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auto test meter

personal FM

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contents

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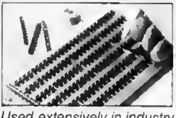

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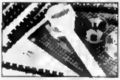

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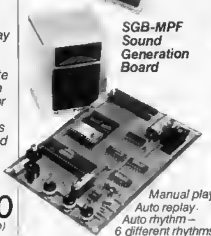

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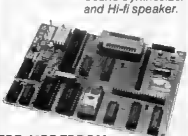

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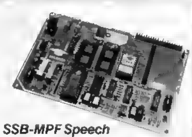

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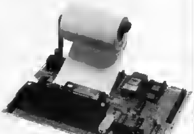

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While researching the background for the VDU (Video Display Unit) card published elsewhere in this issue it occurred to us that it might not be a bad idea to look at how all those characters appear on the screen. In other words, how is the image of the characters built up and what does a video card do exactly? That is what we will try to clarify in this article and even if you have no intension of building a VDU card, it is still an interesting subject.

VIDEO GRAPHICS

how does a video card work?

A video display unit is used to sbow on a screen all the various latters, numbers and signs that are produced by a computer. But it is more than just some sort of talevision set! It also includes the necessary electronics to convert the desired characters into video signals so that the monitor can work with them. However we will first look at bow a monitor (or a TV set) builds up its image from the video signals It receives.

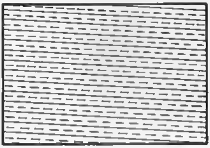
How the image is built up

A monitor (as a display screen used with a computer is generally called) is really only a 'stripped down' television set. Or if you prefer: a TV set is an expanded version of a monitor! Tbe monitor only contains the display tube and the necessary driver electronics and it is supplied with an actual video signal. Tbe bandwidth of a monitor is much wider than that of an ordinary TV set. Typically a good monitor has a bandwidth of 20 MHz, while tbe TV only bas 5.5 MHz (this is the limit of the transmitter bandwidth). The reason wby such a large bandwidth is necessary is a subject to which we will return later. In television tha video signal is modulated onto a carrier wave, so that a receiver and decoder section are also needed to regain the pure video signal from the receivad signal.

The principles of how a television builds up an image on its screen have been dealt with in detail before in Elektor (September 1977, p. 9-33) so there is not really any need to go into the nitty-gritty here. However, there is no harm in running through the major points again. An image is built up of 625 lines at a frequency of 25 Hz (25 images per second). This frequency is high enough to prevent the human eye from detecting any annoying flicker. Each image is divided into two parts, each of which consists of 312½ lines, called rasters. One raster consists of all the uneven lines, the other has all the even lines. These moving images on the rasters then appear as one static image witb no flickering. This technique is known as interlacing and its principle is sbown in figure 1a. As the diagram shows, one raster begins with a half line and the other raster ends with a half line. By ending with a half line, the raster synchronization pulses come a whole number of times the line period (the time taken to scan one complete line on the screen) after the last line synchronization pulse, whereas otherwise the raster synchronization pulses appear one half of a line period later (see figure 2). That difference of a half line defines at what height the electron beam starts writing the next line after the fly-back. Because a half line period corresponds exactly to the height of a half line on the screen the result is that the lines of the two rasters appear precisely between each other.

That is the system used in television, but if we have a static image (such as a screen full of numbers) then these two interlaced rasters cause an annoying 'jumping' effect and this is something to be avoided in monitors for computer systems! However, thera is a trick to prevent this effect from occurring. We have more than enough lines on the screen so we simply use half of the total number of lines and write the same raster on tha cathode ray tube 50 times per second. That can quite easily be achieved with 'software' by ensuring that the raster synchronization pulses always appear at the same interval after the last line synchronization pulse. This is called a non-interlaced image and is possible with a normal TV set or with a monitor and this is the

1a



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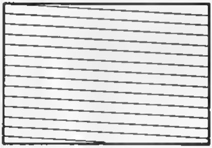


83082-1b

Figure 1. To build up the image in a normal TV set, interlacing is used. This means that two interwoven rasters are written on the screen one after the other. This is shown in figure 1a. Figure 1b shows the non-interlaced image whereby the same raster is written 50 times per second. This gives a flicker-free image for use with a monitor.

2

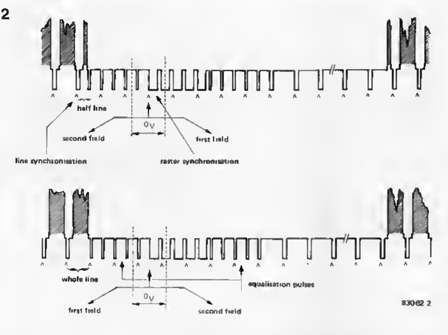


Figure 2. The beginning and ending of a video signal (the so-called raster blanking). Figure a shows the ending of the first raster (it ends with a half line) and figure b shows the ending of the second raster.

3

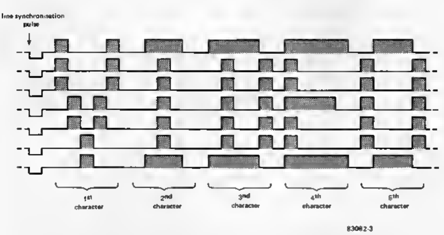


Figure 3. This illustrates how the characters are built up on the screen. It shows seven consecutive video lines with the points where the cathode ray tube must light modulated on them. By putting the lines close under one another and shading the modulations we can quickly see what the word is.

method generally used to produce a flicker-free image (figure 1b).
For each character a matrix of dots is used, 5 x 7 or 7 x 9 are commonly used. Writing a line of letters or numbers on the screen is achieved as shown in figure 3. One row of dots at a time is written for the whole row of characters. So with a 5 x 7 matrix, 7 image lines are needed to write one row of characters. In figure 3 we show a number of these video signals with the modulation needed to write the word shown. Each pulse after the line synchronization pulse means that the electron beam is then lit on the screen. For clarity the pulses are shaded and the lines drawn close together to show how a character is put together. As this diagram shows, the word 'VIDEO' would appear on the screen. The VDU card does not use a 5 x 7 matrix, but 5 x 8 dots. The advantage of this extra line at the bottom is that we can make the lower case letters more accurately. An empty line is drawn between every two lines of characters on the screen so that the characters are separated from each other. Therefore there are actually 9 image lines per line of characters.
The VDU card normally puts 24 x 80 characters on the screen, but that is not to say that 216 (= 24 x 9) lines are all that are needed as in that case the first line would be right at the top of the screen. We also need some room at the side of the screen to prevent any of the characters from being lost here. So what we want in fact is a rectangular piece in the centre of the screen where all the characters will appear. Figure 4 shows how this appears on the screen. A total of 297 lines (33 character lines) and 128 characters can be written on the screen. Therefore we use a space of 216 lines of 80 characters in the centre. The small part of the diagram magnified shows how the VDU card builds up an actual character. We then have a 5 x 8 matrix for the characters, a space of

three dots between characters and an empty image line between each line of characters. At this stage we can look at why the bandwidth of a monitor has to be more than the 5.5 MHz of a normal TV set. In a normal television the line period is 64 μs. Practically none of this time is lost in the electronics because it is compensated for. The duration of each dot of the 80 characters in a line is 64 μs/128 (the theoretical number of characters per line) x 8 (5 dots per character plus 3 spaces) = 62.5 ns. The time for the synchronization pulse is included in the 128 theoretical characters. The highest frequency that could occur is if the pattern is black-white-black-white . . ., in which case the frequency will be 1/(2 x 62.5) = 8 MHz. And that is without even considering the sharpness of the black and white points.
This means that for a normal TV set the quality of the characters in an 80 x 24 matrix is not very good. So we must either use a smaller number of characters per line or a TV set with a proper video input. If we used 40 characters per line, for example, only about half the previous bandwidth would be needed.
Another screen display that is often desirable is graphics symbols. The Elektor VDU card uses special graphics characters on an 8 x 8 matrix whereby the symbols appear directly one after another horizontally. Vertically they can also 'run into' (or 'runinto') each other because the blank line is omitted and simply moved to the bottom of the screen so that the total number of lines remains the same.

How does a VDU card work?

First we will have to see how the VDU

4a

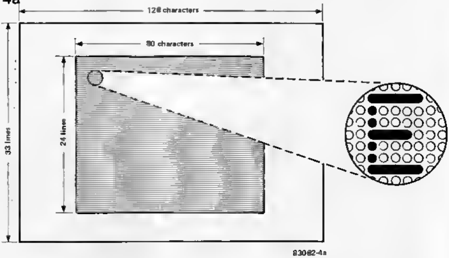


Figure 4a. The image build up in the Elektor VDU card. A maximum of 24 lines of 80 characters can be written. The margins contain no information. The small part seen magnified shows the matrix form used for the characters (5 x 8 matrix with one blank line for separation of the lines of characters).

4b

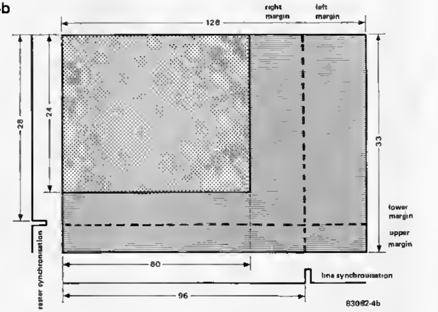


Figure 4b. This is how the CRTC card sees the screen build up. The part to be written is in the upper left hand corner while the rest of the image space is to the bottom and right of it.

5

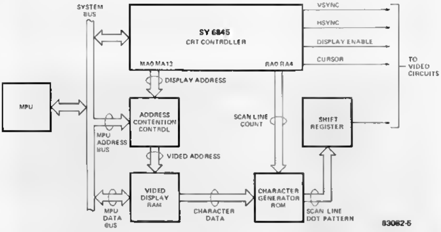


Figure 5. Block diagram of the VDU card. The most important parts are the controller (CRTC), the video RAM and the character ROM.

card builds up an image because it is not exactly the same as is shown in figure 4a. Figure 4b is somewhat different and shows what space the 80 x 24 characters occupy in the total memory field of the card. The actual written part is at the start, while all the empty space is to the right and to the end. However, we want empty margins all round the edges of the screen and this is achieved by stating in the memory field where the horizontal and vertical synchronization pulses should occur. This means in fact that the very bottom part of the address range actually appears at the top of the screen because the monitor starts writing from the top of tbe screen again after the raster synchronization pulse.The same is true of the margins at the left and right of the screen but in this case they depend on the line synchronization pulse.

All the 'digital traffic' is controlled by the CRTC (Cathode Ray Tube Controller) on the video card. This IC has the following tasks:

- locating the address of the character which must be written on the screen
- converting that character into the relevant dot matrix.
- producing the horizontal and vertical synchronization pulses at the right times
- sending tha matrix points of one line to the video input of the monitor.

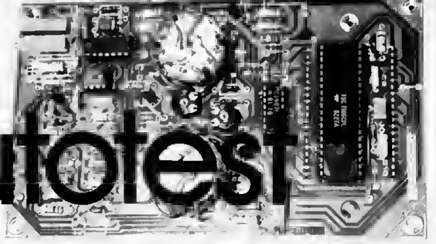
Horizontal and vertical synchronization pulses can also ba combined, as in tha Elektor VDU card, to form a 'composita video' signal.

The controller also has some othar functions such as choosing the desired point matrix, the number of characters per line and the number of lines per image, the choice of interlaced or non-interlaced image and so on. It also drives the cursor which is visible on the screen and controls the connection for a light pen, which is an 'option' on the VDU card.

The block diagram of figure 5 shows the main parts of the VDU card. Apart from the multi-function CRTC it also contains a video RAM and a character ROM. The video RAM stores all the characters which must be written on the screen. If 80 x 24 characters must be written on the screen then 1920 (= 80 x 24) memory locations are needed so a 2 K RAM is used. The ROM contains information on the dot build-up of each character, including the graphics symbols. The CRTC controls communication between the video card and the rest of the computer system via the address and data buses (they are actually combined to form the system bus). Data that must appear on the screen is read by the controller and then placed in the appropriate memory location in the video RAM. To read out the data in the RAM the CRTC runs through the whole address range of the memory so that the 80 characters of a line are read out one after another. The data now goes to tha cheracter ROM and here the dot pattern for these characters is located. Referring back to figure 3 we see that a character is written on eight lines. In the case of the Elektor VDU card each series of 80 characters is read out 8 times, and each time the dot pattern for a single image line is read. All the dots for this line then go to a shift register and they are then output in serial form. When this is combined with the synchronization signal provided by the CRTC the result is a complete video signal.

This article was merely intended to be a brief description of the operation of a VDU card and monitor. We have referred in particular to the Elektor VDU card as published in this issue but most other systems operate in much the same way. However we hope that any questions about this subject have now been cleared up, so now you know what to expect when you build your own!

Our essential friend, the multimeter, is rather out of its depth when confronted with the internal combustion engine. Here a rugged, easy to use, instrument with 'no moving parts' is needed. The Autotest meets these requirements as well as adding a few 'extras' that are seldom found on the average multimeter. A high-current range combined with the ability to read RPM and dwell angles are not only useful but necessary when servicing auto electrics.



autotest

electronic servicing instrument for cars

Of necessity, today's motorist is extremely economy conscious and is therefore more likely to attempt car repairs that were previously the domain of the 'expert'. However, this often leads to the need for specialized equipment, even in the 'electrical' department. Of course, our multimeter will take care of this . . . but will it? In practice, the ordinary multimeter is not really at home with the internal combustion engine for a number of reasons.

- The average multimeter has far too many ranges, not in itself a problem but it can be difficult to operate (especially with greasy hands).
- The current range of a multimeter invariably stops at 1 amp. The fact that aven a car parking light draws almost 2 amps renders our sophisticated multimeter rather useless as soon as a bonnat is opened.
- A good usable low-resistance range is not usually a feature of multimeters. The normal, cramped scale leaves a lot to be desired when looking for corroded bulb holders.
- Robusticity! Or to put it another way, how would your £50 – £100 multimater fare when propped somewhere under the bonnet while attempting to read the output of a voltage regulator of an engine running at 3000 RPM?
- . . . and while on the subject of RPM . . . but no, your meter can't read that, can it! How about dwell angles . . .

By now it will be apparent that a test meter for use on cars is a rather special beast, so much so, that those used by the 'experts' can be very expensive. The Elektor Autotest has been designed to take over the job that our multimeter was never intended to do. As a glance at table 1 will show, it manages this with comparative ease. The 'robusticity factor' is also very high due mainly to the use of a printed circuit board and a liquid crystal display.

Table 1

The Autotest ranges

	maximum range	resolution
current	20 A	10 mA
voltage	20 V 200 V	10 mV 100 mV
resistance	200 Ω 20 kΩ	0.1 Ω 10 Ω
RPM	7000 RPM	10 RPM
dwell	90°	0.1°

The Autotest ranges

Most of the work in the circuit (shown in figure 1) is carried out by a 7106, a 3½ digit A to D converter from Intersil. This IC is capable of directly driving the liquid crystal display and includes its own clock oscillator and internal reference source.

The Autotest has been designed to be as simple to use as possible and, for this reason, some terminals hava more than one function. In practice, this is an ideal situation.

The resistance range

When measuring resistance, connect the test laads between the COM and R terminals and switch S1 to position A. A constant current, generated by transistors T4 and T5, is derived from the reference voltage which appears between pins 32 and 1 of the 7106 (IC3). The constant current is fed to the R terminal and is passed through the resistance to be measured. The consequent voltage drop across the resistor is then measured and the reading will correspond to the value of the resistor.

The constant-current level can be switched to one of two values by S2 to cater for the two different resistance ranges. With switch S2 in position A the current will be 10 μA (determined by R20 and P4), in position B it will be 1 mA (R21 and P5). Fuse F1 protects the circuit against a voltage being inadvertently applied between the COM and R terminals. If this occurs, only the fuse will blow and no damage will be caused to any other components.

The voltage range

To measure voltage, connect the test leads between terminals COM and +. The voltage reading is derived from the voltage divider network consisting of resistors R1 . . . R5 (R31 has negligible effect) with switch S1 in position B. Again, two ranges are provided, 20 V and 200 V, by switch S2.

Current range

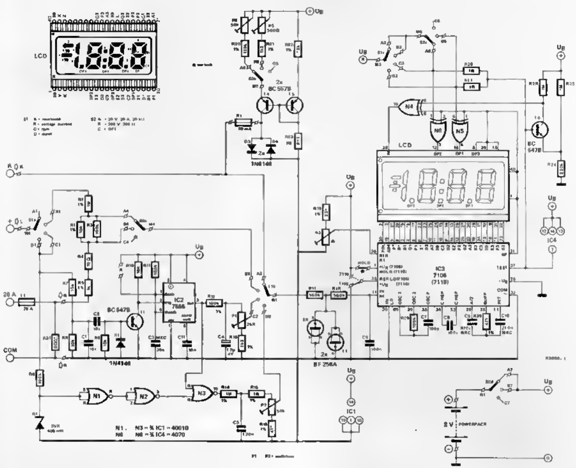
For the current range, connect the leads between terminals COM and 20 A. Only the one 20 A range is provided: this will be sufficient to cater for virtually all applications in car electrics. The current reading is derived from the voltage drop across the 20 A shunt resistor R31. Where do we get a 20 A shunt from?

A shunt resistor which will handle 20 A for the current range can be an expensive item. However, since extreme accuracy is not so important to us in this instance, a suitable shunt can be manufactured quite easily. Copper wire with a diameter of 1.5 mm has a resistance of 1.01 Ω per 100 metres. For the 0.01 Ω we require for a 20 A current range, a length of 99 cms will therefore be needed. To ensure complete accuracy a 1.2 m length of wire can be taken and a current of 1 A passed through it. With an accurate voltmeter find the length of wire which gives exactly 0.01 volts dropped between the two meter leads. Allow about 1 cm more at each end for soldering and then wind the wire into a coil and connect it as shown in figure 2. The coil diameter is not important provided it is of a suitable size to fit into the space allocated to it. The leads going to the meter circuit must be connected directly to the shunt coil itself (there must be exactly the measured length between the connections to N and M) because otherwise inaccuracy will result as the contact resistance will also be measured.

This then provides us with a very economical 20 A shunt but it is not without a disadvantage. A current of 20 A across a 0.01 Ω

Figure 1. The relative simplicity of the circuit for the Autotest is mainly due to the fact that most of the work is carried out by the A/D converter, IC3.

1



'resistor' will produce a power dissipation of the order of about 4 watts. The shunt coil will then be the equivalent of a 4 W electric fire! The temperature rise itself is not so much of a problem if adequate ventilation is provided but, as the shunt warms up, its resistance will increase. This is definitely not a desirable feature, even on a very cold day! Unfortunately, there is no real answer to this problem without the expense that we are trying to avoid. However, if readings are taken as quickly as possible (in about two or three seconds for example), a reasonable accuracy can be expected. Of course, lower current reedings will be less affected. It is worth noting that resistance wire could be used in place of copper wire although it is quite expensive and not very freely available. However its temperature coefficient is about fifty times better! The length will of course have to be recalculated.
It is not advisable to reduce the length of the shunt coil in an attempt to increase the current range of the Autotest. The temperature rise will be significantly faster and it will be very difficult to achieve an accurate current reeding.

RPM measurement

The contact breaker points in the ignition system of the car are the source of the signal used for RPM measurements in the Autotest. The circuit is connected to the car as shown in figure 3. The COM leed can of course be connected anywhere on the chessis of tbe car.
Figure 4 shows the waveform produced by the cb points. When the cb points open, a positive pulse is passed to the input of tbe Autotest and, via R7 . . . T1, triggers the monostable multivibrator (IC2). The output of this IC will be a square wave with a constant pulse width of 3.9 ms. Tbe pulse frequency will be that of the cb points opening. This waveform is integrated with the result thet the charge level on capecitor C4 will be directly proportional to the frequency of operation of the cb points, and therefore, the engine speed. The voltage across C4 is read and displayed as RPM. Preset P1 is included for calibration purposes and will be discussed later.
A distinct advantage of this principle is that the configuration of the engine (4 or 6 cylinder) under test is of little concern. The circuit can cater for all types by selecting the value of R13 and calibrating P1 (see 'Calibration').

Dwell angle measurement

At this point, it may be as well to clarify exactly what 'dwell angle' is. It is common knowledge that the firing of the spark plugs in an internal combustion engine is controlled by the contact breaker points in the ignition system. For maximum efficiency, it is important not only that the cb points open at the correct instant, but also that they are closed for the correct period of time. This is determined by the cb cam profile and – accurate setting of the cb points! In exact terms, the dwell angle is the angle through which the contact breaker cam rotates while the points are closed. It will be obvious then that the dwell angle will alter if the cb points are either bedly set or worn. Thus the dwell range of the Autotest will be able to tell a few tales on the condition of the cb points!
The circuit for the dwell range shares the same input terminal (and most of the components) with the RPM range. However, there is an added problem with the signal waveform from the cb points. In contrast to the RPM range, we need to know when the points close in order to derive the dwell angle. Therefore the cb waveform must be debounced and inverted.
After being voltage-limited by R6 and D1, the cb signal is inverted by gates N1 . . . N3, while for debouncing the circuit for the RPM range is used. The function of the dwell circuit is better explained by the use of the timing waveforms of figure 5. The upper waveform is the signal which can be expected from the cb points, complete with 'ringing'. The second waveform shows that the overshoot has been removed (by D1, N1 and N2) by the time the signal reaches the output of gate N2. The 7555 monostable (IC2) is triggered on the positive going edge and provides a clean square-wave output with a pulse width of 3.9 ms. This is then combined with the output of N2 to produce a final, debounced, inverted signal at the output of N3.
After integration, the voltage across capacitor C5 will correspond to the dwell angle. This is then reed by the 7106 and, when calibrated by P2, provides a direct reading of the dwell angle. A voltage level of 50 mV at the wiper of P2 will produce a reading of 50.0 (degrees).

The A/D converter and display

A few points of note about the 7106 A/D converter. For full-scale indication on the display, an input voltage level of 200 mV

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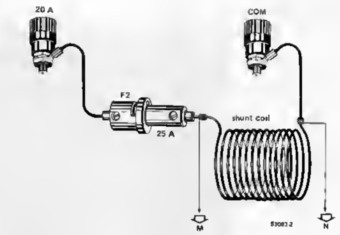

Figure 2. The accuracy of the current range depends to a large extent on how carefully the 20 A shunt is constructed.

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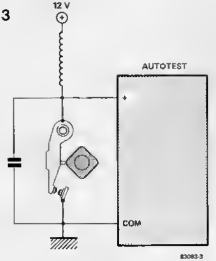

Figure 3. The 'circuit diagram' of the primary ignition system consists of the contact breaker points, the coil and a capacitor.

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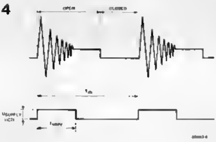

Figure 4. The waveform which can be expected from the contact breaker circuit. Much needs to be done to it before it can be used.

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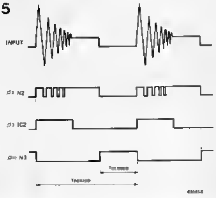

Figure 5. The timing waveforms of the dwell circuit of the Autotest.

will be required between pins 30 and 31 from the 7106. Transistor T6 and gate N4 provide an indication on the display when the supply voltage becomes low enough for the battery to need replacing. As current consumption of the circuit is only of the order of 1.5 . . . 2.5 mA, the battery should have a fairly long life. The car battery MUST NOT be used as a power supply for the circuit as this will cause a short to occur between COM and ⊥.

The 7116 can be used in place of the 7106 as IC3. However, there are minor differences between them. The 7116 has been provided with a 'HOLD' input at pin 1. If this is to be utilised, the wire link on the printed circuit board can be replaced by a switch to enable the display to be 'frozen'. It must be emphasised that this only applies to the 7116 since pin 1 on the 7106 is the $+U_b$ supply pin and the wire link must be fitted. A second link is used to adapt the circuit to the 7106 or 7116 depending on which is used.

The two FETs, T2 and T3, are used as very-low-leakage diodes and, together with R17 and R18, protect the input against high voltage levels which may cause damage to the IC.

The position of the decimal point on the liquid crystal display is determined by switches S1c, S2c and gates N5 and N6.

Construction of the Autotest

Virtually all of the components (excluding the shunt) are mounted on the printed circuit board shown in figure 6: construction therefore should not pose any problems. The liquid crystal display is mounted on the track side of the printed circuit board with pin 1 of the display towards P3. It is strongly advised that open socker strips are used for mounting the display. The internal wiring of the Autotest is illustrated in figure 7.

To provide some measure of shielding from possible interference, due to static or the ignition system, the interior of the case (if it is plastic) can be lined with aluminium foil. This must then be connected to point N on the printed circuit board (not to ⊥ or 0V). Take particular care to ensure that the foil

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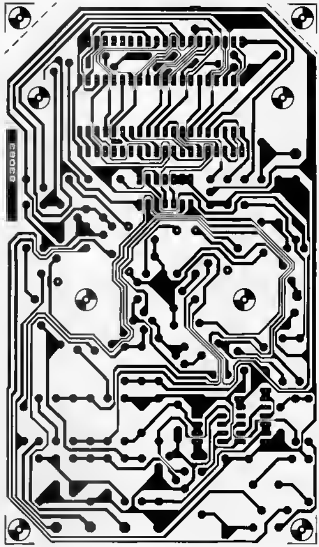

Parts list

Resistors:
R1,R14,R15 = 1 M 1%
R2 = 10 k 1%
R3,R6,R29 = 100 k
R4 = 10 Ω
R5 = 1 k 1%
R7 = 15 k
R8 . . . R10 = 10 k
R11,R12 = 100 k 1%
R13 = 2k2 1% (2k21)
R16,R30 = 47 k 1% (47k5)
R17,R18 = 560 k
R19 = 22 k 1% (22k1)
R20 = 120 k 1% (121 k)
R21 = 1k2 1% (1k21)
R22 = 15 k 1%
R23 = 8k2 1% (8k25)
R24 = 220 k
R25 . . . R28 = 1 M
R31 = 0.01 Ω see text
P1 = 2k5 ten turn preset
P2 = 50 k ten turn preset
P3 = 1 k ten turn preset
P4 = 50 k preset
P5 = 500 Ω preset

Capacitors:
C1,C2,C11 = 10 n
C3 = 39 n (MKC)
C4 = 22 μ/4 V
C5 = 220 n
C6,C8 = 100 n
C7 = 100 p
C9 = 470 n (MKC)
C10 = 220 n (MKC)

Semiconductors:
D1 = 3V3/400 mW zener diode
D2 . . . D4 = 1N4148
T1,T6 = BC 547B
T2,T3 = BF 256A
T4,T5 = BC 557B
IC1 = 4001B
IC2 = 7555
IC3 = 7106 (7116)
IC4 = 4070

Miscellaneous:
F1 = 50 mA fuse
F2 = 25 A auto fuse
LCD = liquid crystal display NDP 530-035A-S-RF-PIC *(Norsem Tel: 0734-884588)*
1.5 mm diameter copper wire
Metal case: Bimbox 5006-16 from Boss Industrial Mouldings LTD (Tel. 80636/716 101)
Plastic case: Bimbox 2006-16

does not cause any shorts to the printed circuit board or the internal wiring. If a metal case is used, it should be connected to point N directly.

The printed circuit board fits, for instance, in the Bimbox 2006-16 (5006-16 metal) from Boss Industrial Mouldings Ltd. The BOC 450 case from West Hyde can also be used with very minor modifications to two mounting holes of the board. The switches are mounted and secured through the holes provided in the middle of the printed circuit board.

Calibration

For the initial calibration, switch S1 should be placed in position B, S2 in position A, and resistor R1 must be short-circuited with a wire link. Apply a reference dc voltage of 150 mV between + and COM. Preset P3 is then adjusted to give a reading on the display of 150.0.

The link across R1 can now be removed and both switches S1 and S2 placed in position A. A resistor with a known value (about 10 kΩ) is then connected between the COM and R terminals. Preset P4 is adjusted to give a reading that corresponds to the value of the resistor. For example, if the resistor used has a value of 10 kΩ, the reading will be 10.00. A similar calibration is carried out with a 100 Ω. In this case, S2 will be in position B and preset P5 is adjusted to provide a reading of 100.0.

The next step involves calibration of the dwell range. With the input terminals of the Autotest open-circuited, and switch S1 in position D (the position of S2 is immaterial),

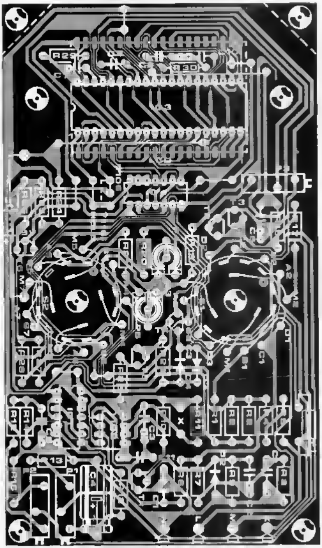

Figure 6. All the components for the Autotest (with the exception of the 20 A shunt) are mounted on the printed circuit board. The liquid crystal display is mounted on the track side of the board. It is recommended that open in-line sockets are used for this purpose.

adjust P2 to display a reading of 90.00. This corresponds to a dwell angle of 90 degrees.
Finally, for the RPM range, the small auxiliary calibration circuit of figure 8 will be required. This circuit generates a pulse waveform with a frequency of 100 Hz, which, for our purposes, corresponds to an engine speed of 3000 RPM for a four cylinder four stroke engine. Connect the generator between the + and COM terminals and adjust P1 to give a reading on the display of 3.00 (RPM = reading x 1000).

The dwell range can be used for engine speeds up to a maximum of 3000 RPM with the circuit as it is. However, if it is thought necessary to measure the dwell angle at higher engine speeds, this can be accomplished with a minor modification to the circuit. A switch in series with a 100 kΩ resistor can be connected across the points marked 'X' in the circuit diagram (left of R10). In practice, this is not usually necessary since it is adequate for most purposes for dwell measurements to be made at lower engine speeds. Although higher engine speeds will show a defective spring on the contact breaker points, it will be very difficult to reach firm conclusions because the automatic advance/retard mechanism may cause an, apparently, unstable reading. This problem can be aggravated by faults in the valve timing, carburettor or even the closed circuit breathing system if it is fitted. At low speeds, however, experience will soon shown whether the points are correctly set or need adjustment. It must be noted that the dwell angle for a specific engine is determined by

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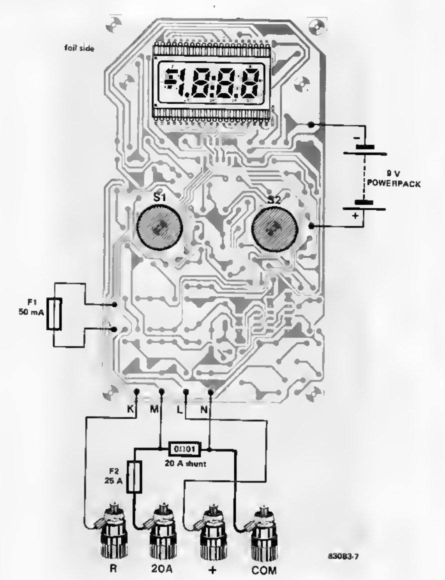

Figure 7. The internal wiring of the Autotest is illustrated here. Refer to the text and figure 2 for details of wiring the shunt coil.

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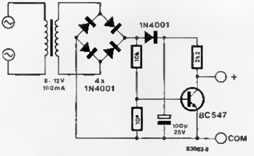

Figure 8. This small auxiliary test circuit is used for calibrating the RPM range. It can be constructed on a small piece of Vero board.

the manufacturer and can be found in the manual for the vehicle in question. It is not normally possible (or necessary) to 'improve' it.

The Autotest is now fully calibrated but, not all engines are 4 cylinder! For other engine configurations a different value for R13 will have to be found. This will not be a problem since a value of 1k5Ω will provide an adjustment range of between 16 mV and 42 mV at the wiper of P1.

Calibration for all engine configurations (with the possible exception of 9 cylinder 7 stroke engines) can be carried out using the same calibration test circuit of figure 8. For a 5 cylinder/4 stroke engine, 100 Hz will be equal to 2400 RPM and P1 should be adjusted for a reading of 2.40. With a 6 cylinder engine, 100 Hz will correspond to 2000 RPM and a reading of 2.00. The values of 1k5Ω for R13 and 1 kΩ for P1 (an adjustment range of 16 mV to 26 mV) will cater for both these engines.

The Autotest can be used on both positive and negative earth vehicles. However, for positive earth, the polarity of the leads will have to be reversed.

It has been more than a year since we published the dynamic RAM card (April 1982, Elektor No. 84), but it is proving to be very popular. Many readers have asked about the possibility of replacing the eight 16 k memory ICs with 64 k chips. Many people suggested how this could be done and all these ideas prompted us to investigate the feasibility. What we came up with is a sort of check list of modifications, which you can tick as you go along.

64 k on the 16 k Dynamic RAM card

524 288 bits = (8 x 64 k) – (8 x 16 k)

from an idea by
K. D. Lorig

We have often thought that we are rather fortunate since electronic components are one of the very few commodities that actually decrease in price. This is currently the situation with the 64 k dynamic RAM ICs, which are also, incidentally, becoming more readily available from a number of different sources. Considering the fact that the majority of 4164s (the first two digits vary from manufacturer to manufacturer) require only a single 5 volt supply, the dynamic RAM card could use 64 k RAMs. Some of the advantages to be gained are, more 'bits par pound', the connectors on the bus card can still be used (an 8 x 64 k card is enough for all the memory space addressable by an 8 bit microprocessor) and the current consumption will be less. The only drawback is the need for 'surgery' to the existing circuitry. Basically, to quadruple the capacity of the memory card all that is needed is to cut a few tracks and make a few new connections.

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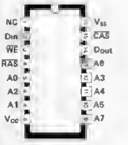

A0 A7	Address Inputs
CAS	Column Address Strobe
Din	Data In
Dout	Data Out
RAS	Row Address Strobe
WE	Read/Write Input
Vcc	Power (+5 V)
Vss	Ground

Figure 1. This is the pin designation for a 4164 dynamic RAM IC. Comparison with a 4116 shows that they are pin compatible except for pins 1, 8 and 9: an extra address line is added (A7) and the –5 V and +12 V supplies are removed.

Deletions

Rather than leave anything to chance we have drawn up a list of everything that has to be done, starting with 'demolition' and finishing with 'reconstruction'. All modifications are shown in figures 2 and 3 which are the circuit diagram and printed circuit board layout respectively.

- Remove IC11 . . . 19 from their sockets.
- Take out capacitors C3, C12 . . . C15, C19 and C20.
- Remove the strap parallel to IC9. We mean the first strap to the right, between the IC and the connector. It connects pin 9 of the 4116s to +5 V.
- Cut the tracks joining:
  - pin 2 of IC4 (N18) to ground
  - pin 2 of IC5 (N19) to ground (remember to remake the connection to ground that this breaks)
  - pin 8 of IC12 . . . 19 to +12 V
  - pin 1 of IC12 . . . 19 to –5 V
  - pin 6 of IC7 (N29) to pin 5 of IC2 (N47)
  - pin 5 of IC2 to pin 10 of IC8 (N31)
  - pin 2 of IC10 to ground
  - pin 3 of IC10 to ground
  - pin 2 of IC10 to pin 3 of IC10.

Check the breaks with a (lack of !) continuity tester.

New connections

The next stage consists of making connections between

- pin 8 of IC12 . . . 19 and pins 1a/1c of the connector (+5 volt supply)
- pin 6 of IC7 (N29) and pin 10 of IC8 (N31)
- pin 8 of IC8 (N31) and pin 5 of IC2 (N47)
- pin 8 of IC6 and pin 2 of IC5 (N19)
- pin 4 of IC10 and pin 2 of IC4 (N18)
- pin 2 of IC10 and pin 19c of the connector (A14)
- pin 3 of IC10 and pin 19a of the connector (A15)
- pin 18 of IC4, pin 18 of IC5 and pin 9 of IC12 . . . 19 (A7)
- pin 9 and pin 10 of IC7 (V-W)
- pin 12 and pin 13 of IC7 (X-Y).

Except for decoding the desired addresses the output pins of the address decoder IC11 leave in two groups, one connected to the V/W input of IC7 and the other to the X/Y input and each is connected to the high logic line via a 470 Ω resistor. If it is decoded as indicated in the diagram the card will be addressed between $0000 and $BFFF without interruption. This is the configuration used for the Junior Computer with DOS. Make the connections shown in figure 3 as two lines from ground to pins 4a and 4c of the connector.

Additional components

When all the modifications mentioned above have been made most of the work is done. All that remains is to substitute a 74LS159

Figure 2. Most of the circuit diagram for the 16 k card remains the same. The modifications consist of adding two address lines (A14 and A15) to enable all of the memory to be addressed, and replacing the address decoder (74154) by its counterpart with open collector outputs, which may be shorted together.

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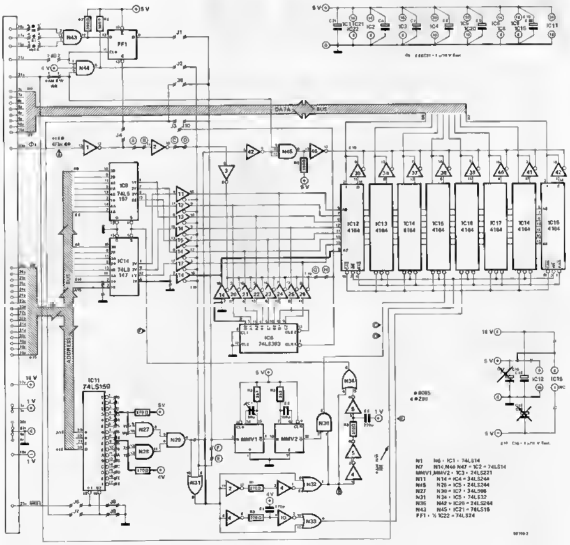

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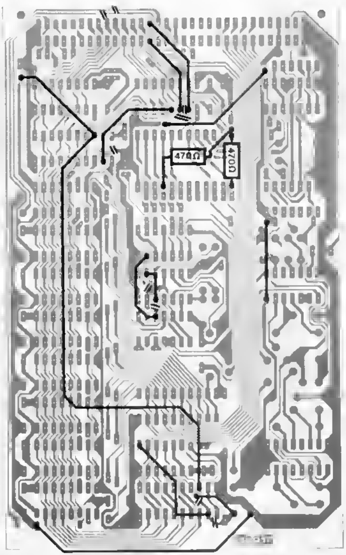
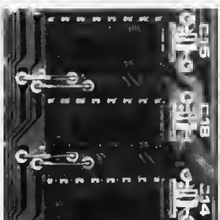
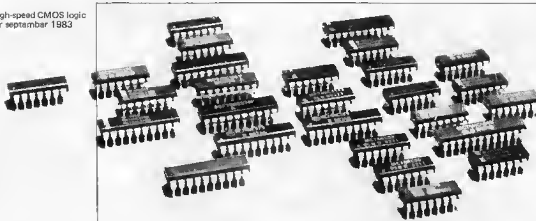


Figure 3. This layout of the printed circuit board clearly shows the tracks that have to be cut and the new connections that are to be made. Note that some ground lines are too narrow for this application and therefore need to be reinforced. And don't forget to remove the strap beside IC9.



(open collector outputs) for the 74LS154 (IC11). If it has not already been done C1 can be replaced by an 80 pF variable capacitor. This is to enable the timing relationship between the triggering of MMV1 and the start of the refresh pulse to be set to prevent the refresh from occurring too soon.
It is a good idea at this stage to run through everything done so far just to check that all is as it should be. Then the last thing to do is to inert all the new memory ICs in their sockets. They are available from a number of different manufacturers, most of whom are Japanese, and have different 'names', except that the last two digits are always '64'. Some possible examples are F 4164 (Fairchild), MB 8264 (Fujitsu), HM 4864 (Hitachi), ITT 4164, MSK 4164 (Mitsubishi), MK 4564 (Mostek), NMC 4164 (National Semiconductor), UPD 4164 C/D and so on . . . the choice is yours. In the article on the 16 k DRAM card the principle of the refresh was described in detail and a program was given for checking the memory, so as a final check it is worthwhile to run this program to check the 524 288 bits of your 'new' card. ◼



new high-speed CMOS logic

LSTTL speed with CMOS current consumption

Speed is not magic, but it has its price: fast logic circuits use more current. TTL technology is fast and greedy, CMOS on the other hand is slow and economical. But now, advances in CMOS technology are making it possible to combine TTL speed with CMOS economy. A new family of logic circuits, high-speed CMOS, combines the speed of LSTTL with the advantages of CMOS and looks set to become the standard and eventually replace both the CMOS and TTL technologies.

The present situation

Bipolar digital ICs have been around for some fifteen years. This first, and for a long time only, technology for logic elements is still the fastest and, through TTL and ECL, also the most successful. Its big drawback remains the power dissipation.
CMOS technology, on the other hand, offers low current consumption, a wide range of supply voltages, and high immunity to input noise. Its drawback is the lack of speed. During the past few years CMOS has become somewhat faster, and TTL, through the LS version, a little less power-greedy. None the less, the two technologies are still separated by a wide gulf. At present, it would appear that CMOS just about offers the best compromise between speed and power dissipation
High-speed CMOS combines the speed of LSTTL with the advantages of CMOS. The youngest member of the TTL family, the ALS version, is faster than LS and has only half its current consumption.

How CMOS has become faster

Standard CMOS and the majority of buffered CMOS-ICs are manufactured by the metal-gate process. Figure 1 shows a

Figure 1. Cross-section of a chip manufactured by the metal-gate CMOS process. The parasitic capacitances which have been drawn in prevent faster switching.

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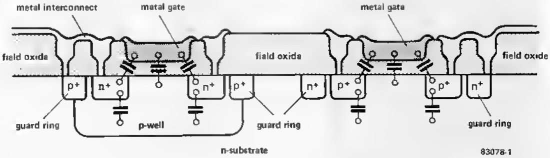

2a HE 4000B

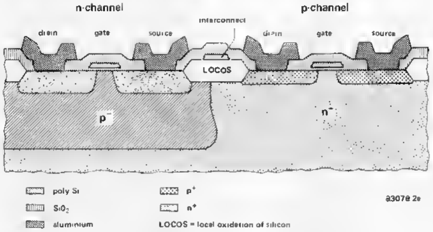

Figure 2a. Cross-section of a chip in the HE 4000B family manufactured by the silicon-gate technique. Reduced internal capacitances allow higher switching speeds.

2b HC MOS

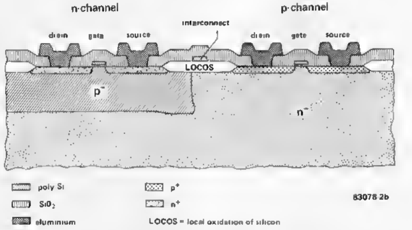

Figure 2b. HCMOS is also produced by the silicon-gate process. Its smaller gate structure causes further reduction in the internal capacitances and higher current gain of the transistors. HCMOS therefore provides higher output currents at higher switching speeds.

cross-section of a chip made in this technique: it represents the complementary n-channel and p-channel transistors. The parasitic capacitances between drain, gate, and source are added for clarity.

The switching speed of a MOS transistor is determined by the time required for the charging and discharging of the internal parasitic capacitances and the external (load) capacitance. This time is dependent not only on the value of these capacitances but also on the current gain, h_{fe}, of the transistor. A transistor with a higher h_{fe} can deliver more current and charge the capacitances faster. A consequence of the metal-gate process is that transistors have relatively large gate regions which overlap to some extent with the drain and source. Small current gain and correspondingly large capacitances are the inevitable result.

To increase the switching speed, it is necessary to reduce the parasitic capacitance as well as to raise the gain of the transistor. This is achieved in the silicon-gate technology which since the mid '70s has been used in the production of CMOS-processors, memories, and also the HEF 4000B family of buffered CMOS-ICs. These CMOS elements are about three times as fast as the standard metal-gate 4000 series.

Figure 2 shows the structure of an n- and a p-channel transistor on a chip of the HEF 4000B family. The gate electrode is no longer of aluminium, but of polycrystalline silicon embedded in a layer of silicon oxide. Polycrystalline silicon can be etched in thinner layers than metal so that in silicon-gate technology the position of the gate with respect to the drain and source can be established more accurately, resulting in an overlap between them which is smaller than in metal-gate devices. This reduces the parasitic capacitances. Shorter gate length and thinner SiO_2 isolating layers under the gate lead to increased current gain.

Silicon-gate CMOS originally used gate thicknesses of about 6 μm which were later reduced to 4 μm. A further reduction to 3 μm combined with even more precise positioning and thinner isolating layers produced an improvement in switching speed by a factor 5 and an increase in output current by a factor 10. This completed the technological quest for a new CMOS-logic

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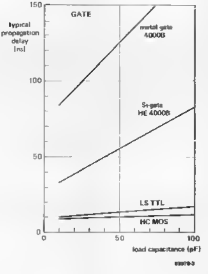

Figure 3. Gate-propagation delay as an indication of switching speed. The graphs show that HCMOS is not only much faster than metal-gate and silicon-gate CMOS, but also has a slight edge over LSTTL.

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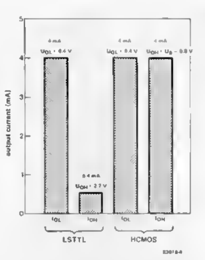

Figure 4. In contrast to LSTTL, HCMOS switches an output current of 4 mA in both logic states.

family which, as regards speed and output current, is equivalent to the LSTTL series.

The 74 HC and 74 HCT series

The relation between the new high-speed CMOS and the 4000 CMOS family refers only to the positive characteristics of the latter: low power dissipation, high immunity to input noise and a wide range of operating temperatures.

Externally, however, the high-speed CMOS resembles the TTL series: pinning, logic functions and type numbering are the same as for TTL. This fortunate decision by the high-speed CMOS manufacturers can only be greeted with relief as it precludes the introduction of a second standard for the 4000 series CMOS.

Equally sensible is the decision to make the high-speed CMOS available in two versions: the 74 HC series for operation from 2 . . . 6 V and the 74 HCT series for operation from 5 V ± 10% and TTL input levels. Otherwise the two series are identical. The abbreviation HC comes from *H*igh-speed *C*MOS; the additional T in the HCT series stems from TTL compatibility. This compatibility is an attractive feature of the HC family: as far as the user is concerned, an IC in the 74HCT series is now nothing more than a 74-LS IC with much smaller power consumption. Dreams do come true sometimes!

Both the HC and HCT versions are fully buffered and have symmetrical outputs (that is, same value current at HIGH and LOW logic levels). Furthermore, of the 120-odd types contained so far in the HC family, several are available as unbuffered inverters and these are suffixed HCU (the 'U' stemming from *U*nbuffered). These types are intended for constructing RC or crystal oscillators, variable threshold trigger circuits, and other circuits operating in a linear mode.

Although the 74-HC family is intended to offer an equivalent for every IC in the 74-LS series, it also makes available some popular ICs from the 4000 series. These are mainly circuits for which there are no equivalents in the TTL series. Thus, for instance, that popular counter and oscillator Type 4060 is available as 74HC4060 or 74HCT4060 in the high-speed CMOS series. Clock-frequency is 40 . . . 60 Hz (with load capacitance of 15 pF) depending on the manufacturer.

Speed and output current (fan-out)

The real advances compared with previous CMOS logic lie in the improvement of speed and fan-out which in high-speed CMOS are comparable to those in TTL. Figure 3 shows graphs of the typical gate-propagation delay vs load capacitance for metal-gate CMOS, silicon-gate buffered CMOS, LSTTL and high-speed CMOS. It is clear that HCMOS is only slightly faster than LSTTL, but its smaller increase in gate-propagation delay at higher load capacitances makes for a larger increase in output current. Typical gate propagation delays in a HCMOS gate are 8 ns at 10 pF, 10 ns at 50 pF, and 11.5 ns at 100 pF load capacitance.

It is also interesting to compare other logic versions of the TTL family, particularly the new 'advanced' ALS series which is two to three times faster than LSTTL. Table 1 gives a comparison of a number of typical circuits in the 74 series.

The buffered versions of the HCMOS family alle have identical output stages. These are, as in CMOS, symmetrical and deliver a current of about 4 mA at both HIGH and LOW. The bus driver outputs can even supply 6 mA in both directions. Figure 4 gives a comparison between the output-current levels of HCMOS and LSTTL. At LOW level output there is no difference between the output currents: both types provide 4 mA at 0.4 V. When the output is logic 1 and the supply voltage is 5 V, a HCMOS circuit delivers 4 mA at an output voltage of not less than 4.2 V while the LSTTL version provides only 0.4 mA at

not less than 2.7 V.
A standard HCMOS output can, therefore, like that of an LSTTL circuit, be connected to up to 10 LSTTL inputs. The fan-out with bus driver output is 15 LSTTL loads. In the case of HCMOS loads, the input currents (typically 1 μA) have practically no effect, so that the fan-out is limited only by the input capacitance (typically 5 pF) and not by the drive power. One output can be connected to up to 20 HCMOS inputs without any noticeable deterioration. If speed and signal-to-noise are not important, it is possible to connect up to 4000 inputs to one output. Only then, at least in theory, is an output current of 4 mA reached.

Current consumption. increase at higher switching frequencies

Lower current consumption not only reduces operating costs, but because of the reduction in heat, it also improves reliability. The quiescent current of HCMOS is, like that of CMOS, negligibly small as, in contrast to TTL, the leakage current is of the order of only a few μA. During switching, however, internal and external capacitances have to be charged which means an increase in current. The higher the switching frequency, the higher the current consumption. In that respect, there is no difference between HCMOS and CMOS, but HCMOS circuits can switch much faster and therefore have a correspondingly higher power dissipation. The quiescent current in TTL circuits is already so high that additional current consumption becomes only noticeable at very high switching frequencies. Figure 5 shows this basic difference between HCMOS and LSTTL. If only one circuit is considered, as in the figure, the power dissipation of HCMOS and LSTTL reaches the same value at an operating frequency of only a few MHz. A practical system, however, consists of a much greater number of ICs which in turn contain several elements such as gates, flip-flops, and the like. LSTTL circuits use the same current whatever their operation; in HCMOS only those elements which actually switch consume power. For instance, in a counter with 10 flip-flops using LSTTL circuits, all flip-flops dissipate the same power, but if HCMOS circuits were used, each flip-flop would consume only half of what the preceding one does. This fact tips the balance firmly in favour of HCMOS, as is shown in figure 6. In a standard microcomputer system with a 2 MHz or 4 MHz CPU, HCMOS circuits would use only a fraction of the power LSTTL devices do. Even in a system with a 10 MHz microprocessor, the power dissipation in HCMOS circuits would be only about one eighth of that if LSTTL devices were used.

Supply voltage, input level, and signal-to-noise ratio

The supply voltage for the HC and HCU versions of the HCMOS family can vary between 2 . . . 6 V. The extension of the lower voltage limit to 2 V is particularly interesting in view of future generations of microprocessors and memories which will require a supply voltage of less than 5 V. Non-stabilized power supplies and batteries can be used without any problems, while one lithium cell or two nicad cells can serve as emergency supply.
The switching levels in HCMOS lie further apart than in LSTTL as can be seen clearly from figure 7. That means on the one hand a higher immunity to noise, but on the other that the inputs of HCMOS devices cannot be connected to the outputs of TTL circuits if the supply voltage is 5 V. ICs in the HC version can, however, be

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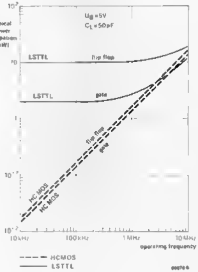

Figure 5. HCMOS shows the same typical increase in power dissipation with switching speeds as CMOS. For a single gate the power cross-over frequency is about 5 MHz, while that for a single flip-flop lies above 10 MHz.

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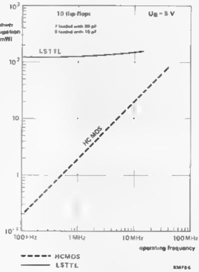

Figure 6. In a more complex circuit comprising a chain of 10 flip-flops, the power dissipation of HCMOS is clearly well below that of LSTTL even at the highest operating frequency.

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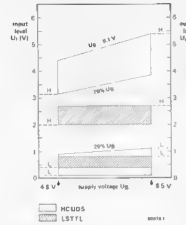

Figure 7. This shows that the noise immunity of HCMOS is far superior to that of LSTTL.

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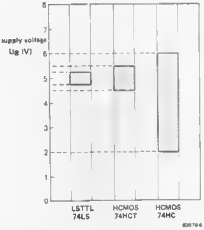

Figure 8. The permitted supply voltage variation of ± 10 per cent in the 74 HCT (TTL-compatible) series is twice that of the LSTTL. The 74 HC series can operate from supply voltages down to 2 V.

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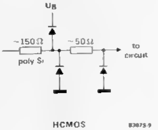
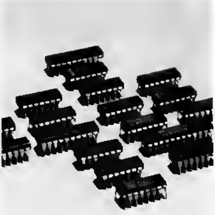


Figure 9. This shows the real improvement in input protection against electrostatic discharges in HCMOS as compared with CMOS.



combined with LSTTL types if the supply voltage is 3 V. None the less, HCT types are TTL compatible if the supply voltage is 5 V. Input levels and immunity to noise are similar to LSTTL. In contrast to the 74LS version, the 74HCT tolerates a supply voltage variation of ± 10 per cent (see figure 8).

Compared with the already hard-wearing CMOS circuits of the 4000 family, the inputs of the HCMOS inputs are even better protected against electrostatic discharges. The input protection circuit shown in figure 9 contains a poly-silicon resistor which limits the current through the protection diode and also reduces the speed with which the current rises. The diodes themselves are also more robust than those used in CMOS ICs.

Manufacturers

HCMOS are produced by a whole series of manufacturers and, for this article, data and other information of the following were used: Philips/Valvo, RCA, National Semiconductor, Motorola, and Fairchild. The ICs produced by these manufacturers in the 74HC, 74HCT, and 74HCU series are identical in all important parameters. Agreement exists between National Semiconductor and Motorola on the one hand and Philips/Valvo and RCA on the other as to common development of HCMOS and exchange of masks. Small differences do exist in the stated values of propagation delay and maximum clock frequency. Whereas there is conformity as to gate-propagation delays with typical values of 8 to 9 ns at 15 pF loads, flip-flops and counters produced by RCA and Philips are slightly faster than those of the other manufacturers. For instance, the maximum clock frequency of the 74HC74 is typically 60 Hz (RCA) or 40 Hz (National Semiconductor) at 15 pF load. Guarenteed minimum values could not be compared owing to lack of relevant information. Table 2 shows small differences in the type coding: each manufacturer has his own prefix.

More important differences exist in the packaging: only Philips/Valvo and RCA have so far planned to manufacture their

Table 1

Gates		HCMOS	LS-TTL	ALS-TTL	S-TTL	unit
74XX00	propagation delay	8	8	5	4	ns
74XX04	propagation delay	8	8	4	3	ns
Multiplexer/decoder						
74XX139	propagation delay					
	select	25	25	8	8	ns
	enable	20	21	8	7	ns
74XX151	propagation delay					
	address	26	27	8	12	ns
	strobe	17	26	7	12	ns
Flip/flops 6 . . . 18 fold						
74XX174	propagation delay	18	20	7	13	ns
	operating frequency	50	40	50	100	MHz
74XX374	propagation delay	16	19	7	11	ns
	enable/disable	17	21	9	11	ns
	operating frequency	50	50	50	100	MHz

Table 2. Type-coding of HCMOS

Manufacturer	HCMOS	HCTMOS	HCUMOS
General	74 HC04	74 HCT04	74 HCU04
Philips/Valvo	PCF 74HC04	PCF 74HCT04	PCF 74HCU04
RCA	CD 74HC04	CD 74HCT04	CO 74HCU04
Fairchild	74 HC04	*	*
National Semiconductor	MM 74HC04	MM 74HCT04	MM 74HCU04
Motorola	MC 74HC04	MC 74HCT04	MC 74HCU04

* not yet available
Note: the table shows the HCMOS types corresponding to types 7404 (TTL) and 74 LS04 (LSTTL)

entire HC programme in LSTTL compatible package. All other manufacturers are restricting the production of LSTTL compatible devices to a small number of types, mostly buffers, decoders, and similar 'computer-related' ICs.

Application

HCMOS devices are not cheap: their prices are noticeably higher than those of LSTTL circuits. This new technology seems, therefore, in the first instance to be of interest only where CMOS is too slow and the power consumption of LSTTL is too high. As soon as prices become more attractive, however, it is probable that particularly the HCT series will replace LSTTL, while the HC series is likely to invade the domain of the 4000 CMOS family.

As far as practical application is concerned, ICs of the HCT series can be used alongside LSTTL types in a circuit as required. In an existing circuit, HCT-MOS-ICs can replace LSTTL-ICs without further ado. In principle, it is possible to convert a TTL or LSTTL printed circuit board to HCMOS, but it is then necessary to change all TTL or LSTTL devices by HCMOS ones: they cannot be mixed. If in doubt, use the following rule: provided the supply voltage is suitable, a HCMOS-IC can drive a TTL-IC, but it is not possible for a TTL-IC to drive a HCMOS-IC.

Another point to watch when converting circuits is that unused MOS-inputs (and those of HC/HCT/HCU-MOS) must be connected without fail to either the + supply line or earth. An unused TTL-input may be left open-circuited: remember that such an input is logic 1!

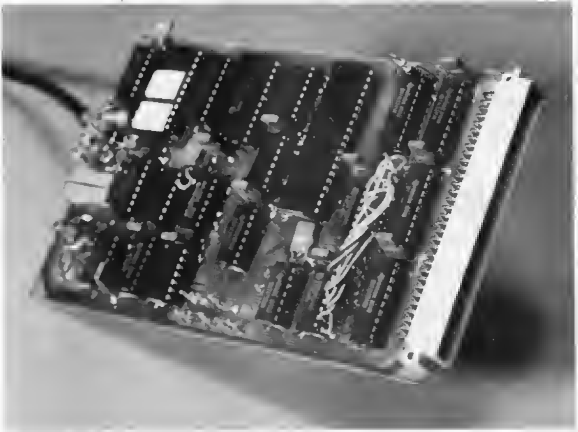
Finally, it should be noted that some manufacturers have given different names to the new technology. Fairchild, for example, call it FACT: Fairchild Advanced CMOS Technology. RCA use the name QMOS. This does not, however, alter the fact that all use the type-coding as indicated in this article.

What of the future?

At least fifty different HCMOS-ICs are now available in standard production form and it seems likely that this number will have doubled by the end of the year. A number of these new devices have already found their way into the catalogues of several electronic component suppliers. Future issues of this magazine will no doubt contain circuits with HCMOS. Already we have spotted interesting circuits like a single-chip telephone modem in the HC data book of one manufacturer. Sounds promising, doesn't it?

TTL
Transistor-Transistor Logic circuits with operating frequencies up to 35 MHz and input current levels of around 1.6 mA
STTL
high-speed version of TTL which is about three times as fast but has double the power requirement; it can attain frequencies up to 100 MHz
LSTTL
TTL circuits in which Schottky transistors and diodes are used in a configuration to give a compromise between speed and power dissipation. Operating frequency is up to 50 MHz and power dissipation is about 2 mW as compared to the standard 10 mW
ALSTTL
Advanced version of LSTTL which is slightly faster and has only about half the current consumption
ECL
Emitter-Coupled Logic circuits which are used where high speeds are required
MOS
Metal Oxide Semiconductor which may be n-channel or p-channel
CMOS
Complementary MOS logic which employs n-channel and p-channel transistors in complementary pairs

VDU card



In Elektor wa like to keep up to date, and we feal that the time has come for a new video card. The VDU card described here is not simply a modern receiver for the old and still popular Elekterminal, rather it is a new design intended to use all the possibilities of a modern computer. It can display 24 lines of 80 characters on the screen, graphics are available, and there are several other possibilities. Numerous Junior Computer users have long been waiting to be abla to equip their computer system with its own video card. However, this card is intended not only for the Junior but also for other processors, such as the 6800 family and tha Z80.

video for computers

in conjunction with
H. Vermeulen

The accompanying article in this issue 'Video graphics' describes the principles of a VDU card and is good background material for anybody who is not totally familiar witb the subject, so, rather than duplicate any of that here, we will simply describe the circuit for the VDU card. At the same time, we must explain what the further possibilities of this card are and this is where we will begin.

VDU card . . . and terminal?

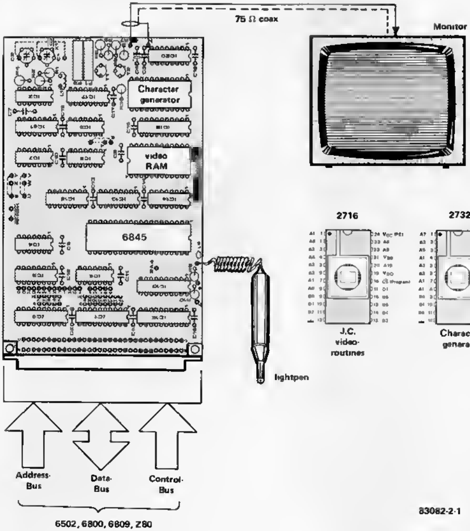
Here we will consider tbe VDU card as an independent unit. In this form it can be connected directly to the expansion bus of the Junior Computer. The only extra component needed is a 2716 EPROM with a VDU output program in place of the printer monitor program.

Figure 1 shows the main components which make up the VDU. First is the actual VDU card, with the Cathode Ray Tube Controller (6845), a 2K video RAM (6116), and the character generator – the block diagram is shown in the descriptive article. The character generator consists of a 2732 EPROM in which all the ASCII and graphics symbols are stored in the appropriate dot-matrix

layout (incidentally, graphics are possible by means of 'poke' commands, but we will return to that later). The card can be connected via a 75 Ω video output to a monitor. A connection for a light pen is also included on the card but no software for this purpose has been given in this basic version. It will be a simple matter to incorporate this at a later date. The diagram also shows the 2716 which contains the video routines for the Junior.
The standard format on the screen is 24 lines of 80 characters and because of the bandwidth required, a proper monitor or a TV set with a video input (not the normal aerial input) is needed.
The card also has an interface to adapt the VDU board for a Z80 processor. Similarly, other 6502 computers can be connected to it, as can the 6800 family. Because complete address decoding is possible on the card it can be adapted to practically every modern computer with one of the processors mentioned; AIM 65, SYM, VIC 20, VIC 64 and so on. One thing to remember is that the VDU card uses the Elektor bus and if it is to be used with other systems, the user will have to work out the connections and video routines himself.
The composite video signal produced by the VDU card can be fed into any monitor. Both the synchronization pulses and the contrast can be adjusted. The whole image can also be inverted to provide black characters on a light background. The cursor can be made to flash or light continuously. The VDU card can be used witb the oscillator containing C1, C2 and L1, or these components can be replaced by a 15 MHz crystal, as shown dotted in the circuit diagram. If this is done the image on the screen will be rock steady.
The card is slightly unusual in that all the timing on the card works with synchronously clocked TTL switching. The advantage of tbis is that no timing faults can occur, even with tbis bigh frequency.
As you can see there are already quite a few

Figure 1. This is a sketch of the major components of the VDU card.

1



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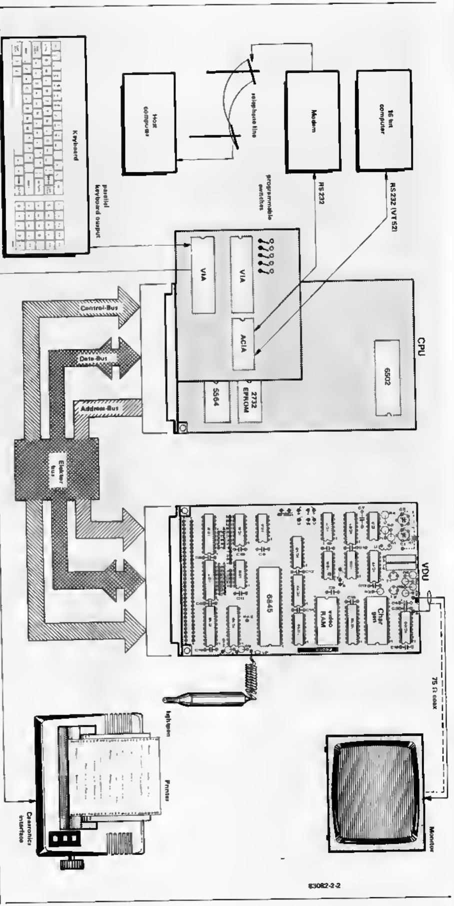

Figure 2. This shows what can ultimately be achieved with the universal terminal containing a VDU card and a CPU card. All the other equipment (computer, modem, printer, keyboard and so on) can be connected to this terminal.

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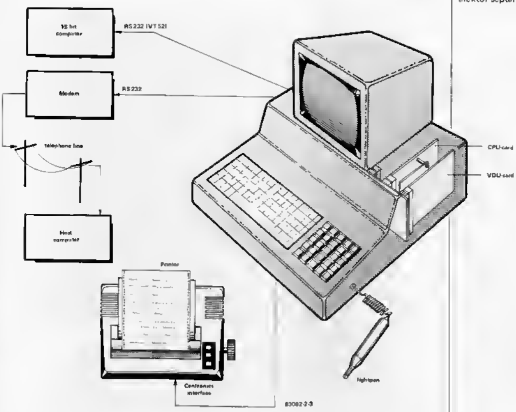

Figure 3. The combination of VDU and CPU cards can also be used as the basis of a complete computer system. The combination controls communication between the various parts of the system and displays information on the screen.

possibilities with the VDU card but there are even more to come. As a follow up to this VDU card we will shortly publish a CPU card especially developed to complement it. These two cards will together form the basis of a universal terminal with RS 232 interface and VT 52 protocol, so that it can be connected to virtually any computer. Figure 2 shows the main parts of this system and of course this terminal can be connected to any computer which has an RS 232 interface. The CPU card contains a 6502 microprocessor, 2 VIAs (Versatile Interface Adapter), an ACIA (Asynchronous Communications Interface Adapter) an EPROM and a RAM. Thanks to a set of through connections on the board the transfer format, speed, number of start and stop bits and the type and number of control bits can be adapted to whatever computer is connected to the terminal. Similarly there is a choice of eight different screen-image formats.

All that is needed to make up a complete terminal is a VDU card, a CPU card, a monitor and a keyboard. The terminal could, for example, communicate over the telephone lines via a modem, with a computer in some other part of the globe, but because of its VT 52 protocol it could also be connected directly to a 16 bit computer. A connection for a printer is, of course, provided. It is also possible to use the CPU card and VDU card together as the basis for a complete computer system, as figure 3 shows. This example is connected to a 16 bitter but, in principle, that could be any type of computer.

The terminal software is located in a 2716 EPROM on the CPU card which can have a maximum of 8 K of random access memory and 16 K of read only memory.

Clearly there are already quite a few possibilities for this two-card combination and certainly there are more than we have mentioned. However we will leave it at that until the article on the CPU card.

The VDU card in a nutshell

Figure 4 shows the circuit diagram for the VDU card. At the left is the system bus and here we see that address lines A0 . . . A10 are connected to the B inputs of the 2 into 1 multiplexers, IC12 . . . IC14. Also address lines A3 . . . A15 are inverted by N1 . . . N13. Complete address decoding is thus possible because the addresses are available either normally at points A3 . . . A15 or inverted at points $\overline{A3}$ . . . $\overline{A15}$. Address decoding for the video RAM is carried out via N37, and for the CRTC via N38. The numbers beside these two gates refer to those used with the Junior Computer. In this case the video RAM is in the range DØØØ . . . D7FF and the CRTC is between D8ØØ and D8ØF.

When N37 gives a chip-select signal the video RAM (IC15) is addressed from the system bus by the microprocessor. By this the address inputs of the 6116 are connected to the address bus of the system via the A inputs of the multiplexers IC12 . . . IC14

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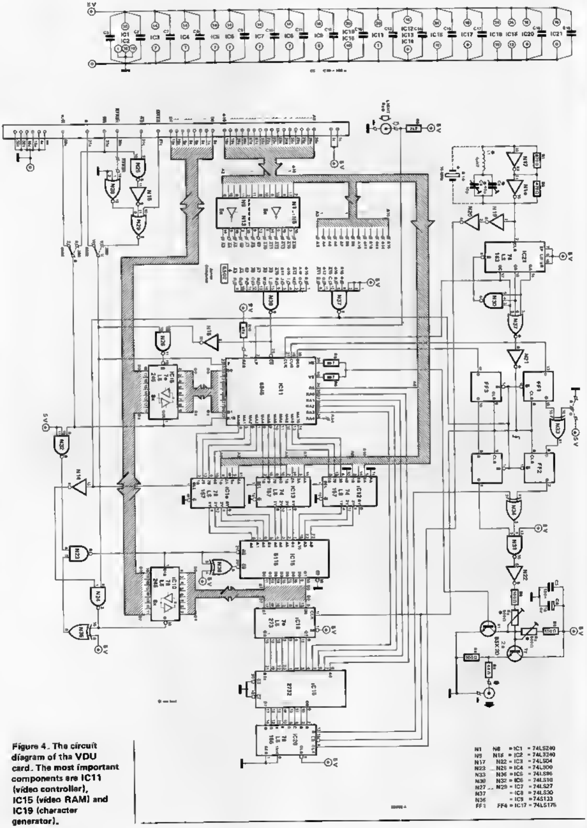

Figure 4. The circuit diagram of the VDU card. The most important components are IC11 (video controller), IC15 (video RAM) and IC19 (character generator).

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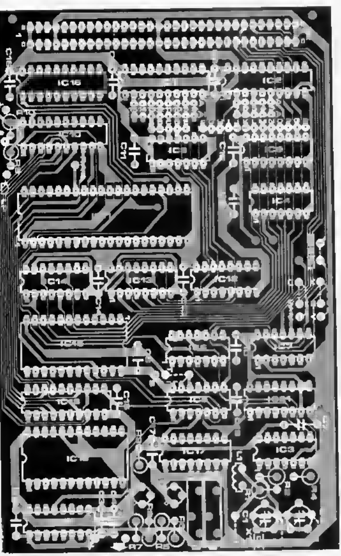


Figure 5. The component layout for the VDU card.

Parts list

Resistors
R1,R2 = 470 Ω
R3,R4,R8 = 100 Ω
R5,R6 = 4k7
R7 = 68 Ω
R9,R10 = 2k2

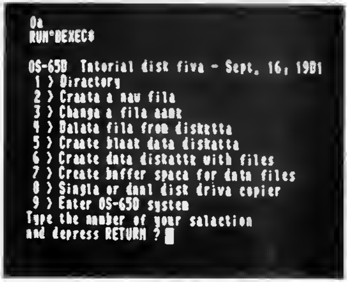
Capacitors:
C1 = 40 p trimmer
C2 = 10 p trimmer
C3,C5 . . . C19 = 100 n
C4 = 1 μ/6 V

Semiconductors
T1,T2 = BSX 20
IC1,IC2 = 74LS240
IC3 = 74LS04
IC4 = 74LS00
IC5 = 74LS86
IC6 = 74LS10
IC7 = 74LS27
IC8 = 74LS30
IC9 = 74S133
IC10,IC16 = 74LS245
IC11 = 6845
IC12,IC13,
IC14 = 74LS157
IC15 = 6116
IC17 = 74LS175
IC18 = 74LS273
IC19 = 2732
IC20 = 74LS166
IC21 = 74LS163

Miscellaneous:
X1 = 15 MHz crystal (for a display configuration of 80 x 24 characters; if this crystal is used C1, C2 and L1 are not needed).
L1 = 4.7 μH
64 pin male connector DIN, use the A and C rows

(select inputs of the multiplexers are logic zero). At the same time data bus buffer IC10 is enabled via N14 and N24. The logic level of the R/$\overline{W}$ line (pin 29c of the connector) ensures that IC15 is enabled via N32, N23 and the $\overline{WE}$ input.
If the CRTC is addressed from the system bus N38 gives a logic zero to the $\overline{CS}$ input. The processor then has access to the internal registers of the 6845 via the system bus. Data bus buffer IC16 is then also enabled via N16 and N26.
IC16 is really only needed of a light pen is to be used with the VDU card. If this is not the case, and data is only written from the bus to the CRTC, then IC16 is superfluous and the 6845 can be connected directly to the data lines with eight wire links.
Address decoder N37 resets flip-flops FF1 . . . FF4 so that no rubbish appears on the screen when the processor accesses the video RAM.
The timing of the VDU card is controlled by the oscillator based on N17 and N18. This supplies the so-called dot frequency, which is 15 MHz for the screen format used here. A coil is necessary to maintain stability of the oscillator at tbis relatively high frequency. For optimum performance, a 15 MHz crystal could be used in the oscillator in place of C1, C2 and L1. IC21 divides the oscillator signal by eight. This IC is a synchronous counter which is reset via N30 when the count reaches seven. Because the reset is only processed by the IC on the following clock pulse, the IC then effectively counts to eight. Output QC delivers the character frequency for the controller. The CRTC counts continuously from ØØØ to 7FF (the whole range of the video RAM) at the frequency of this signal. As the processor now has no access to the video RAM, the address outputs MA0 . . . MA10 of IC12 are connected to the address inputs of the 6116

via the multiplexers, so that all the RAM addresses are continually accessed. The RAM then continuously supplies deta wbich is placed into latcb IC18. A latch is needed to enable the RAM to get all the data stable on the outputs, and it is not clocked until this condition is fulfilled. The output data of the latch can then be used while simultaneously another address is supplied to the RAM. The clock pulse for the latch is supplied via N21.
The information in the latcb now acts as the address for the character generator, IC19. The CRTC simultaneously supplies to the 2732 the row addresses (RA0 . . . RA3) of every character to be displayed so that one row of dots is read out each time for the video line that is to be written on the screen at that time. IC20 converts the dot information from a parallel to serial format. In order to prevent timing faults from occurring with the high frequencies used the shift register is synchronous, and its clock signal is taken directly from the oscillator via N19 and N20. The serial dot information appears at output Y of the IC. The video mixing stage, consisting of N34, N31, N22 and the circuitry around T1 and T2, combines the Y signal from IC20 with the line end rester synchronization pulses supplied by the CRTC (pins 39 end 40). Presets P1 and P2 can be used to set the size of the synchronization pulses end the dot amplitude. It should be noted that each of the presets has an effect on the other and this will be seen when they are adjusted.
There ere two other important signals of the CRTC which have to be dealt with separately. These are DEN and CUR. Output CUR(sor) gives the location of the cursor on the screen and output DEN (Display ENable) indicates when the CRTC is in the active range of the screen (see the section on 'image building' in the descriptive article). The latter signal is needed to keep the screen completely dark outside the active range. These two signals must now be combined with the video signal (via N34 and N31), but that cannot be done directly



because of the time that elapses between an address being supplied to the RAM and the appearance of the dot information at the outputs of the EPROM. The delay time is a few hundred nanoseconds, and that would mean that the cursor end display enable signals would appear too early relative to the dot signal. To alleviate the problem, the DEN and CUR signals are delayed by the two whole character times before being mixed with the dot signal.
The links at pin 12 of N33 enable the user to select a bright (lit) or dark cursor on the screen. This in effect means thet the whole image on the screen can be either normal or 'negative' (in the photographic sense of the word), because if we want to use a dark cursor then all the dot signals on the screen are also inverted by N34. Link 'T' is used for a normal image (dark background) and using link 'S' gives an inverted image (light beckground).
N15, N25, N28 and N29 make up the Z80 interface. These gates ensure that the signals supplied by the Z80 ere compatible with the R/W and enable signals from the 6502. If using a Z80, links U-V and X-Y must be used. The dotted link at pin 13 of N28 is made if the refresh ($\overline{RFSH}$) of the Z80 is used, or alternatively an external refresh signal can be supplied to this pin. For 6502 and 6800 family processors U-W and X-Z must be linked.

Construction

Any hobbyist who has already constructed other computer projects (for the Junior Computer, for example) will have no problem building the video card, especially if the Elektor printed circuit board as shown in figure 5 is used. This figure only shows the component overley for this double sided board.
It is recommended that all the ICs should be mounted in good quality sockets. This is quite important for IC3 and IC20 but these ICs should preferably be soldered directly to the printed circuit board es they deal with high frequency signals. T1 is given in the parts list as BSX 20 but e BC 547B is also suitable. It is important to remember to connect the various wire links (in the Z80 interfece end the one to select normal or inverted image), end the same epplies for the address decnder connections.
If e crystal is used in the oscillator then L1, C1 and C2 can be omitted from the board. Three EPROMs ere needed if the VDU card is to be used with the expanded Junior. These are one 2732 containing the character generetor and two 2716s, TMV and PMV, with the video routines. These last two replace the TM and PME EPROMs and, as they contain the TM and PM software, the Junior is none the worse for it.
With the DOS Junior a 2732 with the character generator and one 2716 containing the video routines (DOSVT) are used. The 2716 is mounted in the socket for IC5 on the interface card. A CMOS RAM 6116 is also needed for the DOS Junior and is put in the IC4 socket on the interface card. This interface card requires a few modifications

for correct operation with the VDU card, so:

- pin 18 of IC4 is joined to pin 20
- the following connections are made: M-J, G-I, I'-G', J'-L', O'-M'.

The DOS Junior (unlike the expanded JC) requires a few software changes in order to work correctly with the VDU card. For this a V 3.3 diskette suitable for the Junior and an Elekterminal or another serial I/O device are needed.

First of all a copy of the diskette is made via Utility 8 and this copy is placed in drive A. Now the modifications given in table 1 are made and the following is entered on the Junior keyboard:

<RST>
<AD> A2ØØ
<DA>

and the bootstrap modifications from table 2 are given. This is followed by:

<AD> A311
<DA> FFFF (video output 1)
FFFF (video output 2)
A2FE (serial output 1)
E1F3 (Centronics output 1)

and then carry on with table 3. When that is done we then have a new V 3.3 diskette adapted to the VDU card.

If there is sufficient interest, we will possibly publish a Paperware to deal with this subject in greater depth, especially as regards the operation of the CRTC and the associated software.

The EPROMs are available as a pre-programmed set from Technomatic Ltd. ESS 522 is for the expanded Junior and ESS 521 for the Junior with DOS.

The circuit works from a single supply of 5 V and draws a current of about 450 mA. When the power is switched on the system must be initialized by pressing the reset button. To set P1 and P2, these two presets are first put to their mid positions. Then they are adjusted to get a clear image on the screen. If a TV set is used instead of a monitor the contrast control must be turned back completely as the bandwidth is generally too large. Trimmers C1 and C2 are used to set the frequency so that the image remains stable on the screen. If a 15 MHz crystal is used in the oscillator this last adjustment is unnecessary.

Table 1.

```
AXCA Ø2ØØ = 39,1

AXCA 2ØØØ = 39,2

AXGO Ø2ØØ

- DISKETTE UTILITIES -

SELECT ONE
1) COMPAR
2) TRACK Ø READ/WRITE
? 2

- TRACK ZERO READ/WRITE UTILITY -

COMMANDS
Rnnnn - READ INTO LOCATION nnnn
Wnnnn/9999,P - WRITE FROM nnnn FOR p PAGES
               WITH 9999 AS THE LOAD VECTOR
3 - EXIT TO OS-65D

COMMAND: RA 2ØØ

- TRACK ZERO READ/WRITE UTILITY

COMMANDS
Rnnnn - READ INTO LOCATION nnnn
Wnnnn/9999,P - WRITE FROM nnnn FOR p PAGES
               WITH 9999 AS THE LOAD VECTOR
E - EXIT TO OS-65D

COMMAND? E

AXCA AAØØ = Ø1,1

AX
```

Table 1. This is how track Ø of the floppy disk is transferred to the RAM memory starting at address $A2ØØ and track 1 to RAM starting at address $AAØØ.

Table 2.	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
A2ØØ	A9	Ø1	8D	5E	26	2Ø	BC	26	A9	2A	85	FF	2Ø	54	27	86
A21Ø .	FE	2Ø	67	29	2Ø	79	2E	AØ	8F	2Ø	EC	22	FØ	Ø3	88	DØ
A22Ø .	F8	8C	ØØ	23	A2	Ø1	8E	C6	2A	4C	41	22	EA	EA	EA	EA
A23Ø :	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA	EA
A24Ø :	EA	A9	ØØ	8D	F7	EF	8D	D2	EF	2Ø	35	F4	2Ø	3Ø	F3	2Ø
A25Ø	81	27	2Ø	73	2D	ØD	ØA	ØA	2A	44	4F	53	2Ø	4A	55	4E
A26Ø .	49	4F	52	2Ø	43	4F	4D	5Ø	55	54	45	52	2Ø	2Ø	56	32
A27Ø :	2E	3Ø	2A	ØD	ØA	ØA	43	4F	5Ø	59	52	49	47	48	54	2Ø
A28Ø :	42	59	2Ø	45	4C	45	48	54	4F	52	ØØ	A9	2E	8D	7C	FA
A29Ø .	A9	FF	8D	7D	FA	A9	ØØ	8D	7A	FA	A9	FC	8D	78	FA	4C
A2AØ:	E6	2A														

Table 2. This is the data needed to modify the bootstrap section.

Table 3.

```
AXGO Ø2ØØ

- DISKETTE UTILITIES -

SELECT ONE
1) COMPAR
2) TRACK Ø READ/WRITE
? 2

- TRACK ZERO READ/WRITE UTILITY -

COMMANDS
Rnnnn - READ INTO LOCATION nnnn
Wnnnn/9999,P - WRITE FROM nnnn FOR p PAGES
               WITH 9999 AS THE LOAD VECTOR
E - EXIT TO OS-65D

COMMAND? WA2ØØ/22ØØ,8

- TRACK ZERO READ/WRITE UTILITY -

COMMANDS
Rnnnn - READ INTO LOCATION nnnn.
Wnnnn/9999 P - WRITE FROM nnnn FOR p PAGES
               WITH 9999 AS THE LOAD VECTOR
E - EXIT TO OS-65D

COMMAND? E

AXSA Ø1,1 = AAØØ/8

AX
```

Table 3. Here we see how the modified bootstrap is written back to the floppy disk.

Manufacturers are always interested in miniaturising receiver circuits and they keep pushing the limits further end further. In e normal receiver set-up extreme integration is to be avoided especially as regards tuning coils, ceramic filters, band filters, and trimmers. Coils especially are a problem. Certainly they could be replaced by gyrator circuits, but because of their complexity these also have certain disadvantages at high frequencies, such as low Q factor, limited dynamic range and fairly high current consumption.

So Philips set out to develop a receiver that was less sensitive to the various problems posed by IC technology itself. And they succeeded with an 18 pin chip that needs only an oscillator and a few small capacitors to form an FM receiver. Everything else is internal, from the aerial input right through to the IF filters and demodulator! The break through came when they decided to abandon accepted practice and chose to use en FLL system (e type of feedback PLL). This system works with a low enough IF (intermediate frequency) so that the IF selectivity can be realised witb RC filters which, unlike LC filters, can be miniaturised successfully. Moreover, the disadvantages inherent in this low IF were suppressed by using a clever muting system.

Figure 1 shows the block diagram of the IC, complete with the components needed for a bog-standard radio. A very simple affair! We will not go any further into this block diagram at the moment es we will concentrate on how this circuit is expanded into something more interesting.

Micro or mini

We are always interested in new ICs and how they can be used end this is the case with the TDA 7000. Now that we've decided we want to use it as the basis for a radio receiver we have to decide what sort of receiver it is going to be. Should it be a normal small FM radio? Or maybe something extremely small? Should the accent be not so much on small dimensions as quality . . .? The character of the IC is an invitation to make a micro radio . . . but that's easier said than done! A real micro design does not seem so interesting. There are limits to how small it can be made if it is to be put on a printed circuit board and we would not seriously consider anything else. So what we want is a 'bigger than micro' design with somewhat bigher quality and without the disadvantages of the 'as small as possible' design. It must have a suitable low frequency amplifier

personal FM

miniature high quality FM receiver

The relatively new TDA 7000 from Philips is an IC that forms the basis of a complete FM receiver just by adding a few passive components. This IC could be described as an 'aerial signal in — low frequency signal out' sort of chip. However, not being satisfied with that, we expanded a little on the basic theme by adding a bit here and there, designed a printed circuit board, and ended up with a high quality mono FM receiver that is quite literally pocket sized!

1

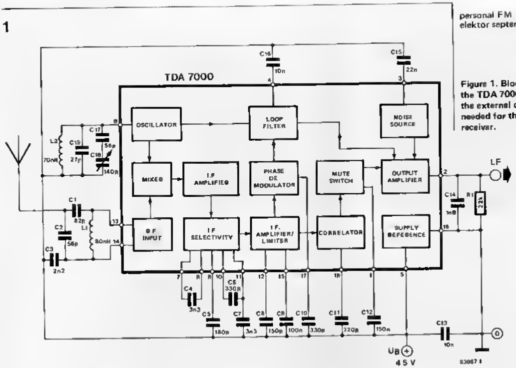


Figure 1. Block diagram of the TDA 7000 including the external components needed for the basic radio receiver.

2

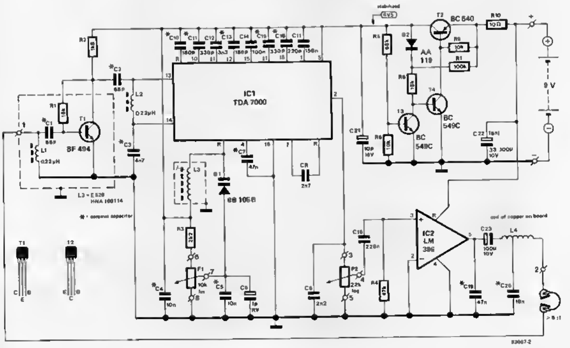


Figure 2. The circuit diagram of our personal FM receiver. The varicap tuning and the extra HF preamplifier improve the reception substantially.

included and the complete unit must all be contained on one printed circuit board so that only a battery, headphones and, possibly, an aerial have to be connected to it.

The circuit diagram

Let us start by saying that, no matter what type of receiver is designed around the TDA 7000, a large part of it will always be the same. Almost everything is included in the IC so there is very little designing to be done with external components, and the receiver design cannot really be changed. The similarities between the design of figure 2 and that in figure 1 are clear enough but there are also a few differences, principally in the input stage and the oscillator. Also the more advanced design (figure 2) includes power supply stabilization and the LF amplifier mentioned before.

Although in principle a small loudspeaker can be used for the output of the radio, it is intended, initially, that small personal cassette type headphones should be used. A secondary advantage of headphones is that the lead can act as an aerial. To avoid making the receiver any bigger and more complicated than absolutely necessary we used a readily available amplifier IC (the LM 386 from National) for the headphone amplifier. This chip supplies very good sound quality and, for a small loudspeaker or headphones, its power output of 0.5 watt is quite sufficient! Furthermore the LM 386 needs only three external components (R4, C19 and C20).

There are a few qualities of the basic design that we were not entirely happy about. In the first case it was found that the sensitivity of about 7 μV is a bit on the low side for a personal FM receiver. If you walk around with that sort of radio receiver the aerial is not always in the most ideal position and the chances are that the station that you are tuned in to will continually disappear under the squelch.

Therefore we decided to include a HF preamplifier (T1). This preamplifier stage is very easy to set up, not at all critical and ensures that the sensitivity is always under 1 μV. As the circuit diagram shows, its input is connected to one side of the headphones so that the lead can act as an aerial. The L4/C21 network has two functions. Apart from suppressing any spurious components

Parts list

Resistors:
R1,R8 = 18 k
R2 = 1k8
R3 = 2k2
R4 = 47 k
R5 = 68 k
R6,R9 = 10 k
R7 = 100 k
R10 = 10 Ω
P1 = 10 k ten turn pot
P2 = 22 k log pot

Capacitors:
C1,C2 = 88 p ceramic
C3 = 4n7 ceramic
C4,C5,C20 = 10 n ceramic
C6 = 1 μ/6 V
C7,C19 = 47 n ceramic
C8 = 2n2
C9,C12 = 3n3
C10,C13 = 180 p ceramic
C11,C15 = 330 p ceramic
C14 = 100 n
C16 = 220 p
C17 = 150 n
C18 = 220 n
C21 = 10 μ/6 V
C22 = 220 μ/10 V
C23 = 100 μ/6 V

Semiconductors:
D1 = BB 105
D2 = AA 119
T1 = BF 494
T2 = BC 640
T3,T4 = BC 549C
IC1 = TDA 7000
supplier: Technometic Ltd.
IC2 = LM 386

Inductors:
L1,L2 = 0.22 μH (coil on Toko former)
L3 = E 526 HNA 100114 (Toko)
L4 = inductance made with copper tracks on the printed circuit board

Miscellaneous:
Leightweigt headphones, at least 8 Ω impedance

3

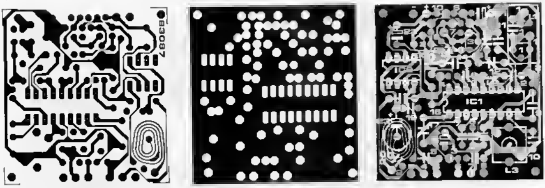


Figure 3. The component overlay for the double-sided board. The large area of copper on the upper side acts as an earth plain for the circuit.

of the output signal from IC2, it also acts as a decoupling circuit between the LF output and the HF input.
There are also a few details about the oscillator which should be changed. First of all the coil. To alleviate supply difficulties we used a standard off-the-shalf Toko coil. There are two problems with using a tuning capacitor for this circuit: availability is often a problem and some sort of mechanical gearing must be used in order to make tuning easier. We decided to kill two birds with one stone and used a varicap diode (D1) in combination with a 10-turn potentiometer (P1) for tha control voltage.
Because the tuning voltaga must ramain very stable, some form of voltage stabilization must ba used. In ordar to spara the (small) battery as mucb as possible, the losses (voltage drop and current consumption) of the stabilizer should be small. This explains the use of a discreta circuit here (T2, T3 and T4) in prefarence to an IC. Even if the battery voltaga drops to 5.5 V this stabilizer still supplias a constant 4.5 V.
And that is tha whole circuit. Note that pin 3 of the TDA 7000 is left unconnected because it was considered that using squelch suppression with artificial noise is going a bit too far. For anybody who wants to use this built in noise generator, a 22 nF capacitor can be connected between pin 3 and the positive supply.

The printed circuit board

Although it was not intended as a micro circuit, the 50 x 50 mm dimensions of the double sided printed circuit board shown in figura 3 still make it very diminutive for a complete FM receiver. Even when the 9 V battery is included the end result can justly be called a personal receiver.
In the case of the HF stage there are absolutely no problems with construction. The worst thing is trying to remember the type number of tbe oscillator coil, L3. It is an E 526 HNA - 100114 from Toko, and that's quite a mouthful for 'the morning after the night before'. However, L4 is not so difficult as it is already etched onto the printed circuit board.
The input and oscillator stages should ideally not be able to 'see' each other. Therefore the area around T1 should be screened, preferably with mu-metal or copper. Spece has been left on the board for these screens and their locations are indicated. The four pieces of screen are soldered into a box and then soldered to the upper side of the printed circuit board. Most of this upper side (or component side) of the board is an 'earth plane'. Therefore, all points which sbould be connected to earth are soldered to the top of the board and the rest simply connect to tha under side. These lattar (non-earth) points are of course the copper 'islands'.
When construction of tha printed circuit board is completed, only the tuning and volume potantiometers (P1 and P2 raspectively) have to be connected, not forgetting the battery and headphonas of course. The connection points are clearly marked.

Adjustment

Normally quite a large section of an article dascribing the construction of an FM receiver would be devoted to setting up, but that is hardly necessary with the TDA 7000. The simple adjustment of L3 to ensure the correct receiver range (87.5 . . . 104 MHz) is all that is required. That can ba done with a frequency counter of course but the simple method is to compere it witb another receiver!
One final point. Evan though it is extremely handy to use the headphone lead as an aerial, it is much better to use a 60 cm (or evan 30 cm!) aerial. And that does not apply only for this receiver, but also for any other personal radio. If an aerial is used it should be connected to the junction of L1/C1 (aerial input) and the headphones between the LF input and ground.
We have spent bours listening to our FM receiver (mainly before the morning coffee break? Ed.) and it must be said that it gives a very good account of itself. The sensitivity is reasonable and the quality of tha sound is actually very good. The only 'but' is that the TDA 7000 is only a mono receiver. But you can't have everything and wbo knows, maybe it is only a matter of time before we get a pin compatible version suitable for stereo. In the meantime we heve a trick up our sleeve that may be just as good but that will heve to wait until — maybe the next issue!

Even today, looking for simple electronic components can give you quite a headache. Take, for example, a simple voltage divider for a voltmeter: when you try to buy the necessary high-stab resistors, the likelihood is that you're told in shop after shop: 'Sorry, we don't stock those'.

precision voltage divider...

. . . for home construction

In the construction of measuring equipment, you normally require a number of precision components. Particularly voltage and current dividers need resistors of 1% tolerance. The simple four-way voltage divider shown in figure 1 has a total resistance of 1 MΩ and requires four resistors: 900 kΩ, 90 kΩ, 9 kΩ and 1 kΩ. And that's where your troubles are likely to start. If you're not lucky enough to find a complete divider somewhere, forget about buying the individual resistors. It's extremely unlikely that you'll find the above four values in the high-stab range in one shop.

Parallel connections

Fortunately, it is possible to make a precision voltage divider with an input impedance of 1 MΩ from standard value resistors. The solution lies in connecting two high-stab resistors in parallel to obtain the required value as shown in figure 2. If a shop stocks high-stab resistors, it's pretty certain that it has standard values of 1 MΩ, 100 kΩ, and so on. And that's what the divider of figure 2 depends on! The resulting resistances are 909.09 kΩ, 90.909 kΩ, 9.09 kΩ, and 1.01 kΩ. The deviation from the ideally required divide factors is smaller than 0.01% so that in practice the variations are entirely dependent upon the tolerances of the resistors used.

In parallel connections as used in figure 2, not all resistors need be 1% types. Because each combination consists of two resistors of which one has ten times the value of the other, the larger one has a much smaller effect on the result than the smaller one. As a consequence, the tolerance of the larger resistor is of much less importance than that of the smaller one. Even if 5% types are used for the larger resistors in the parallel branches, the overall stability will be sufficient. The same is true of R7 because this is pretty small compared with R8.

As an example of the above: if R2 deviates exactly 5% from its nominal value, the variation of the resultant value of R1/R2 is only 0.4%. You might say that the tolerance of the larger resistor improves roughly by a factor equal to the ratio of the two resistors.

Parallel connections have a further advantage: statistically there is only a very small probability that two resistors in a parallel branch both deviate in the same direction. In other words: there is a good chance that the network of figure 2 is more precise than the one constructed from 1% resistors as shown in figure 1.

1

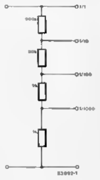


Figure 1. A standard voltage divider with an input impedance of 1 MΩ. Unfortunately, the resistors used are difficult to obtain.

2

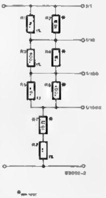


Figure 2. This voltage divider uses standard value resistors. Its input impedance is slightly higher than 1 MΩ, but this will not matter in most applications. The divide ratios, however, are accurate.

3

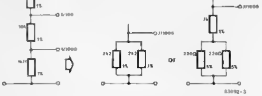
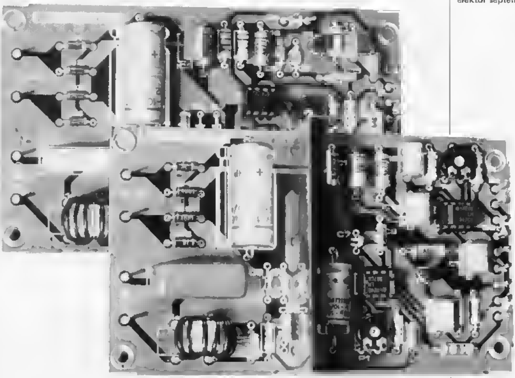


Figure 3. Another possibility, but its input impedance is larger still than that of figure 2.

All in all, the above gives enough reasons to use parallel-connected resistors. Figure 3 gives an alternative which uses fewer resistors. However, its theoretical stability is rather worse than that of figure 2: 0.01% instead of 0.001%.



alarm extension . . .

. . . over the mains

The garden party is in full swing . . . Amidst all the happy noises and chatter it is difficult to hear when the telephone rings or a late guest rings the front-door bell. The alarm extension described here will enable you to hear the phone ringing wherever you are, provided there is a mains socket close at hand.

The principle is well-known: an intercom which uses the mains wiring as the transmission channel. This is a very handy gadget which can be used wherever a mains socket is available. Speech facility is not provided: the receiver merely indicates that the transmitter has 'detected' a certain sound, which may come from the telephone bell or from another source.

General principles

The transmitter and receiver contained in the alarm extension are shown in block form in figure 1. The signal detected by the transmitter is amplified, rectified, passed through a high-pass filter, and then used to switch an astable multivibrator (AMV). This stage generates a 22 Hz square-wave signal which is used to phase-modulate a second AMV. This astable operates at 178 kHz. The output of the modulator is taken via a limiter to a low-pass filter which removes the last traces of any spurious frequencies, so that a 'clean' signal is fed to the mains via a suitable transformer.

The receiver is even simpler than the transmitter. The 'telesignal' is recovered from the mains by means of a suitable transformer. A diode limiter ensures that any high-voltage spikes do not damage the (following) phase discriminator, a phase-locked loop (PLL) with digital and analogue output. The digital output lights an LED to provide an indication when the input signal is locked to the discriminator. The demodulated 22 Hz signal at the analogue output is 'recognized' by a tone decoder which acknowledges receipt of the signal by causing a second LED to light and a buzzer to operate.

The circuit diagram

The transmitter (see figure 2)

The input signal is taken from a telephone adapter coil or simple microphone. A coil does not pick up ambient noise and will therefore give better results . The amplifier, rectifier, and high-pass filter mentioned are shown at the top lefthand of figure 2. They are followed by comparator

IC4, the threshold of which is set by P1. The output of IC4 is used to switch the astable multivibrator formed by IC1. This AMV can be fed simultaneously with a square-wave signal to provide a facility for the remote control of an external equipment connected to the receiver. Details of this will be featured in a future issue.
The second of the 555 timers is also connected as an astable multivibrator. With values shown, IC2 oscillates at around 178 kHz and IC1 at about 22 Hz. Oscillator IC1 is started by a logic 1 at the output of IC4.
The output of IC2 is phase-modulated with relatively good linearity. Any spurious frequencies produced during the on and off switching of IC1 are filtered out by R3/C9. The network around diodes D6 and D7 prevents any mains-born interference from reaching the output of IC2. The filter network L2/L3/C5 removes any harmonics from the phase-modulated signal to ensure that a 'clean' signal is applied to the mains via transformer L1.
The power supply for the transmitter is provided by the usual 5 V voltage regulator IC. The supply transformer must be capable of providing 9 V at 100 mA.

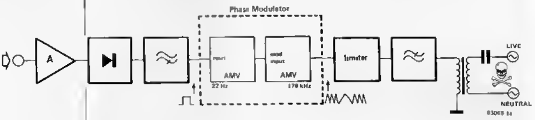
The receiver (see figure 3)
The receiver draws the phase-modulated signal from the mains via C1 and transformer L1, which is identical to L1 in the transmitter. Diodes D1 and D2 protect the demodulator circuit against interference which may be present on the mains voltage. The phase-modulated signal is applied to phase discriminator IC2 via C3.
Apart from a phase-locked loop, IC2 includes a phase detector, a voltage-controlled oscillator (V.C.O.), an output filter (with C8), and a comparator.
The frequency of the V.C.O. is preset to 178 kHz by means of P1. The input signal at pin 3 is, as usual in a PLL, compared with the oscillator output by the phase discriminator. If the input signal is phase-modulated, the difference between it and the oscillator frequency, that is 22 Hz, appears at pin 2. The internal resistance, together with C7, forms a smoothing circuit for the output signal.
When the PLL is locked to a signal at pin 3, the signals at the inputs of the phase detector are in phase. The consequent output of the detector is a constant-voltage signal, which is applied to the non-inverting input of the comparator. This stage compares the signal with an internally set reference level and switches its output (pin 8) to logic 0. LED D7 then lights, indicating that IC2 has 'received' the 178 kHz carrier. The 22 Hz signal is amplified in T1 and applied to tone decoder IC3. On receipt of this 22 Hz signal, the output at pin 8 switches on the LED D8 and the buzzer.
The receiver power supply unit is identical to that of the transmitter.

Construction and adjustment

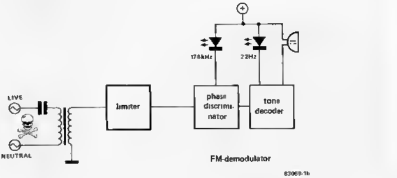
Construction of the alarm extension should present no real problems if our two specially designed printed circuit boards are used. The transmitter board is shown in figure 4, that for the receiver in figure 5. As no special components are used, the construction needs no further explanation. One thing must be borne in mind, however: capacitor C1 in both transmitter and receiver MUST BE 600 V types!
On the receiver board a thin metal screen must be soldered to the appropriate soldering points: the screen is shown in the diagram as a dotted line.

Figure 1. The block diagram contains no surprises: The transmitter (1a) comprises a bell amplifier, a rectifier, a comparator, f.m. modulator, and limiter. The receiver (1b) is even simpler, comprising a limiter, f.m. discriminator, and tone decoder.

1a



b



2

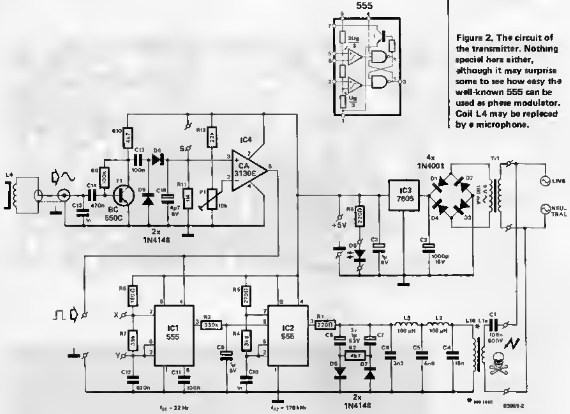


Figure 2. The circuit of the transmitter. Nothing special here either, although it may surprise some to see how easy the well-known 555 can be used as phase modulator. Coil L4 may be replaced by a microphone.

3

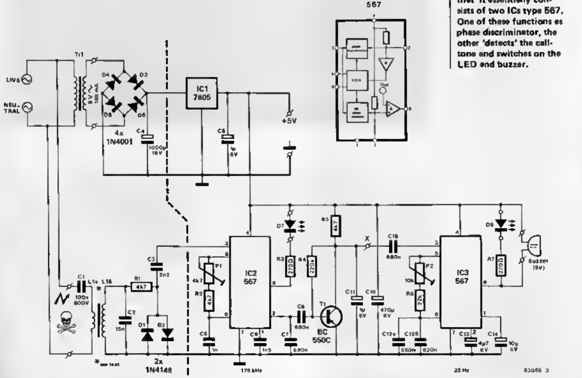
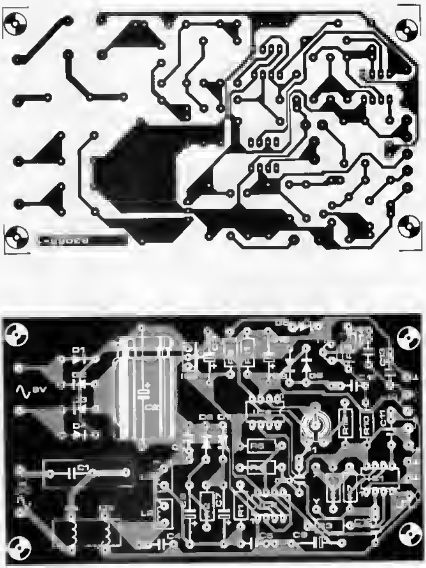


Figure 3. The receiver circuit diagram shows that it essentially consists of two ICs type 567. One of these functions as phase discriminator, the other 'detects' the call-tone and switches on the LED and buzzer.

4



Parts list for the transmitter

Resistors:
R1, R8 = 220 Ω
R2, R10 = 4k7
R3 = 330 k
R4 = 3k9
R5 = 270 Ω
R6 = 180 Ω
R7 = 39 k
R9 = 100 k
R11 = 1 M
R12 = 22 k
P1 = 10 k preset

Capacitors:
C1 = 100 n/600 V
C2 = 1000 μ/16 V
C3, C9 = 1 μ/8 V
C4 = 18 n
C5 = 6n8
C6 = 3n3
C7, C8 = 1 μ/63 V
C10, C13 = 1 n
C11, C15 = 100 n
C12 = 820 n
C14 = 470 n
C16 = 4μ7/6 V

Semiconductors:
D1 . . . D4 = 1N4001
D5 = LED
D6 . . . D9 = 1N4148
T1 = BC 550C
IC1, IC2 = 555
IC3 = 7806
IC4 = CA 3130E

Miscellaneous:
L1a = 10 turns wound evenly spaced onto L1b (see text)
L1b = 40 μH toroidal suppressor choke
L2, L3 = 100 μH
L4 = telephone adapter coil with suction pad
Tr1 = mains transformer with 9 V/100 mA secondary
Plastic case= type BOC 440 (50 mm high) or type BDC 445 (80 mm high) (available from West Hyde Developments Limited)

Figure 4. Layout and foil side of the transmitter printed circuit board. The coupling coil consists of a suppressor choke onto which 10 turns of wire are evenly wound. This additional winding is connected to the mains. Terminals X, Y and S are intended for future extensions.

Each transformer L1 is made by winding 10 turns evenly spaced onto a toroidal suppressor choke (as commonly used in triac circuits). For this purpose enamelled copper wire SWG 18 may be used, but better performance is obtained by the use of insulated stranded wire. The additional winding is connected to mains live: you have been warned!
When the construction has been completed, set all presets to their mid-position. Connect the LEDs, buzzer, and transformers temporarily. Before connecting the coupling transformers to the mains, read the following setting-up instructions.

Setting up the transmitter

- Connect the mains transformer to the mains and check the supply voltages.
- Connect a good voltmeter or an oscilloscope to the output of IC4.
- Attach the telephone adapter-coil or microphone to the transmitter input,

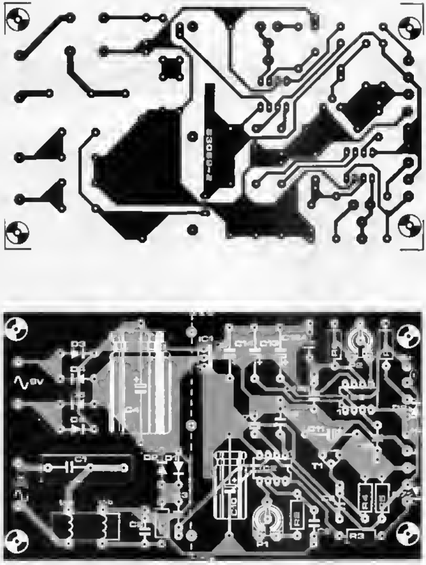
and adjust P1 for maximum deflection on the voltmeter or oscilloscope with the telephone ringing. If the deflection is small, the coil or microphone is located in the wrong place. Better resolution can be achieved by connecting an oscilloscope across C13. The coil can then be placed in a position which gives the greatest amplitude.

- Connect L1 also to the mains.
- Connect 'S' to +5 V by means of a jump wire.

Setting up the receiver

- Connect the mains transformer to the mains and check the supply voltages.

5



Parts list for the receiver

Resistors:
R1, R2, R5 = 4k7
R3, R7 = 270 Ω
R4 = 220 k
R6 = 22 k
P1 = 5 k preset
P2 = 10 k preset

Capacitors:
C1 = 100 n/600 V
C2 = 15 n
C3 = 2n2
C4 = 1000 µ/16 V
C5, C11 = 1 µ/6 V
C6 = 1 n
C7 = 680 p
C8 = 1n5
C9, C12a, C15 = 680 n
C10 = 470 µ/6 V
C12b = 820 n
C13 = 4µ7/6 V
C14 = 10 µ/6 V

Semiconductors:
D1, D2 = 1N4148
D3 . . . D6 = 1N4001
D7, D8 = LED
T1 = BC550C
IC1 = 7805
IC2, IC3 = 567

Miscellaneous:
L1a = 10 turns wound evenly spaced onto L1b (see text)
L1b = 40 µH toroidal suppressor choke
Tr1 = mains transformer with 9 V/100 mA secondary
Plastic case = type BOC440 (50 mm high) or type BOC445 (80 mm high) (available from West Hyde Developments Limited)
Buzzer, 6 V

- Connect the coupling transformer L1 to the mains.
- Adjust P1 till LED D7 lights brightly. This LED will already light, but a position of P1 should be sought where it lights twice as brightly as normal!
- Adjust P2 till LED D8 lights brightly. Same remarks as for LED D7 apply.
- Remove the jump wire from 'S'.
- Finally, with the telephone ringing, check the entire alarm extension for satisfactory operation.

Final notes

- If the sound of the small buzzer is too feeble for your purpose, a relay can be connected (via an isolating diode) in its place. The tone decoder can deliver up to 100 mA output current. The relay can be used to switch on a bright light, a siren, or a similar optical or acoustical device.
- Although a Government Health Warning is not printed on every mains socket, bear in mind that both L1a windings are at mains potential. Therefore, use extreme care when handling the printed circuit boards with the mains supply switched on. Please, gentle reader, do not become a statistic!

Figure 5. Layout and foil side of the receiver printed circuit board. The coupling coil is made exactly as that for the transmitter. Again, the additional winding is connected to the mains! Terminal X is intended for possible future extension.

Nothing generates quite so much interest in computers by raw beginners as a computer that makes noises. This is particularly true with children and especially if the computer can actually play its own tune on command. It can encourage them to take a serious interest in programming and/or computers in general.

Junior Synthesizer

make your computer play your favourite tunes

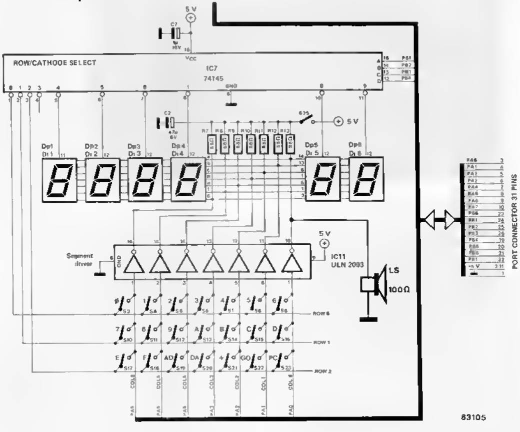
A. Bricart

When a flood of new musical instruments appeared that could be controlled by a microprocessor, some of the many Junior Computer owners must certainly have combined the two ideas. Actually this computer lends itself quite readily to controlling an analogue synthesizer. However, some people have probably not yet taught their computer to play music and so to make it easier we have written a program to turn your Junior Computer into a Junior Synthesizer.

A singing display

The only 'hardware' needed for this JC to JS conversion is a 100 Ω loudspeaker that is connected between one of the display driver outputs of IC11 and ground. No other special interface is needed as the only component used is connected directly to the existing circuit. The audio signal that feeds the loudspeaker is produced by the 6532 on the main board of the computer, and consists of a series of pulses whose frequency is determined by the software. The tune to be played is memorized in page $Ø3ØØ and is made up of a series of bytes, two of which are needed for each note to be played. The first is placed in an even address and corresponds to the pitch of the note; the second, corresponding to the duration of the note, is placed in the next odd address. The pitch depends on the frequency of the pulses, and the duration depends on how long the signal lasts.

1



There are four values of duration possible: minim, equal to two crotchets, each equal to two quavers which in turn are each equal to two semi-quavers. The durations are calculated from the computer clock which has a frequency of 1 MHz. For example, the note 'A' at 440 Hz has a pulselength of 2.28 ms. With a symmetrical waveform, the space lasts 1.14 ms. There is already a timing stage available in the computer (DELAY). So for our 'A', this delay has to be executed 81 times before inverting the logic level ($81 \times 14\ \mu s \approx 1.14$ ms). Thus the hexadecimal value of the pitch of this note is $51 (81 in decimal).
Because the program is very simple, only the $Ø3ØØ page (up to $Ø3FF) can be used to memorize a melody, so it can only have 127 notes at most. The tempo is fixed by the contents of location MULT ($ØØØ2) which can be changed to increase or decrease the speed of play. The rhythm is determined by the magnitude of the bytes in the uneven addresses, although, of course, the value of the durations also varies with the pitch of the notes.
When the processor finds the value $ØØ in an even address (pitch), it is silent for a certain length of time which is normally determined by the contents of the immediately following uneven address. If on the other hand, the value $ØØ is in an uneven address the tune is stopped and starts again from the beginning.
In the example given here, the Junior plays the Menuet du Bourgeois Gentilhomme by J. B. Lully, but with a little experimentation you can probably make it play 'Chopsticks' as well! ◼

Table 1

Note	Hz	pitch code	duration code (minim)	duration code (crotchet)	duration code (quaver)	duration code (semi-quaver)
E	1318.5	1B			84	42
D#	1244.5	1D		F9	7C	3E
D	1174.6	1E		EB	76	3B
C#	1108.7	2Ø		DE	6F	37
C	1046.5	22		D1	6B	34
B	988	24		C6	63	31
A#	932.3	26		BA	5D	2F
A	880	29		BØ	58	2C
G#	830.6	2B		A6	53	2A
G	784	2E		9D	4E	27
F#	740	30		94	4A	25
F	698 4	33		8C	46	23
E	659.2	36		84	42	21
D#	622 2	39	F9	7C	3E	1F
D	587.3	3D	EB	75	3B	1D
C#	554.3	41	DE	BF	37	1C
C	623.2	44	D1	B9	34	1A
B	494	4B	C6	B3	31	19
A#	466.1	4D	BA	5D	2F	17
A	440	51	BØ	5B	2C	16
G#	415.3	56	AB	53	2A	15
G	392	5B	9D	4E	27	14
F#	370	61	94	4A	25	12
F	349.2	66	BC	46	23	11
E	329.6	6C	84	42	21	1Ø
D#	311.1	73	7C	3E	1F	1Ø
D	293.6	79	75	3A	1D	ØE
C#	277.2	B1	6F	37	1C	ØE
C	261.6	89	69	34	1A	ØD
B	247	91	63	31	19	ØC
A#	233.1	99	5D	2F	17	ØC
A	220.6	A2	5B	2C	16	ØB
G#	207.6	AC	53	2A	15	ØB
G	196	B6	4E	27	14	ØA
		ØØ	E0	7Ø	3B	iC
			ØØ			

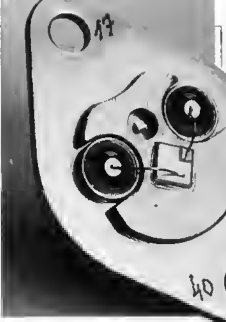
Table 1. The codes for the pitch and duration of the notes shown here can make the Junior Computer play your favourite tune.

```
JUNIOR

M
HEXDUMP: 2ØØ,25D
       Ø  1  2  3  4  5  6  7  8  9  A  B  C  D  E  F
Ø2ØØ: A9 7F 8D 81 1A A9 Ø8 8D 82 1A A9 ØØ 85 ØØ A9 Ø2
Ø21Ø: 85 Ø2 A6 ØØ BD Ø1 Ø3 85 Ø1 FØ E5 A9 4Ø 8D 8Ø 1A
Ø22Ø: 2Ø 5Ø Ø2 A6 ØØ BC ØØ Ø3 FØ Ø8 A9 BF 8D 8Ø 1A 2Ø
Ø23Ø: 5Ø Ø2 C6 Ø1 DØ E5 C6 Ø2 DØ D8 E6 ØØ E6 ØØ A2 FF
Ø24Ø: CA EA EA EA DØ FA 4C ØE Ø2 ØØ ØØ ØØ ØØ ØØ ØØ ØØ
Ø25Ø: A6 ØØ BC ØØ Ø3 A2 Ø2 CA DØ FD 88 DØ F8 6Ø
```

Table 2. This is the program which uses the 6532 and the display driver to generate an audio signal that is heard through the loudspeaker. No physical alteration to the existing circuit is needed.

```
JUNIOR

M
HEXDUMP: 3ØØ,36B
       Ø  1  2  3  4  5  6  7  B  9  A  B  C  D  E  F
Ø3ØØ: 51 58 3D EA 41 DE 3D 75 36 84 51 58 4B 63 5B 9C
Ø31Ø: 61 4A 5B 4E 6C 84 61 94 79 3A 51 58 3D EA 41 DE
Ø32Ø: 3D 75 36 84 51 58 48 63 5B 9C 61 4A 5B 4E 6C 84
Ø33Ø: 61 94 79 3A 61 94 5B 4E 51 B8 51 58 48 63 48 63
Ø34Ø: 56 53 51 BØ 51 58 3D EA 48 63 41 6F 41 6F 51 58
Ø35Ø: 3D 75 3D 75 48 63 41 DE 3D 75 51 58 48 63 5B 9C
Ø36Ø: 61 4A 5B 4E 6C 84 79 74 ØØ 7Ø ØØ ØØ
```

Table 3. The sequence reproduced here corresponds to the notes and rhythm of the Menuet du Bourgeois Gentilhomme by Lully. The even addresses contain the pitches and the uneven addresses are the durations of the notes. Note that in some cases the durations are not exactly minims. The $ØØ at $Ø36B acts as a repeat bar. It indicates that the piece is to be replayed from the start.



All home constructors are constantly looking for simple ways of checking whether electronic components they have in stock are fit for use. This is particularly so in the case of the more expensive transistors, such as the power metal-oxide field-effect transistors, or simply power MOSFETS, as used, for example, in the Crescendo amplifier featured in our December 1982 issue. Although the complete electrical testing of such devices requires complicated, expensive test gear, it is perfectly feasible to check them with a multimeter.
The tests described refer to n-channel devices; by reversing the test leads indicated in the text, p-channel types can also be checked.

Gate to source

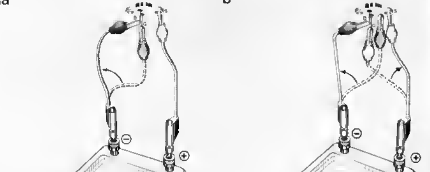
With the multimeter set to highest resistance range (x 10MΩ or x 100 MΩ) check that the resistance between gate and source is infinite. Reverse the test leads and check again.

simple MOSFET check

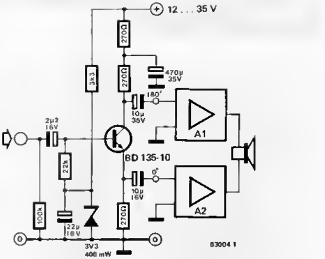
Drain to source (see figure 1)

- Set the multimeter to the lowest resistance range.
- Connect the (red) lead from the + terminal to the source, and the (black) lead from the – terminal to the gate. The gate is now forward biased.
- Move the black lead from the gate and connect it to the drain. The multimeter should now indicate zero ohms (see figure 1a)
- Connect the (black) lead from the – terminal to the source and the (red) one from the + terminal to the gate. The gate is now reverse biased.
- Connect the – lead to the drain and the positive one to the source (see figure 1b). The meter should not deflect because of the equivalent diode between drain and source. If now the + lead is connected to the drain and the negative one to the source, the meter should deflect.
- If the above checks are satisfactory, the device is perfectly fit for use. As many months of experience with, for instance, the 2SK135 and 2SJ50 MOSFETs has shown that these devices are very reliable, a negative result of the above checks is very unlikely.

1a b



technical answers



Simple phase shifter for bridge circuit

The question is often raised regarding the possibility of obtaining more output power with two identical power amplifiers in a bridge circuit.
According to the basic principle, two amplifiers connected in a bridge circuit theoretically produce four times the output power of a single amplifier at the same supply voltage. The loudspeaker in the bridge is provided with twice the voltage. However, this also means that the power amplifiers must supply twice the output current. A normal, properly rated output stage does not have this current reserve. When a bridge circuit is used, therefore, the result is not necessarily four times the power, but a somewhat lower figure (depending on the maximum output current of the amplifier). If the amplifier is not equipped with a current limiting circuit, there is also a risk of overloading the output transistors.
Now let us examine the question of drive. The two amplifiers must be driven in phase-opposition; the loudspeaker is then connected between the two amplifier outputs. A suitable phase shifter consists of a transistor stage with emitter and collector resistors of the same value. The signal at the collector is then identical with that at the emitter, but shifted by 180°. This is exactly what we need to drive two amplifiers in a bridge configuration. Thanks to the relatively high collector current of the BD 135, the output impedance of the phase shifter described here is so low that even amplifiers with an input impedance of only 1 k can be connected without problems. On the other hand, the 20 k input impedance of the phase shifter is high enough to allow the usual preamplifiers to be connected.

missing link

car PDM amplifier (Summer circuits '83 page 7-36)

We regret that one illustration of the double-plated printed-circuit board of this amplifier was omitted from the Summer Circuits '83 issue. At the same time, the foil-side was omitted from the PC board pages. Both omissions are put right in the PC board pages in this issue.

morse converter (may 1983 page 5-52)

Owing to an error in our master EPROM, the hexdump (table 4 — page 5-56) needs a correction: in address B68 the byte EB should be amended to ØB. Readers who have an erroneously coded EPROM can carry out the amendment quite simply, because the RAM of the expanded Junior lies at address EB6C. The following should be typed in:

```
EB6C    4C
EB6D    6C
EB6E    ØB    JMP    ØB6C
```

After the program has been copied to address 4ØØØ and following, EA must be entered at addresses 4Ø32 . . . 4Ø34.
These amendments do NOT apply to the DOS Junior.

floppy-disk interface for the Junior (December 1982 page 12-48)

Our attention has been drawn to a small omission in the December 1982 article on the DOS Junior. In the 3.3 version of the DOS Junior there is an Extended Monitor which permits, among other things, BREAK points to be placed in a program. Some readers who tried this discovered it was not quite possible. This is because the BREAK vector is not located correctly. All that's needed to put matters right is, after switching on the monitor, to place the following data into the adresses indicated.

```
$FA7E    $25
$FA7F    $1B
```

Thus, the BREAK vector points to the routine which controls the BREAK points.

elektor infocard 55

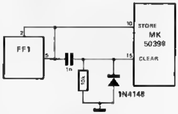
The formulas for the gain of both the Wien-Robinson bridge and twin-T filters contain errors. The correct formulas are:

Wien-Robinson
$$G = \frac{1-\beta^2}{3\sqrt{(1-\beta^2)^2 + 9\beta^2}}$$
where $\beta = f/f_m$

Twin-T filters
$$G = \frac{1-\beta^2}{\sqrt{(1-\beta^2)^2 + 16\beta^2}}$$
where $\beta = f/f_m$

elektor infocard 70

We regret that several errors and omissions crept into infocard 70. The value of capacitors C1 . . . C16 = 150 pF. FF2 does not have a pin 16: this should be pin 14. The divider/counters are not type 4013 but type 4017.
Finally, an RC combination and diode were omitted: the connection between FF1 and the MK 50398 should be as shown below.



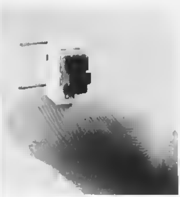
coming soon . . .

Central heating controller
Basicode
Simple anemometer
. . . and many more!

market

Multi-purpose DILswitch

The Erg SDS-1-015 is a low cost, single pole single throw, dual in-line switch. It has a very low profile, 5 mm high. The switch is fully base sealed and besides its obvious uses in miniature and subminiature equipment, is ideal for on-board programming without the need for board removal from close racking systems. The switches can be stacked on a standard 2.54 mm p.c.b. pitch. Switching capability extends from 1 μA to 1 A up to a maximum of 10 VA. Initial contact resistance is typically 20 mΩ, and insulation resistance 100 GΩ.



Erg Components,
Luton Road,
Dunstable,
Bedfordshire LU5 4LJ.
Telephone: 0582 62241

(2646 M)

Multimeter temperature measurement

Anyone who has access to a digital multimeter can now use it as a versatile wide range temperature measuring instrument using standard type K thermocouples, by adding the DVM/TC Interface Unit.

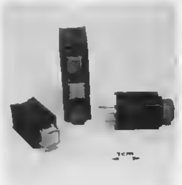
This new device, at considerably lower cost than a dedicated instrument, has a temperature range of − 50°C to +1100°C and incorporates automatic cold junction compensation. Thermocouples are attached through a miniature compensated socket. A basic thermocouple and mating plug are supplied as standard with the instrument. The output of 1 mV per degree centigrade is via a 0.75 metre coiled lead fitted with 4 mm plugs. Long term stability is excellent and the low battery drain allows it to be used for continuous monitoring if necessary. Since the accuracy is not affected by the output loading, it may also be used to interface low output impedance instruments such as chart recorders.

Graham Bell Instrumentation,
PO Box 230,
39 Derbyshire Lane,
Sheffield, S8 OTH.
Telephone: 0742.582370

(2649 M)

LED switches

Ambit has added to its range of ALPS switch products with the new SPAE series of LED illuminated switches. The switch is available with a choice of red, green, orange and yellow LEDs, with corresponding diffuser caps (plus a clear diffuser option).



Either self locking or momentary action is available, with 120 gm pressure to operate the single pole contacts. LED illumination is independant of the switching action.

The switch is carefully designed with a sealed base as a result of the use of insert molding techniques.

Ambit International,
200 North Service Road,
Brentwood,
Essex CM14 4SG.

(2641 M)

Ultra violet exposure unit

Electronic Assistance Ltd. announce their new UV800 ultra-violet exposure unit. Using four 15 watt high efficiancy Actinic UV lamps, it is capable of photo etching over 800 sq cms of pre-sensitised circuit boards or labels in less than 3 minutes.

Timing for the UV fluorescent tubes is based on the ZN 1034E precision timer which achieves 0.1% repeatability over a wide temperature range.

The flame retardant foam pressure pad has been designed to follow a large radius arc when being closed thus preventing relative displacement of artwork and subject.

A positively interlocked microswitch prevents UV emission reaching the operator's eyes when the pressure pad is raised.

Also available is the smaller UV-300 unit which dispenses with the timer but retains the safety features

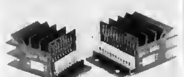
Electronic Assistance Ltd.,
Unit 1,
Brynberth Industrial Estate,
Rhayader,
Powys LD6 5EN.
Telephone. 0597.810711

(2637 M)

Power booster amplifiers

In addition to their existing 15 Watt (Rms) mono power booster amplifier ILP introduce the *NEW* low priced *STEREO* 15 Watt (Rms) per channel version.

Both modules are designed to increase the output power of existing low wattage car radio/cassette players giving the advantage of being able to overcome road and engine noise without introducing annoying distortion. In addition to their being compact and robust (and in encapsulated modular form), they have many important features such as easy two-hole fixing, screw terminal connection blocks for easy wiring-up, automatic supply on switch-on, selectable input level facility and output protection circuitry.



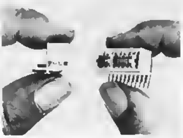
ILP Electronics Ltd.,
Graham Bell House,
Roper Close,
Canterbury,
Kent CT2 7EP
Telephone: 0227.54778

(2653 M)

market

DILswitch

Dual in-line switch type SDDS-10-023 is the first in a new series from Erg. Pins are spaced on a 0.1in matrix in such a way as to allow a saving of 30% of p.c.b. area. Containing 10 on/off switches, the module can be edge-mounted to allow programming without removing a p.c.b. from equipment. Front panel switching can easily and economically achieved by simply edge-mounting the switch on the front edge of the p.c.b., and cutting a small, matching, rectangle in the panel. No additional mounting hardware is required. Each switch in the module can reliably switch from 1 μV/1 μA up to 10 VA. It is purpose designed for use on modern flow soldering and solvent cleaning assembly lines.



The base is totally sealed and the top is factory sealed with a removable, transparent tape. All SDOS switches meet BS 9565 and exceed MIL-S 83504. Colour-coded and numbered switch members show clearly the status of each individual switch at a glance. All switching contacts have one micron minimum of cobalt hardened gold over 2.5 microns nickel barrier for long and reliable switching life. The nylon case is flame proof to BS 2011 Pt2.1 Pz. The total SDDS range will include switches from 2 to 18-way.

Erg Components,
Luton Road,
Dunstable,
Beds LU5 4LJ,
Telephone: 0582.62241

(2730 M)

Rugged calculator

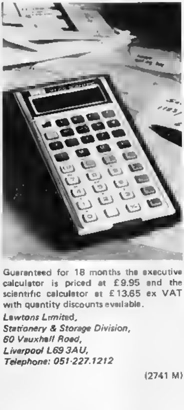
Already tried and tested by users in eleven different countries, the HD 2202S executive calculator and HD 9000S scientific calculator are now available in the UK from Lawtons Limited. Tailor-made to withstand the rigours of daily use in factories, offices and on site, the Lawco HD calculators have been developed and perfected over a period of six years and feature a unique robust cover case support.

Protecting the calculator like a turtle in its shell, the hinged plastic cover is kept firmly locked by six strong moulded hooks, yet folds back to form a calculator support for table or desk top use. The 20° angle of the folded cover means the calculator is easy to read and operate even at a distance, thus leaving more desk space for working documents and notebooks. A special machine, built to test the strength of the cover hinges, has opened and closed the cover case 2,739,416 times and is still trying to break it!

Specially constructed with a stainless steel plate reinforcing the LCD display area, both calculators are strongly built with battery springs made of hard stainless steel and connections between battery springs and circuit boards of soldered wires.

Designed for maximum simplicity in use the executive calculator has all the usual mathematical functions which might be required. The automatic power shut-off 8-9 minutes after the last entry ensures an operating life of 10,000 hours on one leak-proof lithium battery.

The more sophisticated scientific calculator with full statistical functions features true algebraic operating with no less than 8 pending operations. A unique display of the current number of pending operations and parentheses prevents most common errors. The 11 digit internal precision ensures accurate results under all circumstances. One leak-proof lithium battery ensures 3,000 hours of trouble free operation.



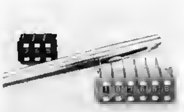
Guaranteed for 18 months the executive calculator is priced at £9.95 and the scientific calculator at £13.65 ex VAT with quantity discounts available.

Lawtons Limited,
Stationery & Storage Division,
60 Vauxhall Road,
Liverpool L69 3AU,
Telephone: 051-227.1212

(2741 M)

New 'Z' multiswitch

Contraves Industrial Products Limited of Ruislip, Middlesex, have introduced a new 'Z' Series to their range of Multiswitch thumbwheel switches. Designed as a more compact version of the well established 'D' switch, the 'Z' Multiswitch is a step index, 10 position switch with BCD or decimal output codes. Its size: 15 mm



high x 7.82 mm wide x 18 mm diameter makes it ideal for use in compact instrumentation where space is at a premium.

Basic technical data includes: — rated current (resistive load) 1-100 mA; maximum current carrying capacity 0.5 A, maximum working voltage 50 V; test voltage 500 V; contact resistance 100 m ohms; permissible ambient temperature −10 . . . +60°C.

Contraves Industrial Products Limited,
Times House,
Station Approach,
Ruislip,
Middlesex HA4 8LH,
Telephone: 08956 30196.

(2736 M)

New Books

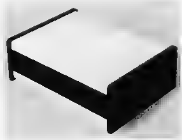
'Practical Design of Digital Circuits' by Ian Kampel (Newnes Technical Books). This is one of the more interesting books which reached us during the summer months. Newnes Technical Books has a name for publishing good-value-for-money works and the present one is no exception. 'Practical Design of Digital Circuits' is, true to its title, eminently practical in its approach. To quote the author in his foreword: 'There is no need for the designer to know how particular ICs function internally, for he uses them as black boxes.' The book is in three parts: the first gives a clear, well thought-out, introduction to basic logic, the second is concerned solely with digital design practice, and the third is dedicated to microprocessors. A number of useful appendices complete the book. A 'must' for the practising and aspiring designer of digital circuits alike.

market

Modular case system

Elinca Products Limited announce the introduction of a new modular case system for the construction of housings for electronic assemblies and instrument displays. Developed from the range of 'SEC cases, the new system is designed for use by manufacturers in the electronics industry or by D.I.Y. enthusiasts.

The new system comprises pre formed body panels, facias and moulded end cheeks, which make up a wide variety of cases, ranging in size from 2 in. by 5 in. by 6 in. up to 2 in. by 5 in. by 13 in. All case sections are pre-punched for instant assembly and are available in a choice of white or black, with natural aluminium or black facia panels. Polished teak veneered end cheeks are also available.

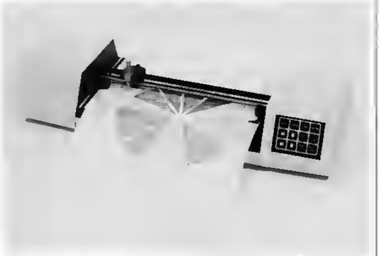


The cases are manufactured in plastic coated metal which is antistatic with high insulation and screening properties, and cheeks are in textured high impact resistant polystyrene.

Elinca Products Limited,
Lyon Works,
Capel Street,
Sheffield S6 2NL,
Telephone: 0742.339774

(2739 M)

Digital plotter



House of Instruments announce a new drum plotter from Houston Instruments. The DMP 40 occupies a space of little more than one square foot yet combines sophisticated firmware options, plotting precision, speed, rugged reliability and ease of operation.

Sizes up to and including A4 and A3 are available on inexpensive media, and perforated or special sheets are not required. Plots, maps, formulae, graphs, script, block letters, drawings, geometric patterns and charts are all available, mistake-free, on ordinary bond paper, drafting vellum, acetate and mylar from data supplied by your mini, micro, mainframe computer, or by both novice and experienced operators. Routines within OM/PL 111 can automatically generate curves, arcs, ellipses and circles of any size. Eleven different line types (solid, dotted or dashed) are provided. Straight and slanted (italic) characters can be drawn at any of 360 possible angles and 255 sizes. Aspect control, in which one axis may be lengthened, as well as the capacity to plot only a portion of a drawing (viewport), and to scale drawings up or down as required, are possible.

While manual entry and control are via a membrane keyboard, a built in RS 232C allows for interface with most current computers. An extensive self test and diagnostic repertoire enable the operator quickly and easily to determine the plotter status.

Exact registration during mono or multicolour plots is achieved by a new paper drive system. Reliable, quiet and accurate stepper motors, controlled by dedicated microprocessors, drive both pen and drum. With both axes plotting in increments of 0.005 inches, virtually step free traces are easily obtained. Stepper motors and associated logic have been refined by Houston Instruments over the years to provide highly reliable operation, generating repeatable plots of precisely defined resolution and high accuracy.

Quiswood Limited,
30 Lancaster Road,
St. Albans,
Hertfordshire AL1 4ET,
Telephone: 0799.24922

(2738 M)

readership survey

first results!

We are still busily counting and evaluating the response to the readership survey in our July/August edition. Although this work is by no means completed, some findings are already obvious. In the first place, some 80 per cent of the replies express a genuine interest in the results, while only a few per cent consider it 'a waste of paper'. Several readers remarked that 'the competition should be interested, too!' True enough, and most of them have a free subscription. So here's something for them to chew on.

We printed the PC board layouts on special pages (mirror image, with the reverse side blank) as an experiment. We thought this would make life easier for everyone who reproduces the boards with photosensitive material. Apparently, we scored a hit: over 30 per cent of our readers ticked the box 'Those special pages are a great help'! As of now, those pages are no longer an 'experiment' – they are a standard Elektor feature!

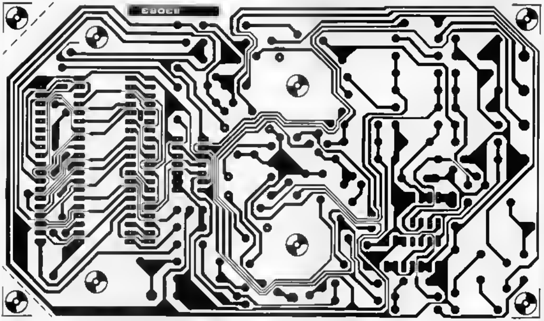
One reader even described how he had been using a similar technique for years. Evidently, he erases the printing on the reverse side with emery paper ('very carefully'), and uses sewing-machine oil to make the paper transparent. He sent us a board he had produced in this way and, believe it or not, it proved to be extremely good!

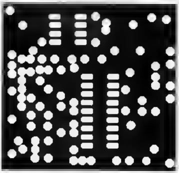
The other results? It's early days yet: we haven't completed the evaluation. But we will publish them as sonn as they're available – possibly even next month. Just one more is worth noting: against 'Editorial introduction/opinion?', most readers ticked 'I'm neutral'. So, this is not an introduction, nor is it an opinion.

service

PC board pages

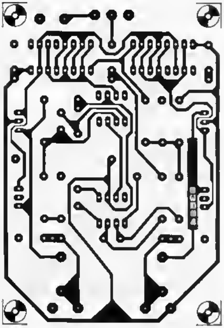
- In view of the enthusiastic response from our readers, we have decided to continue the experimental provision of the special PC board pages. We will, however, review their inclusion from time to time on the basis of readers' interest. The pages contain the mirror images of the track layout of the printed circuit boards (excluding double-plated ones as these are very tricky to make at home) relating to projects featured in this issue to enable you to make, that is, etch, your own boards.
- To do this, you require: an aerosol of 'ISOdraft' transparentizer (available from your local drawing office suppliers; distributors for the UK: Cannon & Wrin), an ultraviolet lamp, etching sodium, ferric chloride, positive photo-sensitive board material (which can be either bought or home made by applying a film of photo-copying lacquer to normal board material).
- Wet the photo-sensitive (track) side of the board thoroughly with the transparent spray.
- Lay the layout cut from the relevant page of this magazine with its printed side onto the wet board. Remove any air bubbles by carefully 'ironing' the cut-out with some tissue paper.
- The whole can now be exposed to ultra-violet light. Use a glass plate for holding the layout in place only for long exposure times, as normally the spray ensures that the paper sticks to the board. Bear in mind that normal plate glass (but not crystal glass or perspex) absorbs some of the ultra-violet light so that the exposure time has to be increased slightly.
- The exposure time is dependent upon the ultra-violet lamp used, the distance of the lamp from the board, and the photo-sensitive board. If you use a 300 watt UV lamp at a distance of about 40 cm from the board and a sheet of perspex, an exposure time of 4 . . . 8 minutes should normally be sufficient.
- After exposure, remove the layout sheet (which can be used again), and rinse the board thoroughly under running water.
- After the photo-sensitive film has been developed in sodium lye (about 9 grammes of etching sodium to one litre of water), the board can be etched in ferric chloride (500 grammes of Fe_3Cl_2 to one litre of water). Then rinse the board (and your hands!) thoroughly under running water.
- Remove the photo-sensitive film from the copper tracks with wire wool and drill the holes.

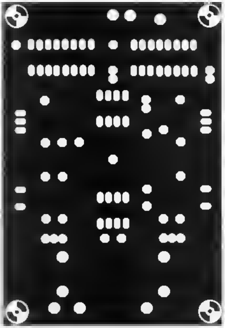


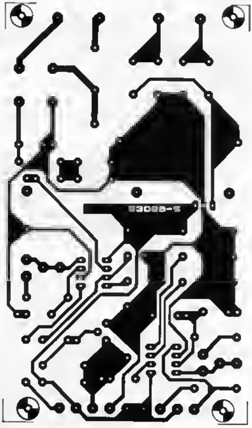


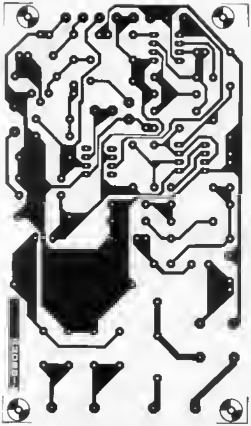
service

PC board pages



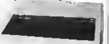






BBC Microcomputer System

OFFICIAL BBC COMPUTER DEALER



MODEL A AVAILABLE £299 Inc VAT

This is the best microcomputer currently on the market 32K RAM 32K ROM 8 modes of operation full colour full-size keyboard internal expansions such as disc interface speech synthesizer Econet interface – in short it is a personal computer capable of expanding into a small business system

BBC Microcomputer Model B	£348	VAT	£399 00
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BBC Mod B + Econet interface	£389	VAT	£447 35
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User guide	£10	VAT	£16 00
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100% BBC COMPATIBLE MITSUBISHI AND TEAC SLIMLINE DISK DRIVES

These drives are supplied ready cased with all the necessary cables formatting program and user disk system guide

There are some useful utilities included e g Epson Screen Dump Program Memory Dump Free Duplicate Merge and Relocate Power consumption of these drives is very low (0 2A typ at 12V 0 4V typ at 5V per drive) Power is taken from the BBC computer

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Single drive 400K 80 tracks	[illegible]	VAT	[illegible]
Single drive 400K 40 80 tracks switchable	£259	VAT	£297 85
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COMPLETE WORD PROCESSOR FOR ONLY £1,099 + VAT

This package consists of BBC Microcomputer View wordprocessor 400K slimline disc drive High resolution 12 Green monitor Juki 6100 18CPS Daisy Wheel printer and all the necessary cables and documentation The above package can be supplied with components of your own choice e g 800K disc drive or a different printer Please phone us for a price for your particular requirement

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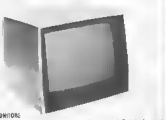

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12 Green screen monitors with composite and sync input Suitable for most computers

* 18 MHz band width high resolution	£89	VAT	£102 35
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* SANYO SCM 14M Medium res 14" 600 dots RGB input supplied with RGB lead	£299 +	VAT –	£343 85
* SANYO SCM 14H High res 14 800 dots RGB input supplied with RGB lead	£449	VAT	£516 35

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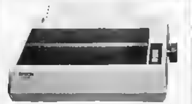

EPSON FX80 80 column 160 CPS normal italic and elite characters 256 user definable characters superscript subscript 11 x 9 matrix bi directional logic seeking hi res bit image printing (960 x 8 dots line) friction and pinfeed 8 international character sets Centronic parallel interface

FX80 PRICE	£379 +	VAT	£435 00

EPSON RX80 80 column 100 CPS normal italic and elite characters 11 international character sets hi res bit image printing bi-directional logic seeking 4 to 10" adjustable pin feed Centronic parallel interface

RX80 PRICE	£258	VAT	£297 00

[illegible] carriage hi res bit image printing true descenders Centronic parallel interface

MX 100 PRICE	£419	VAT	£481 85
RS232 interface for all above printers	£55 +	VAT	£63 25
Intelligent IEEE 488 interface	£65	VAT	£74 75
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This latest addition to Seikosha range gives you print in seven colours 10" wide carriage friction and tractor feed 50 CPS print speed dot addressable high res graphics 4 hammer printing mechanism 10 CPI or 13 3 CPI special Quite printing mode Centronic parallel interface

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STAR DP510 10" carriage 80 columns

SPECIAL PRICE	£249 +	VAT	£286 35

STAR DP515 15 carriage 136 columns

[illegible]	[illegible]	[illegible]	[illegible]
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* CASIO PB-100 Basic language pocket computer 544 program steps Qwerty keyboard 12 char display	£34 75	VAT	£39 96
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* CASIO FA-3 Cassette adaptor for PB100 PB300 FX700	£17 35	VAT	£19 96
* CASIO FP 12 Printer for PB100 and FX700	£38 09 +	VAT	£44 95
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* SHARP PC 1251 Basic language computer 4K RAM 24K system ROM 24 char display Qwerty keyboard user defined key numeric pad	£69 52	VAT	£79 95
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This microcomputer is based on TMS9900 16 bit microprocessor It includes 16K RAM 16 colour high resolution graphic (192 x 256) The screen display is 32 characters 24 lines TI-BASIC Full size keyboard for Software there are about 1000 programs to choose from There are a lot of peripherals available e g Disk Drives Disk Interface Speech Synthesizer Extra RAM Additional language (PASCAL TI LOGO ASSEMBLER)

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PERIPHERALS		
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SPECIAL OFFER JUKI 6100 DAISYWHEEL	£369	VAT	£424 35

THE CP80 QUALITY PRINTER

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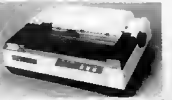
SHINWA CP80 PRINTER	£259	VAT	£297 85
SPARE RIBBON FOR CP80	£5	VAT	£5 75

NEC 8023BE-C PRINTER



This is a high speed printer using bi-directional logic seeking operation 7 x 9 matrix for alphanumerics 8 x 8 for graphics and bit image printing Programmable paper feed original plus three copies Greek characters and high resolution graphics The print quality is exceptional and the price is affordable

Price	£299	VAT	£343 85

★ OKI Microline 80 Printer	£199	VAT	£228 85
★ OKI Microline 82A Printer	£329 +	VAT	£378 35
★ Dragon 32 Computer	£139	VAT	£159 85

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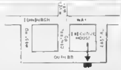

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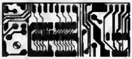
microprocessor HARDWARE



Elektor Publishers Ltd
Canterbury
ISSN 0 905705 15 7

Are you looking for a terminal for your microprocessor . . . ? Or maybe a memory extension? Is your cassette interface too slow or just not good enough? Computer capacity underestimated? How do you program your (E)PROMs? All these and many other questions are answered in this microprocessor hardware book in clear and easy-to-understand language.

The heart of every personal computer is the microprocessor and only a limited number of these are in common use. This book describes a range of peripheral equipment which can be used with an assortment of personal computers using the 6502, 6809, Z80, or 8080 microprocessor. This is obviously not an easy matter, but the book explains all that is necessary to enable the systems to be applied with the minimum number of circuit modifications.

Price £7.50 + 50p postage & packing
To order please use the postage paid order card in this issue.

CIRCUIT OIAGRAM or handbook for Leek 'Point One' — 'TL 10' Power Amplifier (valve). Christopher Smith, 34 High Leys Orive, Leics. LE2 52L. Tel. 713942.

WANTEO, nearly new Oaisywheel typewriter with RS232 interface. Details to P.H. Smallwood, Lr. Trifffeton, Haverfordwest.

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RAMS, set of 8, 4118, £5. EPROMS, 5 V, 2718, 2532, 2 of each, all for £7. 6502 CPU, 6522 PIA, both for £4. Bench meter 6" scale, £20. Mr R. Minchin, 51 Thurleigh Road, London SW12 8TZ.

WANTED, circuit and pinout of SN 76489. Want to make contact with friendly Elektor readers for corresponding on electronics and computing. Write me soon. Hamid-Reza-Tajzadeh, 4th floor, no. 11, Street no. 3, Noarmack, Tehran 16479, Iran.

ACORN ATOM fully expanded 6V7A PSU. Twin A/O. Fully proportional joystick. All in custom teak cabinet, £200 o.n.o. Tel. 0264 54748 (Andover).

TELETEXT DECODER — full spec GMT design. Cased with ultrasonic remote control. £75 o.n.o. plus transit charge. M.J. Hutchinson, 18 The Street, Ovington, Norfolk. Tel. 0953 883879.

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COMMODORE PET 8k RAM, basic3. Lots of S/W including invaders, golf and database. £200 tel. 0934 24856.

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WILLIAM STUART'S Big Ears speech recognition system for UK101, Sprbd, Nascom, Atom. Complete with software, access, new, £35. K.Y. Chang, 70, 1-up, Ashley Street, Glasgow G3 6HW.

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WANTEO. Scope Tube OG7/32 or OB7/32. M. Rymenans, P. Coudenberglaan 21, 2520 Edegem, Belgium.

KSR TELETYPE and stand, working order with manual. Ideal for computer printer or RTTY. Only £60. Phone Davis 01 399 5487.

HELP! Need instructions to build 'CY — ENOFIELO' Micro-writer. B. Schlatter, Shin-ogawa-Machi 6-18, Edogawa-Apato 56, 162 Tokyo, Japan.

WANTEO. ZX — Spectrum circuit diagram, advise TMS4532 — 2ONL4 ORAM equivalent replacement. Uri Sela, Kibutz Lehavot-Habashan, 12125 Israel.

WANTEO: Circuit diagram and workshop info. for Leak Stereo 30 amplifier. Your price or borrow for copying. Philip West, 2/26 Stirling Road, Birmingham B16 9BG.

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05827-62119

elektor switchboard

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PET COMM 2001/16 Mother Board in order £130, add key + mon — you have heart of business system. 8550 RAM chips £8 each. Mr G. Nicklin, 16 Auckland Drive, Halfway, Sheffield S19 5TQ. Phone 0742 483587.

KSR Teletype for sale, £65, working order, used as printer for computer. Phone Dave Davis (Surbiton) 01 399 5487.

WANTED Circuit diagrams for TRD 622 Reel-to-reel tape and pre-amplifier unit. Will pay cost and postage. D. Jones, 60 Sutton Lane, Belle Vue, Shrewsbury, Shropshire SY3 7QO. Tel. Shrewsbury 59932.

WANTED AY-3-8610, ZX81 kit or ready-built. V. Vitovec, Pilestredet 31/320, Oslo 1, Norway.

WANTED CCT diagram of Motorola MPU System using 6800, 6830, 6821, 6850 with Hex I/O. Hand drawn CCT O.K. E.G. Avworo, 28 Eboh Road O/L, Warri Bendel, Nigeria.

NASCOM 1, Bbug, cased, PSU, tapes, leads, manuals, £65 o.n.o. FX702P Computer + printer + cassette interface + paper, all new, £110 o.n.o. Mr N. Ryman-Tubb, 6 Highcliffe Drive, Allbrook, Eastleigh, Hants. S05 4RB. Phone Eastleigh 615414.

JUNIOR Computer + Book 1 — offers? Tel. Basingstoke (0256) 797380.

RTTY TU wanted for TX + RX with Scarab Board + ZX81. For sale — 50m RG213 brand new, unused, £25 o.n.o., MML 144/30LS, vgc, £55 o.n.o. Mike Price, c/o 6 Beaufort Avenue, Langland Abertawe SA3 4NU.

TELETEXT TV Adapter with remote control unit, woth £150 — only £85. Tel. day Gerry 629 3758, eve. 554 7267. Ilford area, collect.

COMPLEX Pulse Generator, TV to 'scope converter + frequency meter for sale. All in same portable case. £47. Inquiries to Declan Quinn, St. Judes, Patrickswell, Co. Limerick, Ireland.

INFORMATION wanted on satellite TV, anything from recommended reading to circuit diagrams greatly welcomed. Richard Simpson, 1 Seymour Close, Marske, Redcar, Cleveland TS11 7EE.

MOTHER BOARD for Computer based on DIN 41612, A+C connectors so I can connect my Elektor boards together, 5+ slots, Mr G. Chester, 4 Burnett Place, Bradford. Tel. 0274 735809.

ROGERS Model HG88 Mk 11 Hi-fi Amp. Require circuit diagram and/or instruction book. Mr W.M. James, 32 Cawston Street, Noth End, Bulawayo, Zimbabwe.

RELUCTANT sale of radio controlled Car digital proportional hardly used, cost £70, selling for £30. Tel. 01 504 0565.

FOR SALE Elektor nos. E27/28, 37, 38, 42, 45, 49. Also see 3½ LCD + 7106 etc. in E99/100. P. Tan, 2 Ridley Road, London NW10. Tel. 01 961 6658.

FLUKE 8200A + 02 High speed digital voltmeter exchange for Dragon 32 or other home micro. Phone Roger 01 968 6807.

HELP to supply or locate source for push button telephone IC, no. CIC910 1E Will appreciate by gifts. Iftikhar Ahmad, P616-A, Angatpura, Rawalpindi, Pakistan.

DISK DRIVES, Double density, double sided. MPI # B52. Use with IBM, TRS80, etc. 90 days factory guaranteed. Only $230. David Jadid, 1162 — 52nd Street, Brooklyn, NY11219, U.S.A. (212) 436 5261.

WANTED Triac Pulse transformers and Information on Hartley CT436 Scope. P. Walsh, 4 Stopford Street, Edgeley, Stockport, Cheshire. Tel. 061 429 6864 evenings.

HOME constructor has new components for sale, Digital, Linear, Microprocessor, TTL, CMOS, etc. Non-working home micro req'd. B.K. Jain, 17 Taylors Lane, London NW10. Tel. 01 459 2553.

TURRET TAGS, tinned brass, for mounting components on PCB or matrix boards, small quantity, offers? Mr J.K. Potts, 42, Keswick Road, High Lane, Stockport, Cheshire.

MONO DXTV Isolated chassis audio/video in/out all band tuner, £25 o.n.o. or swop good cassette recorder/car player. Mr A. Bouskill, 129 Lyminster Road, Sheffield, S. Yorks. S6 1HY. Tel. 0742 311191 after 4.30.

EDDYSTONE 730/4 RX, good condition, realigned makers last year, to swop IC2E or sell, £120. Phone Bacup 874928.

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