	TEMP
QQ23A	DV1210W	£13.63 (A)
QQ24B	DV1220W	£16.88 (A)
QQ25C	DV1230W	£21.30 (A)
QQ26D	DV1240W	TEMP
WQ28F	HSCH1001	55p (E)
YH59P	ICL7109	£19.33 (A)
YY75S	ICL7660CPA	£3.24 (C)
YY93B	ICM7045IPI	£14.20 (A)
YY94C	ICM7216DIPI	£17.45 (A)
YY95D	ICM7226BIPI	£21.90 (A)
YH63T	ICM 7555	£1.32 (D)
QH33L	1R122D	£3.95 (C)
BH45Y	J005	£1.75 (D)
BL36P	J02	£1.80 (D)
BH46A	J04	£1.95 (D)
BH47B	KO1	£3.15 (C)
BH48C	K04	£4.25 (C)
YY74R	L200	£2.69 (C)
WQ29G	LF347	£1.94 (C)
WQ30H	LF351	56p (E)
WQ31J	LF353	99p (E)
QY26D	LF400CN	NYA
QY27E	LF411CN	82p (E)
QY28F	LF412CN	£1.38 (D)

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QY29G	LF441CN	72p (E)
QY30H	LF442CN	£1.38 (D)
QY31J	LF444CN	£1.96 (D)
YY69A	LF13741	55p (E)
QH35Q	LH0042C	£4.46 (C)
QH36P	LM301A	27p (F)
QH37S	LM308	72p (E)
QY09K	LM311N	62p (E)
WQ32K	LM334	£1.10 (D)
YY73Q	LM335Z	£1.42 (D)
QH38R	LM377	£2.25 (C)
QH39N	LM379S	£5.52 (B)
QH40T	LM380	75p (E)
QH41U	LM381	£1.98 (D)
YY84F	LM382	£1.45 (D)
WQ33L	LM383	£1.61 (D)
WQ34M	LM384	£1.98 (D)
WQ35Q	LM387	£1.25 (D)
WQ36P	LM389	£1.49 (D)
QY19V	LM1035	£4.50 (C)
QY33L	LM1037N	£2.21 (C)
QY34M	LM1038N	£2.24 (C)
YY85G	LM1818	£1.95 (D)
YY99H	LM1830	£2.65 (C)
QY36P	LM1851N	£1.46 (D)
YY71N	LM1871	£5.60 (B)
YY72P	LM1872	£5.90 (B)
WQ38R	LM2917	£2.45 (C)
WQ37S	LM3900	£2.24 (C)
QH42V	LM3909	57p (E)
WQ39N	LM3909N	98p (E)
WQ40T	LM3911	£1.31 (D)
WQ41U	LM3914	£3.51 (C)
YY96E	LM3915	£3.24 (C)
YY97F	LM3916	£3.46 (C)
YH64U	LM13600N	£1.39 (D)
YY81C	M083	£4.75 (C)
WH22Y	MD87	£4.95 (C)
YY90X	M108	£18.25 (A)
YY91Y	M147	£6.51 (B)
HQ71N	M251	£12.20 (A)
WH21X	M254	£7.49 (B)
QH43W	MCR102	59p (E)

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QH45Y	MC1310P	£2.30 (C)
QH47B	MC1496	89p (E)
QH48C	MC3302P	80p (E)
QH49D	MC3340P	£1.35 (D)
WQ42V	MCM4027 250ns	£1.88 (D)
WQ43W	MC6800P	£5.10 (B)
WQ44X	MC6802P	£4.72 (C)
WQ45Y	MC6810AP 450ns	£1.86 (D)
WQ46A	MC6821P	£1.99 (D)
QQ03D	MC6845	£7.95 (A)
WQ48C	MC6850P	£2.99 (C)
WQ49D	MC6852P	£2.95 (C)
WQ50E	MC6875L	£6.32 (B)
QY23A	MC10116P	85p (E)
QY35Q	MF10CN	£4.96 (C)
QH54J	MJE340	75p (E)
WQ51F	MJE350	£1.15 (D)
QH55K	MJE2955=TIP2955	£1.20 (D)
QH56L	MJE3055=TIP3055	81p (E)
QH57M	MJ2501	£2.98 (C)
BL38R	MJ2955	£1.10 (D)
QH58N	MJ3001	£2.40 (C)
YY92A	MK50395	£10.50 (A)
YH67X	ML922	£5.25 (B)
QR57M	ML926	£2.45 (C)
QR58N	ML927	£2.45 (C)
YH68Y	ML928	£2.40 (C)
YH69A	ML929	£2.40 (C)
QH59P	MPF102	66p (E)
QH60Q	MPSA14	36p (F)
QH61R	MPSA65	45p (F)
QH62S	MPS3638	21p (G)
QH63T	MPS3638A	18p (G)
WQ53H	MVAM115	£2.10 (C)
WQ54J	NE531	£2.28 (D)
WQ55K	NE 544	£2.18 (C)
QH66W	NE 555	21p (G)
QH67X	NE 556	62p (E)
WQ56L	NE 565	£1.64 (D)
QH68Y	NE 566	£1.60 (D)
QH69A	NE 567	£1.30 (D)
QY10L	NE570	£4.29 (C)
YY87U	NE571	£3.36 (C)
YY68Y	NE5534A	£2.26 (C)
YY67X	NE5539	£7.85 (B)
QH70M	OA47	12p (G)
QH71N	OA90	9p (H)
QH72P	OA91	8p (H)
QH73Q	OA95	8p (H)
QH74R	OA200	8p (H)
QH75S	OA202	13p (G)
QH82D	OC45	47p (F)
QH84F	OC71	31p (F)
QH85G	OC72	42p (F)
QH87U	OC81	42p (F)
QH89W	OC83	45p (F)
QH91Y	OC170	95p (E)
QH92A	OC171	99p (E)
QY37S	Satronics PC1R	£3.62 (C)
QY38R	Satronics PC12R	£6.94 (B)
QH93B	PN3643	30p (F)
WQ57M	PW01	95p (E)
WQ58N	PW06	97p (E)
WQ59P	RO-3-2513	£8.95 (B)
QL00A	R2008B	£2.25 (C)
QL02C	SAM77	£1.20 (D)
QL05F	SC146D	£1.62 (D)
WQ60Q	SFF96364	£9.45 (B)
QL06G	SG1495D	£3.95 (C)
QL07H	SG3402	£3.98 (C)
WQ61R	SH120A	£6.65 (B)
YH66W	SL490	£3.35 (C)
QY18U	SP8680B	£12.40 (A)
QL08J	ST2	25p (F)
QL09K	S005	47p (F)
QL10L	S04	52p (E)
WQ62S	TAA 550	35p (F)
QL11M	TAG1/100	£1.45 (D)
QL12N	TAG1/600	£1.20 (D)
BL35Q	TBA 651	£2.25 (C)
QL13P	TBA810P	95p (E)
WQ63T	TBA820M	70p (E)
YY79L	TCA350Z	£3.95 (C)
WQ64U	TCA4500A	£3.35 (C)
WH20W	TDA1022	£6.75 (B)
YY76H	TDA1024	£1.49 (D)
QY32K	TDA 1102SP	£3.24 (C)
YY70M	TDA2005M	£8.25 (B)
WQ66W	TDA2006	£1.65 (D)
WQ67X	TDA2030	£1.95 (D)
YY86T	TDA341D	£1.90 (D)
QL15R	TIP31A	39p (F)
QL16S	TIP32A	39p (F)
WQ71N	TIP33A	68p (E)
WQ72P	TIP34A	99p (E)
QL17T	TIP41A	49p (F)

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QL18U	TIP42A	45p (F)
WQ73Q	TIP122	99p (E)
WQ74R	TIP127	75p (E)
QL19V	TIS43	55p (E)
WQ75S	TL170C	55p (E)
WQ76H	TLl72C	76p (E)
YY77J	TL430C	99p (E)
YY78K	TL497A	£1.65 (D)
YY88V	TMS1121	£7.65 (B)
QY14Q	UAA170L	£2.50 (C)
QL20W	uA709C	75p (E)
BL22Y	uA723C T099	85p (E)
QL21X	uA723C 14-pin DIL	55p (E)
QL22Y	uA741C 8-pin DIL	23p (G)
QL23A	uA741C 14-pin DIL	78p (E)
QL24B	uA747C	75p (E)
QL25C	uA748C	52p (E)
QL26D	uA78L05AWC	45p (F)
WQ77J	uA78L12AWC	45p (F)
QL27E	uA78L15AWC	45p (F)
QL28F	uA78M05UC	79p (E)
QL29G	uA78M12UC	79p (E)
QL30H	uA78M15UC	79p (E)
WQ78K	u78MGU1C	£1.25 (D)
QL31J	uA7805UC	78p (E)
QL32K	uA7812UC	78p (E)
QL33L	uA7815UC	78p (E)
WQ79L	uA78GU1C	£1.25 (D)
QL34M	uA7805KC	£1.65 (D)
QL35Q	uA7815KC	£1.65 (D)
WQ80B	uA78H05KC	£5.55 (B)
WQ81C	uA78H12KC	£6.49 (B)
WQ83E	uA78HGKC	£6.25 (B)
WQ84F	uA78P05SC	£8.25 (B)
WQ85G	uA79L05AWC	62p (E)
WQ86T	uA79L12AWC	68p (E)
WQ87U	uA79L15AWC	75p (E)
WQ88V	uA79M05UC	89p (E)
WQ89W	uA79M12UC	64p (E)
WQ90X	uA79M15UC	89p (E)
WQ91Y	uA79MGU1C	£1.20 (D)
WQ92A	uA7905UC	£1.38 (D)
WQ93B	uA7912UC	95p (E)
QL36P	uA7915UC	82p (E)
WQ94C	uA79GU1C	£1.25 (D)
WQ95D	uA79HGKC	£8.59 (B)
QQ27E	VK10KM	83p (E)
QQ28F	VK1010	£1.48 (D)
QQ29G	VK1011	£1.35 (D)
WQ96E	VN46AF	£1.10 (D)
WQ97F	VN66AF	£1.55 (D)
WQ98G	VN88AF	£1.62 (D)
QQ11M	VQ1000CJ	£4.30 (C)
QL37S	W005	28p (F)
QL38R	W01	34p (F)
QL39N	W02	38p (F)
QL40T	W04	39p (F)
QL41U	ZN414	£1.25 (D)
QL42V	ZS120	44p (F)
QL43W	ZTX107	22p (G)
QL44X	ZTX108	15p (G)
QL45Y	ZTX109	24p (G)
QL46A	ZTX300	16p (G)
QL47B	ZTX301	20p (G)
QL48C	ZTX302	22p (G)
QL50E	ZTX304	24p (F)
QL54J	ZTX326	98p (E)
QL56L	ZTX330	29p (F)
QL57M	ZTX331	28p (F)
QL60Q	ZTX500	21p (G)
QL62S	ZTX502	19p (G)
QL64U	ZTX504	34p (F)
QL66W	ZTX530	29p (F)
QL67X	ZTX531	33p (F)
QL68Y	ZTX541	31p (F)
QL69A	ZTX542	33p (F)
QL70M	Z5J	£2.84 (C)
QW00A	Z80-CPU	£7.95 (B)
QW01B	Z80-CTC	£4.50 (C)
QW03D	Z80-PIO	£3.99 (C)
QL71N	1N914	4p (H)
QL72P	1N916	5p (H)
QL73Q	1N4001	5p (H)
QL74R	1N4002	4p (H)
QL75S	1N4003	6p (H)
QL76H	1N4004	6p (H)
QL77J	1N4005	6p (H)
QL78K	1N4006	6p (H)
QL79L	1N4007	7p (H)
QL80B	1N4148	4p (H)
QL81C	1N5400	15p (G)
QL82D	1N5401	12p (G)
QL83E	1N5402	16p (G)
QL84F	1N5404	19p (G)
QL85G	1N5406	20p (G)
QL86T	1N5407	21p (G)
QL87U	1N5408	19p (G)
QL88V	1S921	9p (H)
QH46A	1458C	45p (F)
QR00A	2N697	49p (F)
QR01B	2N706	26p (F)
QR03D	2N708	35p (F)
QR09K	2N1711	39p (F)
QR10L	2N1893	32p (F)
QR11M	2N2219	31p (F)
QR12N	2N2369A	22p (G)
QR13P	2N2484	38p (F)
QR14Q	2N2646	62p (E)
QR15R	2N2647	95p (E)
QR16S	2N2904	31p (F)
QR17T	2N2905	31p (F)
QR18U	2N2906	26p (F)
QR19V	2N2907	26p (F)
QR20W	2N2926Or	12p (G)
QR21X	2N2926Ye	12p (G)
QR22Y	2N2926Gn	12p (G)
QR23A	2N3053	34p (F)
QR24B	2N3054	68p (E)
BL45Y	2N3055	75p (E)
QR25C	2N3525	£1.85 (D)
QR26D	2N3702	11p (G)
QR27E	2N3703	11p (G)
QR28F	2N3704	10p (G)
QR29G	2N3705	12p (G)
QR30H	2N3706	14p (G)
QR31J	2N3707	12p (G)
QR32K	2N3708	11p (G)
QR34M	2N3711	11p (G)
QW07H	2N3772	£1.95 (D)
QR35Q	2N3773	£2.70 (C)
QR36P	2N3819	32p (F)
QR37S	2N3823	65p (E)
QR38R	2N3866	£1.10 (D)
QR39N	2N3903	17p (G)
QR40T	2N3904	17p (G)
QR41U	2N3905	15p (G)
QR42V	2N3906	14p (G)
QR43W	2N4058	12p (G)
QR44X	2N4060	12p (G)
QR45Y	2N4061	17p (G)
QR46A	2N4062	12p (G)
QR47B	2N4871	69p (E)

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QR49D	2N5458	42p (F)
QR50E	2N5459	36p (F)
QR51F	2N6073	£1.20 (D)
QW08J	2N6609	£3.55 (C)
QR56L	2SA715	45p (F)
QQ30H	2SA872	39p (F)
QY12N	2SA1085E	34p (F)
QQ31J	2SB716	30p (F)
QR59P	2SC1162	45p (F)
QQ32K	2SC1307	£2.18 (C)
QY11M	2SC2547E	38p (F)
QQ33L	2SD756	30p (F)
QQ34M	2SJ48	£3.82 (C)
QQ35Q	2SJ49	£3.95 (C)
QW09K	2SJ50	£4.54 (C)
QQ36P	2SK133	£3.60 (C)
QQ37S	2SK134	£4.18 (C)
QW10L	2SK135	£4.30 (C)
QW11M	2102 450ns	£1.98 (D)
QW12N	2114 450ns	£1.30 (D)
QW13P	2708 450ns	£3.85 (C)
QQ07H	2716 450ns	£3.65 (C)
•QQ08J	2732 450ns	£5.19 (B)
QQ09K	2764 450ns	£10.48 (A)
QR52G	3N140	£1.62 (D)
QR53H	3N141	DIS
QH51F	3403	98p (E)
QX00A	4000BE	24p (F)
QX01B	4001BE	15p (G)
QL03D	4001UBE	17p (G)
QX02C	4002BE	15p (G)
QX03D	4006BE	50p (E)
QX04E	4007UBE	15p (G)
QW14Q	4008BE	42p (E)
QX05F	4011BE	15p (G)
QL04E	4011UBE	16p (F)
QX06G	4012BE	15p (G)
QX07H	4013BE	35p (F)
QW15R	4014BE	46p (E)
QW16S	4015BE	43p (E)
QX08J	4016BE	22p (F)
QX09K	4017BE	42p (F)
QX10L	4018BE	47p (F)
QW17T	4019BE	42p (F)
QX11M	4020BE	46p (E)
QW18U	4021BE	49p (F)
QW19V	4022BE	43p (E)
QX12N	4023BE	15p (G)
QX13P	4024BE	35p (F)
QX14Q	4025BE	15p (G)
QX15R	4026BE	80p (E)
QX16S	4027BE	21p (F)
QW19V	4022BE	43p (E)
QX12N	4023BE	15p (G)
QX13P	4024BE	35p (F)
QX14Q	4025BE	15p (G)
QX15R	4026BE	80p (E)
QX16S	4027BE	21p (F)
QX17T	4028BE	40p (E)
QW20W	4029BE	51p (E)
QW21X	4031BE	98p (D)
QW22Y	4032BE	75p (E)
QW23A	4033BE	68p (E)
QW24B	4034BE	£2.45 (C)
QW25C	4035BE	48p (E)
QW26D	4038BE	85p (E)
QW27E	4040BE	44p (E)
QW28F	4041UBE	44p (E)
QX19V	4042BE	41p (F)
QW29G	4043BE	52p (E)
QW30H	4044BE	43p (E)
QW31J	4045BE	99p (D)
QW32K	4046BE	49p (E)
QX20W	4047BE	75p (E)
QW33L	4048BE	30p (E)
QX21X	4049UBE	28p (F)
QX22Y	4050BE	26p (F)
QW34M	4051BE	45p (E)
QW35Q	4052BE	60p (E)
QW36P	4053BE	50p (E)
QW37S	4054BE	95p (E)
QW38R	4055BE	85p (E)
QW39N	4056BE	85p (D)
QW19V	4022BE	43p (E)
QX12N	4023BE	15p (G)
QX13P	4024BE	35p (F)
QX14Q	4025BE	15p (G)
QX15R	4026BE	80p (E)
QX16S	4027BE	21p (F)
QX17T	4028BE	40p (E)
QW20W	4029BE	51p (E)
QW21X	4031BE	98p (D)
QW22Y	4032BE	75p (E)
QW23A	4033BE	68p (E)
QW24B	4034BE	£2.45 (C)
QW25C	4035BE	48p (E)
QW26D	4038BE	85p (E)
QW27E	4040BE	44p (E)
QW28F	4041UBE	44p (E)
QX19V	4042BE	41p (F)
QW29G	4043BE	52p (E)
QW30H	4044BE	43p (E)
QW31J	4045BE	99p (D)
QW32K	4046BE	49p (E)
QX20W	4047BE	75p (E)
QW33L	4048BE	30p (E)
QX21X	4049UBE	28p (F)
QX22Y	4050BE	26p (F)
QW34M	4051BE	45p (E)
QW35Q	4052BE	60p (E)
QW36P	4053BE	50p (E)
QW37S	4054BE	95p (E)
QW38R	4055BE	85p (E)
QW39N	4056BE	85p (D)

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QW40T	4060BE	53p (D)
QW41U	4063BE	85p (D)
QX23A	4066BE	28p (F)
QW42V	4067BE	£1.95 (C)
QX24B	4068BE	16p (G)
QX25C	4069UBE	18p (F)
QX26D	4070BE	16p (G)
QW43W	4071BE	16p (G)
QX27E	4072BE	16p (G)
QW44X	4073BE	16p (G)
QW45Y	4075BE	16p (G)
QW46A	4076BE	52p (E)
QW47B	4077BE	16p (G)
QX28F	4078BE	16p (G)
QW48C	4081BE	15p (F)
QW49D	4082BE	16p (G)
QW50E	4085BE	65p (E)
QW51F	4086BE	65p (E)
QW52G	4089BE	£1.40 (D)
QW53H	4093BE	22p (F)
QW54J	4094BE	£1.20 (D)
QW55K	4095BE	75p (E)
QW56L	4097BE	£3.20 (C)
QX29G	4098BE	79p (E)

TRADE QUANTITIES

The letter in brackets after the price indicates the minimum quantity of that item you can buy and qualify for a trade price. See table at start of price list. If you buy less than the quantity shown then the price is that shown. If you want to buy the quantity shown or more of that item, then please contact us for a trade price. If no trade quantity is shown, then the price shown is the best price we can offer regardless of the quantity.
Trade quantities shown for wires or cables of any type is in metres, not reels or parts of metres. Trade quantities for nuts, bolts, washers, Hiatts etc. refers to the number of packs, i.e. to qualify for a trade price on Tag 2BA for example (trade quantity 500), you will need to order 500 packs which is equal to 5000 tags.

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QW57M	4099BE	79p (E)
QW58N	40100BE	£1.96 (D)
QW59P	40101BE	90p (E)
QW60Q	40102BE	£1.50 (D)
QW61R	40103BE	85p (E)
QW62S	40104BE	85p (E)
QW63T	40105BE	85p (E)
QW64U	40106BE	48p (E)
QW65V	40107BE	60p (E)
QW66W	40108BE	£4.30 (C)
QW67X	40109BE	95p (E)
QW68Y	40110BE	£1.10 (D)
QW69A	40160BE	£1.25 (D)
QW70M	40161BE	92p (E)
QW71N	40162BE	85p (E)
QW72P	40163BE	£1.60 (D)
QW73Q	40174BE	68p (E)
QQ38R	40175BE	75p (D)
QW74R	40181BE	£1.99 (D)
QW75S	40182BE	85p (E)
QW76H	40192BE	£1.25 (D)
QW77J	40193BE	68p (E)
QW78K	40194BE	85p (E)
QW79L	40257BE	£1.10 (D)
QX34M	40673	£1.75 (D)
QW93B	4116 250ns	£1.45 (D)
QQ05F	4118 250ns	£4.78 (C)
XX01B	4136	75p (E)
QW80B	4151	89p (E)
QQ06G	4164 250ns	£5.99 (B)
XX02C	4195	£1.45 (D)
QX30H	4416BE	£1.92 (D)
QW81C	4502BE	62p (E)
QX41U	4503BE	42p (E)
QW82D	4508BE	£2.10 (C)
QW83E	4510BE	68p (E)
QX31J	4511BE	52p (E)
QW84F	4512BE	£1.49 (D)
QW85G	4514BE	£1.20 (D)
QW86T	4515BE	£1.20 (D)
QW87U	4516BE	49p (F)
QX32K	4518BE	43p (E)
QX33L	4520BE	52p (E)
QQ42V	4521BE	£3.36 (C)
QQ43W	4522BE	88p (E)
QQ44X	4526BE	95p (E)
QW88V	4527BE	£1.15 (D)
QQ45Y	4529BE	£1.42 (D)
QW89W	4532BE	70p (D)
QW90X	4555BE	50p (E)
QW91Y	4556BE	58p (E)
QQ49Q	4568BE	£3.15 (C)
QQ51F	45100BE	£3.25 (C)
QX35Q	5W Zener 5V6	£1.27 (D)
QX36P	5W Zener 8V2	£1.27 (D)
YH31J	5101-L1	£3.48 (C)
QR55K	634SS2	£4.95 (C)
QQ04E	6402	£5.80 (B)
QQ02C	6502	£5.48 (B)
QW94C	7106	£7.90 (B)
QW95D	7107	£7.95 (B)
QX37S	7400	17p (G)
YF00A	74LS00	17p (G)
QX38R	7401	17p (G)
YF01B	74LS01	17p (G)
QX39N	7402	17p (G)
YF02C	74LS02	21p (G)
QX74R	7403	20p (G)
YF03D	74LS03	17p (G)
QY24B	74S03	68p (E)
QX40T	7404	21p (G)
YF04E	74LS04	20p (G)
QX41U	7405	21p (G)
YF05F	74LS05	20p (G)
QX75S	7406	29p (F)
QX76H	7407	29p (F)
QX42V	7408	21p (G)
YF06G	74LS08	22p (G)
QX77J	7409	22p (G)
YF07H	74LS09	22p (G)
QX43W	7410	17p (G)
YF08J	74LS10	29p (G)
QX44X	7411	24p (F)
YF09K	74LS11	20p (G)
YF10L	74LS12	17p (G)
QX45Y	7413	28p (F)
YF11M	74LS13	31p (F)
QX46A	7414	42p (F)
YF12N	74LS14	44p (F)
YF13P	74LS15	17p (G)
QX78K	7416	31p (F)
QX79L	7417	30p (F)
QX47B	7420	23p (G)
YF14Q	74LS20	21p (G)
QX48C	7421	40p (F)
YF15R	74LS21	20p (G)
YF16S	74LS22	17p (G)
QX80B	7425	28p (F)
QX81C	7426	22p (G)
YF17T	74LS26	22p (G)
QX49D	7427	29p (F)
YF18U	74LS27	29p (F)
YF19V	74LS28	44p (F)
QX50E	7430	17p (G)
YF20W	74LS30	21p (G)
QX51F	7432	36p (F)
YF21X	74LS32	21p (G)
YF22Y	74LS33	40p (F)
YF23A	74LS37	21p (G)
QX82D	7438	32p (F)
YF24B	74LS38	22p (G)
QX53H	7440	24p (F)
YF25C	74LS40	40p (F)
QX54J	7442	48p (F)
YF26D	74LS42	42p (F)
QX55K	7447A	55p (F)
QQ52G	74LS47	65p (E)
QQ53H	74LS48	68p (E)
QX83E	7451	22p (G)
YF27F	74LS51	17p (G)
YF28F	74LS54	30p (F)
QX56L	7470	36p (F)
QX57M	7472	35p (F)
QX58N	7473	32p (F)
YF30H	74LS73	28p (F)
QX59P	7474	32p (F)
YY83E	74ALS74	90p (E)
YF31J	74LS74	26p (F)
QX60Q	7475	45p (F)
YF32K	74LS75	31p (F)
QX61R	7476	32p (F)
YF33L	74LS76	28p (F)
QX62S	7481	£1.75 (D)
QX85G	7483	50p (E)
QX63T	7485	77p (E)
YF35Q	74LS85	70p (E)
QX64U	7486	28p (F)
YF36P	74LS86	28p (F)
QX65V	7489	£3.10 (C)
QX66W	7490	32p (F)
YF38R	74LS90	36p (F)

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QX86T	7491	£1.20 (D)
QX67X	7492	32p (F)
YF39N	74LS92	36p (F)
QX68Y	7493	35p (F)
YF40T	74LS93	36p (F)
QX69A	7494	39p (F)
QX70M	7495	48p (F)
YF41U	74LS95	£1.20 (E)
QX87U	7496	50p (E)
QX71N	74107	26p (F)
YF43W	74LS107	41p (F)
QX88V	74109	53p (E)
YF44X	74LS109	34p (F)
YF45Y	74LS112	64p (E)
YF46A	74LS113	40p (F)
QX72P	74118	£2.30 (C)
QX73Q	74121	33p (F)
WH00A	74122	48p (E)
QQ54J	74LS122	62p (E)
WH01B	74123	42p (F)
YF48C	74LS123	62p (E)
YF49D	74LS125	33p (F)
YF50E	74LS126	33p (F)
WH03D	74132	55p (E)
YF51F	74LS132	45p (F)
YF52G	74LS136	32p (F)
YF53H	74LS138	38p (F)
YF54J	74LS139	44p (F)
WH05E	74141	78p (E)
WH06G	74145	67p (E)
YF55K	74LS145	£1.65 (D)
QX89W	74150	80p (E)
WH07H	74151	65p (E)
YF56L	74LS151	43p (F)
YF57M	74LS153	49p (F)
WH08J	74154	78p (E)
YF58N	74LS154	98p (E)
YF59P	74LS155	37p (F)
YF60Q	74LS156	57p (E)
YF61R	74LS157	35p (F)
YF62S	74LS158	49½p (E)
WH09K	74160	67p (E)
YF63T	74LS160	49p (F)
YF64U	74LS161	49p (F)
YF65V	74LS162	53p (E)
YF66W	74LS163	49p (F)
WH10L	74164	66p (E)
YF67X	74LS164	55p (E)
YF68Y	74LS165	£1.40 (D)
YF69A	74LS166	£1.95 (D)
YF70M	74LS168	£1.20 (D)
YF71N	74LS169	99p (E)
YF72P	74LS170	£2.99 (C)
YF73Q	74LS173	65p (E)
WH11M	74174	81p (E)
YF74R	74LS174	62p (E)
YF75S	74LS175	58p (E)
YF76H	74LS181	£2.95 (C)
YF78K	74LS190	58p (E)
YF79L	74LS191	68p (E)
WH12N	74192	70p (E)
YF80B	74LS192	56p (E)
QX90X	74193	66p (E)
YF81C	74LS193	65p (E)
WH13P	74194	55p (E)
YF82D	74LS194	85p (E)
YF83E	74LS195	45p (F)
WH14Q	74196	48p (F)
YF84F	74LS196	61p (E)
YF85G	74LS197	88p (E)
YF86T	74LS221	63p (E)
YF87U	74LS240	99p (E)
YF88V	74LS241	99p (E)
YF89W	74LS242	99p (E)
YF90X	74LS243	89p (E)
QQ56L	74LS244	87p (E)
YF91Y	74LS245	£2.23 (C)
YF92A	74LS251	53p (E)
YF93B	74LS253	98p (E)
YF95D	74LS257	52p (E)
YF96E	74LS258	55p (E)
YF97F	74LS259	89p (E)
YF98G	74LS261	£2.25 (C)
YF99H	74LS266	32p (F)
YH00A	74LS273	£1.32 (D)
YH01B	74LS279	44p (F)
YH02C	74LS283	69p (E)
YH03D	74LS290	£1.30 (D)
QY39N	74LS292	£11.20 (A)
YH04E	74LS293	96p (E)
QY40T	74LS297	£11.20 (A)
YH06G	74LS298	£1.75 (D)
YH07H	74LS299	£4.25 (C)
YH08J	74LS323	£6.75 (B)
YH09K	74LS363	£2.36 (C)
YH11M	74LS365	39p (F)
YH12N	74LS366	45p (F)
YH13P	74LS367	62p (E)
YH14Q	74LS368	43p (F)
YH15R	74LS373	£1.15 (D)
YH16S	74LS374	£1.30 (D)
YH18U	74LS377	£1.82 (D)
YH19V	74LS378	£1.40 (D)
YH20W	74LS379	£2.40 (C)
YH21X	74LS390	£1.45 (D)
YH22Y	74LS393	£1.40 (D)
YH23A	74LS395	£1.35 (D)
YH24B	74LS398	£1.99 (D)
YH25C	74LS399	£2.50 (C)
QQ59P	74LS600	NYA
QY41U	74LS601	£11.72 (A)
QY42V	74LS604	£4.56 (C)
QQ61R	74LS608	NYA
QQ62S	74LS610	NYA
WH02C	74LS629=74LS124	£1.94 (D)
YH29G	74LS670	£3.96 (C)
QQ63T	74LS684	£4.75 (C)
YH30H	74C917	£8.85 (B)
QY08J	74C925	£5.95 (B)
YH32K	76477	£5.20 (B)
YH33L	76489	£5.64 (B)
YH34M	8T28	£3.30 (C)
YH35Q	8T95	£2.55 (C)
YH38R	8038 CCPD	£4.69 (C)
YH39N	8069 DCQ	£2.95 (C)
YH40T	8080A	£4.95 (C)
YH41U	8085A	£5.99 (B)
YH43W	8211 CPA	£3.25 (C)
YH44X	8212	£1.95 (D)
YH45Y	8216	£1.95 (D)
YH46A	8224	£2.68 (C)
YH47B	8228	£4.94 (C)
YH48C	8250	£9.95 (B)
YH49D	8251	£4.60 (C)
YH50E	8255A	£4.40 (C)
YH51F	8279	£6.46 (B)
YH52G	82S126M1	£2.51 (C)

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QH36P	LM301A	27p (F)
QH37S	LM308	72p (E)
WQ54J	NE531	£2.28 (D)

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YY68Y	NE5534A	£2.26 (C)
YY67X	NE5539	£7.85 (B)
QL20W	uA709C	75p (E)
QL22Y	uA741C 8-pin DIL	23p (G)
QL24B	uA747C	75p (E)
QL25C	uA748C	52p (E)
QH46A	1458C	45p (F)
QH51F	3403	98p (E)
XX01B	4136	75p (E)

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QH28F	CA3130T	£1.10 (D)
QH29G	CA3140T	99p (E)
WQ21X	CA3240E	£1.38 (D)
QH35Q	LH0042C	£4.46 (C)
WQ30H	LF351	56p (E)
WQ31J	LF353	99p (E)
WQ29G	LF347	£1.94 (C)
QY26D	LF400CN	NYA
QY27E	LF411CN	82p (E)
QY28F	LF412CN	£1.38 (D)
QY29G	LF441CN	72p (E)
QY30H	LF442CN	£1.38 (D)
QY31J	LF444CN	£1.96 (D)
YY69A	LF13741	55p (E)

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YH58N	CA3080E	87p (E)
YH64U	LM13600N	£1.39 (D)
QY09K	LM311N	62p (E)
QH48C	MC3302P	80p (E)

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WQ36P	LM389	£1.49 (D)
QH38R	LM377	£2.25 (C)

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QH40T	LM380	75p (E)
WQ34M	LM384	£1.98 (D)
QL13P	TBA810P	95p (E)
BR02C	5W Amp PCB	£1.62 (D)

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WQ33L	LM383	£1.61 (D)
BY73Q	8W Amp PCB	62p (E)
LW36P	8W Amp Kit	£4.45 (C)
YY70M	TDA2005M	£8.25 (B)
WQ66W	TDA2006	£1.65 (D)

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WQ67X	TDA2030	£1.95 (D)
YQ43W	15W Amp Kit	£6.45 (B)
YQ35Q	15W Amp PCB	£1.25 (D)
YQ36P	15W Amp Bracket	65p (E)
YQ38R	30/2 PSU PCB	£1.40 (D)
YQ37S	15W Amp Module	£6.49 (B)

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QY32K	TDA 1102SP	£3.24 (C)
QH41U	LM381	£1.98 (D)
BR04E	LM381 PCB	£2.15 (C)

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YY84F	LM382	£1.45 (D)
QY10L	NE570	£4.28 (C)
YY87U	NE571	£3.36 (C)
YY86T	TDA3410	£1.90 (D)
WQ35Q	LM387	£1.25 (D)

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QY19V	LM1035	£4.50 (C)
QY33L	LM1037N	£2.21 (C)
QY34M	LM1038N	£2.24 (C)

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QH49D	MC3340P	£1.35 (D)
YY85G	LM1818	£1.95 (D)
QY35Q	MF10CN	£4.96 (C)
YY81C	M083	£4.75 (C)
WH22Y	M087	£4.95 (C)

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QB21X	AY 1 0212	£8.20 (B)
HQ53H	Piano IC Kit	£38.44 (A)
HQ52G	AY-1-1320	£4.99 (C)
HQ51F	AY-1-5050	£1.99 (D)
HQ71N	M251	£12.20 (A)
WH21X	M254	£7.49 (B)
YY90X	M108	£18.25 (A)

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YY91Y	M147	£6.51 (B)
YY89W	AY-3 1350	£5.95 (B)
WH20W	TDA1022	£6.75 (B)
YH33L	76489	£5.64 (B)

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YY79L	TCA350Z	£3.95 (C)
YH32K	76477	£5.20 (B)
YQ42V	Sound Effects PCB	£1.10 (D)

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WQ61R	SH120A	£6.65 (B)
QH27E	CA3089E	£2.70 (C)
WQ20W	CA3189E	£1.95 (D)

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WQ37S	LM1820	£2.24 (D)
BL35Q	TBA 651	£2.25 (C)
WQ64U	TCA4500A	£3.35 (C)
QH45Y	MC1310P	£2.30 (C)
BR03D	Decoder PCB	£1.84 (D)

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QL41U	ZN414	£1.25 (D)
QY23A	MC10116P	85p (E)

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QH47B	MC1496	89p (E)
QL06G	SG1495D	£3.95 (C)
QL07H	S73402	£3.98 (C)
QH26D	CA3046	72p (E)
QQ11M	VQ1000CJ	£4.30 (C)
YH66W	SL490	£3.35 (C)

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YH67X	ML922	£5.25 (B)
QR57M	ML926	£2.45 (C)
QR58N	ML927	£2.45 (C)

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YH68Y	ML928	£2.40 (C)
YH69A	ML929	£2.40 (C)
YG37S	CL8960	£31.26 (A)
YY71N	LM1871	£5.60 (B)
YQ69A	LM1871 Xmitter PCB	98p (E)
BX11M	HV Disc 680	9p (H)

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YY72P	LM1872	£5.90 (B)
YQ70M	LM1872 Receiver PCB	95p (E)
WQ55K	NE 544	£2.18 (C)
YQ71N	Servo Driver PCB	85p (E)
WQ76H	TL172C	76p (E)

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WQ75S	TL170C	55p (E)
QR55K	634SS2	£4.95 (C)
YY99H	LM1830	£2.65 (C)
YY73Q	LM335Z	£1.42 (D)
WQ40T	LM3911	£1.31 (D)

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YY98G	AY-3-1270	£8.30 (B)
WQ41U	LM3914	£3.51 (C)
YY96E	LM3915	£3.24 (C)
YY97F	LM3916	£3.46 (C)
YQ66W	LM3914 PCB	85p (E)

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QY14Q	UAA170L	£2.50 (C)
YH30H	74C917	£8.85 (B)
FY90X	Crystal 6.5536MHz	£2.98 (C)
YY93B	ICM7045IPI	£14.20 (A)

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YY88V	TMS1121	£7.65 (B)
QY08J	74C925	£5.95 (B)
YY92A	MK50395	£10.50 (A)

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YY94C	ICM7216DIPI	£17.45 (A)
QY18U	SP8680B	£12.40 (A)
YY95D	ICM7226BIPI	£21.90 (A)
QH67X	NE 556	62p (E)
QH66W	NE 555	21p (G)

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YH63T	ICM 7555	£1.32 (D)
QH68Y	NE 566	£1.60 (D)
WQ56L	NE 565	£1.64 (D)

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QH69A	NE 567	£1.30 (D)
WQ39N	LM3909	98p (E)
YY76H	TDA1024	£1.49 (D)
QY36P	LM1851N	£1.46 (D)
YH43W	8211 CPA	£3.25 (C)
YH39N	8069 DCQ	£2.35 (C)

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WQ32K	LM334	£1.10 (D)
YY78K	TL497A	£1.65 (D)
YY77J	TL430C	99p (E)
WQ62S	TAA 550	35p (F)
YY75S	ICL7660CPA	£3.24 (C)
XX02C	4195	£1.45 (D)

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XX04E	15V Supply PCB	75p (E)
YY74R	L200	£2.69 (C)
BL22Y	uA723C TD99	85p (E)
QL21X	uA723C 14-pin DIL	55p (E)

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YQ39N	0 1A Reg PSU PCB	£1.24 (D)
YQ40T	0 5/1A Reg +V PS PCB	85p (E)
YQ41U	0 5/1A Reg -V PS PCB	85p (E)
YQ54J	0.5/1A Vareg Pos PCB	85p (E)
YQ55K	0 5/1A Vareg Neg PCB	85p (E)

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QY37S	Satronics PC1R	£3.62 (C)
QY38R	Satronics PC12R	£6.94 (B)

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QQ02C	6502	£5.48 (B)
WQ43W	MC6800P	£5.10 (B)
WQ44X	MC6802P	£4.72 (C)
WQ46A	MC6821P	£1.99 (D)
WQ48C	MC6850P	£2.99 (C)
WQ49D	MC6852P	£2.95 (C)
WQ50E	MC6875L	£6.32 (B)
QW00A	Z80-CPU	£7.95 (B)
QW03D	Z80-PID	£3.99 (C)
QW01B	Z80 CTC	£4.50 (C)
YH40T	8080A	£4.95 (C)
YH41U	8085A	£5.99 (B)

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YH46A	8224	£2.68 (C)
YH47B	8228	£4.94 (C)
YH50E	8255A	£4.40 (C)
YH49D	8251	£4.60 (C)
YH48C	8250	£9.95 (B)
YH51F	8279	£6.46 (B)
YH44X	8212	£1.95 (D)
YH45Y	8216	£1.95 (D)
YH34M	8T28	£3.30 (C)
YH35Q	8T95	£2.55 (C)
WQ19V	AY 5-2376	£9.95 (B)
WQ18U	AY-3-1015D	£5.98 (B)
QQ04E	6402	£5.80 (B)

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WQ60Q	SFF96364	£9.45 (B)
QQ03D	MC6845	£7.95 (A)
YH31J	5101-L1	£3.48 (C)
QW11M	2102 450ns	£1.98 (D)
WQ45Y	MC6810AP 450ns	£1.86 (D)
QW12N	2114 450ns	£1.30 (D)
QQ05F	4118 250ns	£4.78 (C)
WQ42V	MCM4027 250ns	£1.88 (D)
QW93B	4116 250ns	£1.45 (D)

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QQ06G	4164 250ns	£5.99 (B)
QW13P	2708 450ns	£3.85 (C)
QQ07H	2716 450ns	£3.65 (C)
*QQ08J	2732 450ns	£5.19 (B)
QQ09K	2764 450ns	£10.48 (A)

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XY84F	Softy 2 System	£169.00 (A)
XY83E	EPROM Eraser	£42.95 (A)
YH52G	82S126M1	£2.51 (C)
WQ59P	RO-3-2513	£8.95 (B)
YH38R	8038 CCPD	£4.69 (C)

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YQ65V	8038 PCB	85p (E)
QW80B	4151	89p (E)
QQ01B	DAC0801LCN	£2.45 (C)

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QQ00A	ADC0804LCN	£4.45 (C)
YH59P	ICL7109	£19.33 (A)
WQ38R	LM2917	£2.45 (C)
YQ67X	LM2917 PCB	85p (E)
QW94C	7106	£7.90 (B)
QW95D	7107	£7.95 (B)

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BY76H	7106/7 PCB	£1.45 (D)
WR29G	Transkt 3-Lead TO18	16p (G)
WR30H	Transkt 4-Lead TO18	35p (F)
WR31J	Transkt 3-Lead TO5	19p (G)
WR32K	IC Skt 8-Lead	55p (E)
WR33L	IC Skt 10-Lead	67p (E)
QY44X	Insulator TO3	18p (G)
QY45Y	Insulator P	14p (G)
WR24B	Kit TO3	8p (H)
WR25C	Kit TO66	9p (H)
WR27E	Kit SO55	9p (H)
WR26D	Kit TO126	5p (H)
WR23A	Kit (P) Plas	6p (H)
XX14Q	Soldercons	90p

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BL17T	DIL Socket 8-pin	9p (H)
BL18U	DIL Socket 14-Pin	11p (G)
BL19V	DIL Socket 16-pin	12p (G)
HQ76H	DIL Socket 18-pin	16p (G)
HQ77J	DIL Socket 20-pin	17p (G)
HQ78K	DIL Socket 22-pin	20p (G)
BL20W	DIL Socket 24-pin	19p (G)
BL21X	DIL Socket 28-pin	24p (F)
HQ38R	DIL Socket 40-pin	31p (F)
FR25C	Insertion Tool	80p (E)
YG27E	Header 14-pin	54p (E)
YG28F	Header 16-pin	63p (E)
YG29G	Header 24-pin	£1.10 (D)
YX50E	ZIF Socket 24-Way	£3.40 (C)
FL56L	Transistor Cover	10p (G)
HQ79L	Heatsink 92F	14p (G)
HQ80B	Heatsink 18F	24p (F)
FL78K	Heatsink Clip-On	16p (G)
WR34M	TO5 Chassis Heatsink	89p (E)

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FL59P	Vaned Heatsink TO3	46p (F)
FL58N	Vaned Htsnk Plas Pwr	34p (F)
FL57M	Vaned Heatsink IC	72p (E)
HQ70M	Heatsink 2E	£2.55 (C)
FL41U	Heatsink 4Y	£1.96 (D)
HQ69A	50W Hi-Fi Heatsink	£1.95 (D)
HQ81C	8W Hi-Fi Heatsink	£1.17 (D)
FL42V	Flat Heatsink	£3.71 (C)
FL54J	Heatsink 100N	£2.15 (C)
FL55K	Heatsink 100NDR	£2.60 (C)
FL77J	Heatsink 6W-1	£5.78 (B)

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YB26D	Heatsink 600N	£13.95 (A)
FL79L	Thermpath	£3.60 (C)
HQ00A	Silicone Grease Tube	84p (E)
WY08J	Standard Fan	£15.50 (A)

SPEAKERS

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HY12N	Ultrasonic Transducr	£6.20 (B)
QY13P	Piezo Transducer27mm	30p (F)
QY16S	Rubber Disc 27mm	5p (H)
FL39N	Buzzer 6V	88p (E)
FL40T	Buzzer 12V	88p (E)
FL38R	AC Bell	£1.90 (D)
FL37S	Bell Xformer	£4.95 (C)
FQ08J	Bell Push	£1.10 (D)
FQ09K	Nameplate Bell Push	55p (E)

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YB25C	Baby Siren	£9.25 (B)
LH96E	Plastic Siren	£5.50 (B)
LH98G	Hawaii Five-O Siren	£24.95 (A)
XG14Q	Electronic Siren	£19.95 (A)
XQ71N	Re-entrant Horn Sndr	£26.50 (A)
YW52G	2in Piezo Tweeter	£2.49 (C)

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WF54J	Direct Radiant Piezo	£3.95 (C)
WF09K	Piezo Horn Flush	£5.96 (B)
WF55K	Piezo Horn Recessed	£5.99 (B)
WF56L	Wide Angle Piezo	£7.90 (B)
LB23A	Mag Earpiece 2.5mm	25p (F)
LB24B	Mag Earpiece 3.5mm	25p (F)
LB25C	Crystal Earpiece	55p (E)
YW57M	Stethoscope	75p (E)
*WF20W	Mag Headset	£4.85 (C)
LH81C	Education Headphone	£5.75 (B)
LH82D	Boom Mic Headphone	£12.35 (A)
LH83E	Stereophone DH150P	£4.25 (C)

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WF13P	Stereophone HP110C	£5.40 (B)
WF14Q	Stereophone DH207	£7.99 (B)
LH84F	Stereophone M110B	£8.60 (B)
LH85G	Stophone SH590/HS310	£12.64 (A)
YK56L	Persnl Stereo Phones	£4.95 (C)
LB13P	Headphone Adaptor	£3.95 (C)
WB04E	L/S Lo-Z 388	85p (E)
WB05F	L/S Lo-Z 458	89p (E)
WB08J	L/S Lo-Z 508	89p (E)
WB09K	L/S Lo-Z 568	89p (E)
WB13P	L/S Lo-Z 668	89p (E)
WF57M	Hi-Z L/S 64R	99p (E)
YW53H	L/S Lo-Z 768	99p (E)
WF58N	3 inch Tweeter	£1.45 (D)
YW54J	15W Cone Tweeter	£2.85 (C)

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WF24B	Multi-Cell Tweeter	£5.95 (B)
WF33L	Free Stand Tweeter	£5.95 (B)
WF43W	Dome Tweeter	£5.45 (B)
WF44X	Rectangular Tweeter	£5.45 (B)
WF02C	Crossover 2-Way	£4.20 (C)
WF03D	Crossover 3-Way	£5.20 (B)
WF46A	Controlled Crossover	£10.69 (A)
WF47B	Low-Cost 4in Spkr	£2.94 (C)
BK30H	Spkr Fixing Clamp	25p (F)
YW55K	Plastic Car Grille	90p (E)

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WF48C	Hvy Duty Car Spkr	£6.45 (B)
WF50E	Elliptcal Spkr CM641	£3.35 (C)
WF18U	Elliptcal Spkr CM742	£4.45 (C)
WF23A	Elliptcal Spkr CM852	£5.20 (B)
WY13P	Elliptcal Spkr LT853	£6.45 (B)
WF00A	Rd Speaker LT530	£6.99 (B)
WF52G	Rd Speaker LT610	£5.75 (B)
WF08J	Rd Speaker CM820	£5.95 (B)
WF11M	Rd Speaker LT830	£7.30 (B)
WF12N	Rd Speaker LT840	£11.45 (A)

TRADE QUANTITIES

The letter in brackets after the price indicates the minimum quantity of that item you can buy and qualify for a trade price. See table at start of price list. If you buy less than the quantity shown then the price is that shown. If you want to buy the quantity shown or more of that item, then please contact us for a trade price. If no trade quantity is shown, then the price shown is the best price we can offer regardless of the quantity.

Trade quantities shown for wires or cables of any type is in metres, not reels or parts of metres. Trade quantities for nuts, bolts, washers, Hiatts etc. refers to the number of packs, i.e. to qualify for a trade price on Tag 2BA for example (trade quantity 500), you will need to order 500 packs which is equal to 5000 tags.

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WF53H	20W Squawker	£3.25 (C)
WY15R	40W Squawker	£5.25 (B)
XG02C	Loudspeaker 12in 35W	£19.75 (A)
XQ77J	Fane 50 4R	£19.95 (A)
XB26D	Fane 50 8R	£21.45 (A)

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XQ78K	Disco 80 4R	£29.45 (A)
XB27E	Disco 80 8R	£29.45 (A)
XQ79L	Forte 1250TC 8R	£21.75 (A)
XQ80B	Forte 1250TC 16R	£21.75 (A)
XQ81C	Forte C1285TC 8R	£28.45 (A)
XQ82D	Forte C1285TC 16R	£28.45 (A)
XQ83E	C15 Bass 8R	£57.80 (A)
XQ84F	C15 Bass 16R	£57.80 (A)
XB28F	Power L/S Cabinet	£49.00 (A)

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AF33L	Mini Speaker System	£45.50 (A)
AF34M	SW Spkr in Cab	£9.95 (B)
AF35Q	15W Spkr Pair	£33.50 (A)
AF31J	20W Spkr Pair	£63.00 (A)
AF32K	PA Spkr in Cab	£21.99 (A)
XY79L	Ceiling Speaker	£11.75 (A)
YL15R	Bracket Minor 5	£6.50 (B)
YL16S	Bracket Bek 100	£14.95 (A)
YK54J	Wallclamps Duo 220	£15.95 (A)

SWITCHES RELAYS

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FH97F	SPST Ultra Min Tggle	66p (E)
FH98G	SPDT Ultra Min Tggle	69p (E)
FH99H	DPDT Ultra Min Tggle	75p (E)
FH00A	Sub-Min Toggle A	70p (E)
FF70M	Sub-Min Toggle J	80p (E)
FH01B	Sub-Min Toggle B	89p (E)
FH03D	Sub-Min Toggle D	£1.06 (D)
FH04E	Sub-Min Toggle E	99p (E)
FF71N	Sub-Min Toggle K	£2.35 (C)
FH05F	Sub-Min Toggle F	£1.29 (D)
FH07H	Sub-Min Toggle H	£1.25 (D)
FF72P	Sub-Min Toggle L	£2.15 (C)
FH08J	4-Pole SM Toggle	£2.35 (C)
FH39N	Toggle Sw	60p (E)
YL01B	Toggle Switch Cover	47p (F)
FH10L	Std Toggle SPST	50p (E)
FH11M	Std Toggle SPDT	57p (E)
FH12N	Std Toggle DPDT	77p (E)
BK32K	10A SPST Toggle	95p (E)
BK33L	10A SPDT Toggle	£1.15 (D)
FH17T	H/D Toggle Type 4	£4.25 (C)
FH18U	H/D Toggle Type 7	£1.95 (D)
FH19V	H/D Toggle Type 8	£4.40 (C)
FH20W	H/D Toggle Type 9	£3.20 (C)

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FH13P	Duck Bill Toggle	55p (E)
YX56L	Chrome Bar Toggle	85p (E)
YX64U	Min Rocker SPST	69p (E)
YX65V	Min Rocker DPDT	£1.15 (D)
FH30H	SPST Rocker	39p (F)
FH31J	SPDT Rocker	49p (F)
YR68Y	Rocker Neon	63p (E)
YR69A	Rocker Sw DP	69p (E)
FH34M	DPDT Rocker	98p (E)
YR70M	Dual Rocker Neon	98p (D)
BH58N	Co-ax Switch SO239	£6.99 (B)
BH59P	Co-ax Switch PL259	£6.99 (B)
XX26D	DIL Switch SPST Dual	£1.20 (D)
XX27E	DIL Switch SPST Octl	£1.50 (D)
XX28F	DIL Switch SPDT Sgl	95p (E)
XX29G	DIL Switch SPDT Quad	£2.95 (C)
FF73Q	Rotary SW12B	74p (E)
FF74R	Rotary SW6B	70p (E)
FF75S	Rotary SW4B	79p (E)
FF76H	Rotary SW3B	79p (E)
FH42V	Rotary SW12	70p (E)
FH43W	Rotary SW6	75p (E)
FH44X	Rotary SW4	75p (E)
FH45Y	Rotary SW3	75p (E)
XX45Y	Switchpot 1p 12w	85p (E)

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FF83E	Thumbwheel Decimal	£3.32 (C)
FF84F	Thumbwheel BCD	£3.32 (C)
BK49D	End Cheeks	78p (F)
BK50E	Dial Stops	35p (F)
YR77J	Push Wheel BCD	£5.45 (B)
YR79L	Push Whl End Cheeks	99p (E)
FH40T	Key Switch	£3.60 (C)
FH57M	Rotary Mains	75p (E)
FH95D	Roller Microswitch	£1.15 (D)
FH46A	Maka Shaft	£1.10 (D)

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FH47B	Maka Wafer 1p 12w	£1.06 (D)
FH48C	Maka Wafer 2p 6w	£1.06 (D)
FF81C	Maka Wafer 2p 9w	£1.25 (D)
FH50E	Maka Wafer 4p 3w	£1.10 (D)
FH51F	Maka Wafer 6p 2w	£1.17 (D)
FH52G	Maka Wafer 1p 12w MB	75p (E)
FH53H	Maka Wafer 2p 6w MB	£1.05 (D)
FF82D	Maka Wafer 2p 9w MB	29p (F)
FH55K	Maka Screen	5p (H)
FF87U	Click Switch	30p (F)
FF88V	Click Cap Black	18p (G)
FF89W	Click Cap Blue	18p (G)
FF90X	Click Cap Green	18p (G)
FF91Y	Click Cap Grey	18p (G)
FF92A	Click Cap Ivory	18p (G)
FF93B	Click Cap Red	18p (G)
FF94C	Click Cap White	18p (G)
FF95D	Click Cap Yellow	18p (G)
HY34M	Click Key Black	24p (F)
FF61R	Keyboard Switch	23p (G)
FF62S	Keytop 1 Position	18p (G)
FF63T	Keytop 2 Position	29p (F)
FF64U	Keytop 3 Position	56p (E)
FF65V	ASCII Transparency	£1.35 (D)
YR71N	Switch Contact Sheet	£1.49 (D)

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FF77J	SP Slide	12p (G)
FH35Q	Sub-Min Slide	15p (G)
FF79L	Long Chrome Slide	22p (G)
FH36P	Std Slide Switch	15p (G)
FH38R	4-Pole Slide	69p (E)
FH59P	Push Switch	17p (G)
YR67X	HQ Push Switch	39p (F)
FH60Q	Break Push	23p (G)
FH91Y	Motor Start Press	43p (F)
RK82D	Lge Red Push Button	69p (E)
FF96E	Square Push Black	77p (E)
FF97F	Square Push Green	77p (E)
FF98G	Square Push Red	77p (E)
FF99H	Square Push Yellow	77p (E)
YW41U	Square Psh Lck Black	75p (E)

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YW43W	Square Psh Lck Red	75p (E)
YW14X	Square Psh Lck Yllow	75p (E)

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FH41U	Pushlock SPCO	£1.20 (D)
FH66W	Pushlock DPCO	£1.45 (D)
FH94C	Pressil Switch	28p (F)
FH92A	Press Toe Sw Type 1	£1.20 (D)
BK31J	Press Toe SPST 2	£1.39 (D)
FH93B	Press Toe Sw Type 2	£1.95 (D)
LB64U	Foot Switch	£4.25 (C)
FH37S	Mains Push	£1.10 (D)
LB91Y	Flasher Unit 2-Way	£5.75 (B)
LQ00A	Beginners Morse Key	£1.90 (D)
LQ01B	Professl Morse Key	£5.40 (B)
HY00A	Touch Pads Rect	22p (G)
HY01B	Touch Pads Tri	27p (F)
YR88V	Solenoid 12V	£5.36 (C)
YR89W	Solenoid 240V AC	£4.85 (C)

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FH67X	Latchswitch 2-pole	46p (F)
FH68Y	Latchswitch 4-pole	59p (E)
FH69A	Latchswitch 6-pole	99p (E)
FH70M	Latchswitch 8-pole	£1.45 (D)
FH71N	Latchswitch 10-pole	£1.25 (D)
BW11M	Latchsoft 2-pole	60p (E)
BW12N	Latchsoft 4-pole	£1.20 (D)
FH72P	Latchdummy	32p (F)
FH74R	Mains Latchswitch	£1.59 (D)
FH75S	Latchbracket Single	16p (G)
FH76H	Latchbracket 2-way	38p (F)
FH78K	Latchbracket 4-way	45p (F)
FH80B	Latchbracket 6-way	64p (E)
FH82D	Latchbracket 8-way	64p (E)
FH84F	Latchbracket 10-way	69p (E)

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FL31J	Rd Latchbutton Black	14p (G)
FL32K	Rd Latchbutton Green	14p (G)
FL33L	Rd Latchbutton Grey	14p (G)
FL34M	Rd Latchbutton Red	14p (G)
FL36P	Rd Latchbutton Chrm	22p (G)
BW13P	Sm Latchbutton Black	11p (G)
BW14Q	Sm Latchbutton Chrm	33p (F)
FH61R	Rct Latchbutton Blk	14p (G)
FH62S	Rct Latchbutton Grey	14p (G)
FH63T	Rct Latchbutton Red	14p (G)
FH64U	Rct Latchbutton White	14p (G)
FH87U	Magiclight Bttn Blu	23p (G)
FH89W	Magiclight Bttn Orng	42p (F)
FH90X	Magiclight Bttn Yllw	49p (F)
BW15R	Latchbush Blue	39p (F)
BW16S	Latchbush Green	45p (F)
BW17T	Latchbush Orange	45p (F)
BW18U	Latchbush Yellow	39p (F)

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BK47B	Micro-Min Relay	60p (E)
YX94C	Ult-Mn Rlay 12V SPDT	96p (E)
YX95D	Ult-Mn Rlay 12V DPDT	£1.49 (D)
BK48C	Ult Mn Rlay 6V DPDT	£1.10 (E)
YX96E	3A Min Relay	99p (E)
YX97F	10A Mains Relay	£1.65 (D)

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YX98G	5A Mains Relay	£1.95 (C)
YX99H	12V 30A Relay	£2.15 (C)
FX23A	Open Relay 6V	£3.25 (C)
FX24B	Open Relay 12V	£3.88 (C)
FX26D	2p Sub-Min Relay 6V	£3.45 (C)
FX27E	2p Sub-Min Relay 12V	£3.45 (C)
FX30H	4p Sub-Min Relay 12V	£3.99 (C)

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FX48C	Power Relay 12V	£3.95 (C)
FX49D	Power Relay 230V AC	£4.25 (C)
HY20W	Relay Flat 12V	£1.98 (C)
FX50E	Reed Relay 6 to 9V	£1.98 (D)
FX51F	Reed Relay 9 to 12V	£2.15 (C)
FX88V	Dil Reed Relay 1p 5V	£1.95 (D)
FX89W	Dil Reed Relay 1p12V	£2.15 (C)
FX90X	Dil Reed Relay 2p 5V	£3.99 (C)
FX91Y	Dil Reed Relay 2p12V	£3.85 (C)
FX93B	Dil Rd Rly 1p C/O12V	£7.60 (B)

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FX68Y	Reed SW Standard	89p (E)
FX69A	Reed SW Compact	£1.75 (D)
FX70M	Reed SW Miniature	69p (E)
FX71N	Magnet Small	38p (F)
FX72P	Magnet Large	88p (E)

TEST GEAR

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HF19V	Test Prod Black	45p (F)
HF20W	Test Prod Red	45p (F)
HF21X	Probe Clips	98p (E)
YX57M	Min Probe Black	42p (F)
YX58N	Min Probe Blue	38p (F)
YX59P	Min Probe Green	42p (F)
YX60Q	Min Probe Red	42p (F)
YX61R	Min Probe Yellow	42p (F)
HF30H	Pistol Probe Black	£1.24 (E)
HF31J	Pistol Probe Red	£1.24 (E)
HF22Y	Lo-Cost Test Probe	74p (E)
HF32K	Moulded Test Probe	79p (E)
HF33L	4mm Test Probe	89p (E)
YR93B	Test Lead Kit	£2.75 (C)
FY73Q	Logic Probe	£9.50 (B)
FY88V	Continuity Probe	99p (E)

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FL61R	Signal Injector	£5.99 (B)
FY74R	IC Test Clip	£2.35 (C)
YB21X	Safebloc	£7.50 (B)
BW05F	Scope Probe BNC	£15.63 (A)
YR95D	Lo-Cost Scope Probe	£3.75 (C)
XB82D	Crotech 3030	£167.90 (A)
	Carr in UK with XB82	£8.45

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XB83E	Crotech 3131	£286.00 (A)
	Carr in UK with XB83	£9.45 (B)
YX38R	Low Cost Counter	£49.90 (A)
LH05F	Transistor Testr HFE	£15.20 (A)
YB82D	LCR Bridge	£25.30 (A)

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YB81C	Seesure Sig Gen	£27.30 (A)
YK40T	Seesure CMOS Tester	£34.95 (A)
YW93B	Low Cost Multimeter	£4.85 (C)
FL60Q	Pocket Multimeter	£7.50 (B)
YB83E	Small Multimeter	£15.95 (A)

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YK35Q	Multimeter 2050	£11.95 (A)
YK37S	Range Dblr Multimetr	£19.95 (A)
YW68Y	Multimeter Type 320	£16.25 (A)
LH93B	Taut-Band Multimeter	£23.95 (A)
YB87U	100K Multitester	£44.00 (A)

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YB84F	Microtest 80	£19.09
YB85G	Supertester 680G	£33.30
YB86T	Supertester 680R	£37.80

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LH80B	Clamp Meter	£26.90 (A)
YK36P	Low Cost DMM	£29.95 (A)
YK32K	Multimeter DD601	£39.95 (A)

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YK34M	Auto Range Meter	£54.50 (A)
LH95D	DMM 100	£88.61 (A)
YK01B	RF Frequency Meter	£69.95 (A)
YB04E	Grid Dip Meter	£45.00 (A)

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XY75S	Ham Multimeter	£31.95 (A)
WY18U	SWR Meter 310	£10.75 (A)
WY19V	SWR Meter 110	£14.75 (A)
WY21X	SWR Meter 178	£24.95 (A)

TOOLS

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LH15R	Hobby Box	£3.45 (C)
FR22Y	Storage Drawer	98p (E)
BR48C	Hex Trimmer	24p (F)
BR51F	Trim Tool	45p (F)
BR49D	Preset Trimmer	72p (E)
BR50E	Trim TT5	60p (E)
BK34M	Trim Tool Set	£1.25 (D)
FY07H	Min Screwdriver Set	85p (E)
BR58N	Jewllers Scrwdvr Set	£2.30 (C)
BK44X	11 Pce S/Driver Set	£6.45 (B)

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BR79L	Intrchgbl Scdrvr Set	£1.69 (D)
YW60Q	Min Tool Set	£2.10 (C)
FY08J	Utility Set	£4.49 (C)
YX74R	Min Screwdriver	10p (G)
BR52G	Small Screwdriver	34p (F)
BR53H	Large Screwdriver	36p
FY10L	Driver S3	26p (F)
FY12N	Driver S5	89p (E)
FY13P	Driver S6	63p (E)
BK35Q	Driver S7	£1.25 (D)
BK36P	Driver S8	£2.25 (C)
FY15R	Pozidriver P1	£1.94 (D)
FY17T	Pozidriver P2	£1.60 (E)
BK37S	Pozidriver 3	£1.15 (D)
BK38R	Pozidriver 4	£2.25 (C)
BR71N	Mains Tester	60p (E)

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LH75S	Spiraldriver	£4.25 (C)
YW92A	Ratchet Socket Set	£5.99 (B)
WY04E	Cushiongrip Drvr Set	£5.84 (B)
FY19V	Low Cost Min Cutters	£4.25 (C)
BR75S	Ins Min Cutters	£6.93 (B)
BK42V	Slant Edge Cutters	£6.7[illegible] (B)
FY20W	Box-JT End Cutter	£6.95 (B)
FY21X	Low-Cost Cutters	£2.25 (C)
FY76H	Large Low Cost Cutts	£3.75 (C)
BR74R	Side Cutters	£5.95 (B)
FY22Y	Box JT Side Cutters	£7.60 (B)
BR72P	Side Cutters S55	£5.40 (C)
YW67X	Tweezers	19p (G)

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BK43W	Pearl Catcher	£1.75 (D)
FY24B	Low Cost Min Pliers	£3.90 (C)
BR78K	Ins Min Snipe	£5.72 (B)
BK41U	Hooked Pliers	£6.75 (B)
BR77J	Bright Pliers	£4.99 (C)
FY25C	Low Cost Pliers	£1.95 (D)
FY26D	Box Combined Pliers	£3.99 (C)
BR73Q	Long Snipe Pliers	£7.49 (B)
BR90X	Box Radio Pliers	£6.52 (B)
FY27E	Low-Cost Long Pliers	£3.99 (C)
BR92A	Combination Pliers	£4.95 (B)
FY28F	Low-Cost Elec Pliers	£2.85 (C)
FY29G	Low-Cost HD Pliers	£2.45 (C)

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BR91Y	Electricians Pliers	£4.90 (C)
FY30H	Pincers	£3.42 (C)
FY31J	Crimp Tool	£2.15 (C)
BR76H	End Action Strippers	£5.99 (B)
BR93B	Wire Strippers 3A	£2.35 (C)
BR94C	Wire Strippers 8B	£1.49 (D)
BR95D	Wire Strippers 9	£3.96 (C)
BR96E	Stripmaster	£16.25 (A)
XX11M	Blade L4421	£6.25 (B)
BR97F	Blade L5361	£6.20 (B)
FY32K	Hand Wrap Tool	£6.48 (B)
YK52G	Helping Hands	£5.95 (B)
YK53H	Helping Hands + Mag	£7.95 (B)
FY34M	Allen Keys AF	£1.64 (D)
FY35Q	Allen Keys Metric	£1.46 (D)

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YR82D	Min Spanner Set	£2.10 (C)
YW61R	Box Spanner Set	£2.15 (C)
FY36P	Min Spanner 24	£1.15 (D)
FY37S	Min Spanner 68	£1.15 (D)
FY38R	Ring Spanner 02	£1.99 (D)
FY39N	Ring Spanner 46	£1.69 (D)
FY45Y	Crescent Wrench 160	£3.35 (C)
FY46A	Crescent Wrench 210	£4.20 (C)
FY40T	Box Spanner 2BA	£1.25 (D)
FY41U	Box Spanner 4BA	£1.25 (D)
FY42V	Box Spanner 6BA	£1.25 (D)
FY43W	Box Spanner 8BA	£1.25 (D)
FY47B	Adjustable Wrench	£3.20 (C)
YW63T	Needle File Set	£6.94 (B)
FY49D	Needle File Flat Wrd	£1.75 (D)
FY50E	Needle File Hand	£1.75 (D)
FY51F	Needle File Halfrnd	£1.96 (D)
FY52G	Needle File Round	£2.27 (C)
BR63T	Junior Hacksaw	99p (E)
BR64U	6in Hacksaw Blades	98p (E)
FY54J	Wire Brush	45p (F)
FY55K	Wet & Dry Fine	20p (G)
FY56L	Wet & Dry Med	19p (G)
FY57M	Wet & Dry Course	28p (F)

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*FY02C	Utility Knife	£1.60 (D)
FY03D	Retractable Knife	£1.99 (D)
FY04E	Knife Blades	99p (E)
YW64U	Snap-Off Blade Knife	99p (E)
FY05F	Scalpel Handle	£1.75 (D)
FY06G	Scalpel Bld Type II	46p (F)
BR59P	Punch 3/8in	£4.38 (C)
BR60Q	Punch 7/16in	£4.29 (C)
BR61R	Punch 1/2in	£4.64 (C)
BR62S	Punch 9/16in	£4.86 (C)
BR80B	Punch 5/8in	£4.64 (C)
BR81C	Punch 3/4in	£4.83 (C)
BR83E	Punch 1in	£5.20 (B)
BW00A	Punch 1 1/2in	£6.49 (B)
YK27E	Chassis Punch Set	£13.45 (A)

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FY53H	Mini Vice	£3.85 (C)
LH79L	Reliant Kit	£21.95 (A)
BW03D	Reliant Drill	£7.60 (B)
BW02C	Titan Drill	£11.25 (A)

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YW65V	Mini Mains Drill	£14.25 (A)
XB12N	Drill Stand	£14.95 (A)
BR[illegible]4F	Reliant Collar	75p (E)
BW04E	Drill Power Supply	£13.99 (A)
BR65V	Twist Burr 0.8mm	43p (F)
BR66W	Twist Burr 1.4mm	43p (F)
BR85G	HS Twist Drill 0.8mm	75p (E)
BR86T	HS Twist Drill 1mm	75p (E)
BR87U	HS Twist Drill 1.4mm	75p (E)
YY28F	Long-Life Drill 1mm	£1.20 (D)
LH77J	20-Piece Tool Kit	£8.25 (B)
LH78K	40-Piece Tool Kit	£14.95 (A)
LH76H	Wishbone Sharpener	£6.85 (B)
YW66W	Pin Drill	£4.95 (C)
HQ02C	HS Drill 1/16in	19p (G)
HQ03D	HS Drill 5/64in	23p (G)
HQ04E	HS Drill 3/32in	29p (F)
HQ05F	HS Drill 7/64in	32p (F)
HQ06G	HS Drill 1/8in	36p (F)
HQ07H	HS Drill 9/64in	39p (F)
HQ08J	HS Drill 5/32in	43p (F)
HQ09K	HS Drill 11/64in	49p (F)
HQ10L	HS Drill 3/16in	53p (E)
HQ11M	HS Drill 13/64in	56p (E)
HQ12N	HS Drill 7/32in	65p (E)
HQ13P	HS Drill 15/64in	72p (E)
HQ14Q	HS Drill 1/4in	75p (E)
HQ15R	HS Drill 17/64in	95p (E)
HQ16S	HS Drill 9/32in	98p (E)
HQ17T	HS Drill 19/64in	£1.12 (D)
HQ18U	HS Drill 5/16in	£1.19 (D)
†HQ19V	HS Drill 21/64in	£1.26 (D)
HQ20W	HS Drill 11/32in	£1.36 (D)
HQ21X	HS Drill 23/64in	£1.54 (D)
HQ22Y	HS Drill 3/8in	£1.54 (D)
HQ23A	HS Drill 25/64in	£1.75 (D)
HQ24B	HS Drill 13/32in	DIS
HQ25C	HS Drill 27/64in	£2.18 (C)
HQ26D	HS Drill 7/16in	£2.32 (C)
HQ27E	HS Drill 29/64in	DIS
†HQ28F	HS Drill 15/32in	£2.73 (C)
HQ29G	HS Drill 1/2in	£2.99 (C)

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FY59P	Retractable Rule	£2.75 (C)
FY60Q	Feeler Gauge Imp	95p (E)
FY61R	Feeler Gauge Metric	97p (E)
FY62S	Iron CX	£6.59 (B)
FY63T	Element CX	£2.94 (C)
FR30H	Bit 6/1106	89p (E)
FY64U	Bit 1100	84p (E)
FY65V	Bit 1101	92p (E)
FR31J	Bit 7/1101	£1.19 (D)
FY66W	Bit 1102	93p (E)
FY67X	Bit 1103	92p (E)
FR01B	Element Type CN	£2.65 (C)
FR02C	Handle Type CN	95p (E)
FR03D	Bit 102	84p (E)
FR04E	Bit 104	88p (E)
FR05F	Bit 106	84p (E)
FR06G	Bit 820	89p (E)
FR07H	Bit 821	84p (E)
FR08J	Bit 822	84p (E)
FR12N	Iron X25	£6.32 (B)
FR13P	12V Iron MLX12	£7.48 (B)
FR14Q	Element X25	£2.65 (C)
FR15R	Element MLX12	£2.49 (C)
FR16S	Bit No. 50	89p (E)
FR17T	Bit No. 51	92p (E)
FR18U	Bit No. 52	89p (E)

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FR20W	Stand ST4	£2.19 (C)
FR11M	Sponge ST3	11p (G)
RK33L	Sponge ST4	32p (F)
FY68Y	Kit SK3	£8.92 (B)
FY69A	Kit SK4	£8.99 (B)
WY05F	Rechargeable Iron	£27.80 (A)
YX68Y	B50 Bit Angled	£3.62 (C)
YX69A	B50 Bit Flattened	£3.65 (C)
YX70M	B50 Lamp	85p (E)
YX71N	B50 Holder	62p (E)
YX72P	B50 Sponge	29p (F)
FR10L	Heat Sink Tweezers	19p (G)
FR23A	Solder Sucker	£4.50 (C)
FR24B	Sucker Tiplet	£1.55 (D)
FR26D	Desolder Tool	£7.25 (B)
BK39N	Desolder nozzle 3	85p (E)
BK40T	Replacement O rings	[illegible]5p (E)
FR63T	Deslor Washer Type 2	24p (F)
HY13P	Deslor Nozzle Type 2	89p (E)
FR28F	Desolder Nozzle	£1.55 (D)
FR29G	Solda Mop	68p (E)

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FR21X	Solder D622	75p (E)
FY70M	1/2kg Reel Solder	£10.50 (A)
FY71N	Aluminium Solder	43p (F)
FY72P	Conductive Paint	£5.35 (B)
LH04E	Freeze-it	£1.94 (D)
LH03D	Switch Cleaner	£1.94 (D)
YB77J	Servisol	£1.66 (D)
LH02C	Aero Klene	£1.55 (D)
YB73Q	Aero Duster	£1.75 (D)
YB74R	Silicone Grease	£1.98 (D)
YB75S	Plastic Seal	£1.55 (D)
YB76H	Foam Cleanser	£2.35 (C)
YB78K	Excel Polish	£1.78 (D)
YB79L	Anti Static Spray	£1.72 (D)

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YB80B	Fire Extinguisher	£4.85 (C)
FL43W	Evostik Impact	99p (E)
FL46A	Cyanoacrylate	£1.55 (D)
LQ02C	Potting Compound	£3.55 (C)
FL44X	Araldite Rapid	£2.25 (C)
FL45Y	Double Bubble Sachet	28p (F)
FL47B	PVC Tape Black	35p (F)
FL48C	PVC Tape Blue	35p (F)
FL49D	PVC Tape Brown	35p (F)
FL50E	PVC Tape Green	35p (F)
FL51F	PVC Tape Red	35p (F)
FL52G	PVC Tape White	35p (F)
YR99H	PVC Tape Yellow	35p (F)

WOUND COMPONENTS

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LB40T	9.5 Coil Former	60p (E)
LB17T	Former 351	24p (F)
LB18U	Former 450	16p (G)
LB19V	Former 722/1	13p (G)
LB20W	Former 722/2	18p (G)

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LB21X	Former 722/8	13p (G)
LB22Y	Former 722/4	18p (G)
LB41U	Dust Core Type 4	10p (G)
LB42V	Dust Core Type 6	11p (G)
LB43W	Dust Core Type 8	17p (G)
LB44X	Former Base	12p (G)
LB36P	Screening Can 10	10p (G)
LB39N	Screening Can 15	14p
LB62S	A/P Beads	35p
HX05F	Small Pot Core	£1.30 (D)
HX06G	Core Type 2	£1.55 (D)

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HX07H	Bobbin Type 2	96p (E)
HX08J	Clips Type 2	5p (H)
HX09K	Type 3 Core	£1.85 (D)
HX10L	Type 3 Bobbin	65p (E)
HX11M	Type 3 Clips	6p (H)
HX12N	Large Pot Core	99p (E)
HX13P	Bobbin Type 4	10p (G)
HX14Q	Mtg System Type 4	£1.10 (D)
HW23A	GE Coil L15	£1.95 (D)
HX58N	GE Coil L9	£2.20 (C)
HX57M	GE Coil L8	£2.20 (C)
HW24B	GE Coil L14	£1.95 (D)
HX56L	GE Coil L7	£2.[illegible] (C)
HX55K	GE Coil L6	£2.[illegible] (C)
HX54J	GE Coil L5	£2.[illegible] (C)
HW25C	GE Coil L12	£1.99 (D)
HW26D	GE Coil L11	£1.99 (D)

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HX24B	Choke 0.5H	£1.15 (D)
HX25C	Choke 1H	£1.15 (D)
HX26D	Choke 2H	£1.15 (D)
HX27E	Choke 4H	£1.15 (D)
LR07H	Filter Pot Core	£2.15 (C)
XX30H	Equaliser Pot Core	£1.99 (D)
HW27E	Choke 10H	£1.96 (D)
HX22Y	Choke RFC5	£2.36 (C)
HX23A	Choke RFC9A	£2.65 (C)
HW28F	Choke 5uH HC	59p (F)
HX15R	Choke 1.5mH	58p (E)
HX16S	Choke 2.5mH	59p (E)
HX17T	Choke 5mH	66p (E)
HX19V	Choke 10mH	29p (F)
WH25C	Choke 0.22uH	52p (E)
WH27E	Choke 0.47uH	53p (E)
WH29G	Choke 1.0uH	45p (F)
WH30H	Choke 1.5uH	74p (E)
WH31J	Choke 2.2uH	45p (F)
WH32K	Choke 3.3uH	45p (F)
WH33L	Choke 4.7uH	49p (F)
WH34M	Choke 6.8uH	55p (E)
WH35Q	Choke 10.0uH	45p (F)
WH36P	Choke 15.0uH	61p (E)
WH37S	Choke 22.0uH	48p (F)
WH38R	Choke 33.0uH	48p (F)
WH39N	Choke 47.0uH	48p (F)
WH41U	Choke 100uH	54p (E)
WH45Y	Choke 470uH	55p (E)
WH47B	Choke 1mH	76p (E)

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HX42V	Toko YRCS 11098	51p (E)
YG30H	Toko YRCS12374	52p (E)
HX43W	Toko YHCS 11100	52p (E)
YG31J	Toko CSK3464	53p (E)
YG32K	Toko YMCS17104	51p (E)
HX97F	Toko ACS 34342	64p (E)
HX98G	Toko ACS 34343	46p (F)
YG39N	Toko KAC8448	48p (F)
YG36P	Toko KAC8449	46p (F)
LB00A	IFT 13	£1.62 (D)
LB01B	IFT 14	£1.75 (D)
LB03D	IFT 16	£1.72 (D)
LB02C	IFT 15	£1.81 (D)
LB05F	IFT 18 465kHz	£2.19 (C)
LB06G	IFT 18 1.6MHz	DIS
HX28F	Toc 1	£1.99 (D)
HX82D	Min Tr LT44	55p (E)
LB14Q	Min Tr LT700	55p (E)
YR91Y	Min Tr LT800	33p (F)
LR06G	Mc Xfm Typ2 200 600R	£19.45 (A)
YX84F	Z Changer	£7.85 (B)

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HX81C	Pulse Transformer	£3.82 (C)
YX66W	Line Transformer	£3.35 (C)
BK57M	600 Ohm Isotran	£5.45
•WB00A	Sub-Min Tr 6V	£1.30 (D)
•WB01B	Sub-Min Tr 9V	£1.30 (D)
•WB02C	Sub-Min Tr 12V	£1.40 (D)
WB06G	Min Tr 6V	£3.46 (C)
WB11M	Min Tr 9V	£4.25 (C)
WB10L	Min Tr 12V	£3.35 (C)
YK28F	Tr 12V 0.5A	£4.36 (C)
LY03D	Tr 10VA 15V	£4.95 (C)
WB22Y	Tr 34V HP	£8.15 (B)
WB16S	Min Tr 20V	£3.35 (C)
WB20W	Min Tr 24V	£3.35 (C)
WB07H	Tr 34V 1A	£7.85 (B)

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WB25C	Tr 12V 1A	£6.55 (B)
WB26D	Tr 12V 2A	£7.95 (B)
YK02C	Tr 32 0 32 2A	£13.45 (A)
YK07H	Tr 32 0 32 4A	£22.25 (A)
YK08J	Toroidal 30VA 6V	£7.94
YK09K	Toroidal 30VA 9V	£8.59
YK10L	Toroidal 30VA 12V	£8.59
YK11M	Toroidal 30VA 15V	£8.59
YK12N	Toroidal 30VA 18V	£8.59
YK13P	Toroidal 50VA 6V	£9.96
YK14Q	Toroidal 50VA 9V	£9.96
YK15R	Toroidal 50VA 12V	£9.96
YK16S	Toroidal 50VA 15V	£9.96
YK17T	Toroidal 80VA 18V	£10.98
YK18U	Toroidal 80VA 22V	£10.98
YK19V	Toroidal 80VA 30V	£11.98
YK20W	Toroidal 120VA 30V	£11.98
YK21X	Toroidal 160VA 35V	£13.98
YK22Y	Toroidal 300VA 35V	£15.98
YK23A	Toroidal 500VA 35V	£19.98
WB03D	Tr 9V 1 1/2A	£6.25 (B)
WB12N	Tr 20V 1A	£8.25 (B)
WB17T	Tr 28V 1 1/2A	£9.95 (B)
XB38R	TR 32032/6 1/2A	£23.25 (A)
HX59P	Trnsformer Mtg Plate	66p (E)
LW34M	15/22V Power Tran	£14.84 (A)
LW33L	Tr 240V Isotran	£4.95 (C)

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YK03D	Matinee Transformer	£13.75 (A)
YG12N	Min Motor	£2.45 (C)
YG13P	Small Motor	£1.25 (D)
YG14Q	Servo Mechanism	£3.60 (C)

TRADE QUANTITIES

The letter in brackets after the price indicates the minimum quantity of that item you can buy and qualify for a trade price. See table at start of price list. If you buy less than the quantity shown then the price is that shown. If you want to buy the quantity shown or more of that item, then please contact us for a trade price. If no trade quantity is shown, then the price shown is the best price we can offer regardless of the quantity.
Trade quantities shown for wires or cables of any type is in metres, not reels or parts of metres. Trade quantities for nuts, bolts, washers, Hiatts etc. refers to the number of packs, i.e. to qualify for a trade price on Tag 2BA for example (trade quantity 500), you will need to order 500 packs which is equal to 5000 tags.

READERS LETTERS

Bouquets and Brickbats

Dear Sirs,
After much delay herewith some brief bouquets and brickbats from one of your regular customers.
1. I think your service, mail and phone is superb. When phoning it is wonderful to speak to someone pleasant, helpful, and intelligent — a rare combination these days. Keep it up! Also, the reply-paid envelope is a tremendous blessing — without it you might well lose a lot of orders just because of the sheer hassle of finding and addressing an envelope. In short, you've got it right.
2. I must confess to being slightly disappointed with the new catalogue. It's OK, but a supplement to the previous one might have done. Dare I mention loose-leaf again?
3. Could not the price list be produced in alphanumeric order, rather than page order? It would surely be easier for you — since the info must come from your computer system — and I'm sure customers would find it easier to use. I mean alphanumeric order of your ordering codes, of course.
4. Why on earth have we had to get caught up in a new resistor colour code, when the industry standard code does all that is necessary? I nearly returned the last order to you, thinking Maplin had fallen on its face, until I realised at the last moment what had happened. I dread to think of the confusion it must cause some people. Black mark to Maplin.
Keep up the good straightforward service, and a happy and successful New Year to all at Maplin.

H. C. BURFORD
Ryde, Isle of Wight

1. Many thanks for your comments, though a lot of customers have had a problem recently getting through to our sales desk. These phones have been incredibly busy, but if you get ringing, do hang on. We changed our phone system recently and whereas in the past you were answered and then had to hang on if sales were busy, under the new system your call enters a queue and you are answered in the order in which the calls arrived. The advantage to you, of course, is that there is no phone charge whilst you're hanging on, but you are in the queue just as you were before. However, by the time you read this our extra sales telephones may be operational and the problem relieved.
2. A catalogue supplement is difficult to use as you then have to look in two places for your choice of a particular type of item. Loose-leaf is a good idea, but just too expensive.
3. We are very much against having the price list in alphanumeric order since it becomes very difficult to compare prices of similar items. Hopefully, however, our next catalogue due in November this year will have the prices printed on the page.
4. Unfortunately the five-band colour code is the international standard for 1% tolerance resistors. It has been the standard in industry for many years, but hobbyists will not have seen it much due to the previously prohibitively high cost of close tolerance resistors. But I have to agree that it's a blessed nuisance having to relearn resistor colour codes. The price of progress, I suppose.

CB Projects

Dear Sir,
Re: Chris Walker's letter, letters page Nov-Feb price list.
I, too, as probably many other people, subscribed to the Maplin magazine "Electronics" on the strength of the 27MHz CB project and am most disappointed that it was not printed. However, I do see the logic of not including it due to the massive slump in CB rig prices which I think has caught everyone by surprise, including me. Why, though, should you leave people like me, who haven't had the time or money to take the RAE examination, without radio projects for CB. I am sure that there would be a great deal of interest if Maplin were to publish a 934MHz band project for which the transceivers now made are either very hard to get or extremely expensive. This band has been entirely neglected since its announcement and one suspects left for the elite few. I understand that the range attainable with this equipment will be quite small despite the more efficient aerial systems, but in built-up areas after working hours (and not at 3.30 a.m.) the range on standard 27MHz is very small (about 2 miles at the very maximum in my area), if one does not resort to illegal power amplifiers. So come on, Maplin, stop giving us dull Ultrasonic intruder projects for the 25,000,000th time (in the electronic press) or computer controlled railway systems and give us something we can get our teeth into (although we might need burglar alarms if we get a 934MHz band transceiver by the way availability is going at present).

H. JAREMKO

The problem with a project to build a CB transceiver at 934MHz is that the standard of construction will have to be exceptionally high for the project to work. Remember that a kink in a wire is a tuned circuit at these frequencies. Our technical editors think that it is beyond the capabilities of the average constructor. Not only that, but some very sophisticated test gear will be required to align it and ensure it is working correctly. Very few people will have access to such test gear. The only possibility is if we produced ready-made pre-aligned modules for the rf stages and let you build the rest. We'll have a look at the possibility of doing that. We were surprised to read your comment about the RAE exam. This is not very expensive to take and since it consists only of choosing the correct answer out of a list of possible answers for each question, anyone capable of making and faulting on a 934MHz transceiver should be able to pass with no problem at all. Once you've passed, of course, the equipment and frequencies you can use far exceeds anything possible with CB.

Knowledge In The Wrong Hands

Dear Sir,
Having read Chris Walker's letter in your December/February edition I feel that to an extent that I must agree with some of his comments regarding the publication (or not as the case is) of the 2m/CB project. However, I sincerely trust that the Maplin Magazine is not going to lower itself by following so many other electronics based magazines and become another pseudo-CB publication. Very few CB operators and potential CB operators have either the knowledge or the equipment to construct satisfactory transceivers within the legal specification, and those that are capable are either in the communications industry or are licenced amateur band operators who are probably sick at the idea of constructing/testing a project like that. The infered suggestion in your reply to Chris Walker's letter that you are going to publish a major transceiver project in a forthcoming issue makes me wonder just how much more illegal transmission such magazines as yours will allow before you realise that a lot of knowledge in the wrong (unqualified/unlicenced?) hands can spell serious problems for authorised users of certain frequency bands. E.g. Fire and Police radio which is just above the 2m band, Ambulance service which is third harmonic of parts of 27MHz band, etc.
However, I do appreciate the majority of contents of your magazine and, although contradicting myself to an extent, would like to see the publication of a 2m synthesiser article including the 600KHz repeater shift facility.

N. R. NEGUS
(Home Office Telecoms Engineer)
Gloucester

Whilst we would be the last to advocate illegal transmissions, we do feel that there are a lot of licensed amateurs who would enjoy building a well-designed transceiver. We would almost certainly supply the rf transmitter stage as a ready-built pre-aligned module, so this should eliminate interference problems which might otherwise arise. In the end I think it would really be up to us to produce a high quality design which was easy enough to build and sufficiently well documented that it could be built without causing problems to others.

Atari vs BBC

Dear Sir,
I have been amused, and rather irritated by your recent newsletter correspondence concerning the Atari vs BBC computer.
I was stunned by such sweeping generalisations as "for home use the Atari is a much better proposition". On what basis do you make this statement? In my opinion, whoever wrote that is either ignorant or stupid or both.
Computers are essentially for programming — not for making pretty pictures! There can be no denying that the Atari has 256 "hues" available, when the BBC Micro has only 8 colours (not colors!), but can the Atari handle recursive procedures with local variables, or complex (conditional) machine code macro-assembly? Does it support structures such as Repeat/Until, or If/Then/Else?
As regards your comment about languages ("the others [Unix, Fortran, Cobol] are not suitable for home use") — what is this gross generalisation supposed to mean anyway? No, Fortran and Cobol (at least the standard versions) are not suitable for playing Space Invaders — but they put to shame even the amazingly advanced BASIC of the BBC Micro, for programming power. Lastly, Unix is not a language, but an operating system, and is, by definition, suitable for any system on which it is implemented. Check your facts before generalising!
As to the "extra chips" in the Atari machine: Do you honestly believe that all the BBC graphics and sound capabilities are handled by one (albeit 2MHz) 6502? Again, you have not checked your facts.
The BBC Micro has a custom designed ULA (uncommitted logic array) which handles graphics — making possible the excellent "palette" facilities, and a separate 4-channel sound generator, with an interrupt-driven queue, enabling processing to continue while sounds are being made.
Finally, your last comment in your reply to Mr Grimley Evans ("don't expect the basic machine . . .") is simply RUBBISH. I've used both, extensively, and in my opinion, the *only* ways in which the Atari is superior are the larger number of colours, and in sprite graphics ("player missile" graphics to Atari — that sums it up!), and this latter can be achieved on the BBC by considered use of the "palette" facility.
Please, Maplin, your customers expect better of you than the Sinclair trick of degrading other peoples' products on inaccurate or incomplete information. If you sold the best computer on the market, you would have no problem advertising!

GERAINT A. WIGGINS
Corpus Christi College, Cambridge

We are not swayed by this letter from our opinion that the Atari is a better computer for home use than the BBC. Calling us ignorant or stupid does not alter the facts. You are quite right when you say that computers are for programming, but the most interesting programs are those which make the computer do something. The fact is that there is more hardware in the Atari for your programs to talk to, so your programs can do more interesting things. The BBC may have a ULA, but this is just an array of logic functions. In its place the Atari has a second real microprocessor driven by its own program and yet another dedicated chip to deal with the player/missiles or sprites. We would be the first to admit that the BASIC supplied with the Atari is not

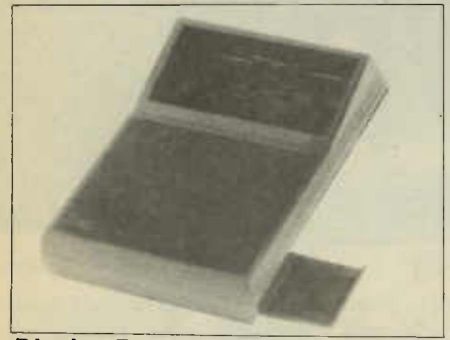
MAPLIN NEWS

Two Battery Holders

A pair of battery holders to supplement the range shown on page 27 of our catalogue. One to hold a single 'C' type cell and one to hold a single 'D' type cell, both with solder-to-tag connections. Sizes are 61 x 28 x 25mm for the 'C' type and 69 x 35 x 27mm for the 'D' type.

Order As

BK45Y (HP11 Single Box) Price 19p
BK46A (HP2 Single Box) Price 19p



Display Box

A box moulded in black plastic with a clip-on battery cover. The case is snap-together, and is ideal for projects which need to be hand-held. Dimensions are: 110mm long x 80mm wide x 30mm high at the rear and 21mm high at the front.

Order As HY25C (Display Box) Price 50p

Echo Machine EM-006

A high quality echo chamber using solid state bucket-brigade delay lines. The unit is finished in matt black, and the inputs are standard mono jack sockets. The MIC socket is the input jack for low impedance (-46dB/10k), and the INSTRUMENT socket is the input for an instrument or line output of hi-fi, organ, synthesizer etc. (-20dB/220k). There is a footswitch jack on the rear for a remote control switch.

The delay time control is variable between 20 and 200msec, and there are three selections of output level (0, -20, and -40dB) to enable connection to any amplifier. There is also a peak level indicator, which will show when the input level is excessive and likely to cause distortion.

The balance control sets the mixture of echo and straight through sounds, with no echo at 'direct', total echo at 'delay', and even at the centre position. The repeat control sets the number of repetitions of echo sound, the dial being rotated clockwise to increase the repetitions.

Overall size: 220 x 150 x 55mm.

Order As XG30H (BBD Echo EM-006) Price £55.00

NEW ITEMS SINCE CATALOGUE

BK66W	Modulator UM1286	**Price £11.90**
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LK04E	Scratch Filter Kit	**Price £24.90**
LW95D	Inverter Kit	**Price £49.95**
LW96E	Sound Generator Kit	**Price £10.95**
LW97F	Panic Button Kit	**Price £4.50**
LW98G	Programmable Timer Kit	**Price £6.95**
LW99H	Modem Kit	**Price £39.95**
QQ39N	4412VP	**Price £8.00**
QY43W	XR2211CP	**Price £4.45**
QY50E	SP0256	**Price £8.98**
XG29G	Inverter Transformer	**Price £22.50**

Readers' Letters continued

the most brilliant BASIC in the world. That does not mean that a good BASIC would not be able to do what you said. After all, it is exactly the same microprocessor (6502) in both Atari and BBC. In fact, BASIC A+ does support structured programming and Atari Microsoft BASIC is also far superior to Atari's basic BASIC. Equally Atari's Macro Assembler is a very powerful piece of software. But in the end, even if the programs you write look nicer on the BBC than on the Atari, they cannot do as much as they would on the Atari because there just isn't as much hardware in the machine to do interesting things with. My comment about Unix, Fortran, Cobol etc. did not imply that they were all languages; I said that they were large pieces of software, and they are not suitable for home use because for example a half decent Fortran compiler would fill all the RAM in an 8-bit micro before you started to write a program. The same applies to Cobol. It would be nice to be able to run programs that use Unix, but having loaded the operating system, how much room would be left for the program? The answer is: very little.

The graphics features that you mention as available on the BBC are included on the Atari, but are relatively minor features in comparison to the special capabilities of the video processor in the Atari. The Atari can have its own second machine code program running simultaneously with, but completely unseen by the main BASIC or machine code program and linked to the 50Hz TV frame rate via the video processor's interrupt system. The Atari could for instance move (rotate, pan in and out, scroll through etc.) a complex three-dimensional colour picture while the main program gets on with other work. Such complex, time critical calculations and processing can occur without disturbing the main program. Real time sharing on your own home micro!

Finally, let's look at your strange comment that "computers are essentially for programming — not making pretty pictures!" To produce anything meaningful, a computer must communicate with its user. Our eyes can assimilate vastly more information than any other of our senses, so any computer that can transfer its results by means of pictures is going to be far more interesting to interact with. This is probably not important in the office or schoolroom where it is the printed results that matter. But at home instead of writing purely academic programs on the BBC, you can write programs on the Atari that will actually produce visually meaningful results as well as printed results. It may well be that the BASIC listing will look prettier on the BBC, but it won't do as much as on the BBC as on the Atari, because it doesn't have the hardware to do it. And that's a fact! That's why we stand by our original statement. We are convinced that after carefully considering all the relevant points, the Atari stands out as the best computer available at the moment for home use.

If you have any interesting comments to make about your hobby in general or Maplin in particular then please write to: The Editor, Maplin Mag, P.O. Box 3, Rayleigh, Essex SS6 8LR. Please write clearly and keep your letters brief and to the point. Thank you.

MAPLIN MOISTURE METER

by Robert Kirsch

- ★ **Low cost**
- ★ **Simple to use**
- ★ **May be used on wood, brick, plaster, etc**
- ★ **Built-in calibration**

The Maplin Moisture Meter is an electrically very simple instrument that enables the moisture content of various materials to be measured. The Moisture Meter has a function similar to damp meters of the type used by surveyors and builders. Its chief use is to detect dampness and rot in buildings, so that immediate remedial measures can be taken before irreparable damage occurs. Other uses include determining whether a wall is in a suitable condition for hanging wallpaper or painting, and these are explored in more depth later in this article.

Circuit Description

The circuit is shown in Figure 1, and it will be noted that the device is basically an ohmmeter using a transistor to make it more sensitive than the type found in an ordinary multimeter. TR1 forms a standard common emitter amplifier, whose gain is mainly determined by the collector load R1 and RV1. The gain is adjusted by RV1 to compensate for transistor tolerances, battery voltages, and thermal effects in the transistor before use.

The voltage drop across the collector load is measured by the meter M1, whose full scale deflection is set by the variable resistor RV2 and R2. R3 forms a meter shunt to help damp the meter movement.

The base of TR1 is fed via R4 to S1a, which selects the two calibrate and one working mode of the instrument. In position A the transistor is biassed hard on, and at this point full scale deflection is set by adjusting RV1 so that the meter reads cal A.

When the switch is in position B the transistor gain is set by RV2 so that the meter reads cal B. The fourth position of the switch connects the test probes to the base circuit of the transistor, which is then biassed to a point dependant on the resistance of the surface being tested.

Construction

There is no PCB in this design, and the components may be assembled as shown in Figure 2, taking care to sleeve all component leads to prevent short circuits. Ensure the transistor, meter, and battery are all connected with the correct polarities.

The probes may be made from any sharp steel needles, and should be as fine as practical to prevent damage to tested surfaces. The points from ordinary darts have been found very satisfactory. These may be arranged to form a single unit or used as separate probes, but in both cases remember that in use they must be inserted one inch apart.

A new self-adhesive scale (BK67X) is available for the meter (RX54J), and this should be fitted as follows:

Remove carefully the plastic front of the meter and undo the two screws holding the scale to the meter body, noting roughly the positions of the two end stops. Remove the scale plate from

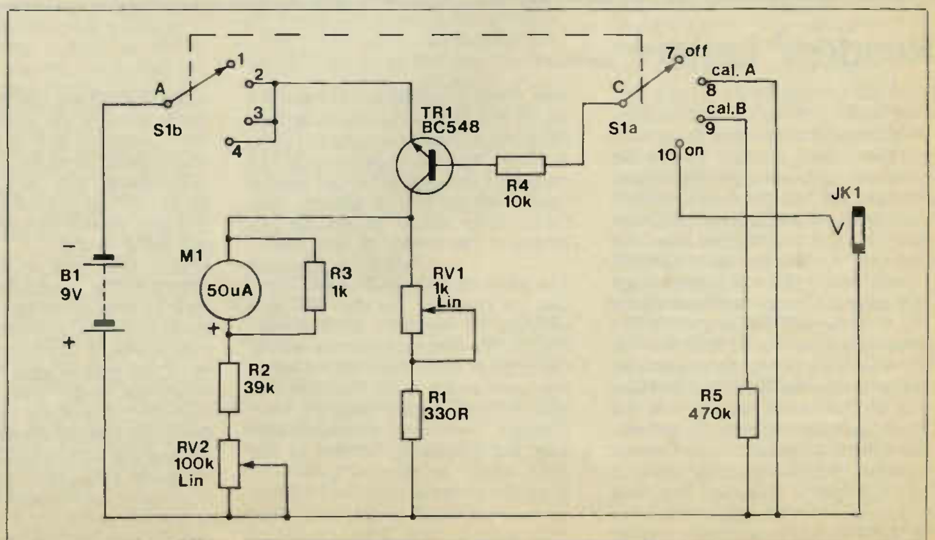


Figure 1. Circuit diagram.

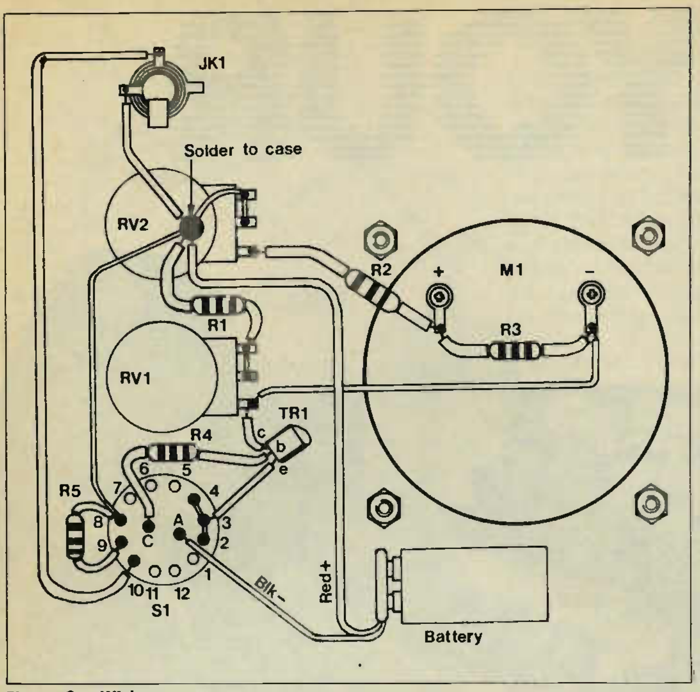
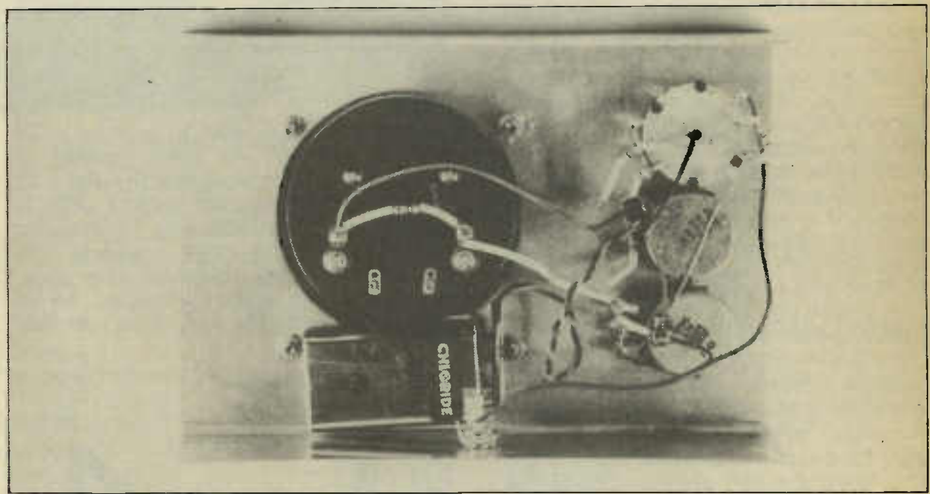


Figure 2. Wiring.

MOISTURE METER PARTS LIST

Resistors — All 0.4W 1% metal film unless specified.

R1	330R		(M330R)
R2	39k		(M39K)
R3	1k0		(M1K)
R4	10k		(M10K)
R5	470k		(M470K)
RV1	1k0 lin pot		(FW00A)
RV2	100k lin pot		(FW05F)
Semiconductors			
TR1	BC548		(QB73Q)
Miscellaneous			
S1	Switch (Rotary Sw 6B)		(FF74R)
JK1	Jack skt 3.5		(HF82D)
PL1	Plug plas. 3-5		(HF80B)
M1	Meter		(RX54J)
	PP3 clip		(HF28F)
	Potting box small		(LH57M)
	Moisture scale		(BK67X)
	Cable single black (2 metres)		(XR12N)
	Wire (Hook-up) black (as req.)		(BL00A)
	Potting compound		(LQ02C)
	Isonuts M3	1 pkt	(BF58N)
	Isoshake M3	1 pkt	(BF44X)
	Systoflex 2mm black	1 metre	(BH06G)
	Box AB13		(LF14Q)
	Knob K10A	3 off	(RK89W)



the meter, taking care not to bend or damage the needle assembly. Remove the backing from the new scale and align it with the scale plate, pressing it down from one edge to the other and ensuring that no air bubbles are formed.

Reassemble the scale plate to the meter body, checking that the needle end stops are in the correct position by gently blowing the meter needle to its extremes and making sure that these are just beyond the extreme markings on the scale. The end stops should be adjusted if necessary before tightening the screws. Replace the front cover.

Calibration

The meter calibration should be checked before use. This is accomplished as follows:

1. With S1 to OFF check the zero reading of the meter and adjust the screw on the meter front if necessary.
2. With S1 to A adjust RV1 until the meter reads Cal A on the scale.
3. With S1 to B adjust RV2 until the meter reads Cal B on the scale.
4. Switch to ON. The meter is now ready for use.

If these readings cannot be obtained a new battery may be required.

Use

The meter is used by pressing the two probes hard onto the surface under test, and holding them about one inch apart. The reading should then be taken from the appropriate scale. The tips of the probes should enter about a quarter inch into wood, if it is the surface under test. If there is heavy condensation then the surface should be wiped dry before taking measurements.

Scales

Any surface may be considered dry if the needle does not move from zero, or is less than 0.1 on the reference scale.

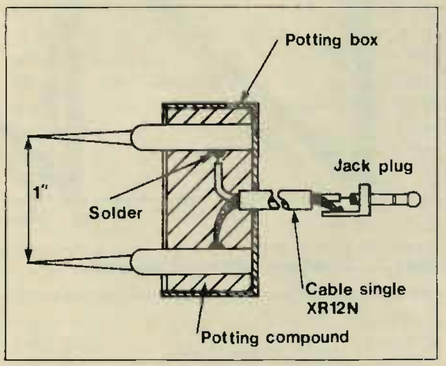


Figure 3. Typical probe detail.

Wood

The normal moisture content of timber varies with the temperature and type of wood. The upper two scales (WOOD 1 and 2) are used to test the following types of wood:

WOOD 1: Close grain types, e.g. ash, oak, beech, douglas fir. These woods are often found in older properties.

WOOD 2: Open grain timber, e.g. whitewood, redwood, deal.

A normal reading for wood is about 10 to 12% in heated locations and 15% in unheated locations. Any reading above normal could indicate dampness problems, any new timber may begin to deteriorate if left untreated when it is above this level. Dry rot can thrive in wood with a moisture content of 18% or above. When the reading is above 28% the wood has reached fibre saturation point, and this is marked on the scale as 'F.S.P.'

Reference

The reference scale is used as a guide to the moisture content of brick, plaster, concrete, and various building materials, although some types of building blocks have a high carbon content, and therefore will not give a true reading. If there is any doubt a known dry sample should be tested to make sure that no reading is obtained. The source of dampness may be found by taking several readings and noting the area(s) in which the highest reading occurs, this being nearest the source of moisture.

A surface reading of 1.5 on the reference scale indicates that the surface may be painted with emulsion or water-based paints, and a surface reading below 0.5 may be covered with oil-based paints. Any reading above 2 should definitely not be painted.

WITHIN YOUR SCOPE

by Paul Harding

The Cathode Ray Oscilloscope (CRO), or scope, is probably the most useful of all the instruments available to the electronics enthusiast, professional or amateur. For, although its accuracy is not very great, it can serve as an AC or DC voltmeter, a time and frequency meter, a phasemeter, and, with a few extra components, a current and power meter. This flexibility in use is what makes the CRO so important in all fields of electronics, from DC power supplies to RF communications. So why haven't we all got one? The main reason, as usual, is the cost. Until recently there have been few CROs available for under about £350, and this is too expensive for all but the most enthusiastic amateurs. However, in the last couple of years several manufacturers have done their best to fill the gap in the market, and have produced instruments which fit the needs and the pocket of the electronics hobbyist. This article has been written as an introduction to what a CRO is, how to use it, and what it can do for you.

The Cathode Ray Tube

Although a modern (and expensive) professional oscilloscope may look very complicated, and have extra features not found on cheaper ones, all scopes consist of the same basic units, as shown in figure 1. The most important part of the scope is the cathode ray tube (CRT). This consists of four main parts: the cathode filament, the accelerator, the plates, and the screen. The CRT works by producing electrons at the hot cathode and forming them into a narrow beam, which is aimed at the fluorescent screen through deflection plates. By varying the electric potential of the deflection plates, the beam can be bent to produce a small fluorescent dot on the screen. This 'bending' of the beam can be done very fast to produce an apparently continuous line or 'trace' on the screen. This is exactly the same technique as that used to produce a TV picture, although the beam bending is usually done electromagnetically with a TV CRT. The trace on most general CROs is usually green. This is because the phosphor with the highest brightness, known as P31, gives off green light, although other phosphors, used for special purposes, can be different colours. The part of the tube that produces the electron beam is often called the electron gun, as it literally 'fires' electrons at the screen. As many modern scopes display two or more traces, it is necessary to have either more electron guns, or, more commonly, to switch the beam from one trace to the other so fast that the effect cannot be seen on the display. More of this later.

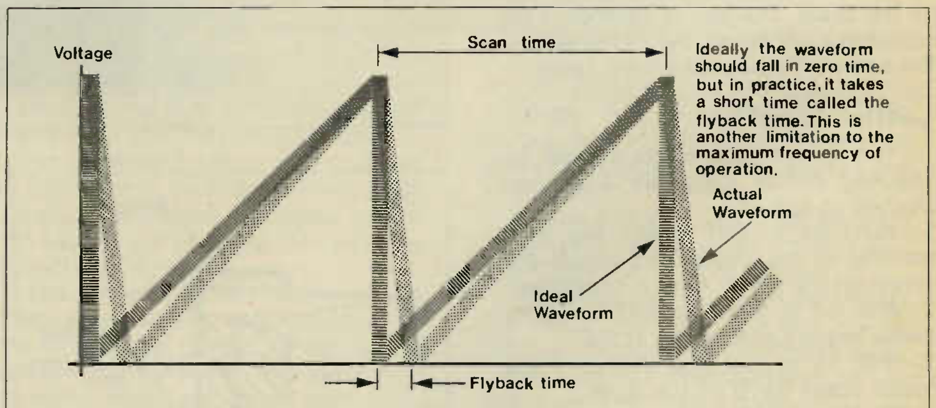


Figure 2. Timebase (sawtooth) waveform.

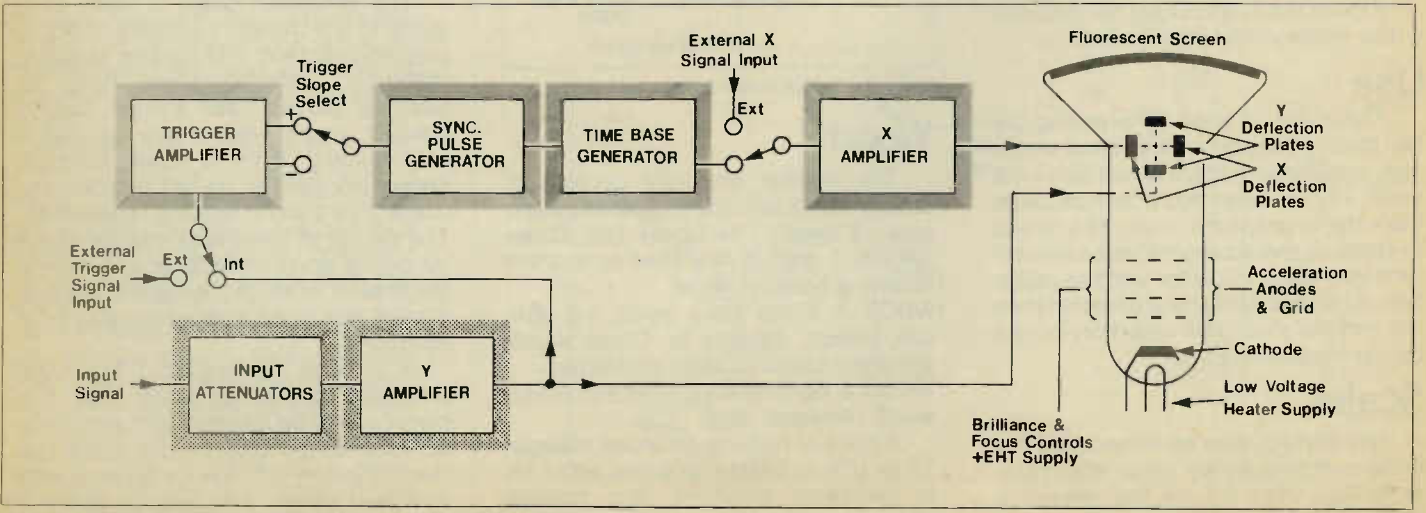


Figure 1. Block diagram of a CRO, showing just the basic parts.

Sweep Speeds and Triggering

The deflection plates are in two pairs, the X pair for horizontal deflection and the Y pair for vertical deflection. The Y plates are fed with a voltage from the Y amplifier which is proportional to the signal applied to the input. This in turn moves the electron beam a distance proportional to the voltage plates, because the voltage needed by the deflection plates is usually around 100V, and the signal of interest may only be 10mV, so a voltage gain of around 10,000 is required of the Y amplifier. This amplifier must also have a bandwidth at least as great as the maximum frequency of operation, i.e. a 100MHz CRO must have 0-100MHz bandwidth amplifiers. Anyone who has built a wideband amplifier will know the many difficulties and understand why the cost of scopes increases dramatically with bandwidth.

The X amplifier is similar to the Y amplifier, but in normal use it is fed with a different type of signal, known as a timebase. The timebase signal is a voltage waveform that increases proportionally with time, moving the electron beam across the screen at a steady rate. When the beam has crossed the screen the voltage is reduced quickly and the beam returns to the left, ready to start its next sweep. This waveform is shown in figure 2, and is a sawtooth waveform. A selector switch on the front panel varies the frequency of the sawtooth, which in turn varies the sweep speed. The speed is usually variable in steps from about 1cm/s to 1cm/us using this control. Thus, by applying a signal proportional to the input voltage to the Y plates, and a signal proportional to time to the X plates, a graph of voltage against time is displayed on the screen. Without additional circuitry the display would not be stable, and it would be difficult to see the displayed waveform.

It is necessary to synchronise the timebase with some point on the input waveform, i.e. the timebase starts its sweep across the screen at exactly the same point each time. The circuit which does this is called the trigger. Trigger circuits usually give the operator a choice of different operating modes; Internal, External, Line and TV are those usually found on moderately priced scopes. The essential difference between each mode is the source of the trigger signal. When internal is used the trigger signal is derived from the input signal, but external operation requires the input of the trigger signal to the external trigger socket on the scope.

TV triggering is a special purpose trigger normally used only when examining video signals at frame frequency. Line triggering uses the mains frequency as the synchronisation signal, and is useful when looking at ripple and hum waveforms that are at mains frequency. Most scopes also offer an automatic trigger position, which sets the trigger level for normal operation. When auto is not in use the trigger level will have to be set manually for the most stable display, using the trigger level control.

Display Methods

As previously mentioned, most modern scopes have two separate traces, usually derived from one electron gun. The electronic switching to obtain two traces takes two different forms, ALTERNATE and CHOPPED operation. The choice is left to the individual, as both have advantages over the other, hence the appearance of the CHOP/ALT switch as part of display mode controls. In alternate mode the upper and lower traces are scanned alternately (hence the name) i.e. the signal applied to channel one is displayed in one sweep time and then channel two waveform is displayed in the next. The vertical positions of the two traces can be altered of each other, allowing waveforms to be compared directly on top of each other if necessary. This mode of operation has the disadvantage of not necessarily displaying both signals in correct time relationship, i.e. two signals that are occurring at the same time may appear slightly displaced when alternate scanning is used. This is not a problem with chopped mode.

Instead of displaying a whole trace of one channel, then the other, as in alternate mode, a small part of one trace is displayed, then a small of the other. This continues until both traces are fully displayed. Thus the two traces are displayed together, and no distortion of the time relationship is possible. The main disadvantage of chopped operation is that for a good clear display the 'chopping frequency' should be at least 100 times greater than the frequency to be displayed. As the chopping rate is normally fixed, this limits the maximum frequency at which it can be used. Exceeding this limitation results in the waveforms appearing as a series of dashes on the screen.

To use a scope as a measuring instrument the calibration of the scale must be known. The scale is usually a grid of 1cm squares, with units of volts per cm vertically and seconds per cm horizontally. Both are variable, either in steps or continuously, giving typical scales of 50V to 10mV per cm and 5sec to 0·1 us. The time and voltage divisions are calibrated during manufacture, and the manufacturers data should be studied to obtain accuracy figures for the scope in use. For the majority of scopes ±3% of the displayed value is typical, and this should be remembered when deciding whether or not to use a scope for a particular measurement. As an example, if the display on the tube is 3cm high and the vertical amplifier is set to 1V per cm, the signal has an amplitude of 3V ± 3%. Note that there is often additional error caused by the thickness of the trace, therefore there is no point in measuring the height of the waveform as 3.125cm when the thickness of the trace is likely to be about 0.05cm. The focus and brightness controls should be set to produce a fine and clear line to minimise this form of error. An important point to remember is that excessive brightness can cause the phosphor on the screen to 'burn', producing dark spots on the screen which are permanent damage that can only be rectified by replacing the tube (expensive, even on cheap scopes).

Probes

No scope is of much use unless it can be connected to the circuit to be tested, and a piece of leftover mains cable will not do! The reason for this is that the world is full of electro-magnetic waves, produced by anything that uses electricity (including the scope itself), that are all too easily picked up by an unshielded cable. Nearly all scopes have socket inputs of the BNC type, and for the minimum requirements a scope lead may consist of about 2m of coaxial cable with a BNC plug at one end and a pair of small 'croc clips' at the other. Generally it is much better to use a proper oscilloscope probe. These are priced at around £15. Only two types are usually available to the hobbyist, the X1 and X10 multiplier probes, sometimes combined in one unit with a switch. A X1 probe has no effect on the input signal, and only serves to match the impedance of the scope to that of the circuit under test in such a way as to minimise distortion of the signal. A X10 probe is used for the same purpose, but also increases the input impedance of the scope, typically from 1M to 10M Ω. This is of use where the signal to be displayed comes from a high impedance source, i.e. very little current can be drawn without affecting the signal being studied. These probes also reduce the effective capacitance applied to the circuit, which is of greater value when higher frequencies are being used. The disadvantage of the X10 probe is that the signal into the scope is reduced by a factor of 10, hence any measurement of voltage will be 10 times too small, and must be multiplied by 10 to give a correct result. Other probes the reader may come across are 'active probes', which are to produce a very high input impedance, and 'current probes', which, when placed around a wire, produce a voltage output proportional to the current flowing in the wire. Under no circumstances should an oscilloscope be connected to a voltage greater than the maximum indicated by the manufacturer, or serious damage may occur.

Another common mistake is to connect the 'ground' of the probe lead to a point which is not at ground potential. For safety, the scope is connected to the mains ground, but it is not always true that the chassis of the equipment being tested is also grounded. Look at the circuit and make sure that you choose an earth point at earth potential, or current will flow in the earth conductor and probably blow a fuse, or worse!

Usage

Now that you have some idea of how a scope works, what can you use it for? DC voltage measurement is just a case of grounding the input, selecting DC coupling, setting the V/cm control to a suitable value, and positioning the trace on one of the grid lines. Applying the probe to a point on a circuit will give a deflection which can be interpreted as a voltage using the scale (remember to connect the ground lead to zero or ground potential). If an AC voltage is present the waveform can be seen, and its peak-to-peak value obtained. This is the voltage from the top to the bottom of the waveform. Most volt-meters are calibrated in RMS (root mean square) volts, and so if an RMS reading is wanted it must be converted. For a sinusoidal voltage the RMS value is 0.707 times the peak value, which is in turn half the peak-to-peak value e.g. a waveform of peak-to-peak value 10V has a peak value of 5V and an RMS value of 3.535V. Most scopes have a switch which allows the input to be either AC or DC coupled. When in the DC position both DC and AC voltage can be measured, but if there is only a small AC voltage with a comparatively large DC (as with ripple on a DC supply) it may be difficult to measure the AC component. By switching to AC coupling the DC can be removed and the AC can be easily measured.

As the X axis is calibrated in time, it is just as easy to measure the period, and hence the frequency, of a waveform. Once a stable display is obtained, using the trigger con-

continued on page 53

FOUR SIMPLE CIRCUITS

To follow on from his popular series Starting Point, Robert Penfold has produced some simple but useful circuits for the inexperienced constructor to try his or her hand at. We show veroboard layouts, circuit diagrams and parts lists — the rest is up to you. All you have to do is follow the instructions.

Portable Stereo Amplifier

This amplifier is battery powered and is built into a case about 500mm wide which also houses the two loudspeakers. It is intended for use with a personal stereo cassette player, radio, or radio/cassette unit, and it enables loudspeaker operation to be obtained without losing portability. In effect it converts a personal stereo unit into a conventional stereo radio or cassette unit, but when maximum portability is needed the personal stereo unit alone can be used.

The circuit is based on a LM377N dual audio power amplifier device, and the two power amplifiers in this device are rather like operational amplifiers having high current output stages. The amplifiers are used in the non-inverting mode with the non-inverting outputs biased to an internal potential divider circuit of the LM377N which has its output at pin 1. C9 provides decoupling of this bias voltage. The negative feedback loops give the amplifiers a voltage gain of only about 15dB (5.5 times), and a higher level of voltage gain would be pointless since personal stereo units provide a fairly high output voltage of about 1 volt RMS. Using a 12 volt supply (eight 1.5 volt dry cells or preferably ten AA NiCad cells) the circuit provides a maximum output power of about 1 watt RMS or so (per channel) at low distortion. The volume, balance, and tone are adjusted using the controls on the personal stereo unit.

When S2 is open R7 results in the two output signals being mixed together to a certain extent, but they are mixed in such a way that signals in both channels tend to partially cancel out one another, and this boosts the channel separation. With the limited loudspeaker separation of the unit this can produce a better stereo effect, but how well or otherwise this system works depends to a large extent on the programme source used. However, in most cases it seems to give a more spacious and realistic effect.

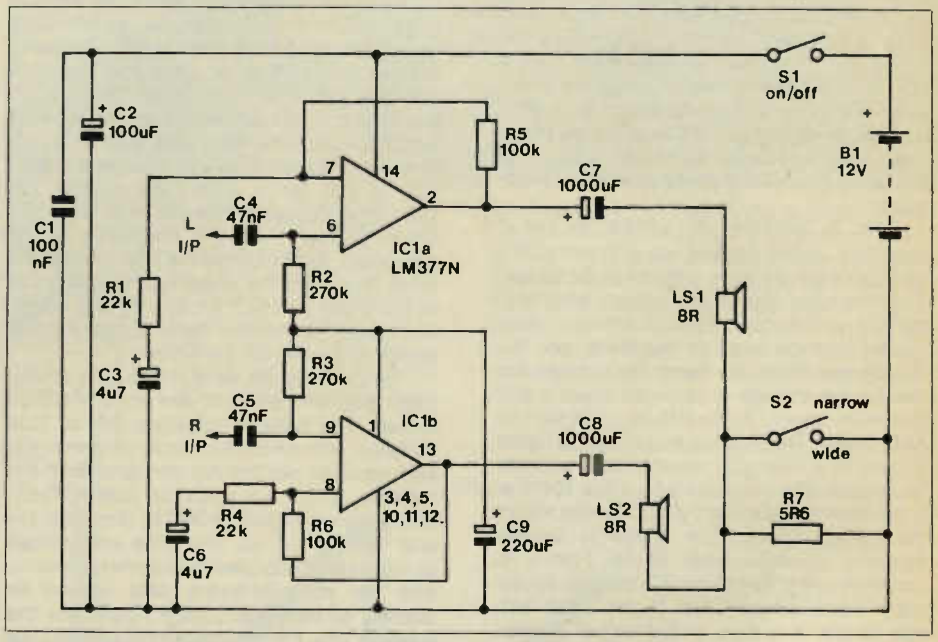


Figure 1. The portable stereo amplifier circuit diagram.

THE PORTABLE AMPLIFIER VEROBOARD ASSY PARTS LIST

Resistors — All 0.4W metal film 1%			
R1,4	22k	2 off	(M22K)
R2,3	270k	2 off	(M270K)
R5,6	100k	2 off	(M100K)
R7	5R6		(M5R6)
Capacitors			
C1	100nF polycarbonate		(WW41U)
C2	100uF 25V axial electrolytic		(FB49D)
C3,6	4u7 63V axial electrolytic	2 off	(FB18U)
C4,5	47nF polycarbonate	2 off	(WW37S)
C7,8	1000uF 16V	2 off	(FB82D)
C9	220uF 16V axial electrolytic		(FB61R)
Semiconductors			
IC1	LM377N		(QH36R)
Miscellaneous			
S1,2	SPDT sub-min toggle A	2 off	(FH00A)
LS1,2	Loudspeaker 6" x 4" 8R impedance	2 off	(WF50E)
B1	12V battery		
	Veroboard holes strips 0.1 inch matrix		
	Plastic or metal case		
	Connection wire as req.		(BL09K)

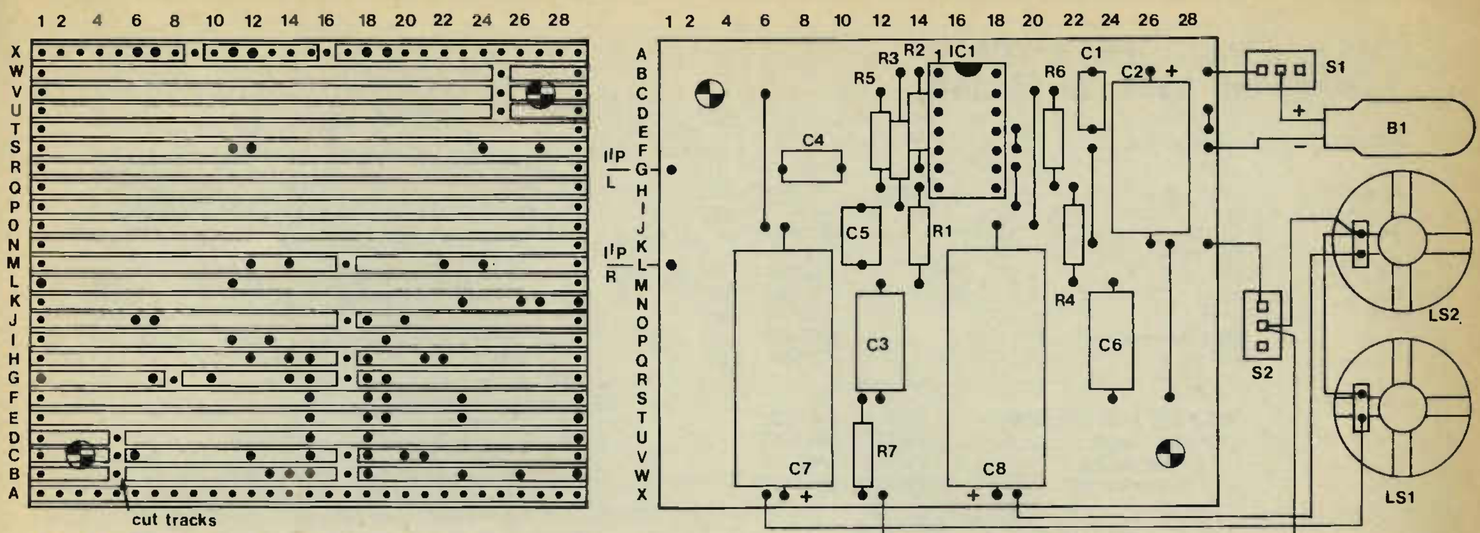


Figure 2. The veroboard layout and wiring for the PSA.

Sinewave Generator

Most Wien Bridge sinewave generator circuits use an expensive thermistor to stabilise the output signal level so that low distortion and no significant change in output amplitude with variations in output frequency are produced. This circuit uses an alternative approach with an automatic gain control circuit based on an operational transconductance amplifier being used to provide the output stabilisation. The noise and distortion performance is not equal to the best thermistor stabilised circuits, but at well under 1% it is more than adequate for most purposes including accurate frequency response measurements. There is no significant variation in the output level over the frequency range of the unit, which is approximately 15Hz to 150kHz in four ranges (15Hz to 150Hz, 150Hz to 1.5kHz, 1.5Hz to 15kHz, and 15kHz to 150kHz).

Normally circuits of this type use an operational amplifier with a controlled amount of negative feedback to maintain the voltage gain at the correct level,

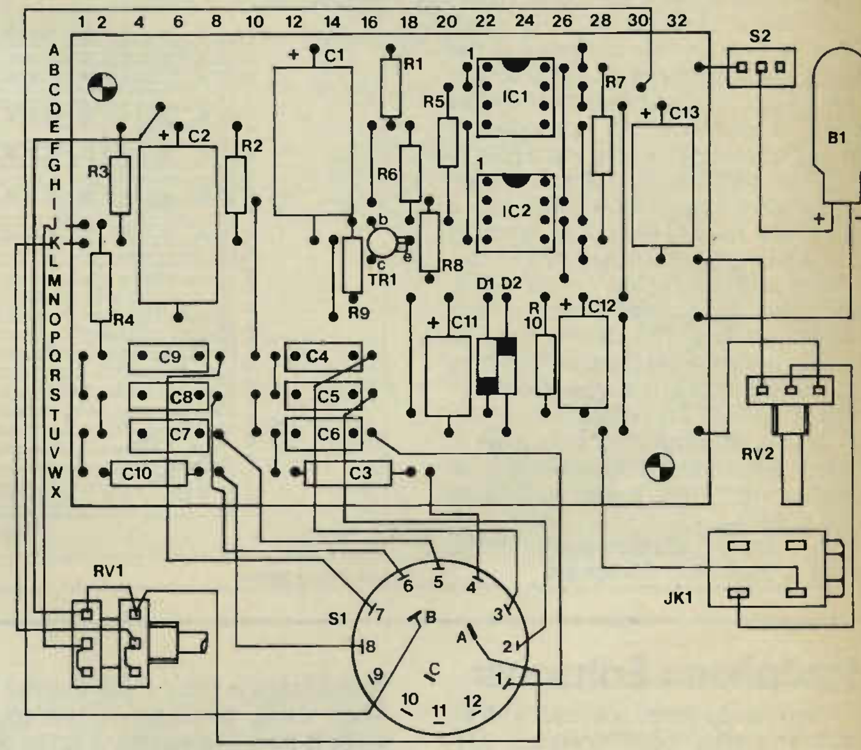


Figure 6. The wiring for the sinewave generator.

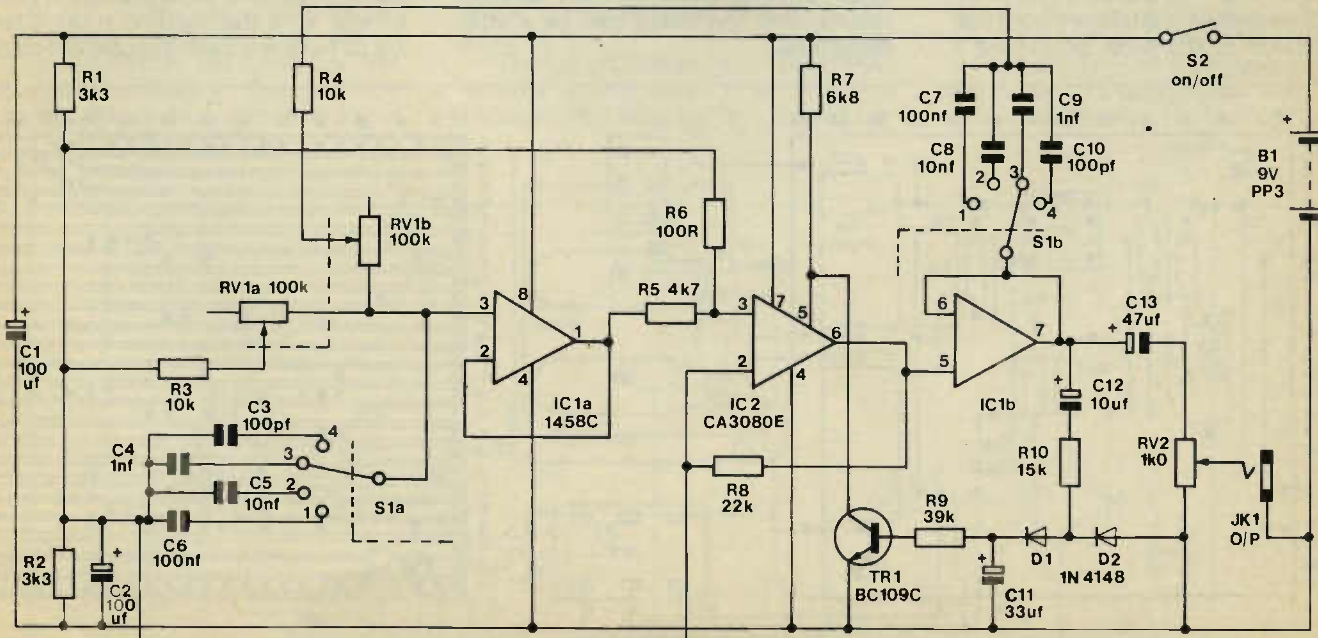


Figure 5. The sinewave generator circuit diagram.

THE SINEWAVE GENERATOR VEROBOARD ASSY PARTS LIST

Resistors — All 0.4W metal film 1%

R1,2	3k3	2 off	(M3K3)
R3,4	10k	2 off	(M10K)
R5	4k7		(M4K7)
R6	100R		(M100R)
R7	6k8		(M6K8)
R8	22k		(M22K)
R9	39k		(M39K)
R10	15k		(M15K)
RV1	100k dual pot lin		(FW88V)
RV2	1k0 pot lin		(FW00A)

Capacitors

C1,2	100uF 25V axial electrolytic	2 off	(FB49D)
C3,10	100pF 1% polysty	2 off	(BX46A)
C4,9	1nF polycarbonate	2 off	(WW22Y)
C5,8	10nF polycarbonate	2 off	(WW29G)
C6,7	100nF polycarbonate	2 off	(WW41U)
C11	33uF 16V axial electrolytic		(FB35Q)
C12	10uF 25V axial electrolytic		(FB22Y)
C13	47uF 25V axial electrolytic		(FB39N)

Semiconductors

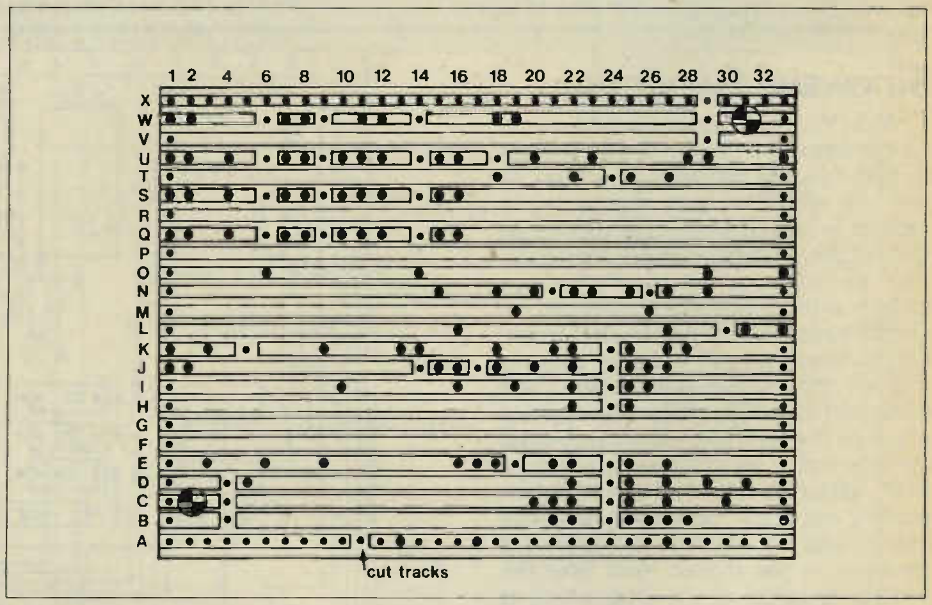
D1,2	1N4148	2 off	(QL80B)
TR1	BC109C		(QB33L)
IC1	1458C		(QH46A)
IC2	CA3080E		(YH58N)

Miscellaneous

S1	3-pole 4-way rotary Sw 4B		(FF75S)
S2	SPST sub-min toggle A		(FH00A)
JK1	Jack socket mono plastic		(HF90X)
B1	PP3 battery		
	PP3 connector		(HF28F)
	Veroboard holes strips		
	0.1 inch matrix		
	Plastic or metal case		
	Connection wire as req.		(BL09K)
	Knob	3 off	

but in this case a current controlled amplifier based on a CA3080E transconductance amplifier (IC2) is used. IC1 is used to provide buffering at the input and output of the amplifier so that it has a high input impedance and a low output impedance. R7 provides a strong bias to the amplifier input (pin 5) of IC2 so that the circuit has a high voltage gain and initially produces a high output level of low purity. Some of the output signal is coupled by C12 to a rectifier and smoothing circuit which generates a positive bias which switches on TR1. This diverts some of the bias current from the amplifier bias input of IC2, and by a simple feedback action stabilises the output level of the circuit at approximately 2 volts peak to peak. RV1 enables the output level to be adjusted from this maximum figure down to zero.

The current consumption of the circuit is about 4.5 milliamps.



Veroboard layout.

Headphone Enhancer

When headphones are used with an ordinary stereo (non-binaural) programme source proper stereo imaging is not obtained. The stereo image when using loudspeakers stretches from one loudspeaker to the other producing a sound-stage in front of the listener, but when using headphones the sound-stage is from one earphone to the other and therefore within the listener's head! This obviously gives far from realistic results, and the effect can be a little disturbing.

There are ways of obtaining a more spacious effect, and the most simple of these is to reverse the phase of one channel so that the two channels are out of phase and fail to produce a stereo image. With this method sounds tend not to have any definite apparent origin,

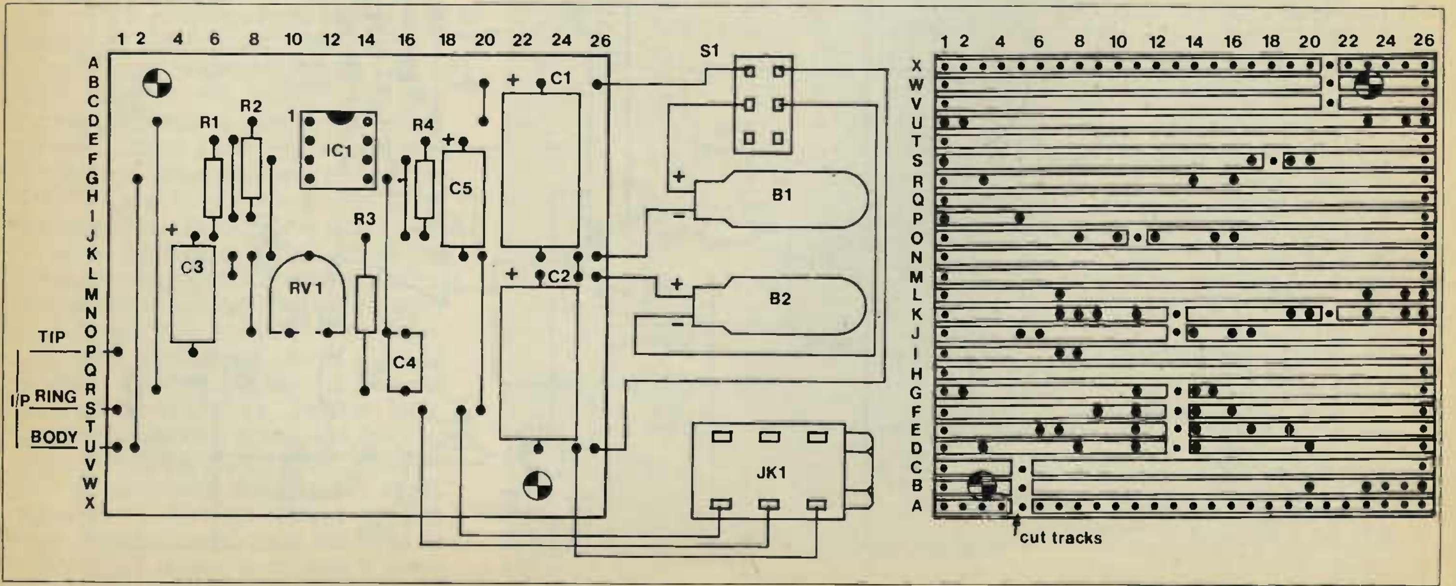


Figure 4. The veroboard layout and wiring for the headphone enhancer.

but have a vagueness in this respect. A better effect is produced using a compromise between normal stereo and out of phase stereo, with the two channels in phase at some frequencies and out of phase at others. This gives a more vague and spacious effect than normal stereo, but does not totally destroy the stereo imaging.

The circuit shown here is a simple phase shift circuit which can be used as a headphone enhancer. IC1a is a straightforward inverter, and IC1b is used as a conventional phase shifter. At low frequencies C4 has no significant effect and IC1b acts as an inverter so that there is no phase shift through the circuit as a whole. At higher frequencies the coupling to the non-inverting input through C4 reduces the phase shift provided by the circuit. This gives zero phase shift at the highest audio frequencies, and a 180 degree phase shift through the circuit as a whole. R5 is used to control the point at which the transition from zero phase shift to 180 degree phase shift commences, and with this component at minimum the circuit gives no significant phase shift at audio frequencies (i.e. normal stereo). At maximum value a large phase shift is produced over much of the audio spectrum. In practice this component is set to give the best subjective results.

The enhancer can be used in either stereo channel, and the output will drive low, medium, or high impedance headphones satisfactorily.

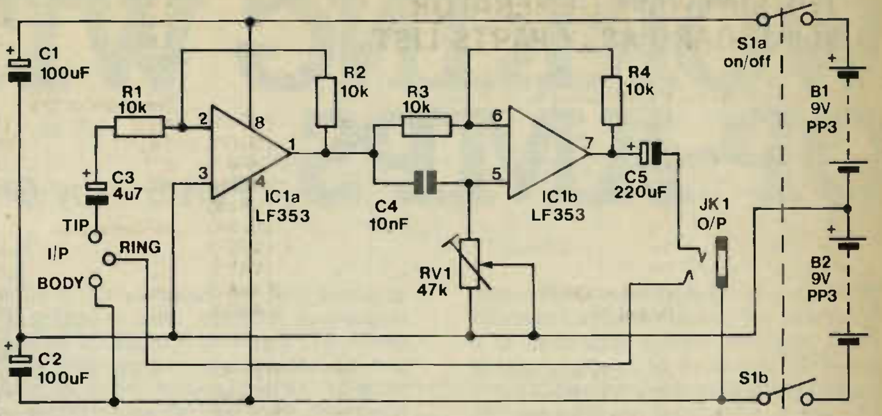


Figure 3. The headphone enhancer circuit diagram.

THE HEADPHONE ENHANCER VEROBOARD ASSY PARTS LIST

Resistors — All 0.4W metal film 1%			
R1,2,3,4	10k	4 off	(M10K)
RV1	47k hor. s.min preset		(WR60Q)
Capacitors			
C1,2	100uF 25V axial electrolytic	2 off	(FB49D)
C3	4u7 63V axial electrolytic		(FB18U)
C4	10nF polycarbonate		(WW29G)
C5	220uF 16V axial electrolytic		(FB61R)
Semiconductors			
IC1	LF353		(WQ31J)
Miscellaneous			
S1	DPDT sub-min toggle E		(FH04E)
JK1	Jack skt std		(HF92A)
	Jack plug stereo plastic		(HF88V)
	Cable twin (as required)		(XR21X)
B1	PP3 battery	2 off	
	PP3 connector	2 off	(HF28F)
	Veroboard holes x strips		
	0.1 inch matrix		
	Plastic or metal case		
	Connection wire (as req.)		(BL09K)

Stylus Organ

Conventionally a stylus organ uses a simple oscillator in conjunction with low frequency amplitude or frequency modulation (tremolo or vibrato) to produce a more interesting and musical sound than that given by an unmodulated oscillator. This circuit uses an alternative approach and has two audio oscillators. One of these produces the main audio tone signal while the other is a few hertz off-tune and mixed with the main signal at about -10dB. This gives a much "richer" sound than using a single oscillator and in this respect the circuit is at least equal to conventional designs, if not superior.

The two oscillators each use a CMOS 4046BE device which is a low power phase locked loop, but only the voltage controlled oscillator section of each 4046BE is used in this circuit, plus the internal 5 volt zener diode of IC2 which gives a stabilised supply for the tone generators in conjunction with load resistor R4 and decoupling capacitor C1. A number of 100k preset resistors are used to provide a series of voltages which give the appropriate notes from the tone generator. Thirteen presets are

continued on page 63

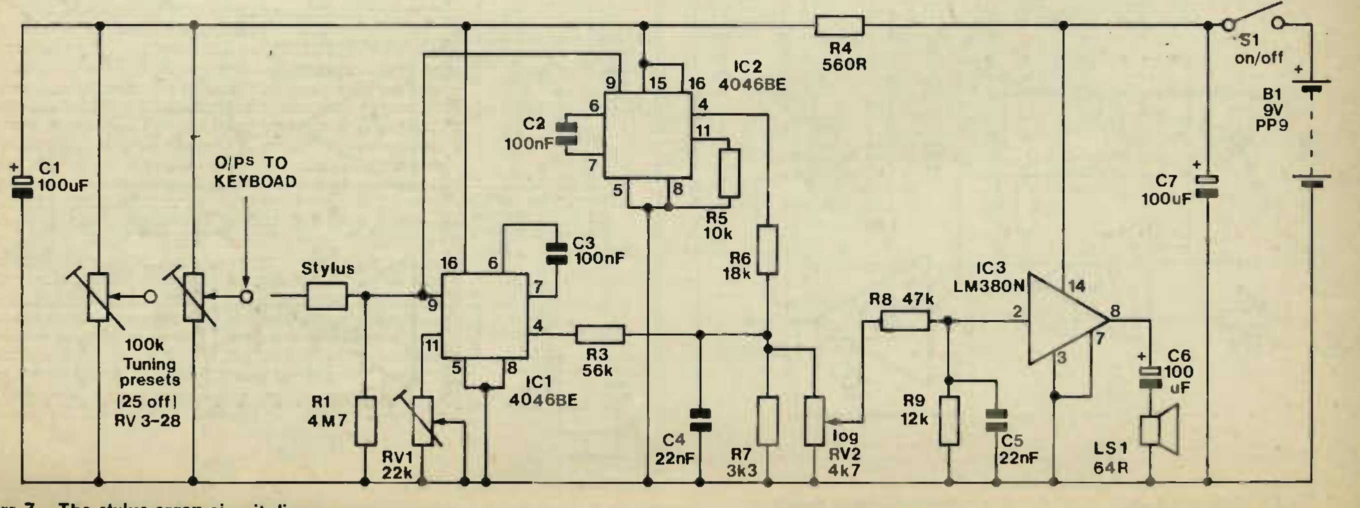


Figure 7. The stylus organ circuit diagram.

WORKING WITH OP-AMPS

Part 5 *by Graham Dixey C.Eng., M.I.E.R.E.*

The circuits which follow are mainly concerned with measurements. The ability to measure various quantities to a reasonable degree of accuracy is vital in electronics. Because of the nature of a signal or its source, amplification is often needed, either to raise the signal level to a value high enough to drive a moving-coil meter, for example, or to 'buffer' a high impedance source. In other instances an amplifier may be used in such a way as to 'linearise' the measurement of passive quantities such as resistance and capacitance, so improving scale readability and accuracy. These are all possible applications for the ubiquitous op-amp. Some of the circuits described point to possible applications of the op-amp in a particular role; others are complete instrument designs (albeit not very sophisticated) in themselves, ready to be engineered into useful tools for the work-bench. It is hoped that they are all of some interest.

Peak Signal Detector

Voltmeters for measuring a.c. are often 'mean-sensing, r.m.s. calibrated' for sine-wave inputs. Sometimes there is a need for a meter that will read peak values of any waveform, the peak signal detector can be used as the basis for such an instrument.

The circuit is shown in Figure 1 and employs two op-amps. One of these, IC1, is the peak detector proper while IC2 is used as a voltage follower to isolate the detector from the output. The function of the circuit is to develop and retain (temporarily) the peak value of an input voltage, whatever the waveform of that input. As shown, the circuit responds only to positive peaks because of the polarity of diode D1. If this diode is reversed then the circuit will respond to the negative peaks instead. Of course, if the input waveform is symmetrical it hardly mattters which peak is being measured since both are the same. However, for asymmetric waveforms it may be useful to be able to measure either peak value at will or even total peak to peak value.

Now for the operation of the circuit. If it is assumed that the capacitor C1 is initially uncharged (perhaps after re-setting with switch S1) then only if diode D1 conducts can C1 acquire any charge. This will be achieved for any positive input, no matter how small, since the high gain of the op-amp will ensure that D1 is forward-biased. To appreciate the scale of this statement, assume that the diode needs 0.6V of forward bias and the op-amp gain is 10^5. Then the peak input signal to cause the diode to conduct (just) is $0.6/10^5$=6 microvolts. Thus, the circuit is capable of responding to very small signal levels though it will undoubtedly need some gain later to make use of it, even assuming that 'noise' doesn't get into the act. An essential feature of the circuit is that it remembers the largest peak applied to it; the voltage developed across C1 only changes upward, never downward (except that the charge on C1 decays slowly once the input level has been reduced). Thus, if three successive positive peaks, of values 1V, 3V and 2V are applied to the circuit, it will store the 3V peak and disregard the later 2V peak. This happens because whenever the input voltage is less than the capacitor voltage, the diode becomes reverse-biased and there is only the input impedance of the op-amp as the discharge path for C1. To answer the question, 'when does the capacitor stop charging up?', the answer is that it does so when the voltage at the inverting input equals that at the non-inverting input.

Figure 2 shows the ideas of Figure 1 extended to measure peak to peak values of any waveform. IC1 and IC2 respectively measure the positive and negative peaks of the input waveform. These peak values, V_{p1} and V_{p2} may or may not be equal. The total peak to peak excursion is $V_{p1} + V_{p2} = V_{pt}$. This 'total' voltage is developed by using a 'subtractor' circuit, based on IC3. This works because the output of IC3 is the difference between its two inputs which are of opposite sign anyway. Thus,

$$V_{pt} = V_{p1} - (-V_{p2}) = V_{p1} + V_{p2}$$

The Linear Rectifier

This circuit, shown in half-wave form in Figure 3, uses the high gain of the op-amp to 'linearise' the conduction of a rectifier diode. As is well known, a silicon diode needs about 0.6V in the forward direction before conduction commences; which means, of course, that at low signal levels the d.c. output may be negligible or zero. Linearising the operation means that the rectifier output is made to be directly proportional to the signal input, whatever its size. Characteristics for normal and linear operation are also shown in Figure 3.

The circuit acts as an inverter, the point being that the feedback loop is only completed when one or other diode conducts. Up to this point the op-amp operates at full open-loop gain. This means that if the open-loop gain is, say, 10^5 then the input required to start a diode conducting is about 6 microvolts. Once a diode is conducting the gain is unity since it is then defined by either R2/R1 (negative half-cycles) or R3/R1 (positive half-cycles), the usual expression for the gain of an inverter. Two outputs are available, either positive or negative going. The circuit does not have to be used at unity gain. For example, if R2 and R3 are both increased to 100kΩ, the gain is slightly less than five.

If a full-wave rectifier is required, the circuit of Figure 4 can be used. The two separate outputs of the original circuit are each given unity gain by a second op-amp IC2 and, at the same time, the negative half-cycles are inverted to give a full-wave output.

High Impedance d.c. Voltmeter

A limitation of moving-coil multimeters is their low terminal impedance for small voltages. For example, if a typical sensitivity of 20kΩ/V is considered when the voltmeter is on the 3V range, then the impedance that the meter presents to the test circuit is only 20 × 3 = 60kΩ, which may not always be

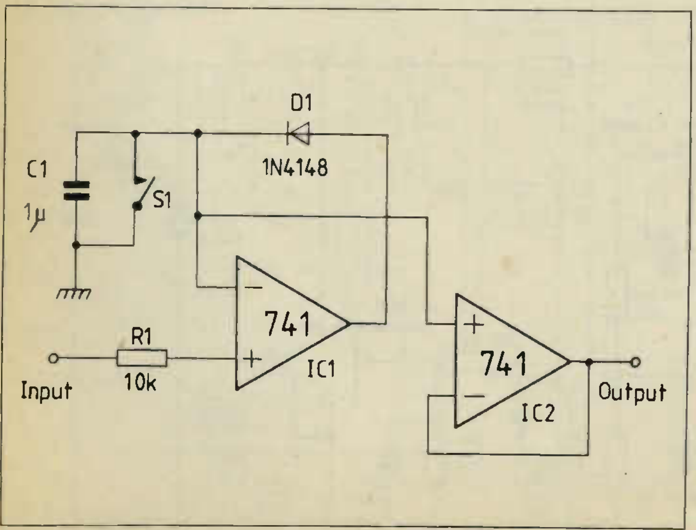


Figure 1. Peak Voltage Detector

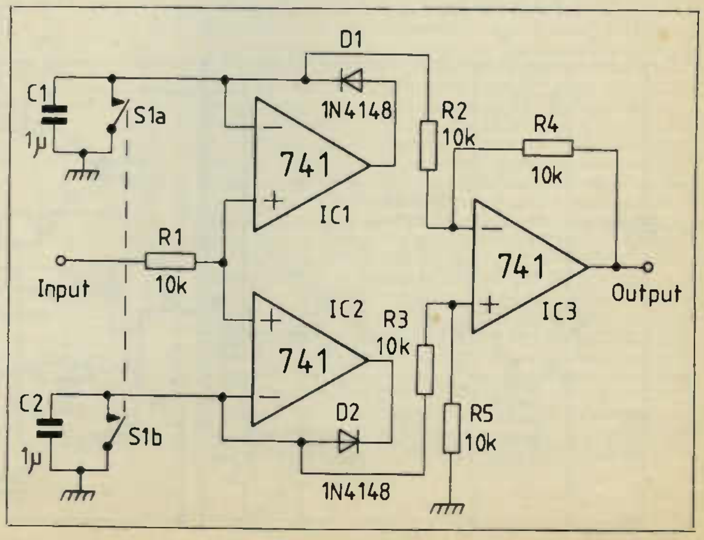


Figure 2. Peak to Peak Voltage Detector.

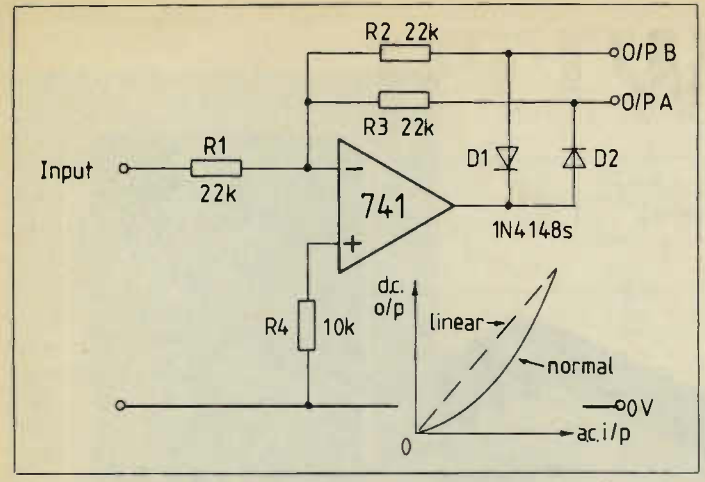


Figure 3. Linear Rectifier (Half-wave)

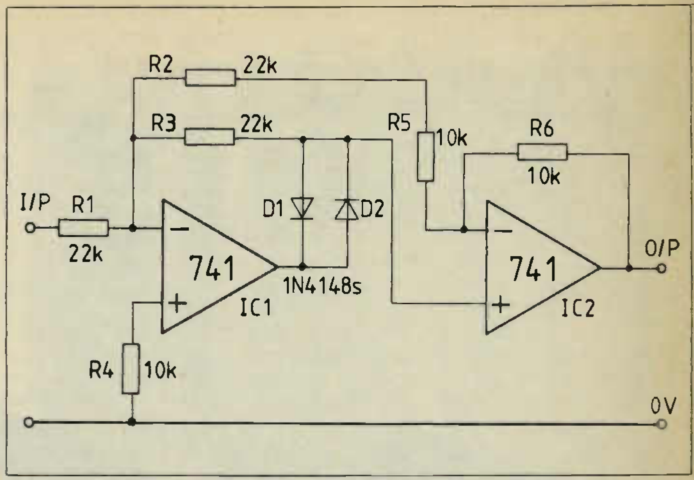


Figure 4. Linear Rectifier (Full-wave)

high enough. This is because the lack of any amplification means that the meter has to draw all of its current from the test circuit. Using the op-amp allows gain to be interposed between the test point and the meter. Hence, two advantages accrue; the input impedance is increased and smaller voltages can be measured with an accuracy not possible with conventional multimeters.

There are a variety of ways of achieving these aims and Figure 5 shows an approach based on the use of an op-amp in the non-inverting mode. The gain is determined by R8, RV2 and R9 and is set at 200 by these values. Since this gain is only required at the lowest full-scale input value (100mV), an input attenuator is used (R1-R6) to reduce the input level on other ranges. Any of the full-scale inputs will give 10V d.c. at the output of the op-amp thus, if using a 1mA meter, R7 and R10, together with the resistance of the meter should equal 10kΩ. The arrangement is not critical since RV2 is used to make slight gain adjustments i.e. is used to calibrate the instrument.

The result is an instrument that will measure direct voltages down to a few millivolts at an input impedance always better than 100kΩ.

A Linear Ohmmeter

The measurement of resistance is usually carried out in one of two ways, either with a bridge or, more likely, using the resistance facility of a multimeter. A bridge that is of any real use is likely to be expensive so that the amateur (and many professionals) resort to the multimeter to sort out the values of unknown resistors. Unfortunately, because of the basic principle on which it works — deflection being inversely proportional to resistance — the scale is decidely non-linear. This is acceptable for rough and ready checks but rules out measurements of any precision. Once again the op-amp comes to the rescue; since the gain of an inverting amplifier is directly proportional to the value of its feedback resistor then, for a constant and precise input, the output is directly dependent upon the value of this feedback resistor. By making the unknown resistance act as the feedback resistor, the output obtained, indicated on a moving-coil meter, directly relates to the unknown resistance. The idea can be extended to measure different ranges of resistance by switching in different values of input resistor. The circuit is shown in Figure 6.

The part of the circuit centred on transistor Q1 provides a stable standard voltage — in this case 1V. This is adjusted precisely by means of RV1 when a voltmeter is connected between its wiper and 0V to set up this standard value. This stabilised voltage is the constant input to the inverting amplifier. The input resistors are R3-R6 and their values are equal to the full-scale resistance value of the range selected. Thus, as shown, there are four ranges, selected in decades, from 1kΩ to 1MΩ full-scale. Obviously alternative values could be used although those shown are probably as useful as any. A pair of terminals is provided for the unknown resistor Rx and these are shunted by a 1kΩ resistor R8 in series with a normally closed push-button switch. Some arrangement like this is necessary to protect the meter because, if the Rx terminals are open while power is applied to the circuit, the amplifier will then have its full open-loop gain with the result that the output will go into negative saturation. The result would be that the meter pointer would endeavour to wrap itself around the end stop. With R8 equal to 1kΩ, the gain can never exceed unity when S2 is closed. Pressing S2 replaces the 1kΩ resistor with Rx and the meter will read its value. Similar reasoning

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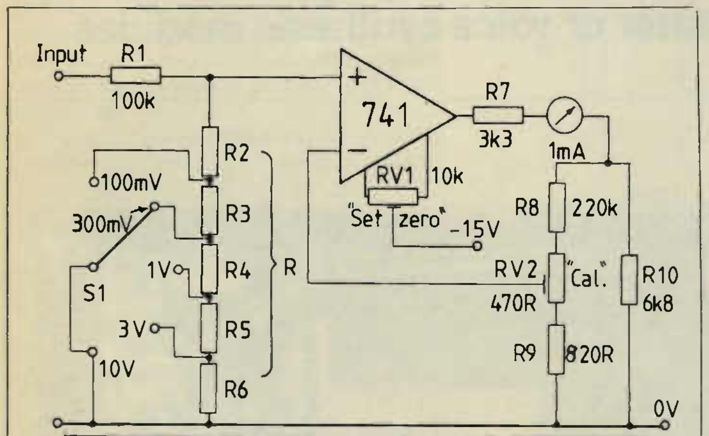


Range	Resistor ratio	R value	Practical value of R
100mV	2 : 1	100k	100k
300mV	6 : 1	20k	18 + 2.2 = 20.2k
1V	20 : 1	5.26k	4.7 + 0.56 = 5.26k
3V	60 : 1	1.69k	1 + 0.68 = 1.68k
10V	200 : 1	500R	220 + 270 = 490R

Figure 5. High Impedance d.c. Voltmeter

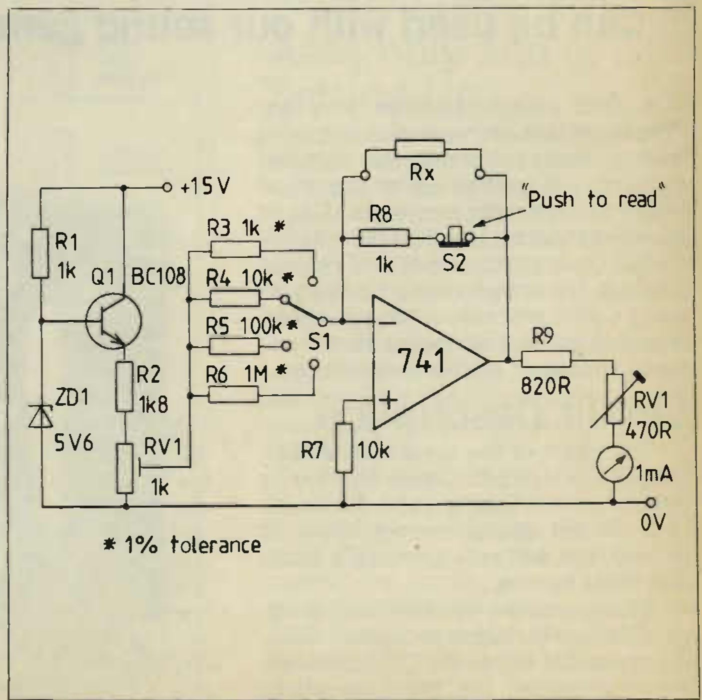
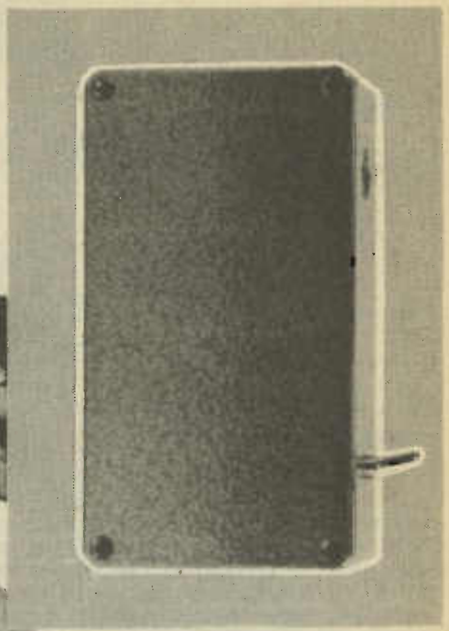


Figure 6. Linear scale Ohmmeter



ZX81 TV SOUND AND NORMAL-INVERSE VIDEO

by Dave Goodman

- **Audio input for sound on TV speaker**
- **Video reversing switch for normal or inverted display**
- **Can be used with our sound generator or voice synthesis modules**

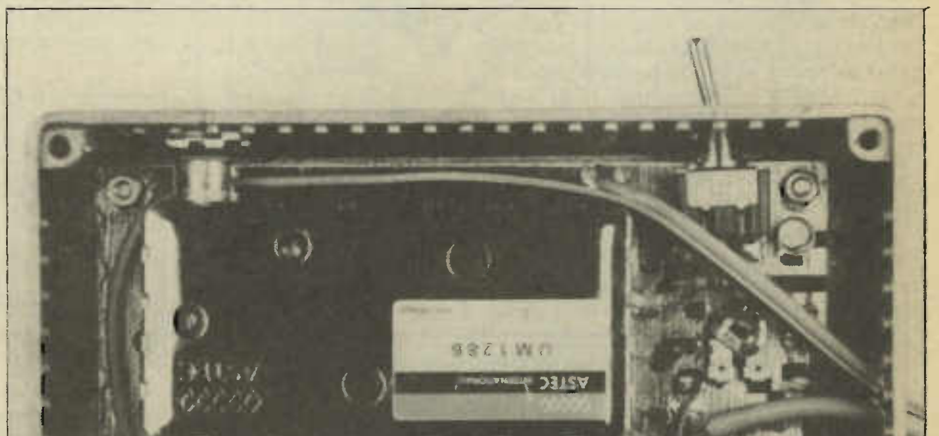
Sound effects, whether they are taped voice for narration purposes or 'laser blasters' and 'photon zappers', will give an added degree of reality to computer programs. This is especially true for the ZX81, with its low resolution Graphics mode and Plotting displays, but unfortunately facilities for audio signal processing have not been included as part of the system hardware, and must be fitted externally.

Circuit Description

The heart of the system is MODULATOR 1, which produces a 591.5 MHz vision carrier. This is used to drive a UHF TV set (either monochrome or colour), but will only produce a black and white picture.

All necessary video modulation signals, along with frame and sync pulses, are produced within the ZX81 circuitry. Figure 4 shows the basic waveform connected to pin 4 (the video input).

An externally produced audio signal



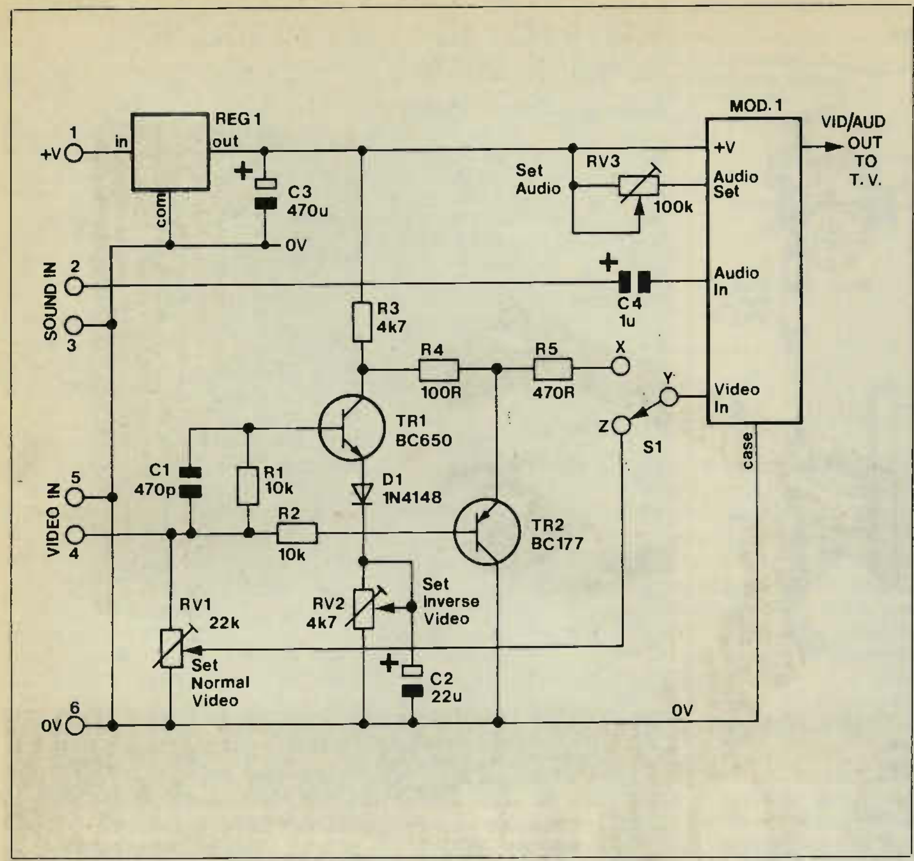


Figure 1. Circuit diagram

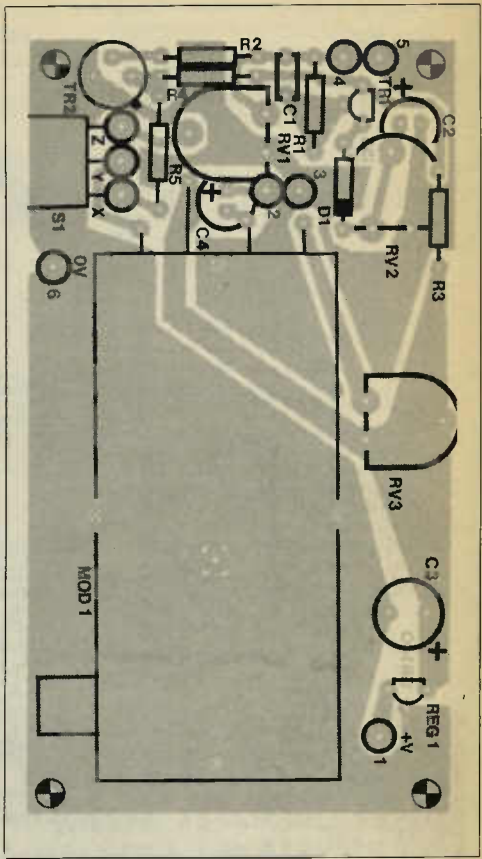


Figure 2. PCB and legend

is connected to pin 2, via C4, to MOD 1, and this is used to frequency modulate a 6 MHz sound carrier that is generated internally. Both video and sound sub-carriers are then added to the vision carrier, and the input to the TV set is via the aerial socket. RV3 can be adjusted to 'tune' the audio signal carrier if required, and RV1 can be set to give the desired contrast level on the TV display (see setting up details).

To achieve a satisfactory sound output from the TV speaker a minimum of 100mV peak input level is needed, but signals in excess of 1V peak may produce distortion, and will need to be attenuated with a suitable resistor. Note that Maplin sound modules develop the correct signal levels, and will not need adjusting.

REG 1 has been added so that the positive rail (pin 1) can be connected to a separate PSU or to the ZX81 PSU direct, with a dual 3.5mm connector. This saves taking the computer +5V rail into the outside world with possible disastrous consequences.

As an extra facility to this project, circuitry has been added to invert the produced display, for white printing on a black background. This effect can be invaluable if eyestrain is to be prevented when using the computer for long periods. To produce this effect it is necessary to invert the video waveform before connecting into MOD 1, but if the composite signal is inverted, the frame and sync pulses will be also, and the picture will be lost. The waveform in figure 4 shows the correct levels for operation and TR1 inverts both video and sync signals. RV2 sets the conduction point of TR1 so that the peak black and white signals can be adjusted

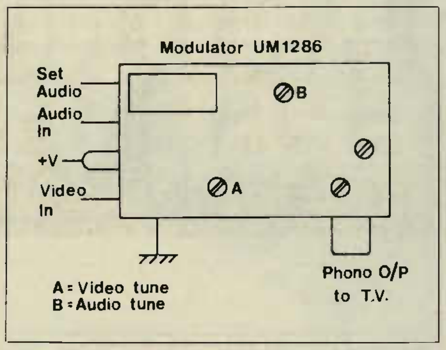


Figure 3. Modulator pin-outs

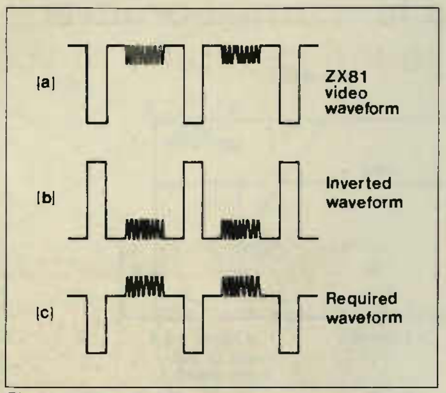


Figure 4. Waveforms

for definition. TR2 conducts to the negative sync. pulse, and pulls the potential set at R4 and R5 down to 0V, keeping the sync pulse negative but allowing the video to remain inverted. S1 selects either inverted or normal video, so that preprogrammed cassettes can be used without problems. Note that no facility exists for driving a monitor screen, although the video in, from S1, could be connected by an emitter follower for this use, but this would be a matter for further experimentation.

Construction

Building the project is quite straightforward. Ensure that the 0V pins 3 to 5 and 6 are soldered to both sides of the PCB 0V (earth plane). MODULATOR 1 has four legs, which go through the PCB and solder onto the track underneath. Make sure that REG 1, TR1, and TR2 have been inserted the right way round (see legend), and that D1, C2, C3 and C4 are correctly orientated.

When soldering make sure that no shorts exist between tracks on both sides of the PCB. Clean any excess solder from the PCB before use.

Assembly and Setting Up

I must stress here that extreme caution should be exercised when soldering to the ZX81. It is very easy to damage the computer by faulty workmanship, and any manufacturing guarantees will probably be forfeit if this happens, so follow all the instructions carefully.

For all adjustments to pots and dust cores it is advisable to use a plastic trimming tool, as this will eliminate the possibility of damage occurring from breakages.

Set the wipers of RV1, RV2 and RV3 to central positions, then refer to figure 5 connection diagrams. Remove the ZX81 PCB from its case and snip the centre wire coming from the UM1233 modulator halfway between it and the PCB. Take a piece of connecting CO-AX cable, strip both ends about 15mm down and separate the mesh screen from the inner conductor. Twist, tin, and solder the screen to the outside

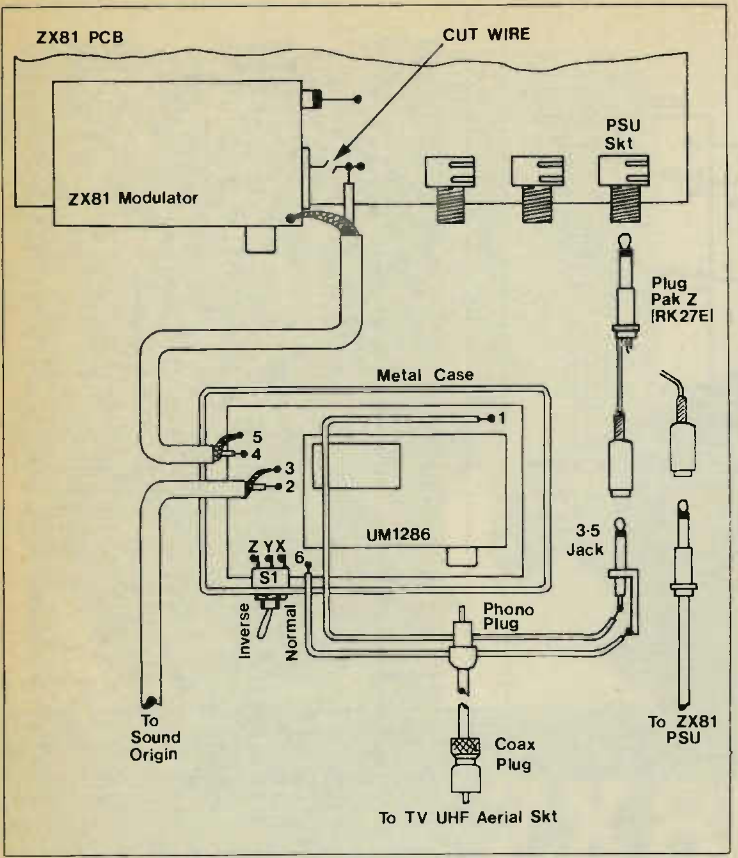


Figure 5. Connections to the ZX81 and TV

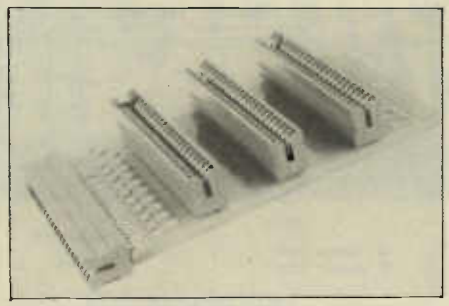
PARTS LIST FOR ZX81 TV SOUND/ INVERSE VIDEO

Resistors — All 0.4W 1% Metal Film			
R1,2	10k	2 off	(M10K)
R3	4k7		(M4K7)
R4	100R		(M100R)
R5	470R		(M470R)
RV1	22k Hor sub-min Preset		(WR59P)
RV2	4k7 Hor sub-min Preset		(WR57M)
RV3	100k Hor sub-min Preset		(WR61R)
Capacitors			
C1	470pF ceramic		(WX64U)
C2	22uF 16V PC elect		(FF06G)
C3	470uF 16V PC elect		(FF15R)
C4	1uF 35V tantalum		(WW60Q)
Semiconductors			
D1	1N4148		(QL80B)
TR1	BC550		(QB74R)
TR2	BC177		(QB52G)
REG1	uA78L05AWC		(QL26D)
Miscellaneous			
MOD1	UM1286		(BK66W)
	Circuit Board		(GB14Q)
	Veropin 2141	1 Pkt	(FL21X)
	Box DCM5004		(LH71N)
	C/S screw 6BA × ½"	1 Pkt	(BF12N)
	Nut 6BA	1 Pkt	(BF18U)
	Washer 6BA	1 Pkt	(BF22Y)
	Spacer 6BA × ¼"	1 Pkt	(FW34M)
S1	Switch sub-min toggle A		(FH00A)
	Plug pak Z		(RK27E)
	Plug plas 3.5		(HF80B)

A complete kit of parts is available for this project.
Order As LK02C **Price £19.95**

edge of the ZX81 modulator case. The inner conductor is then soldered to the cut video input wire protruding from the PCB. The other end of the CO-AX cable goes to pin 4 and pin 5 (0V) on the sound module.

For the positive supply it is advisable to use Plugpak Z (RK27E) and a 3.5mm plug (HF80B) with the plug tip connecting to positive (pin 1). Supplies between +8V and +30V may be used here, so it can be safely connected to the ZX81 PSU using the recommended adaptor. Solder the plug sleeve to 0V (pin 6).



The ZX81 Extendiboard.

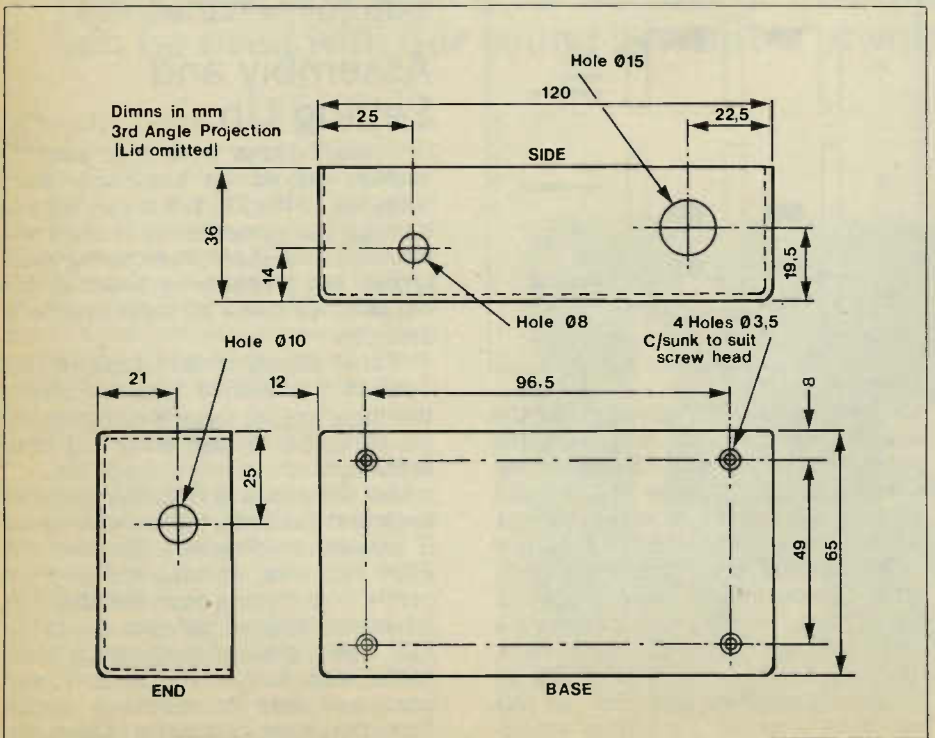


Figure 6. Box drilling details and dimensions

Your Sinclair PSU will then plug into the remaining socket on the plugpak, which then connects into the ZX81 power socket.

Fit a phono to CO-AX lead between the sound module and TV set, then switch on both PSU and TV. Tuning should be around channel 35. Position S1 to the 'NORM' mode and the 'K' cursor will appear as normal, but if the picture is grey or lacking contrast then adjust RV1.

Set S1 to the 'INV' mode and adjust RV2 for peak black background and minimum white streaking. Try entering a CHR$ SET print routine for full character display, then balance RV1 and RV2 in appropriate modes for picture clarity. Note that TV contrast and brightness may need to be adjusted when switching between modes.

Audio signals should be connected to pins 2 and 3 (0V) with screened cable. Approximately 100mV peak signal is required, although levels up to 1V peak may be acceptable. Apply a sound source, either a signal generator or a sound producing module if you possess one, to the audio input. Slight retuning of the TV may be necessary to balance sound and video reception. Switch between modes (S1) and ensure that sound is available on both settings.

Figure 3 shows the UM1286 MODULATOR and tuning cores. Although not advisable, slight adjustment of the two marked A and B can be made with a plastic trimming tool for improved sound and picture reception, but only do this if you feel there is real room for improvement. It is recommended that you fit this project into a box, and figure 6 shows drilling positions for the switches and sockets etc.

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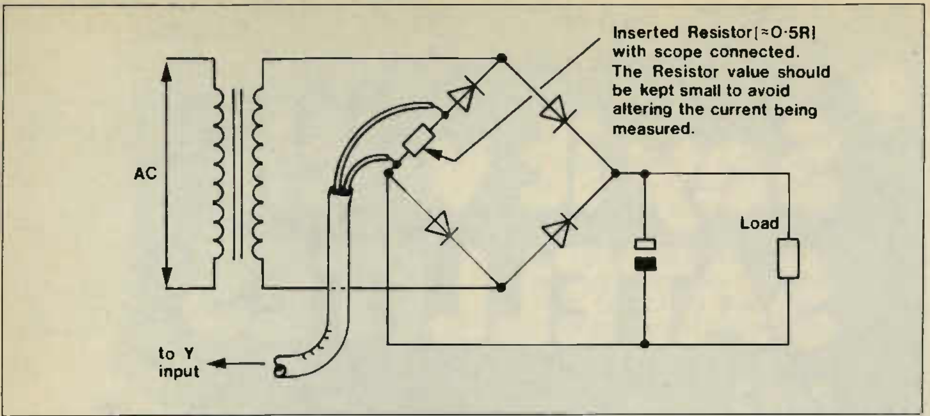
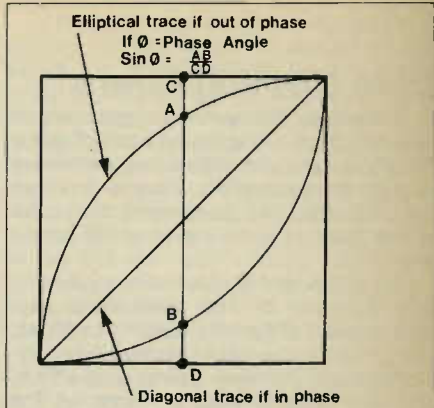


Figure 3. Using a resistor to see a current waveform.



CD is the maximum height of the trace.
AB is the height of the ellipse at its centre.
For accuracy adjust gain for a large as possible display. The diagonal will be the other way if the signals are 180°out of phase.

Figure 4. Phase measurement using Lissajou figures.

trols, the period can be measured as the time taken for a given point in a waveform to re-occur, e.g. if a waveform completes one cycle in one cm on the screen and the time/division selector is at 1ms per cm, then the period is one millisecond, and the frequency, given by the reciprocal of the period time, will be 1kHz.

Time and voltage measurement are the basic functions of an oscilloscope, but it is not difficult to use it for other purposes. If you need to see a current waveform, then a known resistor, small enough not to greatly affect the circuit under test, can be put into circuit, and the scope connected across the resistor. The voltage waveform on the screen will then be proportional to the current flowing in the resistor, as V=IR (see figure 3). A current probe uses a different principle, which does not affect the circuit, but these are very expensive, certainly much dearer than a resistor, and not widely available.

Another quantity of interest is phase. This can be seen on a scope by displaying the waveforms on a dual beam scope (preferably using chopped mode) and measuring the time displacement by direct comparison. An alternative can be used when there is an external X input and both waveforms are sinusoidal. The two signals are fed to the X and Y inputs, producing what is known as a Lissajou figure. This will be a diagonal straight line if the signals are in phase, but will appear elliptical if there is a phase difference. Figure 4 shows the display and how to obtain the phase angle value.

Fault-Finding

To use a scope as a test or fault-finding instrument, it is of course necessary to know what waveform is to be expected of a given point in a circuit. This information can often be found in service manuals, but an understanding of how a circuit works is essential if a scope, or indeed any other instrument is to be used for fault-finding. Fortunately many of the circuits published in the hobbyist magazines have detailed descriptions of how each circuit works, and these can be of great help. Often it is possible to 'follow' a signal through a circuit from input to output, and see with a scope what each part of the system is doing. In this way each part is checked until an unexpected result appears, indicating a fault.

There are many books on the subject of fault-finding with a CRO, and they cover in greater detail than is possible here how to check different types of circuits. With experience you may be able to quickly find faults in the most complicated equipment with only a scope. As the cost of these useful instruments decreases, a scope is more and more representing a worthwhile investment to any serious electronics enthusiast, and will help him or her to a greater understanding of their hobby.

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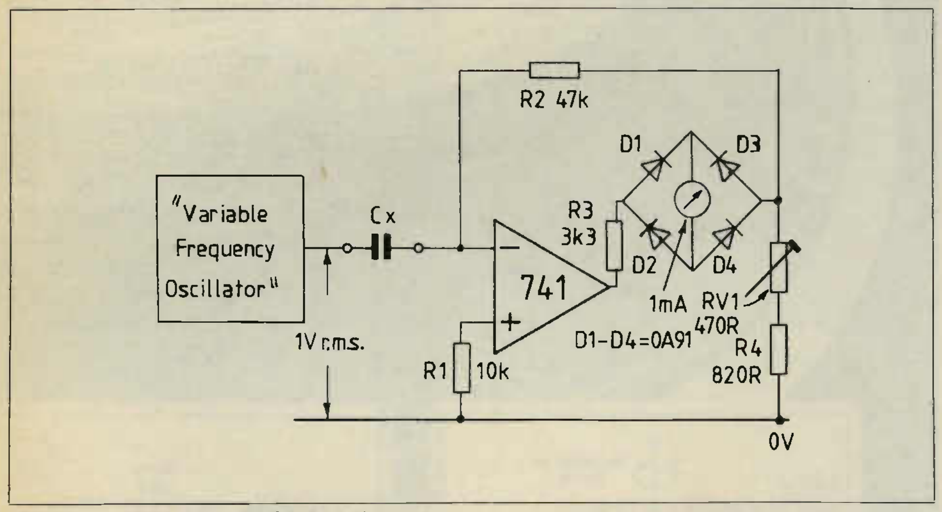


Figure 7. Linear-scale capacitance meter.

shows that, when the value of Rx is totally unknown, the highest resistance range should always be selected. To be absolutely safe,a circuit consisting of two germanium diodes in inverse parallel (e.g. 0A91s) can be wired across the meter. Resistor R9 and the pre-set RV2 determine the current in the meter, calibration being effected by means of RV2. This is done by selecting the 10kΩ range, using a close tolerance 10kΩ resistor for Rx (e.g. a decade box or 1% type) and adjusting RV2 for precisely full-scale deflection. This assumes that RV1 has been adjusted already to give exactly 1V at its wiper as mentioned earlier. If R3-R6 are all close tolerance resistors, the instrument will now read correctly on all ranges.

Linear Scale Capacitance Meter

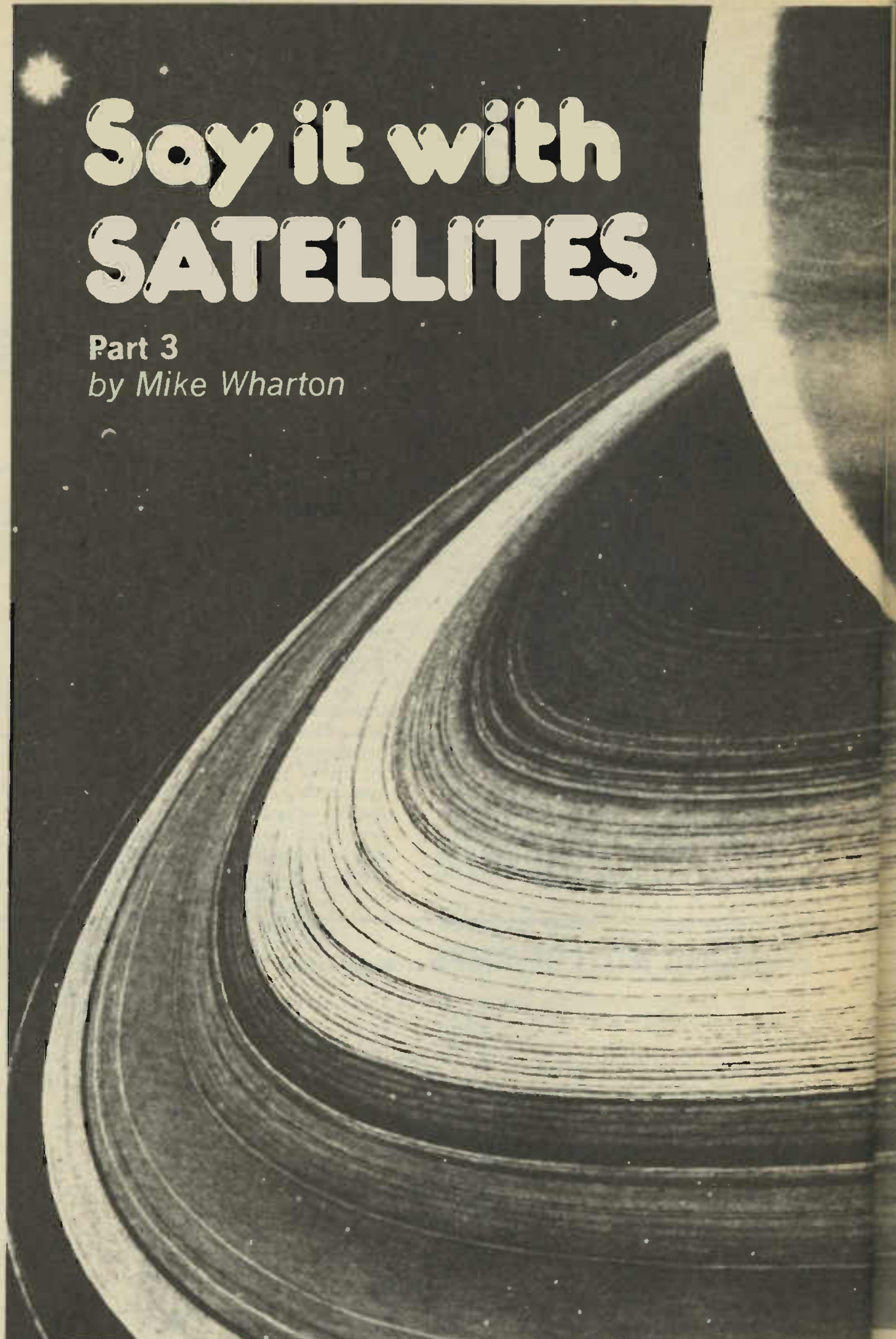
There are certain similarities between this circuit (Figure 7) and that of the linear ohmmeter. The obvious difference is that the unknown is in the input rather than in the feedback path. Since it is capacitance that is being measured, the technique will be an a.c. one so that a source of alternating signal will be required whose frequency is variable. Apart from this, the method depends upon the 'reactance X' of the unknown capacitor determining the amplifier gain when it is compared with a fixed resistor R2 whose value is 47kΩ. That is to say, amplifier gain G is equal to R2/X. When these are equal, the gain is unity and the meter can be calibrated to read full-scale under these conditions. Since G is proportional to 1/X and X is proportional to 1/C, ($X = 1/2\pi fC$), then G is directly proportional to C and the scale is linear. RV1 is used to calibrate the meter and can be adjusted to give full-scale with a known value of Cx = 10nF in circuit and an input of 1V r.m.s. at a frequency of 338Hz. The range of capacitance quoted stops at 100nF because a further decade up to 1μF would mean an input frequency of only 3.38Hz unless some other factor can be changed. This 'other factor' is the amplitude of the input voltage. If this is reduced 10:1 to 100mV while the frequency is kept at 33.8Hz, a further range up to 1μF full-scale is created.

The main difficulty of the design is the need for a variable input frequency. The significance of this requirement depends upon one's facilities. If an audio-signal generator is available then this can be used, provided that both frequency and amplitude can be monitored with a reasonable degree of accuracy. Failing this, a switched-frequency oscillator with pre-set output amplitude would have to be constructed. This could be based on the op-amp Wien bridge circuit with the capacitor values switched to give the required frequencies. At least it gives one the chance to apply some of the ideas in Part Three of this series.

Say it with SATELLITES

Part 3

by Mike Wharton



More Ups and Downs!

The interval between the appearance of these articles is a long time in terms of space exploration, and what follows may well be out of date by publication. Despite this not being the latest 'hot space news', it is useful to look back on some events of the recent past.

The U.S. Space Shuttle has now successfully launched its first commercial payload, a couple of communications satellites, and its future now looks reasonably secure. The Russians are never slow to miss a trick, and were able to steal a march on the Americans by launching the first satellite in this manner. The tiny ISKRA-2 (Russian for 'spark'), satellite was launched from the air-lock of the Salyut/Soyuz orbiting space station back in May 1982. It never really did anything worthwhile, and, due to its low orbit, fell back to Earth a few weeks later.

One of the more spectacular 'downs' of the last few months was the attempt to put a pay-load into orbit using the European Ariane launcher. The two satellites, Marecs-B and Sirio-2, unfortunately ended their flight at the bottom of the Atlantic Ocean, possibly due to the failure of a fuel pump. This has been something of a major set-back for the European launcher programme, which is intended as a commercial competitor to the U.S. Space Shuttle.

The launch site for this venture is at Kourou in French Guiana, South America. This site is interesting, being only about 5 degrees North of the Equator. By utilising the added velocity of the earth's rotation to the launch velocity, a 17% 'throw weight' advantage is obtainable over Cape Canaveral. At the moment, however, this must be cold comfort to those involved in preparing Ariane, which still seems beset by development troubles.

OSCAR-9 is back!

Not that it ever went away, but this latest of a series of Amateur satellites has had its problems. During the time between this and the first article of the series, UOSAT/OSCAR-9 has been effectively 'off the air'. At the time of its launch, now well over a year ago, it was expected to provide a stimulus for interest in satellites by schools and colleges. Fortunately, control of the craft has now been regained, and attempts to stabilise its orbit should have been completed successfully. This satellite contains a number of interesting scientific experiment packages, including a TV type camera and a Speech Synthesiser. The camera is intended to produce pictures with a resolution of about 2km, but it remains to be seen if this hitherto untried method of obtaining a 'satellites — eye — view' of earth will prove to be successful.

The second experiment mentioned above is intended to transmit data from some of the other experiments on board in the form of synthesised speech. Again, at the time of writing, this has yet to give a proper account of itself! If UOSAT/OSCAR-9 proves to be of continuing interest, and these experiments can be made to work properly, more details of their reception may be given in a subsequent article. In the mean time, its telemetry beacon may be heard on a frequency of 145.825 MHz, if you possess a suitable receiver; the signal strength from the satellite is quite good, and it can be picked up on a 'hand-held' receiver on close passes. This brings us neatly to the next problem, that of finding out when an orbiting satellite is passing overhead.

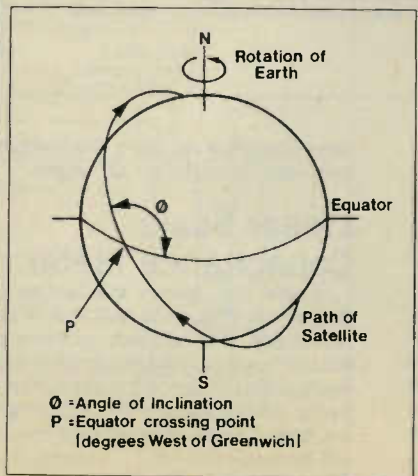


Figure 1.

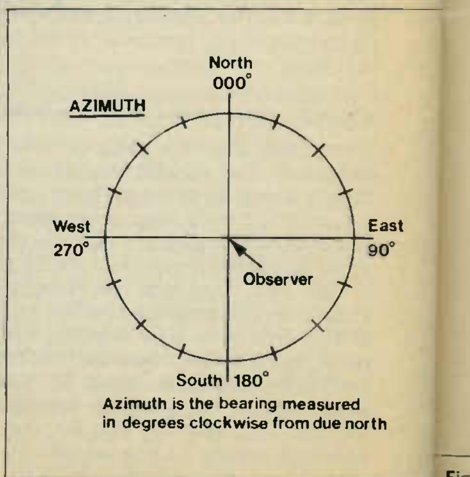


Figure 2.

Where are all the Satellites?

There are many ways of determining the path of an orbital satellite, from the use of special maps and projections to complicated trigonometry; a simple method is to set up a receiver tuned to the appropriate frequency and to wait for the arrival of the signal, hardly a method to be recommended, though. For anyone with access to a home computer, this possibly represents one of the most convenient ways, for even the much maligned ZX-81 has better computing power in this respect than the Petappletandy machines. Before looking in more detail at this method, let us consider the problems involved, without getting bogged down in any maths.

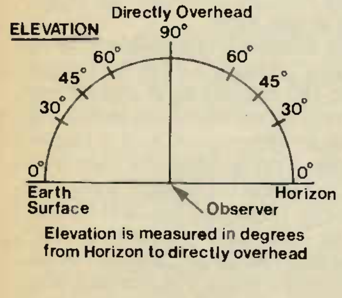
The best 'viewpoint' from which to look at the problem is that of someone in outer space, when the earth/satellite system would look like that shown in Fig. 1. Most of the orbital satellites have trajectories which carry them in more or less circular orbits towards the North and South Poles; those satellites with highly elliptical orbits are difficult to predict, and will not be considered here.

In defining the orbit of a satellite there are certain parameters which must be known; the time taken for it to travel once round the earth is called the Period, and twice in each circumnavigation the satellite crosses the Equator. The time at which it crosses on its North-bound journey is a useful reference point, usually given as the Equator Crossing Time. It is also necessary to know the Altitude, or height above the earth's surface, of the satellite. Whilst the satellite is orbiting the earth, this, too, is rotating on its axis once every 24 hours and must be taken into account in the calculation. Thus if, for example, a satellite crossed the Equator at exactly midday, and its Period was 60 minutes, then it would cross the Equator going in the same direction at 13:00 hours.

During this time the earth would have rotated through 15 degrees, i.e. 360/24. Thus if the Longitude at which the satellite crossed the Equator is known, then the crossing point and time can be predicted for subsequent orbits. Not everyone, of course, lives on the Equator, and we need to be able to preduct passes over the British Isles. For this we also need to know the Angle of Inclination of the orbit, shown as Ø in Fig. 1. The task of calculating the position of the satellite then resolves into two parts, that of finding its position over the surface of the earth, and then exactly which location will be underneath the path at a particular time.

It is not necessary to be directly below an orbiting satellite in order to receive a radio signal from it (incidentally, they are all too small, too high and moving too fast ever to be seen with the naked eye). Thus, depending on the altitude of the satellite, signals should be of adequate strength as it rises over the horizon and passes either to one side or the other, fading away as it then sets below the horizon. If one is attempting to receive the signals on a directional antenna, such as a 2-metre Yagi, then it is important to have some idea of the path which the satellite will describe as it passes by, so that the antenna may be tracked round to follow the source of the signal. To do this, one needs information on the Azimuth and Elevation of the satellite as it passes overhead. Fig. 2 explains these two terms; Azimuth is used to describe the position of the satellite with respect to an observer standing at the centre of a circle, with due North being zero (and 360 degrees) and South being 180 degrees. The Elevation is the 'height', in degrees, which the satellite attains during its pass, with the horizon being at zero degrees and a point directly overhead being at 90 degrees. The use of a globe of the earth may be helpful in trying to visualise all these aspects of the problem.

In order to determine the Azimuth and Elevation of an orbital satellite as it passes close by then, one needs to know the time and Longitude of its Equator Crossing, the Period, its Inclination, its Attitude and your own Latitude and Longitude. These last two are fairly easy to find by using an Atlas, but the other information can be more difficult to come by. This is aggravated by the fact tha the parameters are constantly changing, for although space is usually regarded as being empty, there is sufficient material to exert a drag on the satellite and gradually slow it down. This means that it is not possible to predict satellite passes too far into the future without continually updating the relevant parameters. For this reason it is suggested that any preliminary attempts at satellite tracking be made on the above mentioned UOSAT/OSCAR-9, since the University of Surrey provide a source of up to the minute information. This can be obtained for the price of a phone call, to Guildford 61202, where a recorded message will give the latest orbital parameters. You may find it difficult to copy them down correctly the first time, as the information comes thick and fast, and it is suggested that a cassette recorder is rigged up to tape the message. Table 1 gives the orbital parameters and Equator Crossing time as of the 4th January 1983.



Elevation is measured in degrees from Horizon to directly overhead

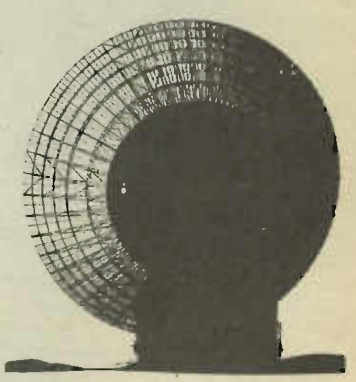
Figure 2.

Table 1
Orbital Parameters and Data for 4th January 1983

Period: 95.708656 minutes — MEAN ALTITUDE: 550km
Inclination: 97.46° — Longitude increment: 23.93°

Orbit No:	Equator Crossing Time (hours:mins:secs)	Equator Crossing Point Degrees West of Greenwich
6890	13:09:17	330.50
6891	14:44:59	354.43
6892	16:20:41	18.36

```
L.
   10 REM AZIMUTH/ELEVATION TABLE FOR OSCAR-9
   20 CLS
   30 PRINTTAB(12,2);"OSCAR 9 AZ-EL"
   40 PRINTTAB(3,10);"What is the LATITUDE of your station. Enter in Degrees NOR
TH",:INPUT LA
   50 CLS
   60 PRINTTAB(3,10);"What is the LONGITUDE of your station? Enter in Degrees We
st.":INPUT LO
   70 CLS
   80 LET L=LA*PI/180
   90 LET G=LO*PI/180
  100 CLS
  110 PRINTTAB(3,10);"PLEASE ENTER THE TIME OF EQUATOR CROSSING AS HHMM (EG 0945
)"
  120 INPUT X$
  130 IF VAL X$<0 OR VAL X$>2400 THEN GOTO 110
  140 CLS
  150 PRINTTAB(3,10);"PLEASE ENTER EQUATOR CROSSING BEARING IN DEGREES WEST (EG
30.2)"
  160 INPUT W
  170 CLS
  180 PRINTTAB(12,1);"OSCAR 9 AZ-EL"
  190 PRINTTAB(0,3);"EQX ";X$;" Bearing ";W;" Degrees West for           Station at
  Longitude  ";LO;" and Latitude ";LA,
  200 PRINTTAB(1,6)"TIME ";TAB(13);"AZIMUTH";TAB(25);"ELEVATION"
  210 PRINT,,
  220 LET T=6
  230 LET B=ASN(0.99153*SIN(2*PI*T/95.708656))
  240 LET C=ACS((COS(2*PI*T/95.708656))/(COS B ))+(T/4+W)*PI/180
  250 LET T=T+2
  260 IF T>45 THEN GOTO 370
  270 LET Z=ABS (C-G)
  280 IF Z>PI THEN LET Z=ABS(2*PI-Z)
  290 LET D=ACS (SIN L*SIN B+COS L*COS B*COS Z)
  300 IF D>0.4 THEN GOTO 230
  310 LET AZ=57.3*(ACS((SIN B-SIN L*COS D)/(COS L*SIN D )))
  320 IF C>G AND C<(PI+G) OR C>(2*PI+G) OR C<(G-PI)THEN LET AZ=360-AZ
  330 LET EL=(PI/2-(ATN(6921*SIN D/(6921*COS D-6371))))*57.3
  340 GOSUB 420
  350 PRINTTAB(2);T$;TAB(16);INT (AZ);TAB(29);INT(EL)
  360 GOTO 230
  370 PRINT "END"
  380 PRINT "Do you wish to process another set of data for this location? Answer
  Y/N":INPUTA$ :IF A$="Y" OR A$="N" THEN GOTO 390 ELSE GOTO 380
  390 IFA$="Y"THEN GOTO 100
  400 PRINT "Do you wish to alter the Latitude and Longitude?":INPUT A$:IF A$="Y
"THEN GOTO 20
  410 STOP
  420 LET X=VAL(X$)
  430 LET X=X+T-2
  440 LET X1=X-(INT(X/100))*100
  450 IF X1>=60 THEN LET X=X+40
  460 IF X>2400 THEN LET X=X-2400
  470 LET V$="0000"
  480 LET T$=STR$(X)
  490 LET Y=4-LEN(T$)
  500 LET Z$=LEFT$(V$,Y)
  510 LET T$=Z$+T$
  520 RETURN
```



APPENDIX 1

```
OSCAR 9 AZ-EL
EQX 1309 Bearing 330.5 Degrees West for           Station at Longitude  2 and Lati
tude 52
TIME          AZIMUTH      ELEVATION

  1319          122          1
  1321          109          8
  1323          82           17
  1325          42           17
  1327          14           9
  1329          0            1
END
OSCAR 9 AZ-EL
EQX 1445 Bearing 354.43 Degrees West for           Station at Longitude  2 and Lat
itude 52
TIME          AZIMUTH      ELEVATION

  1453          177          0
  1455          182          10
  1457          195          28
  1459          272          52
  1501          328          23
  1503          339          8
END
OSCAR 9 AZ-EL
EQX 1620 Bearing 18.36 Degrees West for           Station at Longitude  2 and Lati
tude 52
TIME          AZIMUTH      ELEVATION

  1630          239          0
  1632          258          4
  1634          281          5
  1636          304          3
END
```

APPENDIX 2

Computer Program

The program given in Appendix 1 has been written for the BBC Computer, but it is possible by taking account of changes in syntax to configure it for many other machines. The only possible problem will be with those machines which do not contain the functions for Arcsine (ASN), Arccos (ACS), or Arctan (ATN).

When Run, the program should give a table of Times, and the corresponding Azimuth and Elevation over 2 minute intervals for the particular pass. Not every pass given in the UOSAT Bulletin will be visible from every point in the British Isles, but to obtain the Time and Equator Crossing Longtitude for consecutive orbits, it is only necessary to add on the time of one Period and then work out the angle through which the earth will have rotated in this time.

Using this method it is possible to work out the Equator Crossing Times for Longtitudes around 180 degrees West, and putting these into the program where requested will give the plot for those passes of a North-South direction. Finally, Appendix 2 shows a sample plot for UOSAT/OSCAR-9 using the data for Equator Crossing Time and Longtitude given in Table 1, for an earth station located at 52 degrees North, 2 degrees West. It is recommended that a trial run be made with this data first, to make sure no errors have sneaked in during typing, and if these results cannot be reproduced then check the program before proceeding further. Good hunting!

ROAD TESTING THE M5

continued from page 14

able, but we are unable to determine whether it was possible to address these locations directly with BASIC-I.

Many people will want to write machine code programs and an assembler will be available for this. Since BASIC is not built into the machine, a full 55.25K of RAM (once extended) is available to the machine code programmer, and don't forget that none of this is wasted for screen display maps, since this can all be contained in the video processors own separate 16K of RAM.

Utilities

Two utility programs will be available on cassette as an aid to using the video processor. With the first utility an image is created on the screen then saved to cassette. Sprites for animation are registered int the sprite area of the video processor before program execution, then the program is executed. The user can create any scene or design they wish.

The second utility generates the background colours and images. The program creates and registers the colours in the same way as the sprite utility. These utilities can be used with BASIC -I and so do not require either understanding or use of the more complex BASIC-G.

Instruction Manuals

Although not yet printed, I was assured by the manufacturers that the technical documentation and instruction guide supplied with the machine reach a very high standard. Operation of the M5 is carefully and simply explained even for the absolute novice.

A separate book is available with the monitor listing and source listing for BASIC-I. The book explains how the monitor operates and how BASIC-I is programmed. A further book is available giving a complete description of the M5 hardware.

Computer Games Limited, the people who sell Activision in the UK have won the rights to sell this remarkable little machine in the home computer market. It should sell for around £190 including VAT and offers a lot of power for this price. Later in '83 a 3½ inch disk drive with over 100K capacity selling for about £100 will become available, the first of a new breed of miniature disk drives. With high density storage available at this very low price, the M5 will be a very serious contender in the home computer market.

Maplin are expecting their first deliveries of the M5 in April or May this year.

MAPLIN'S TOP TWENTY BOOKS

1. (3) Games for the Atari by S. Roberts (WA47B) (cat. P62)
2. (1) De Re Atari (WG56L) (cat. P62)
3. (-) Master Memory Map (XH57M) (cat. P62)
4. (-) Audio Circuits and Projects by Graham Bishop (XW46A) (cat. P41)
5. (9) Cost Effective Projects around the Home by John Watson (XW30H) (cat. P41)
6. (12) Projects for the Car and Garage by Graham Bishop (XW31J) (cat. P30)
7. (2) Atari Computer Operating System Users Manual and Hardware Manual (WA46A) (cat. P62)
8. (-) Atari BASIC Learning by Using by Thomas E. Rowley (WG55K) (cat. P62)
9. (-) The BBC Micro - An Expert Guide by Mike James (WK04E) (cat. P63)
10. (17) Atari Sound and Graphics by Herb Moore, Judy Lower, and Bob Albrecht (WA39N) (cat. P62)
11. (7) Programming the 6502 by Rodnay Zaks (XW80B) (cat. P54)
12. (-) VIC Programmers Reference Guide (WA33L) (cat. P63)
13. (8) Power Supply Projects by R. A. Penfold (XW52G) (cat. P38)
14. (6) Electronic Synthesizer Projects by M. K. Berry (XW68Y) (cat. P50)
15. (14) Adventures with Micro-Electronics by Tom Duncan (XW63T) (cat. P30)
16. (-) The TTL Data Book (WA14Q) (cat. P33)
17. (4) Towers' International Transistor Selector Update 2 by T..D. Towers (RR39N) (cat. P32)
18. (-) The Art of Programming the 1K ZX81 by M. James and S. M. Gee (WA38R) (cat. P64)
19. (9) IC555 Projects by E. A. Parr (LY04E) (cat. P39)
20. (10) Newnes Radio and Electronics Engineers Pocket Book (RL06G) (cat. P30)

These are our top twenty best-selling books based on mail-order and shop sales during November and December 1982 and January 1983. Our own publications and magazines are not included. We stock over 450 different books relating to electronics or computing, and the full range is shown on pages 29 to 65 of our 1983 catalogue. For prices see page of this magazine.

COMING IN THE NEXT ISSUE. . .

- ★ Modem Interface for not only the ZX81, but also the Atari, the VIC20, and the Dragon
- ★ New series on programming in 6502 machine code
- ★ CMOS crystal calibrator
- ★ Sweep Oscillator
- ★ Logic Probe
- ★ Enlarger Timer
- ★ D'Xers Audio Processor

All these and more for only 70p. Still the best value for money.

BASICALLY BASIC

Part 15

Graham Hall, B.Sc.

In the final part of this series a summary of the most widely available BASIC statements, functions and operators will be given. The descriptions do not apply to any one version of BASIC, this can only be done by your system's user guide, but aim to give a general overview of the facilities available in BASIC; hence some of the statements or functions described may not be available in the version of BASIC that you are using.

Statements

In the definitions to follow the format of each BASIC statement is defined in the context of a program line. A statement can consist of several 'elements' or portions — in these definitions, elements in angle brackets <> are required, elements in square brackets [ ] are optional and elements in braces { } represent a choice of elements, one of which is required.

The elements and their abbreviations are:

variable (var)	Any legally named BASIC variable
line number	Any legal BASIC line number
expression (exp)	Any legal BASIC expression
message	Any combination of characters
condition (cond)	Any relational condition
argument (arg)	A dummy variable name
statement	Any legal BASIC statement
string	Any legal BASIC string constant or string variable
list	The legal list for that particular statement
dimension	One or two dimensions of an array

Statement Format and Example

REM (comment statement)
line number REM [message]
1Ø REM COMMENTS ARE IGNORED BY THE COMPUTER

LET (assignment statement)
line number [LET] < var > [, < var > , < var > . . .] = < exp >
15Ø LET B = 4 * A * D
16Ø C = 1ØØ

DIM (dimension statement)
line number DIM < var (dimensions) > [, < var (dimensions) > , . . .]
5Ø DIM Z$ (6, 1Ø), A (5Ø)

IF THEN, IF GOTO (conditional statement)
line number IF < cond > { THEN < statement > | THEN < line number > | GOTO < line number > }
2Ø IF X > Y THEN PRINT "WARNING!"
3Ø IF Z = Ø THEN 99Ø
4Ø IF Z = Ø THEN GOTO 99Ø

FOR (loop statement)
line number FOR < var > = < exp > TO < exp > [STEP < exp >]
7Ø FOR J = **-1 TO 19 STEP 2**
8Ø FOR J = A TO 1Ø
The FOR statement initialises a loop. Together with its corresponding NEXT statement, it controls the execution of the statements between the FOR and the NEXT statement. A simple numeric variable must be used after the FOR, and the same variable must appear in the NEXT statement. The first numeric expression is the 'initial loop value'; the second expression is the 'terminating loop value'. The STEP expression is the optional 'loop increment value'. If it is not specified a default value of one is assumed. Transfer by a GOTO statement into an uninitialised loop is not allowed. Placing one loop inside another is called 'nesting'. BASIC allows several levels of nesting.

NEXT
line number NEXT < var >
1Ø NEXT J
The NEXT statement terminates a FOR loop. The variable must be the same as the variable in the corresponding FOR statement.

DEF (definition statement)
line number DEF FN < var > (arg) = < exp (arg) >
3Ø DEF FNT (X) = (9/5) * X + 32
The DEF statement establishes a user defined function. The function type is determined by the variable type following the characters FN (i.e. if a string variable is specified the DEF statement defines a string function).

GOTO (unconditional branch statement)
line number GOTO < line number >
2Ø GOTO 19Ø
The GOTO statement unconditionally transfers control to a specified line number.

ON GOTO (semiconditional branch statement)
line number ON < exp > GOTO < list of line numbers >
15 ON X GOTO 1Ø, 7Ø, 9Ø, 5
The ON GOTO statement is used to branch to one of a list of specified lines based on the result of an expression.

GOSUB (call subroutine statement)
line number GOSUB < line number >
3Ø GOSUB 6ØØ
The GOSUB statement transfers control to a subroutine that begins at a specified line number.

ON GOSUB (semiconditional branch to a subroutine statement)
line number ON < exp > GOSUB < list of line numbers >
35 ON Y GOSUB 6ØØ, 112Ø, 9ØØ
The ON GOSUB statement is used to transfer program control to one of a list of subroutines based on the result of an expression.

RETURN (return from subroutine statement)
line number RETURN
7Ø RETURN
The RETURN statement is the last executable statement in a subroutine. It transfers control to the statement following the last executed GOSUB statement.

CHANGE (string conversion statement)
line number CHANGE { < array name > | < string var > } TO { < string var > | < array name > }
5Ø CHANGE A$ TO F
8Ø CHANGE M TO R$
The CHANGE statement converts a list of integers (real numbers are truncated) into a string of characters and vice versa. Element 0 of the list contains the value representing the length of the string.

READ (read data statement)
line number READ < list of variables >
35 READ X, Y, Z$
The READ statement is used to assign data to variables from a list of values built into a data block by a DATA statement. The assignment is made as the program runs.

DATA (data specification statement)
line number DATA < list of values >
125 DATA 3.14, 8.21, "STRING", -1
The DATA statement is used to provide a pool or block of information to a program in conjunction with the READ statement. Each data item in the list is separated with commas.

RESTORE (reset data statement)
line number RESTORE
9Ø RESTORE
The RESTORE statement enables the same values in the DATA statement to be used for more than one READ statement variable. It does this by moving a pointer which points to the next available data item in the DATA list, back to the beginning of the DATA list.

PRINT (output data statement)
line number PRINT [< exp > , < list >]

65 PRINT "RESULTS", G, H + 11
The PRINT statement outputs the specified data to the terminal. The expression list can be expressions, variables, or quoted strings separated by a comma or a semicolon. Commas cause the output to terminal fields or columns; semicolons ignore the fields. If the PRINT statement is used without a following expression a blank line is output to the terminal.

INPUT (data input statement)
line number INPUT [< string >,] < list >
3Ø INPUT "TIME & DATE", T$
The INPUT statement is used to assign data to a program from the terminal when the program is run. The program requests data by printing a question mark on the terminal and then waiting for characters to be input.

STOP (suspend program execution statement)
line number STOP
35 STOP

The STOP statement is used to temporarily halt program execution enabling the results of the program up to the point of the halt to be checked. Files remain open and a message indicating the location of the halt is printed on the terminal. The execution of the program can be continued by typing CONTINUE.

END (program terminator statement)
line number END
4Ø95 END
The END statement terminates program execution. It must appear as the last statement in the program.

OPEN (open file statement)
line number OPEN <string> {FOR INPUT / FOR OUTPUT} AS FILE # <exp>
1Ø OPEN "RESULTS" FOR INPUT AS FILE # 1
2Ø OPEN "KEYDATA" FOR OUTPUT AS FILE # 2
3Ø OPEN "DATES" AS FILE # 3
The OPEN statement enables a new file, or an existing file, to be opened and associated with a file number which establishes a communication channel between the program and the file.

CLOSE (close file statement)
line number CLOSE # <exp> [, # <exp>]
175 CLOSE #1, #2, #3
The CLOSE statement is used to close a file and dissociate it from a communication channel. When no file numbers are specified all opened files are closed.

PRINT # (write data to file statement)
line number PRINT # <exp>, < list >
9Ø PRINT #3, A$; ","; B
The PRINT # statement is used to write data to a file associated with the communication channel number specified.

INPUT # (read data from a file statement)
line number INPUT # <exp>, < list >
The INPUT # statement is used to retrieve data from an opened file to use as input to the program. The INPUT # statement line that retrieves data from a file must duplicate the format of the PRINT # statement that wrote the data.

Functions and Operators

Functions are pre-written routines that perform commonly used operations. The following tables list the Math, Print and String functions and the Logical, Arithmetic and Relational Operators available in BASIC.

Function	Description
ABS (X)	Returns the absolute value of X.
ATN (X)	Returns the arctangent of the value X in radian measure.
COS (X)	Returns the cosine of the radian value X.
COT (X)	Returns the cotangent of the radian value X.
EXP (X)	Returns the numeric constant 'e' (2.71828) raised to the power of X.
INT (X)	Returns the largest integer value of X.
LOG (X)	Returns the natural logarithm of the value X.
POS (X)	Returns the current position on the output line.
RND (X)	Returns random numbers.
SGN (X)	Returns an indication of the sign (+, - or Ø) of X.
SIN (X)	Returns the sine of the radian value X.
SQR (X)	Returns the square root of X.
TAB (X)	Causes output to be printed at the X column on the output line.
TAN (X)	Returns the tangent of the radian value X.

Math and Print Functions.

Function	Use
ASC (X$)	Converts the first character in the string, X$, to its equivalent ASCII value.
CHR$ (X)	Converts the ASCII code number, X, to its equivalent character.
LEFT (X$, n)	Indicates a portion of the specified string, X$, in a range from the left-most character to the nth character.
LEN (X$)	Indicates the number of characters in the specified string, X$.
MID (X$, n1, n2)	Indicates a substring in the specified string, X$, that begins at position n1 and is n2 characters long.
RIGHT (X$, n)	Indicates a substring in the specified string, X$, in the range of n to the right-most character.
SPACE $ (n)	Produces a string of n spaces.
STRING $ (n1, n2)	Creates a string that is n1 characters long and is composed of the characters specified by the ASCII code, n2.
VAL (X$)	Computes the numeric value of the numeric characters contained in the specified string, X$.

String Functions.

Table 3. Arithmetic Operators.

BASIC symbol operator	Arithmetic operation	Example	Description
+	addition	X + Y	add Y to X
-	subtraction	X - Y	subtract Y from X
*	multiplication	X * Y	multiply X by Y
/	division	X/Y	divide X by Y
^ or ↑ or **	exponentiation	X ^ Y	raise X to the Yth power

Operator	Use	Meaning
NOT	NOT X	logical negative of X
AND	X AND Y	logical product of X and Y
OR	X OR Y	logical sum of X and Y
X OR	X X OR Y	logical exclusive OR of X and Y

Logical Operators

Mathematical Symbol	BASIC Symbol	Example	Meaning
+	=	X = Y	X is equal to Y
<	<	X< Y	X is less than Y
⩽	<= or =<	X< = Y	X is less than or equal to Y
>	>	X > Y	X is greater than Y
⩾	>= or =>	X >= Y	X is greater than or equal to Y
≠	<>or><	X<>Y	X is not equal to Y

Relational Operators.

COMPUTER NEWS

The Northern Computer Fair

Thank you to all the people who supported our stand at the Northern Computer Fair, we were amazed and extremely pleased at the response and hope to see all of you again next year. Manchester is definitely on our list of new sites for shops!

The organisers did an excellent job, the hall was light, spacious and airy, with plenty of room for everyone, the facilities were some of the best we have seen at an exhibition, and even the security guards were helpful! All these, plus the fact that we were extended such a warm welcome, combined to make this a highly enjoyable event.

Once again the Ataris, with their high degree of visibility, were the main attraction, but when people had been drawn to our stand a lot of interest was displayed in the books and software, with the Maplin Modem receiving quite a bit of attention. Our stand was also one of those filmed by Granada Television for their 'Granada Reports' programme, so we may have reached an even wider audience than originally hoped for.

Our technical staff, who were on hand to answer technical queries, found meeting the computer-using public 'face-to-face' a useful experience. They were also surprised at how knowledgeable everybody was, especially some of the children. The level of computer awareness in schools is obviously rising rapidly.

The 1983 Maplin catalogue proved very popular, and we sold all that we took with us, which was a considerable amount. Fastest selling computer was the Atari 800 with 48K RAM, and we noticed an increase in the sales of disk-based software, with Star Raiders still the favourite title, but being chased by Choplifter and SAM.

Thank you, once again, to everyone who came along to see us. We hope that you enjoyed it as much as we did.

COMING SOON

THE Midland Computer Fair
Personal computers
Home computing
Small business systems

Bingley Hall, Birmingham April 28th to 30th 1983

Following the outstanding success of the Northern Computer Fair, Maplin are pleased to announce that they will also be exhibiting at the new Midland Computer Fair, which takes place at Bingley Hall, Birmingham, from the 28th to the 30th of April. The doors will be open from 10 a.m. to 6 p.m. on the 28th and 29th, and from 10 a.m. to 5 p.m. on the 30th. The fair is all about personal computers, home computing, and small business systems, and we hope that all our customers and readers in the Midlands will come and see us.

The Maplin stand will be showing our extensive (and ever-increasing) range of computers and software, all of which will be available for purchase. If you come along you will be able to try out many of these for yourself, as we will be having our usual 'customer participation' displays.

You will also be able to buy not only the 1983 Maplin catalogue, but also a whole host of books and literature on computers and related subjects. Free leaflets on hardware and software will also be placed about the stand, so nobody should go away empty-handed. Our technical staff will also be at hand to answer any queries you may have concerning computers and electronics in general.

The Scottish Personal Computer World Show

MacRobert Pavilion, Edinburgh April 16-18, 1983

At last — a chance for all those of you 'north of the border' to visit a personal computer show without having to travel to the other end of the country. Edinburgh is host for the first time to a show which covers all sectors of micro computer applications.

The show is at the MacRobert Pavilion, which is part of the Ingliston Exhibition Complex, adjacent to Edinburgh Airport, and is being held alongside the Scottish Ideal Home Exhibition. The Pavilion offers the finest setting for an exhibition outside London or Birmingham, and no parking problems! There is plenty of space within the immediate vicinity, and you should have no trouble finding room for your car. There is a regular bus service too!

The show is being held from the 16th to the 18th of April, which is a holiday weekend in the Glasgow/Edinburgh area, and the opening hours are from 10 a.m. to 9 p.m. on the 16th, 10 a.m. to 6 p.m. on the 17th, and 10 a.m. to 5 p.m. on the 18th. Tickets will cost £2.50, and there will be a joint ticket for both events available at a reduced rate, although details of pricing have not yet been finalised.

All the usual Maplin goodies will be on demonstration and sale, including some items of software and hardware that are so new we don't even know their names yet! If you are finding it difficult to choose between the incredible variety of computers and software available, then our technical staff will be only too pleased to help you, and answer any questions you might have.

A representative of the Atari User Group will also be on hand to talk to those of you who have already bought, or are seriously thinking of investing in one of the Atari range of computers and peripherals. They would also be pleased to meet any current members of the group, and to hear their ideas for future issues.

THE NEW ATARI HOME COMPUTER

At the giant Consumer Fair in Las Vegas in January, Atari were showing for the first time their new 1200XL computer. Though it probably won't be launched in the UK until late 1984, the new computer is styled differently, but is otherwise almost identical to the 800. It will come fully equipped with 64K RAM which for normal use is the same as the 48K 800 but perhaps allows you to change the operating system. It has one or two little extras such as one touch cursor controls, a key marked "Help" which can be used to give useful instructions on selected programs and an electronic keyboard lock that prevents accidental entries or tampering.

The new machine has a self-test function, say Atari, but we were unable to discover what this actually was, and a foreign character set which Atari claim "lets you communicate in many European languages." When it is first released Atari say it will sell for about £550 — rather expensive. Nevertheless it seemed clear to us that there can only be one reason why Atari have launched a new machine so little different from the 800.

It doesn't become clear until you look inside the machine and when you see the single, neat circuit board it is obvious that it is much cheaper to manufacture than the 400 or 800. The machine has been launched it seems to us so that it can eventually be priced competitively with the machines that will be around in 1985 and 1986 and we would not be at all surprised to see the 1200XL selling for much less than the current 800 price, in a few years time.

NEW VIDEO COMPUTER GAME PACKAGE HAS EXPANSION MODULES

A new idea from CBS electronics is a video computer with add-on expansion units. The basic console is a sleek black unit with two joysticks and incorporated number pads which can be stored in the console. CBS claim superlative graphic resolution and excellent sound effects.

But the main feature of this new system is its add-on capability. The first add-on unit is an Atari converter. This will simply plug on to the front of the main console and allow you to use cartridges designed for the Atari Video Game.

The second add-on is a Turbo Drive Module which consists of a steering wheel, dashboard and accelerator pedal. This should make car race games exceptionally realistic and looks like a lot of fun.

The third add-on is a keyboard that turns the game into a home computer. We weren't able to get much information on this add-on, but we'll be watching this new system carefully as it could become very popular.

CBS will also be releasing lots of new games on cartridge and all will be available for Atari, Mattel Intellivision and their own unit. Games include Bally Midway's Gorf and Wizard of Wor, Sega's Turbo, Zaxxon and Carnival, Exidy's Mouse Trap and Venture, Universal's Ladybug and Cosmic Avenger, Peyo's Smurf Rescue in Gargamel's Castle and Nintendo's Donkey Kong.

The new system whose full name is CBS Colecovision is being distributed in the UK by Ideal Toys.

NEW SOFTWARE

A massive new selection of software has become available for our range of home computers since our 1983 catalogue was published. Unfortunately, there is insufficient space to describe it all, but issue 4 of our software leaflet (XH52G) will be published early March with descriptions of most of the new items. Alternatively many of the items for Atari, Commodore 64, Dragon, Spectrum and VIC20 are described in the new Mapsoft catalogue (XH60Q) price £1.

Atari

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S.A.G.E. Pack also contains 48K version on Disk	1C-32K-KH12N	£35.95
The Eliminator	1C-16K-KH13P	£17.95
The Eliminator	1D-32K-KH14Q	£17.95
Draw Poker	1C-16K-KH15R	£11.95
Controller	1C-16K-KH16S	£18.95
Controller	1D-40K-KH17T	£21.95
Tank Arcade	1C-16K-KH18U	£11.95
Andromeda Conquest	1C-32K-KH19V	£13.45
Andromeda Conquest	1D-40K-KH20W	£17.45
Telengard	1C-48K-KH21X	£17.45
Telengard	1D-48K-KH22Y	£19.95
Moon Patrol	1C-16K-KH23A	£18.95
VC	1C-32K-KH24B	£14.95
VC	1D-40K-KH25C	£18.95
Book of Basic Adventures	Book	£14.50*NV*
Quick Reference Chart	Booklet	£1.99*NV*
Book of Hints	Book	£4.99*NV*

Commodore 64

Temple of Apshai	1D-BC57M	£27.45
Upper Reaches of Apshai	1D-BC58N	£13.80
Curse of Ra	1D-BC59P	£13.80
Sword of Fargoal	1D-BC60Q	£20.75
Crush, Crumble & Chomp	1D-BC61R	£20.75
Jump Man	1D-BC62S	£27.45

Dragon

Alcatraz II	1C-BC63T	£8.00
Mansion Adventure I	1C-BC64U	£8.00
Flipper	1C-BC65V	£8.00
Planet Invasion	1C-BC66W	£8.00
Defense	1C-BC67X	£8.00
Space Monopoly	1C-BC68Y	£8.00
Scarfman	1C-BC69A	£8.00
Escape	1C-BC70M	£8.00
Space War	1C-BC71N	£8.00
Calixto Island	1C-BC72P	£7.95
Typing Tutor	1C-BC73Q	£7.95
Flag	1C-BC74R	£7.95
Dragon Mountain	1C-BC75S	£7.95
Chess	1E-BC76H	£24.95
Astroblast	1E-BC77J	£19.95
Black Sanctum	1C-BC78K	£7.95
Galax Attax	1E-BC79L	£19.95
Rail Runner	1E-BC80B	£19.95
Breakout/Middle Kingdom	1C-BC81C	£7.95
Dragon Trek	1C-BC82D	£9.95
Wizard War	1C-BC83E	£7.95
Golf	1C-BC84F	£7.95
Vulcan Noughts & Crosses	1C-BC85G	£7.95
Games Compendium	1C-BC86T	£7.95
Deadwood	1C-BC87U	£6.90

Spectrum

The Hobbit (48K)	1C-BC88V	£14.95
Timegate (48K)	1C-BC89W	£6.95
Space Intruders	1C-BC90X	£4.95
Meteor Storm	1C-BC91Y	£4.95
The Chess Player (48K)	1C-BC92A	£6.95
Speakeasy (48K)	1C-BC93B	£4.95

VIC20

Innovative Cassette 1	1C-BC94C	£5.95
Shark Attack	1C-BC95D	£9.99
Martian Raider	1C-BC96E	£9.99
Multisound Synthesiser	1C-BC97F	£9.99
Junior Maths: Birds & Apple Tree (+3K)	1C-BC98G	£4.99
Junior Maths: Engineshed (+3K)	1C-BC99H	£4.99
Junior Maths: Sub-Traction & Lighthouse (+3K)	1C-KK00A	£4.99
Skramble	1C-KK01B	£9.99
Myriad (+3K)	1C-KK02C	£9.99
Space Storm	1C-KK03D	£6.99
Night Crawler	1C-KK04E	£9.99
Hopper	1C-KK05F	£9.99
Space Phreeks	1C-KK06G	£9.99
Chess (+16K)	1C-KK07H	£7.00
Rescue At Rigel (+16K)	1C-KK08J	£20.75
Sword of Fargoal (+16K)	1C-KK09K	£20.75
Crush, Crumble & Chomp (+16K)	1C-KK10L	£20.75
Monster Maze	1E-KK11M	£27.45
Invasion Orion (+16K)	1C-KK12N	£17.25
Datestones of Ryn (+16K)	1C-KK13P	£13.80
Plattermania	1E-KK14Q	£27.45
Ricochet (+8K)	1C-KK15R	£13.80
Princess & Frog	1E-KK16S	£29.95
Ant Eater	1E-KK17T	£29.95
Typo	1E-KK18U	£29.95
Tank Arcade	1C-KH18U	£11.95

Note that some of the titles listed above will become available during the life of this magazine, so please check for availability.

JUPITER ACE IN OUR SHOPS NOW

For personal callers only, the incredibly fast Jupiter Ace microcomputer is now on sale in our shops (not available by mail order). The Ace uses the highly efficient Forth programming language. Excellently documented, easy to use and provides an economical method of learning this fascinating language. Price only £89.95.

CLASSIFIED

VARIOUS FOR SALE

C.B. RADIO Superstar 360, AM/FM/USB/LSB/CW high-mid-low bands, 5kHz shift. Built in SWR. Complete with antennae and mag mount. £120 ono. Phone West Drayton 47355.

NEW ICs packeted Tandy LS. TTL. LM series 90 total, 2 pre-amp stereo kits, list £24.95, mixer panel part built, list £69.95. Offers for lot. H. Catterson. Tel. 0642 821176.

SENSORY CHESS Challenger 9 for sale, £150. It won the 2nd World Microcomputer Chess Championship and has an official US rating of 1771! Tel (0302) 721456/49475.

TRANSCENDANT 2000 Synthesiser, £150; Minisonic Mk 2, £125. As new, built 2 DFMs £15 each. Ten boxes incomplete projects, kits, offers. Wayne Kerr LCR bridge, £25. Tel. Bridge 01-735 1862.

SOLARTRON DUAL Beam oscilloscope type CD-1400 15 MHz, spare plug-in modules, full working order, £70. Phone Graham, 01-651 5104 S. Croydon, Surrey.

30W VALVE AMPLIFIER, £5; record player, £5; 12in. speaker in double cabinet, offers; 'old' typewriter, £5; valves, £1 each. J. Weston, 47, Furnace Terrace, Pontyberem, SA15 5AE.

MUSICAL FOR SALE

I NEED to dispose of my matinee organ to make room for the next project. Any reasonable offer considered. Please telephone Dunblane 822841.

MATINEE ORGAN for sale, fully assembled and working, £300. Lincoln 20332.

TWO, 60 NOTE keyboards, £5 each. One 25 note R/C pedalboard £10; wood pieces to make suitable console, £5. Buyer collects. Taylor, Lutterworth (045 55) 2781.

MAPLIN MES53 organ, two 61 note manuals, short pedalboard, 50 stops, drawbars, MES55 auto rhythm, rotor sound, reverb, fully working, £700 ono. Phone Alan Perkin, Reading (0734) 883103 working hours.

MATINEE ORGAN, tested, ready to install in cabinet, £325 or exchange other electronic project. Telephone 'John' Wisbech (0945) 64805 evenings.

ORIGINAL MAPLIN MES 52 organ, two 49 note manuals, 13 note pedalboard, rhythm unit, attractive solid oak cabinet. Requires attention but has been working, £130 o.n.o. Burntwood 71594 evenings.

If you would like to place an advertisement in this section then here's your chance to tell Maplin's 140,000 customers what you want to buy or sell, absolutely free of charge. We will publish as many advertisements as we have space for. To give everyone a fair share of the limited space, we will print 30 words free of charge. Thereafter the charge is 10p per word.

Please note that only private individuals will be permitted to advertise. Commercial or trade advertising is strictly prohibited in the Maplin Magazine.

Please print all advertisements in bold capital letters. Box numbers are available at £1.50 each. Please send your advertisement with any payment necessary to: Classifieds, Maplin Mag, P.O. Box 3, Rayleigh, Essex SS6 8LR.

For the next issue your advertisement must be in our hands by 6th April 1983.

MAPLIN 3800 SYNTH. Fully built, tested and tuned. Complete with leads and manuals. Must sell, £250 o.n.o. Mr. T. Parkinson, 112, Oxford Road, Hartlepool, T52J 5RT.

MARSHALL 4-INPUT 100W valve amplifier + pair 2 x 12" Celestion columns £200 ono; WEM Copicat Echo, £50 ono, also microphones, stands, mixers, etc., part exchange? Felixstowe (Suffolk) 3994.

30 NOTE PEDALBOARD (radiating/conv.) £10; 30 K/A pedal jacks fitted series pots, wired 7 voices, £5; pair matching 61 note wooden manuals (angled fronts) £10 each; pair similar curved fronts, set (73) F/P chokes, A/D type C/T £10; set Ferrite chokes, Bobbins wound rocker switches, contact blocks. List with pleasure. Wolsey, Puffins. Seaview Lane, Seaview, I.O.W.

HI-FI FOR SALE

MAPLIN STEREO cassette deck kit, still in original box, £20 ono. Tel. Trowbridge 65245.

CRIMSON ELEKTRIK CPR1 preamp module with regulator PSU, and 2X CE1004 poweramp modules with instructions. All £40. Tel. Dave 051-426 5742.

COMPUTERS FOR SALE

ZX81 SOFTWARE. Four programs in fast machine code. Breakout 3K 3 levels, Hustle 2 levels, Othello 4k play the computer football 3k, £4 for cassette or s.a.e. For details to J. Hurley, 20 Dane Acres, Bishop's Stortford, Herts.

ATARI (VCS), 2 joysticks, 2 paddles, aerial switch box, adaptor and 4 cartridges (Space Invaders, Missile Command, Space Ware & Combat). Guaranteed till 5/7/83, only £90. R. Cyrus, 244, Latymer Court, Hammersmith Road, London, W6 7LB.

VIDEO GENIE EG3003 computer, 2 manuals, monitor, integral cassette recorder and 2 games, £230. Phone Crayford 528119.

ZX81 16K pools prediction program. Gives a 55 result prediction based on up to two years results. Lists any results, totally bombproof, on quality C12 cassette, £3.50. D. Allsopp, 206B, Corsham Road, Whitley, Melksham, Wilts.

ATARI EASTERN Front, 1941, 16k cassette, in its box with instructions, £18. Stanford-le-Hope (0375) 672077, after 5 p.m.

3K RAM PACK for VIC20 computer, brand new and unused, £18. Tel. Tony Pandy (0443) 437859 after 6 p.m.

WANTED

WANTED URGENTLY, instruction manual (or good quality copy) for Telequipment Serviscope Minor oscilloscope. G. Sage, 33 Barn Meads Road, Wellington, Somerset TA21 9BD. Tel. 6795.

WANTED GENUINE Leslie unit to install in organ cabinet. Would consider complete tone cabinet, exterior condition not important. Please contact Alford, 24 New Barn Lane, Alton, Hants. Tel. 84659.

WANTED, information on I.C.'s marked: 7214 KRE 1236-0574, 7215 KDO 1236-0590, 7215 KEU 1236-0582. Write 26 Clifford Road, Penrith, Cumbria, postage costs etc. (within reason) refunded. Any items loaned will be returned.

WANTED. Marble effect key tabs, flute 5⅓', flute 8', flute 4' (white), reed 4' (yellow). M. Alder, Laurel Cottage, Brewery Lane, Thrupp., Stroud, Glos. GL5 2EA. Tel. 0453 884451.

continued from page 47

THE STYLUS ORGAN VEROBOARD ASSY PARTS LIST

Resistors — All 0.4W metal film 1%

R1	4M7		(M4M7)
R3	56k		(M56K)
R4	560R		(M560R)
R5	10k		(M10K)
R6	18k		(M18K)
R7	3k3		(M3K3)
R8	47k		(M47K)
R9	12k		(M12K)
RV1	22k hor preset		(WR59P)
RV2	4k7 pot log		(FW21X)
RV3-28	100k hor preset	25 off	(WR61R)

Capacitors

C1,C6,C7	100uF 25V axial electrolytic	3 off	(FB49D)
C2,3	100nF polycarbonate	2 off	(WW41U)
C4,5	22nF polycarbonate	2 off	(WW33L)

Semiconductors

IC1,2	4046BE	(QW32K)
IC3	LM380N	(QH40T)

Miscellaneous

S1	SPST sub-min toggle A	(FH00A)
B1	PP3 battery	
	PP3 connector	(HF28F)
LS1	Loudspeaker Ø66mm 64R impedance	(WF57M)
	Stylus lo cost test probe	(HF22Y)

needed for a single octave organ, and twenty-five are needed for a two octave type (this gives a complete scale including semitones in both cases). R2 enables the secondary oscillator to be set just off-tune from the main oscillator. The two oscillators will track with sufficient accuracy over a one or two octave range. R1 takes the control inputs of the oscillators to the negative supply potential and blocks oscillation when the stylus is not connected to one of the tuning presets.

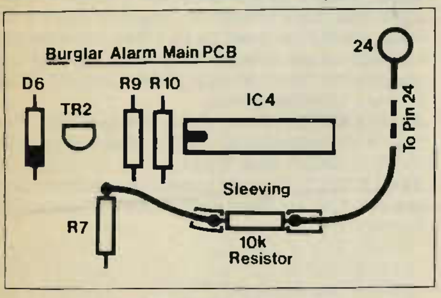
A simple passive mixer circuit is used to combine the outputs of the tone generators at the correct relative levels, and the signal is then taken via volume control VR1 to a simple audio output stage using an LM380N. This gives an output power of about 100mW RMS into a high impedance loudspeaker which should give adequate volume, but an 8 ohm speaker can be used if higher output power and volume are required. C4 and C5 are used to reduce the harmonic content on the output signal which is otherwise excessive due to the squarewave output signals from the tone generators.

The unit covers one octave either side of Middle C.

CORRIGENDA

On the frequency counter PCB (GB02C), two circles designating through pins have been omitted. One is situated just above R6, and the other is just below R6.

Owners of the Maplin Home Security System may be pleased to know that, with the addition of a minor modification, the requirements of British Standard 4737 can be met. Some insurance companies insist that systems be to this standard, so the modification is well worth fitting. With reference to the drawing, connect a 10k resistor, via a short length of wire, between pin 24 on the motherboard and the base connection of TR2. You may find it easier to connect onto the base resistor R7, just below TR2. Resistor R2 on the PSU PCB should be either shorted out or have a link connected in place of it.



ZX81 KEYBOARD MOD

For those who are experiencing difficulties connecting both keyboard ribbon cables to the ZX81 (Micro) PCB sockets — we stock two right angled connecting plugs.

a) RA LATCH MINICON PLUG 5 WAY (RK67X)

b) RA LATCH MINICON PLUG 8 WAY (YW18U)

Although these plugs are a latching type, the plastic latching section can be removed on both plugs and the ribbon cables soldered to the shorter ends. Insert the plugs into both PCB sockets.

When connecting up your ZX81 keyboard, always ensure that mains power is removed before plugging the adaptor L (RK27E) connector into the ZX81 and the keyboard. When all connections have been made, switch mains power on. When disconnecting the system mains power should be switched off prior to unplugging.

AMENDMENTS TO CATALOGUE

Please amend your 1983 catalogue as follows:

Page 25
The Aerial Rotator (XB54J) is not supplied with cable. Use 4-core mains (XR48C). Make no connections to terminal 2 of the controller. The wire from terminal 3 of the controller must be connected to terminals 2 and 3 at the rotator.

Page 66
The Snap-Together Plastic Boxes (YK48C, YK49D, YK50E, YK51F) dimensions stated are all internal.

Page 74
Laminate Aluminium large (XY20W) size is now 482 x 190mm (19 x 7½in).

Page 89
The sub-miniature single-ended electrolytic capacitor YY35Q is now only 35V working, not 40V as stated.

Page 99
The picture of the 2m Rubber Duck (YG15R) shows a UHF plug, but the item is supplied with a BNC plug as stated in the text.

Page 104
The Atari 400 (AF36P and AF37S) sound generators can only be 'piped' to a TV speaker. There is no DIN socket available for connection to an amplifier.

Page 122
BC44X (Computavoice) is a cassette, and BC36P (Cave Hunter) and BC38R (Starship Chameleon) are both cartridges.

Page 257
The Sharp stylus STY117 is the same as our stylus HR97F (Stylus Sanyo 2611), not BK08J as shown in our stylus guide.

Page 259
The High Quality Cassette Head Cleaner (BK28F) is now being supplied with a tape head cleaning stick and a 30cc bottle of tape head and capstan cleaning fluid.

Page 331
The 2732 EPROM (QQ08J) programming is achieved by applying +25V to pin 20 and +5V to pin 18, not pins 20 and 21 as stated.

Page 341
The mono headset (WF20W) is now terminated in a mono ¼in jack plug, not a 3.5mm jack plug as stated.

Page 374
The utility knife (FY02C) is shown incorrectly in the picture. This knife is NOT retractable.

Page 384
The overall size of the sub-miniature mains transformers (WB00A, WB01B and WB02C) is now 30 x 27 x 35mm, and fixing centres are 46mm.

DID YOU MISS THESE ISSUES?

Copies of issue 4 are now sold out, but a reprint of the projects from issue 4 is available and contains:

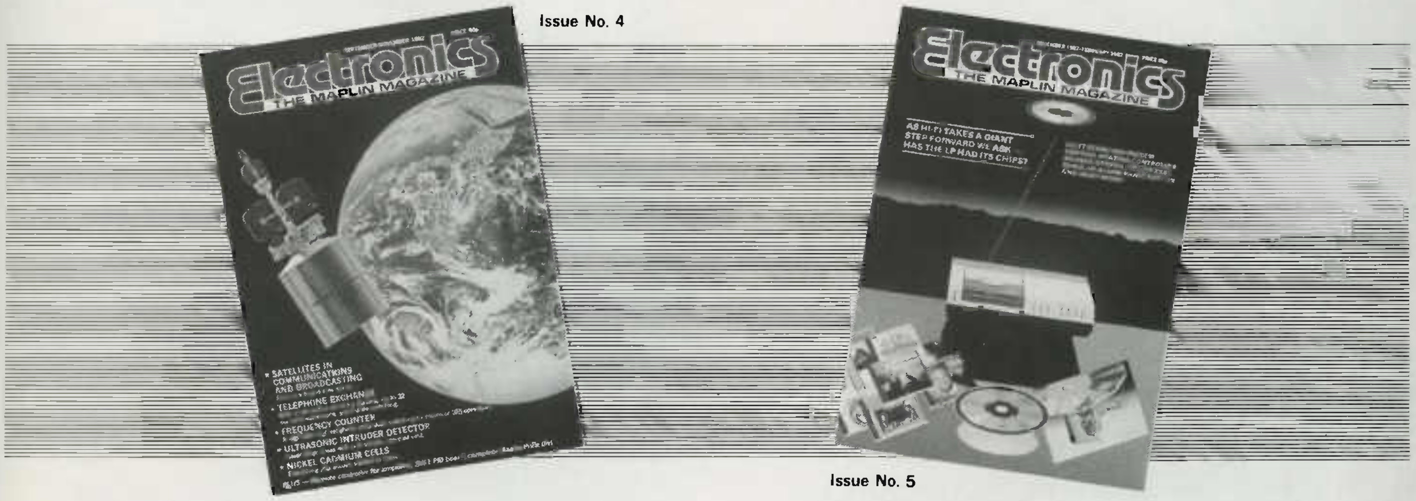
Telephone Exchange: A complete telephone exchange with up to 32 extensions on 2-wire lines. Ideal for the home, office, or small factory. Save £££'s on rental charges. Full construction details for up to 16 lines in this book.

Remote Control for Amplifier: Adjust volume, balance, and tone whilst you sit back and relax with our infra-red remote control. Designed for use with our 25W MOSFET Amp, but can be fitted to most amplifiers.

Frequency Counter: This superb, easy-to-use, low-cost, 8-digit frequency counter with superior specification covers the 10Hz to 600MHz band. Incorporates full push-button control, electronic switching, and one input for the whole range.

Ultrasonic Intruder Detector: This easy-to-build ultrasonic transceiver covers up to 400 square feet; though more than one can be used for larger areas. The unit automatically adjusts itself to transmit at the frequency where the transducers give their maximum output. Up to three of these units may be connected to our home security system.

All this for just 60p. Order As XA04E (Maplin Magazine Volume 1 No 4). Price 60p*NV*



Issue No. 4

Issue No. 5

Copies of issue 5 are still available for just 60p, and include the following projects:

Modem. With this low-cost, high quality modem, transmission speeds of 300 baud are obtainable over ordinary telephone lines. Send data to your friends anywhere in Europe, or talk to our computer.

Inverter: Ideal for camping or caravanning, this inverter uses MOSFET transistors for the ultimate in reliability. During emergency power cuts, use the inverter to keep your central heating going.

ZX81 Sound Generator: Here's a really noisy project for micro-computer enthusiasts. It plugs straight in to our ZX81 extension board and is really easy to make. Your ZX81 will have full BASIC control over three tone generators, with single address access.

Central Heating Controller: For our more experienced constructors, this project will give your central heating system optimum performance and could save you a lot of money this winter.

Panic Button. A useful add-on for our Home Security System that will give many of our older citizens peace of mind. Issue five also included features on the Compact Digital Disc, Interfacing Microprocessors, and choosing the right wires for projects, and the last part of the Starting Point series, along with Basically Basic, Say it with Satellites, and Working with Op-Amps.

All this for just 60p. Order As XA05F (Maplin Project Book Volume 2 Issue 5). Price 60p*NV*

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