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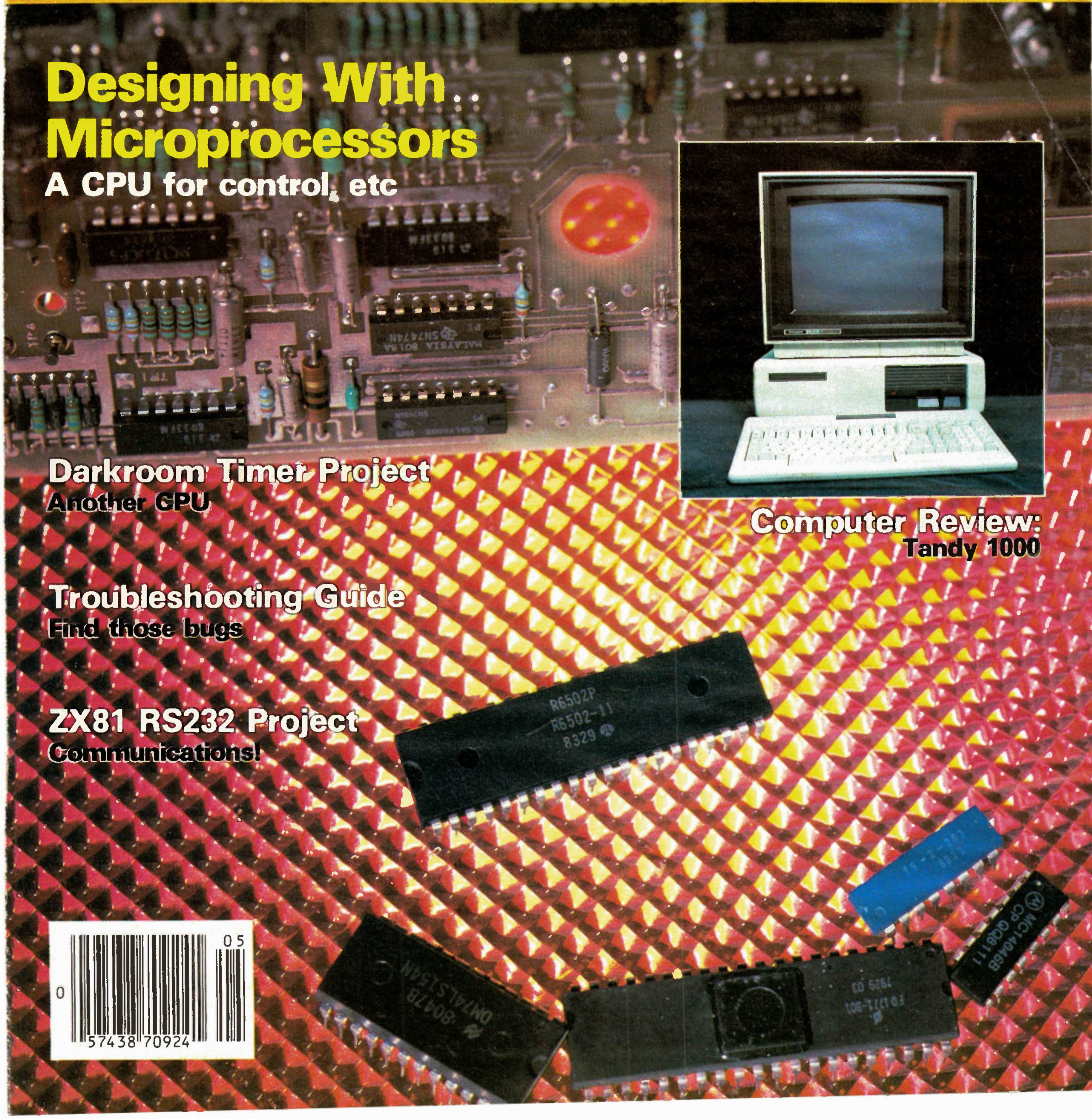
Electronics Today

Complex Numbers

May 1985

Canada's Magazine for Electronics & Computing Enthusiasts



Designing With Microprocessors
A CPU for control, etc

Darkroom Timer Project
Another CPU

Computer Review:
Tandy 1000

Troubleshooting Guide
Find those bugs

ZX81 RS232 Project
Communications!

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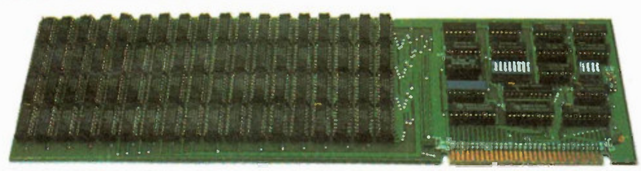

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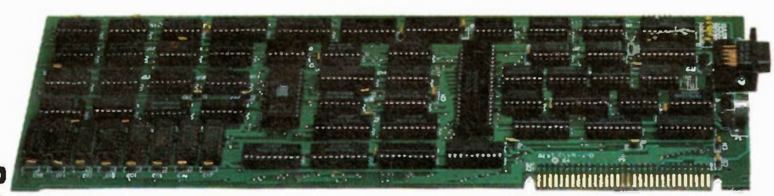

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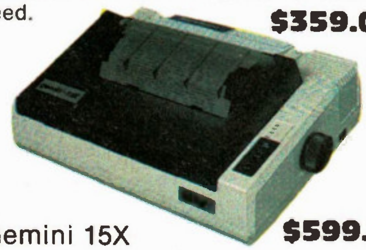

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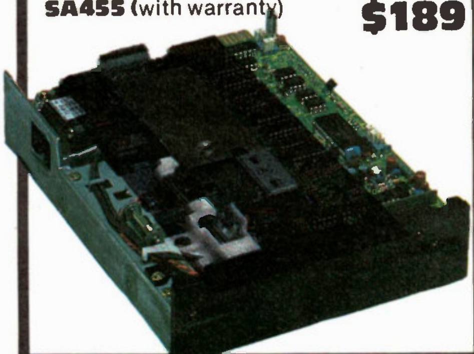

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Electronics Today

May 1985

Vol. 9 No. 5

Canada's Magazine for Electronics & Computing Enthusiasts

Our Cover

The 6502 CPU chip is spotlighted on page 12; the Tandy 1000 MS-DOS computer is reviewed on page 49. Photos by Bill Markwick.

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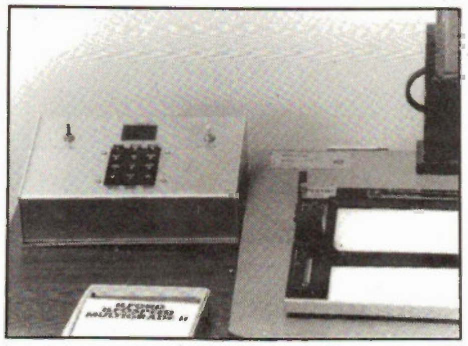

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While every effort has been made to ensure that all constructional projects referred in this magazine will operate as indicted efficiently and properly and that all necessary components are available, no responsibility whatsoever is accepted in respect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

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Component Notation and Units
We normally specify components using an international standard. Many readers will be unfamiliar with this but it's simple, less likely to lead to error and will be widely used everywhere sooner or later. ETI has opted for sooner!

Firstly decimal points are dropped and substituted with the multiplier: thus 4.7uF is written 4u7. Capacitors also use the multiplier nano (one nanofarad is 1000pF). Thus 0.1 uF is 100nF, 5600pF is 5n6. Other examples are 5.6F = 5p6 and 0.5pF = 0p5.

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

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

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

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Mr. Robert Keto, Senior Vice-President, Managing Director, Radio Shack Canada, recently announced the signing of an agreement with Bell Cellular making Tandy/Radio Shack a single-source retailer for cellular telephone service in Ontario and Quebec.

"The agreement establishes Tandy/Radio Shack as a retail representative on an exclusive basis," explained Mr. Keto. "Through our Radio Shack Computer Centres, we will sell and install mobile telephone equipment and process the necessary application to susbscribe to Bell Cellular service."

Auto-Ranging Probe-Type DMM

A new probe type digital multimeter featuring auto-ranging on all functions, audible continuity test, data hold and rugged ABS plastic case construction with RFI/EMI shielding has been introduced by B&K-PRECISION, Industrial Electronic Products Group of Dynascan Corporation.

The Model 2802 displays all measurements on a 3½ digit easy to read LCD display with annunciators for function, polarity, low battery, and overrange indication. It also measures dc voltage in five ranges — 200 mV to 500 V, ac voltages in four ranges — 2000 mV to 500 V, and resistance in six ranges — 200 to 20M .

When the DATA HOLD switch is depressed, the meter "holds" the reading and allows probe tip to be moved from the point of measurement. The Data Hold feature is selectable for all measurements.

B&K-Precision is represented and stocked by Atlas Electronics Limited, 50 Wingold Avenue, Toronto, Ontario. Branch sales offices are in Montreal, Ottawa, Winnipeg, Calgary, and Vancouver, with distributors located across Canada. For further information please feel free to contact: Bruce Petty, at (416) 789-7761.

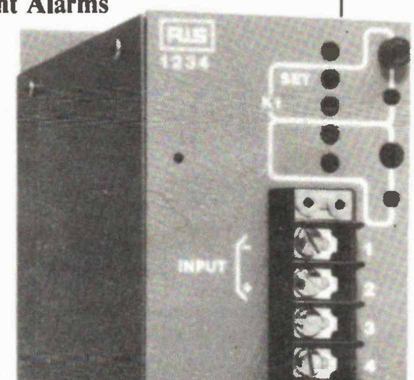
Programmable and Portable Synthesized Function Generator

A synthesized function generator that is also programmable and portable has been introduced by Allan Crawford Associates Ltd. at a price in Canada of less than $2600.

Typical applications for the new Wavetek Model 23 function generator include use in narrow band testing of digital or analog communications systems, Doppler sonar or medical diagnostics such as the detection of blood flow or heart valve movements, and numerous electronic instrumentation test systems where a test signal or local oscillator is required.

The Model 23 includes a rotary encoder, allowing for increment or decrement values to be shown on a liquid crystal display. Operating from 0.0001 Hz to 32 MHz, the unit is capable of frequency accuracy of plus-or-minus 0.005%. The Model 23 contains AM, FM, trigger and gate modes, and is optionally RS232 or GPIB programmable. For more information contact: Mrs. Kelly Widdes; Electronic Instrument & Systems Division; Allan Crawford Associates Ltd; 5835 Coopers Ave., Mississauga, Ontario L4Z 1Y2, (416) 890-2010.

True Fail-Safe Voltage/ Current Alarms



Rochester Instrument Systems (RiS) recently developed the industry's first electronic alarms with true fail-safe operation. Voltage/current models ET-1234 and ET-1235 utilize a patented, fail-safe circuit concept that features the monitoring of internal components. This monitoring is facilitated by use of dynamic rather than conventional static energizing of the trip relay(s). The new alarms are unique in that a single predictable output state (de-energized "alarm" state) will occur on them in the event of any of the following: power failure, loss of input signals, excessive drift, or the failure of any critical component. the fail-safe feature on competitive alarms is limited to just power failure and loss of input signals; therefore failure of critical components, disabling the alarm itself, could possibly go undetected.

The ET-1234 is a single trip alarm, the ET-1235 is a dual trip version. Nine standard input ranges are available spanning input currents of 200 microamps dc to 50 milliamps dc. Voltage inputs range from 100 millivolts dc to 10 volts dc. Full span continuous trip set with LED trip indication and deadband are field adjustable. Other standard features include 600 volts ac or 1000 volts dc isolation, a high level of RFI immunity, plus 115 volt input surge protection from wiring errors. For more information about ET-1234/35 fail-safe voltage/current alarms, contact: Rochester Instrument Systems Ltd., 915 Kipling Ave., Toronto M8Z 5H4 Canada.

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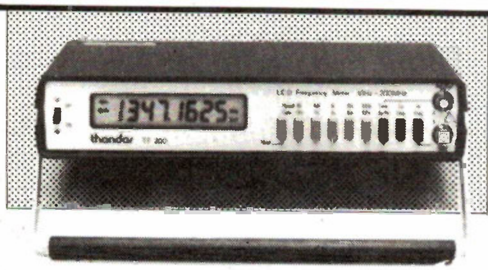

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Frequency Range:	10Hz-200MHz (To 600 MHz when used with TP600 prescaler)
Sensitivity:	10mV rms 20Hz-100MHz, 30mV rms 10Hz-20Hz, 100MHz-200MHz
Functions:	Frequency, Time Average Period, Totalize and Reset, 2 ranges, 5 Gate times. External clock facility. Power take-off for optional TP600 prescaler.
Accuracy:	+(1 count + timebase accuracy). Timebase factory set within + 0.3ppm
Battery life:	Typically 200 hours from 6 alkaline 'C' cells
Size:	255 x 150 x 50mm
Weight:	1200gms with batteries

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The Thandar SC110 represents a breakthrough in oscilloscope development. For the first time every engineer, serviceman and technician can carry the most fundamental piece of electronic test gear with him everywhere — an oscilloscope.

Bandwidth:	DC to 10MHz
Sensitivity:	10mV / division to 50V / division
Sweep Speeds:	0.1 μsecs / division to 0.5 secs / division
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Size:	255 x 150 x 40 mm
Weight:	800 gms exluding batteries

Multimeters

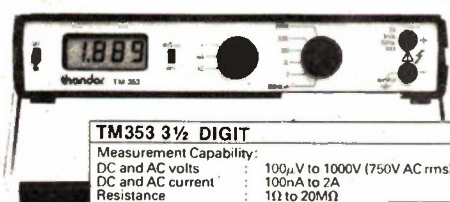
$325⁰⁰

TM351 3½ DIGIT

Measurement Capability:
DC and AC volts : 100μV to 1000V (750V AC rms)
DC and AC current : 100nA to 10A (20A for 10 secs)
Resistance : 100mΩ to 20MΩ

Diode check

Accuracy:	Basic accuracy: ±(0.1% of reading + 1 digit)
Battery life:	Up to 4000 hours from 6 alkaline 'C' cells
Size:	255 × 150 × 50mm
Weight:	1200gms including batteries



$269⁸⁰

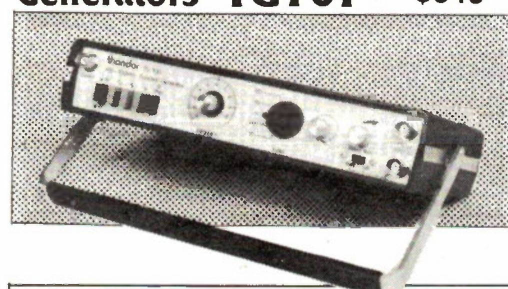
TM353 3½ DIGIT

Measurement Capability:
DC and AC volts : 100μV to 1000V (750V AC rms)
DC and AC current : 100nA to 2A
Resistance : 1Ω to 20MΩ

Diode check

Accuracy:	Basic accuracy: ±(0.25% of reading + 1 digit)
Battery life:	Typically 3000 hours from 6 alkaline 'C' cells
Size:	255 × 150 × 50mm
Weight:	1200gms including batteries

Generators TG101 $345⁰⁰



Frequency Range:	1Hz to 100kHz
Functions:	Sine, Square, Triangle and DC from variable 600 output. External sweep input permits 300:1 linear sweep below range maximum, i.e. below 0.1Hz on 10Hz range.
Outputs:	1mV to 10V from variable 600 output; variable DC offset to ± 5V. TTL output.
Power Requirements:	120V or 240V AC (nominal) 50/60Hz
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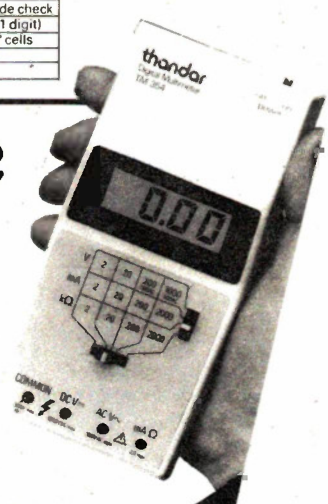

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AC volts : 1V to 500V AC rms
DC current : 1μA to 2A
Resistance : 1Ω to 2MΩ

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Circuit Board Lowers Cost of High Frequency Bread-Boarding

A new drilled breadboard has isolated pads for easy component mounting on one side, clearance-hole ground plane for shielding high frequency circuitry, on opposite side, is now available.

Designated the Model 8007 Circbord™ by Vector Electronic Company, the board measures 6.5-inches wide by 4.5-inches long (16.57cm by 11.43cm) providing space for up to 50, 16-pin DIPs. Holes in the board are 0.042-inch (0.11cm) diameter spaced on 0.1-inch (0.25cm) centers. The board is made of 0.062-inch (0.16cm) thick blue epoxy-glass composite material meeting U.L. Flammability rating 94V-0 and the pads and ground plane are two-ounce copper clad with reflowed solder plating.

In single quantities, the Model 8007 breadboards are priced at $14.75. Distributed in Canada by: CESCO, 24 Martin Ross Ave., Downsview, Ont., 416-661-0220, M3J 2K9; Future Electronics, 237 Hymus Blvd., Pointe Claire, Que., 514-694-7710 H9R 5C7; R-A-E Industrial Electronics, 3955 Gardner Court, Burnaby B.C., V5G 4J7, 604-291-8866.

Computing Devices Company of Ottawa has been awarded a 5.5 million dollar contract by Spar Aerospace Limited of Toronto for engineering development of the Scan Converter and Imaging Signal Processing portions of an Infra-Red Search and Target Designation System (IRSTD) being developed for the U.S. Navy and the Candian Department of National Defence. This order is a follow-up to scan conversion and digital display prototype development completed for Spar and successfully tested at sea by both the Canadian and United States Navies.

Light Pen Graphics

Tech Sketch has introduced a light pen color graphics system for the IBM Personal Computer and the PCjr that costs less than $70, including software. According to company officials, this is the lowest-cost light pen system available for IBM computers. The Tech Sketch light pen — which is covered by a lifetime warranty — and the Micro Illustrator software have a suggested retail price of $69.95. Tech Sketch products are distributed in Canada by Citation Software, 1901 Logan Ave., Winnipeg, Manitoba R2R 0H6.

VIZ Frequency Counter

VIZ Test Equipment recently announced the introduction of the WD-756 frequency counter capable of measurements from 5Hz to 1GHz.

The unit is equipped with an eight LED display with lead-zero blanking along with discrete LEDs as annunciators. Additional features are: switchable low-pass filter, two channel inputs, and a switchable attenuator that prevents overloads by reducing high amplitude signals to 1/10th. To reduce E.M.I./R.F.I., all critical circuits are enclosed in a shielded metal case.

For more information contact H.W. Cowan Canada Ltd., P.O. Box 268, Richmond Hill, Ontario L4C 4Y2. (416) 773-4331

continued on page 58

Configurations

This month Ian Sinclair examines the area of power supplies and some of the facts you aren't often told.

POWER PACKS, you might think, are among the simpler of electronic circuits to design, and yet there is probably more cut-and-try used in the power supply section of a circuit than in all the rest of the circuitry that you construct. The reason seems to be a lack of coherent explanations of the action of the reservoir capacitor — only too often you are simply told that it "provides a ground route for AC ripple", and no more. We start this month, by clearing up this misconception.

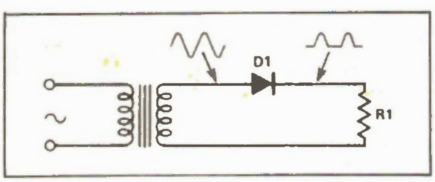


Fig. 1 Simple half-wave rectifier circuit with no reservoir capacitor. The waveform is undirectional, but certainly not what we would call DC.

Consider for the sake of simplicity, a half-wave rectifier circuit and a load (Fig. 1). The waveform across the load will consist of about half of the input waveform, the positive half in this example because of the way we have chosen to connect the diode — reverse the diode and you will select the negative half of the wave. This type of output is called a *undirectional* wave — the peaks are in one direction (positive) only, with no negative peaks — but it isn't exactly anyone's idea of DC. A DC voltmeter connected to the load of this circuit reads what DC voltmeters always read, the average voltage, which is around E_0/pi; approximately $0.32E_0$, assuming that the diode is 'perfect' in the sense of having no forward voltage drop across it. We can allow for the forward drop, which can't be neglected if the output voltage is low, by subtracting its value from E_0, the peak AC input. This is only an approximation, but it is good enough for practical purposes.

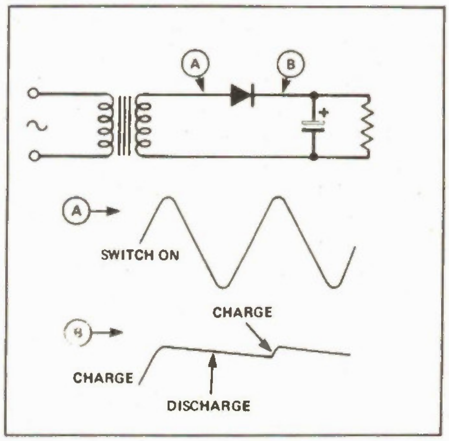


Fig. 2 A half-wave circuit with a reservoir capacitor added. The capacitor charges to the peak voltage of the input wave, and the charged capacitor supplies the load while the diode is reverse-biased.

Bring On The Reserves

Now when a reservoir capacitor is connected to the circuit (Fig. 2), things change considerably. To start with, imagine that the load resistance is very high, so that only a small amount of current is being taken. Instead of the rectifier conducting for the whole positive cycle of the AC wave, it now conducts only for a tiny fraction of the time of the wave, right at the peak. The reason is that the first half-cycle, when the supply is switched on, will charge the reservoir capacitor to the peak positive value of the AC wave, less the forward diode drop, and when the AC input at the anode of the diode drops below this value, the diode will cut off. From this moment until the next positive peak of the wave comes along, all the current that is supplied to the load is supplied from the reservoir capacitor, which is why it's called a reservoir! Far from just being a bypass for AC, the reservoir is the main store and supplier of DC to the load.

All the current that dribbles out from the capacitor results in the voltage across the capacitor dropping as its charge is drained, so that the diode has to supply charge again next time it conducts. You don't get something for nothing — the diode passes large currents for short time intervals instead of conducting steadily over a half-cycle as it did when no reservoir was used. The overall result is that the diode has to be able to pass peak currents that are many times greater than the average current, it spends most of its time cut off, the maximum reverse voltage across the diode is twice the AC peak voltage (see Fig. 3), and there is a 'ripple' on the output wave which is caused by the drop in votage as the reservoir capacitor discharges (Fig. 4). The waveform of this ripple is a sawtooth, rich in harmonics, not simply a piece of left-over sine wave as some explanations would hint at, so that it is a potent source of hum interference in the rest of the circuit.

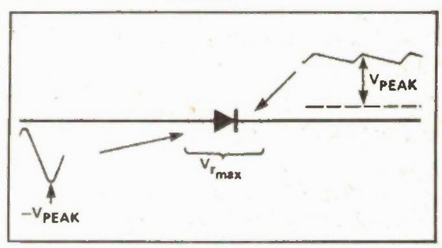


Fig. 3 This shows why the peak reverse voltage on the diode is doubled when a reservoir capacitor is used.

The approximate amplitude (peak to peak) of the ripple is given by It/C, where I is the average current drawn by the load, C is the size of reservoir capacitor, and t is the time between positive wavepeaks. Using units of milliamps for I, microfarads for C and milliseconds for t, we get units of volts for the amplitude of ripple. For example, if you draw 100mA from a 100uF capacitor with a half-wave rectifier for which t is about 20 mS, then the ripple amplitude is (100 x 20)/1000, or 2 V, which isn't exactly negligible. Using a full-wave rectifier, which recharges the capacitor at 10 mS intervals, you get a 1 V ripple. This formula *isn't* foolproof — it applies only when you have the situation

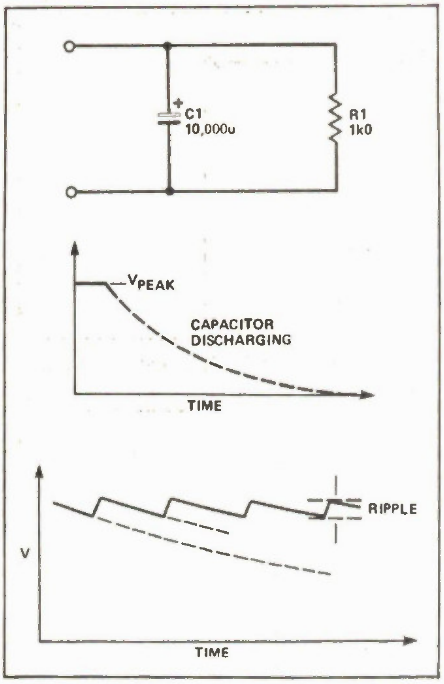


Fig. 4 The waveform of ripple, caused by the time constant of the reservoir capacitor and load resistance.

in hand, and will give silly answers if the reservoir capacitor is much too small or if the amplitude of the AC input is very small, but it's a good guide to realistic values for power supplies generally.

The voltage output of the circuit with no load current is equal to the AC peak voltage, but as the load current increases, the ripple also increases and the average DC output drops until it can become almost as low as the value you would get with no reservoir, $0.32E_0$ for half-wave, and twice as much as for full-wave (bridge or split-secondary type of circuit). Figure 5 summarises the operating conditions for different rectifier configurations. Ripple, and the drop of output voltage when output load current is taken, can be minimised by increasing the size of the reservoir capacitor. Obviously, it is also an advantage to have a short time between recharging the reservoir, so that high-frequency supplies need less in the way of reservoir capacitance — one of the many reasons for the popularity of switch mode power supplies these days.

A Stable Situation

Another defensive measure is stabilisation. Stabilisation does not mean that some circuit is used which will miraculously bump up the voltage output from the reservoir capacitor, it simply means making the best of what you have. Suppose you have a nominal 8V supply, and that at the full planned output current of 150mA it can have a 2V peak-to-peak ripple. This value implies that the voltage will drop momentarily as low as 6V twice on each

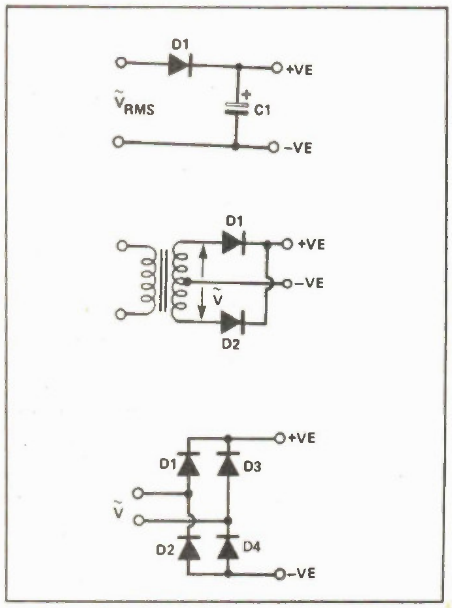


Fig. 5 A summary of the conditions for common power supply configurations.

AC cycle, assuming that full-wave rectification is used, so that if we use only 5V of this supply, these changes caused by ripple will not affect the 5V output at all. This is the action of a stabiliser — it's a circuit which is a voltage-dropper, but arranged so that the drop is variable, keeping the output voltage constant while the input voltage varies.

A stabiliser has to operate so as to fulfil two requirements. First it must keep its output voltage constant as the input voltage varies, the second, it must keep the output voltage constant as the load current varies. The two may sound identical at first glance, but they are not — the first calls for the output to be constant while the voltage across the stabiliser is varying, the second calls for the combination of the stabiliser and the rest of the power pack to have almost zero internal resistance.

Figure 6 shows a very basic form of stabiliser. The voltage at the output is set by the value of the zener diode, and because of the voltage across the base-emitter of a transistor, the output voltage will be around 0V6 less than the zener diode voltage. This should ensure that the voltage of the output is stabilised against changes at the input to some extent as the load current increases. Nevertheless the stabilisation is better than it would be in the absence of the circuit (something wrong if it were not!), and can be improved by amplifying the signal to the base of the regulator transistor — a variation on the circuit is shown in Fig. 7. The output voltage is compared with zener voltage, and the ouput of the comparator is used to control the base of the regulator transistor. Very low output resistance of the order of a few milliohms can be obtained using circuits of this type.

I've drawn the circuit as a block diagram because it isn't very often nowdays that we have to build stabilisers with separate components. The reason, of course, is the ready availability of IC regulators, particularly the 78 series.

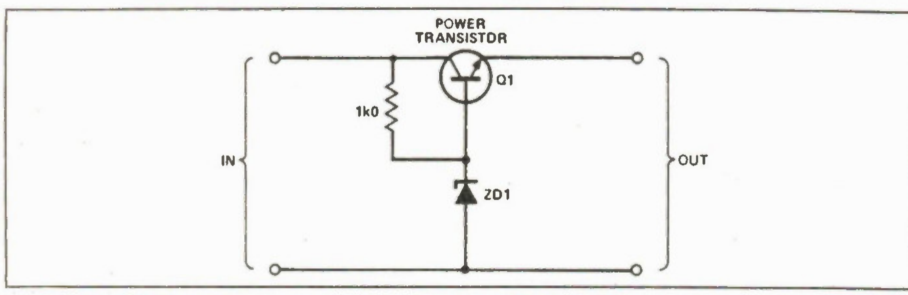


Fig. 6 An elementary stabiliser — the power transistor in this example would be a medium-power type with a high value of h_{fe}.

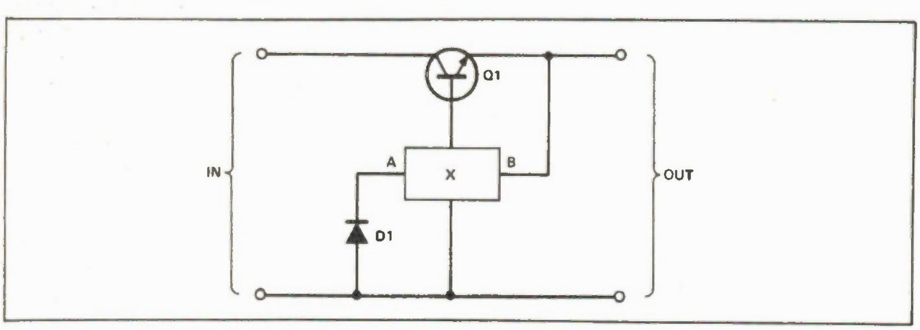


Fig. 7 A block diagram of the comparator type of power supply stabiliser. This type is rarely built nowadays because of the ready availability of IC equivalents.

These take advantage of being ICs (so that circuit complications are not a problem for production, only for design) to incorporate features such as current foldback, meaning that the current will be regulated if there is any risk of over-dissipation. This should prevent overload and give these regulators a very long life — I say should because in my experience these regulators fail quite frequently and I suspect that the fold-back arrangements are not always completely effective.

The 78 series covers most of the 'popular' supply voltages, but if we should want an odd value then a modification to the circuitry, as shown in Fig. 8 can do the trick. Similarly, if we want a lot more current from the output than the normal 78 series can supply, then we can use the IC to control an external transistor, as shown in Fig. 9. Circuits like these can cope with about 99 per cent of our needs.

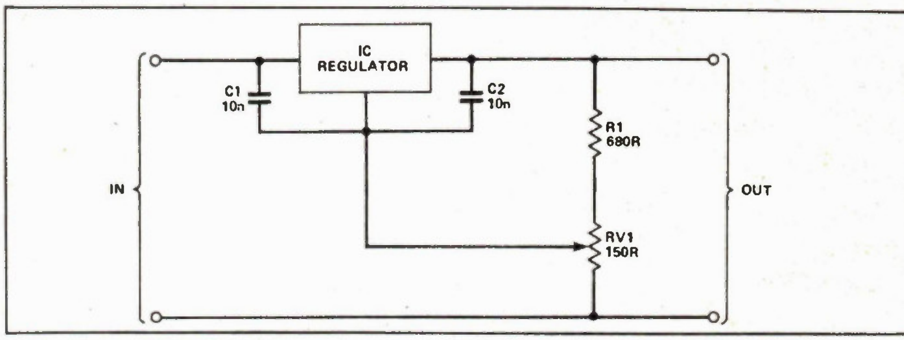


Fig. 8 Varying the output voltage of an IC stabliser. A variable resistor is illustrated, but a fixed value resistor could be used once the correct value has been established.

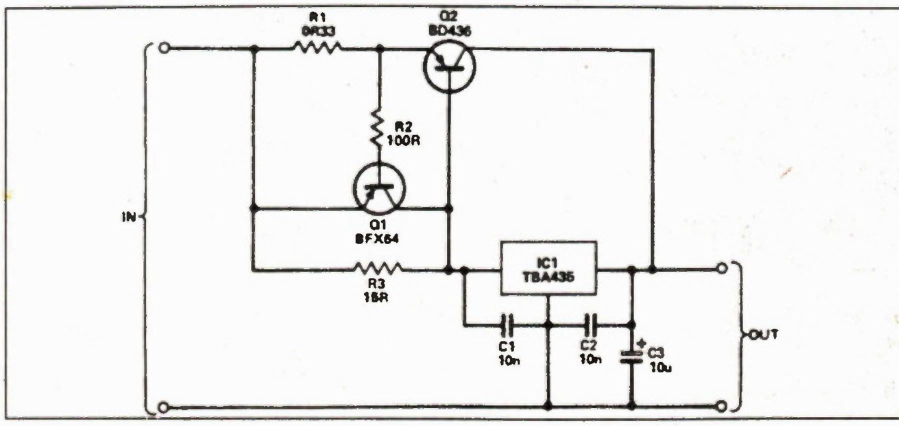


Fig. 9 Increasing the current-handling capability of an IC stabiliser. The stabiliser handles the rated current, and any amount beyond this value is handled by the auxiliary transistor circuit, preserving voltage stability.

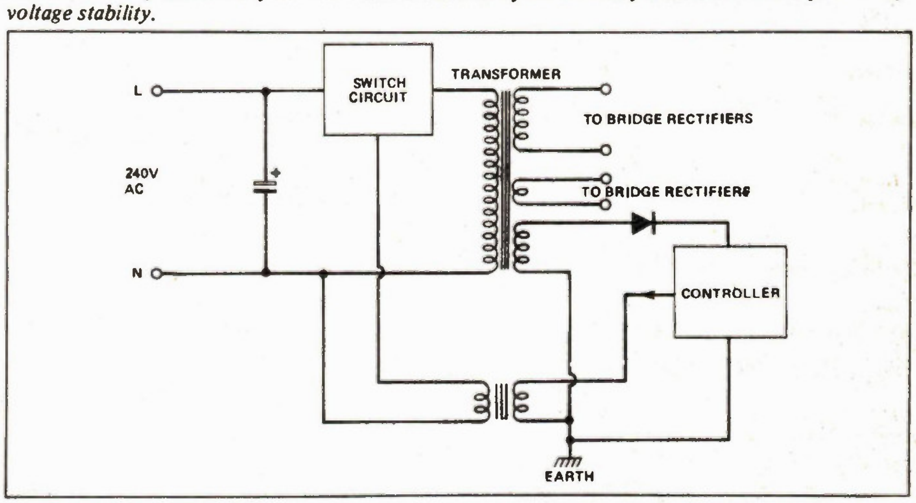


Fig. 10 An outline of a switched mode power supply. No values are shown, because the transformer is a critical component and the other circuitry can be obtained in IC form.

Switching The Subject

Having mentioned switch mode power supplies, however, I feel I should explain further because, unless you follow the development of TV circuitry, you may not have come across details of them (though a switch mode supply was used in the venerable Apple 2 computer, and a switch mode supply is now used in the BBC computer after early users complained that the old version burned the varnish off their tables). Basically the principle is to dispense with a mains transformer, and rectify the mains voltage so as to produce a high voltage DC. By dispensing with the resistance of a mains transformer, and by using a reservoir capacitor of surprisingly modest capacitance (but rated for 500 V!), this supply, voltage can be very stable. It is then applied to a switching circuit which charges a capacitor several thousand times per second and discharges it just as frequently into the primary of a transformer which, because it operates with high-frequency signals, can be small and well-insulated. The outputs of this transformer are rectified, and need only small reservoir capacitances because of the high frequency that is used. There is no need for a stabliser of the old-fashioned wasteful type either, because the output voltage can be sampled by a comparator, and the output of the comparator used to alter the switching times. The idea is that if the output voltage drops, the switch can spend more time passing current into the primary of the transformer; if the output voltage is too high, the switching circuits cut off earlier. There is no waste involved — what is not used is held in the reservoir capacitor ready for the next switching operation.

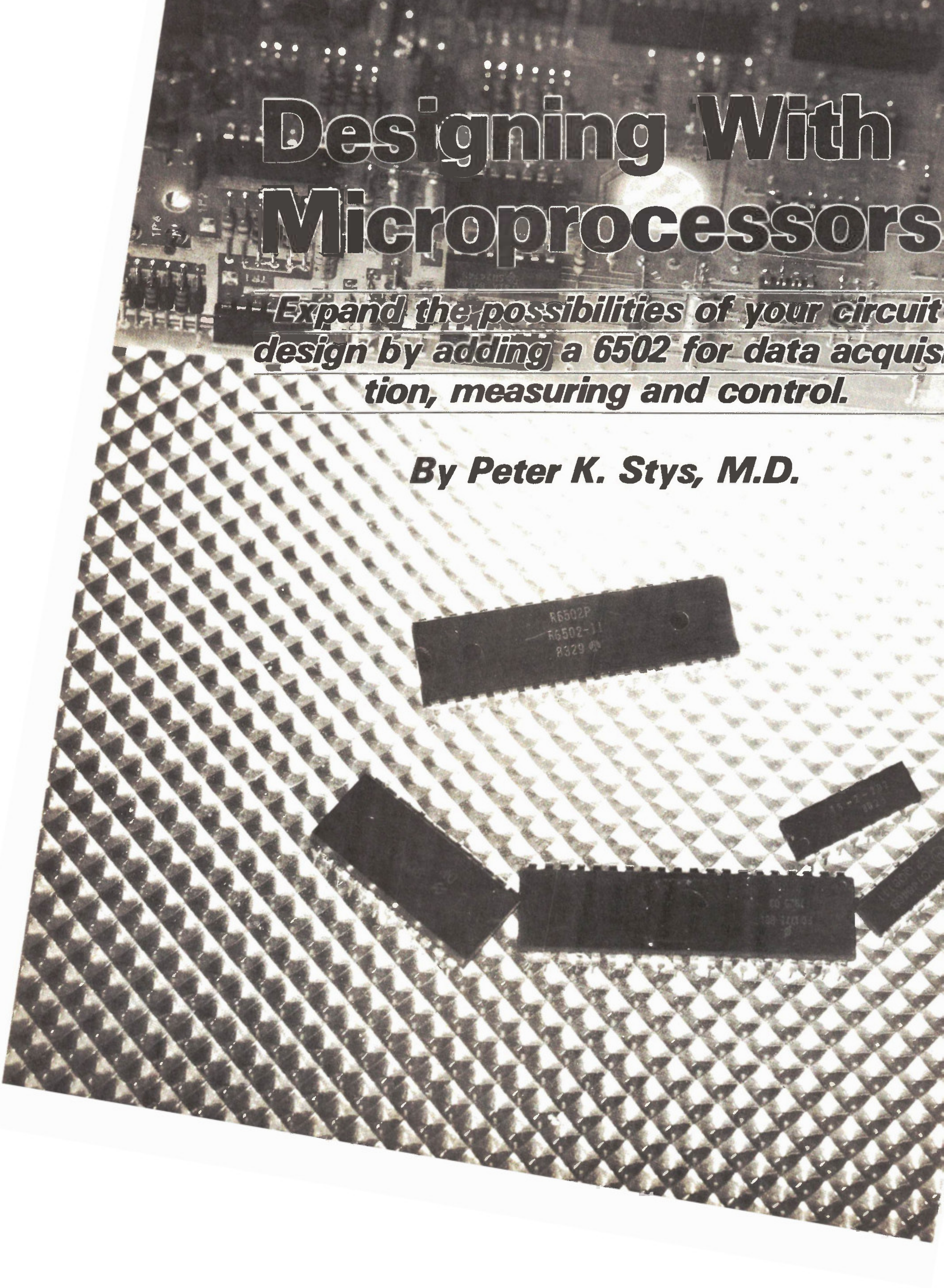
The main advantage is that the supply runs astonishingly cool, with no huge heatsinks needed for the regulator. The advantages for TVs and computers are obvious — I remember one computer which left scorch marks and which could have served as a toaster. Another advantage is that no AC voltage adjuster is needed — whatever the mains voltage happens to be will be compensated for by the switching process, and there are ICs which will take care of the whole operation.

One point of caution concerns servicing. If you are working on switch mode power supply, remember that it uses high voltages, and that part of the circuit is always live to the mains when it is operating. On many TV receivers, in accordance with the belief that a good designer will make the inside of a TV as dangerous as possible in order to kill off amateur mechanics, the whole chassis is live or at least not isolated from the line. The growing trend to make TVs in monitor form so that they can be connected directly to video recorders instead of by the ridiculous method of remodulating the signal may at last bring us electrically into line with the rest of the world in this respect. ■

Designing With Microprocessors

Expand the possibilities of your circuit design by adding a 6502 for data acquisition, measuring and control.

By Peter K. Stys, M.D.



IN this world of powerful 16 and 32-bit microprocessors, one might wonder what the future holds for their primitive 8-bit predecessors. The outlook isn't necessarily hopeless. Although clearly out-matched as far as brute computing power is concerned, owing to their relative simplicity, the trusted 8-bit CPUs are ideally suited for a very important role: real-world interfacing, including data acquisition, control and the ability to make "smart" decisions as sampled real-world data changes. Furthermore, what makes a microprocessor-based circuit so versatile is that its function can be altered by modifying the control program in ROM, with few, if any, accompanying hardware changes.

This article describes both the hardware and software design of a simple, "universal" microcomputer that can be easily incorporated into any instrument or circuit, giving it the ability to intelligently control its environment, sample information and communicate this data with a host computer for further analysis. The applications are limited only by your imagination.

Design Considerations

In designing the microcomputer, the most important features are generality and universality; in essence a workhorse, completely application-independent. At the heart is, of course, an 8-bit CPU. In anticipation of many channels of data and control, up to 16 input and 16 output lines are provided. Flexibility of design enables you to configure your system with as many or as few I/O lines as required, optimizing cost and chip count. A hardware counter is included for high-speed operations in those cases where software loops would be too slow. The 128 bytes of RAM is enough for most applications, especially when a serial link is established with a host machine. Finally, two kilobytes of EPROM holds the monitor software routines. Again, the circuit can be configured as minimally or as fully as is necessary.

Hardware

The CPU chosen was the 6502. It is relatively fast, cheap and easy to program due to its simple architecture. Furthermore, since all assembly language programs were developed on an Apple II (also 6502 based) most routines can be debugged while running on the Apple, with the help of the many development/debugging aids available. The software aspect will be discussed in detail in a later section.

Fig. 1 shows the schematic for a 1 MHz crystal clock (IC1a-c), the 6502 CPU (IC2) and a 74LS138 address line decoder (IC3). IC3 decodes the three most significant address lines into eight active low signals used to select one of eight devices. Only five of the eight lines are used in this circuit. **Fig. 2** shows the circuit for a two bit control/communications port (IC4), the 2K static RAM (IC5) and the 2K EPROM (IC6). IC4 is a 74LS74 dual D flip-flop configured as a two bit output port: the most significant bit (IC4b), bit 7 of the data bus, is the transmit line for sending serial data to the host computer. The least significant bit (IC4a), bit 0, is the MODE bit and serves a special function. Depending on its state, it will map either the EPROM (when MODE = 1) or the RAM (when MODE = 0) onto the uppermost 2 Kbytes of address space ($F800 — $FFFF). This describes the two modes of operation: the 'CONTROL' mode when the EPROM is enabled, allows basic housekeeping and communications to be performed, whereas the 'EXEC' mode forces the program present in RAM to be executed. The advantages of swapping memory in this manner will be discussed in the software section.

For a 1 MHz clock, both memory devices should have access times of 450 nS or faster. Any 2K static RAM can be used as long as it is logically similar to the one shown (most are). Note that an image of the 2K of RAM is always present at $D800 — $DFFF regardless of the state of the MODE bit. This enables routines in the EPROM to load the RAM with data from the host computer.

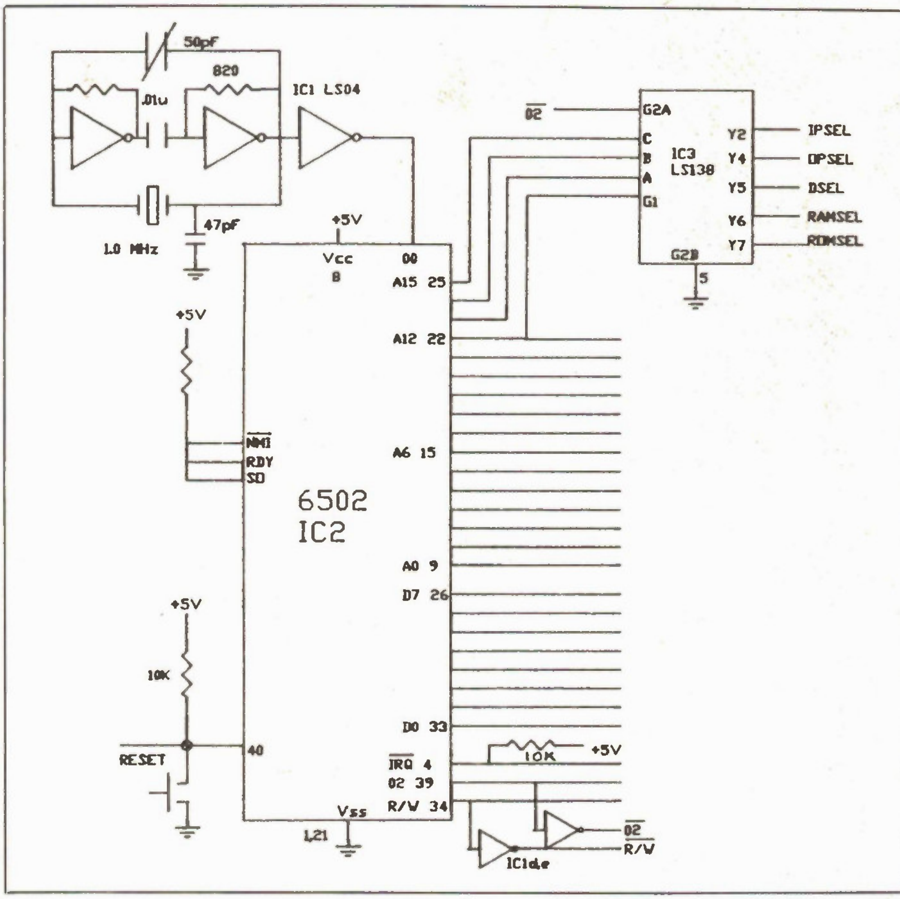


Fig. 1 The 6502, clock, and select circuitry.

Support Chips

As with any "chip family", there are a number of support chips available specifically designed to make interfacing a snap. **Fig. 3** shows the circuit diagram for interfacing the 6532 RAM, I/O and timer chip (RIOT for short). The reader is urged to consult the 6532 data sheet since a detailed description of its internal operation is beyond the scope of this article. The assembly language programmer should be thoroughly familiar with its inner workings in order to fully exploit the 6532's capabilities. Here is a brief description of the RIOT. It contains 128 bytes of on-chip static RAM enabled when the $\overline{RS}$ pin (tied to A9) is low. A0 — A6 then select one of the 128 RAM locations which occupy addresses $0000 — $007F. When $\overline{RS}$ is high, the I/O and timer are selected, and address lines A0 — A4 are used to program the various modes of operation.

Each of the sixteen I/O pins can be individually assigned as input or output. Interrupts can be generated either by the timer or from an external signal via a programmable edge-detect input (PA7). Note how simple it is to interface the RIOT to

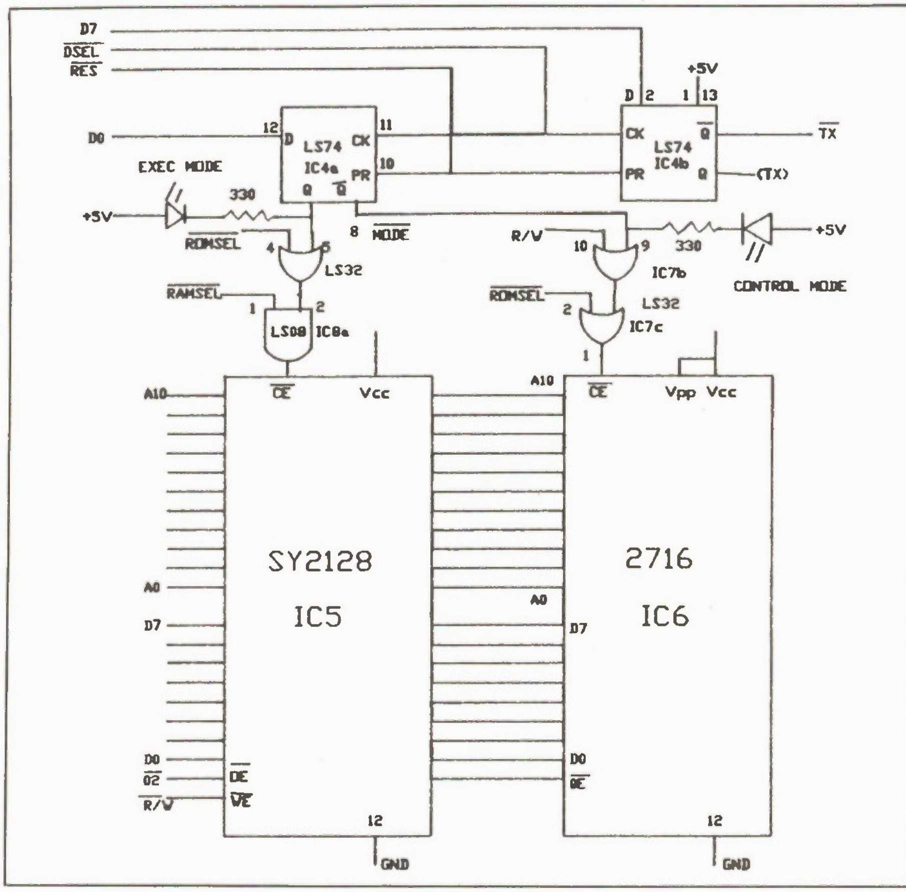


Fig. 2 The 2128 and EPROM circuitry.

the 6502; all corresponding control pins are simply tied together, with all necessary gating performed internally. The $\overline{IRQ}$ output from the RIOT is an open drain pin and therefore the 10k pull-up resistor is essential for proper operation. A pair of optional monostables (IC10) was added which flash two LED's each time the RIOT or the input port are addressed. This feature is most useful in the initial stages of development to monitor, at a glance, whether a new program is in the right ballpark or has gone haywire, as is all too often the case.

Just in passing, avoid using Y0 (74LS138 pin 15) to select the RIOT. Although it appears very tempting to tie this signal to $\overline{CS2}$, it would violate certain timing requirements and would prevent the RIOT from ever being enabled. Using A12 instead does not change the addressing and satisfies all the timing.

I/O Ports

Finally, another pair of input (IC11) and output (IC12) ports adds another sixteen peripheral I/O lines (**Fig. 4**). Bit 7 of the input port is reserved for receiving serial data from the host. The diode is needed to prevent the RS-232 signal from exceeding ⁵5 volts. The input diode within the 74LS04 inverter (IC1f) clamps the negative excursions to ground. Since most RS-232 drivers are inverting buffers, IC1f is needed to re-invert the signal to "normal" before reception. If your line is unbuffered and comes directly from a serial communications chip, you can omit the diode and inverter and feed the TTL compatible signal directly to pin 17 of IC11. This also applies to the transmitting latch, IC4b; if your serial board does not have an inverting receive buffer, then use the true output on IC4b (TX, pin 5) rather than the inverting one as shown in Fig. 2. Keep in mind that unbuffered signals cannot drive lines more than a meter or two in length at high baud rates.

By examining the circuit diagrams, you can see that extra logic was included to eliminate the possibility of signal conflicts should a fledgling program run amok (for example, IC7d prevents writing to input port IC11). Once the software is properly debugged, this protection becomes redundant and can be eliminated. The section on applications will show how the same circuit can be remarkably simplified, yet retain all the functions described. The next section considers the software which allows programs, developed on the host, to be loaded into the prototype and tested in their actual hardware environment.

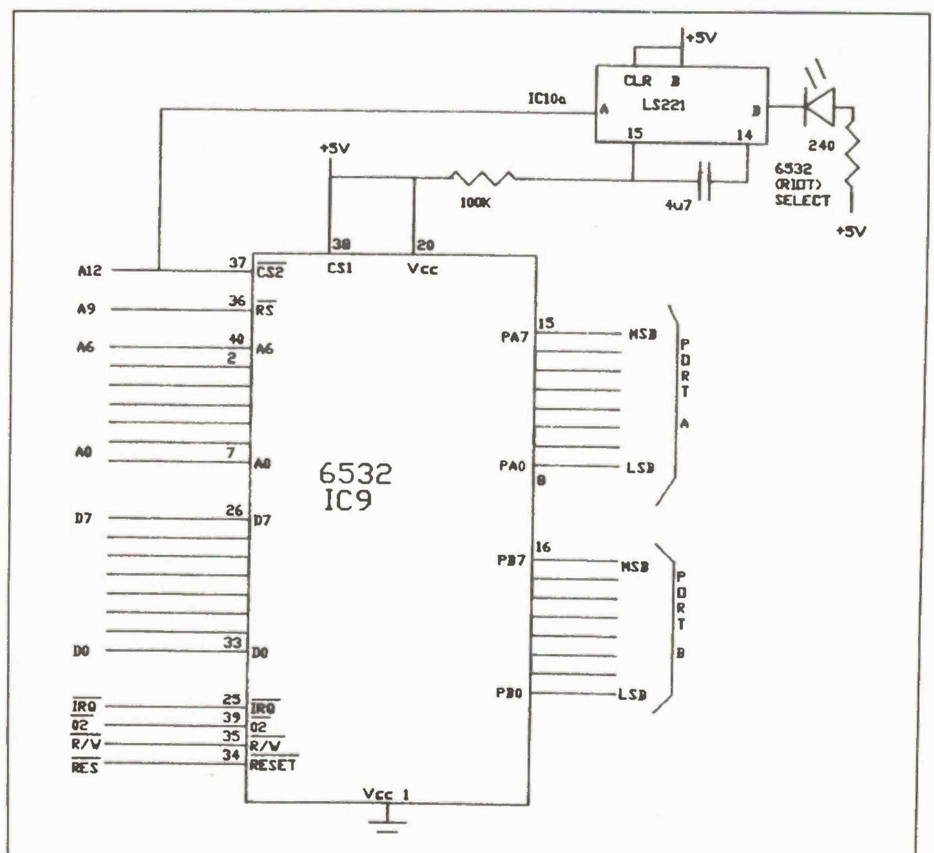


Fig. 3 The 6532 RAM, I/O, and Timing (RIOT) chip.

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Side One: Apple DOS files

Apple Binary Encryption and Apple Binary Decryption, with source files: Programs to keep peering eyes from your valuable data. See the article in the February 1985 issue of CN!.

Racquel.Pic: An Apple HiRes implementation of the CP/M teletype drawing offered in Almost Free Software Volume II.

HGR Dump: A BASIC editor that lets you preselect options before sending your HiRes picture to the printer. Written for a Dumpling-GX card, but easily modified.

HGR Invert: A fast binary program that displays the 'negative' of any HiRes picture in memory. BRUNning it again restores the picture.

Magfiler: A magazine article database in Applesoft BASIC. The February issue of CN! has already been entered to get you started.

Miniature Golf: A binary HiRes game of golf, with a truly wicked course. The sixth hole's a dandy.

Memtest: This short, two-sector binary program comes in handy when your Apple starts to hiccough. It writes and reads to memory from $0800 to $BFFF. Three passes and your RAM's in fine shape.

Forced Read, with source: A short binary program originally appearing in Electronics Today, this program has incredible error handling.

APCP/M: A handy utility for the Applesoft user who also dabbles in CP/M, this program will read a text file up to 16K in length from an Apple CP/M disk and write it to a DOS disk. Known affectionately as 'Reverse APDOS'.

DM II: From the Apple User Group of Sweden comes forth this DOS modifying program that allows you to change commands, error messages, catalog headers and volumes, and even fiddle with DOS entry points.

Star Patrol: An Applesoft implementation of the HiRes ADAM program appearing in the February edition of CN!. Your mission is to shoot elusive space bats.

Attenuators: An Applesoft BASIC program to aid calculating resistance and loss.

Capacitors: A similarly Applesoft BASIC program to help calculate capacitance and frequency response.

Side Two: IBM files

SD: An acronym for Sorted Directory, this program produces a more visually appealing directory than can be had from the MS-DOS DIR command.

FORTH: A small BASIC implementation of FORTH. You can expand the primitives or add new ones as they become necessary.

Datafile: Everyone needs a database manager. This one's written in Microsoft BASIC.

Blueterm, with source: A terminal program for the PC. Suggested hardware requirements include a modem...

Poker!: A BASIC program pitting you against your PC. Where's that straight flush when you need it?

Bandit: An alternative to that Las Vegas trip you've been planning. Appearing in the June issue of CN!, this BASIC program simulates a one-armed bandit.

CalcNOW!: A spreadsheet program written in BASIC. While very good at what it does, we don't expect Lotus to be nervous.

Cashacc: Written in BASIC, this is a cash acquisition and limited accounting package for the PC.

UnWS, with source: When you TYPE a WordStar file, you usually get garbage. This program strips the high bits from the WS file of your choice to make it legible again.

Note: Neither the Apple nor the IBM disk sides are bootable. Both Apple DOS 3.3 and MS-DOS are copyrighted disk operating systems, property of (respectively) Apple Computers Incorporated and Microsoft Corporation. In order to read the files on the Completely Free Software Disk, first boot a disk with either DOS 3.3 or MS-DOS on it, then either CATALOG or DIR the side that's relevant to your machine. From this point, you'll be able to run the applications programs, though it's suggested that you copy the files onto another disk.

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Software

The software needed to run the system can be divided into three logical blocks:

1) Main program
2) Machine language drivers
3) ROM-based monitor

The first two software blocks run on the host (an Apple II+ in the author's case), whereas the third is 'permanently' written into EPROM on the prototype.

The main program (block 1) is written in BASIC. It functions as a high level interface with the user, performing tasks such as fetching binary files from disk and transferring data to and from the prototyping micro. To perform the latter, it relies on a set of machine language subroutines (block 2) that drive the serial communications card. Each type of card will require a different set of drivers. Although very simple, it is important that these drivers supply the appropriate data at the appropriate times to satisfy the requirements of the last software block.

The third block consists of the machine language routines contained in EPROM on the prototype. These routines complement the host-resident software, permitting transfer of data between the two computers. Listing 1 illustrates the source code for these housekeeping routines. It was developed on an Apple II+ and assembled using Lazer Systems' LISA assembler. As mentioned above, Fig. 5 demonstrates the main logical sequence followed by the monitor program.

When the 6502 is RESET it fetches a RESET vector from $FFFC (low byte) and $FFFD (high byte) which in this case forces a jump to $F800. This is the main entry point to the program. The CPU is then initialized, including the setting of the stack pointer to $FF. The programmer must be aware of how the stack operates since it shares the 128 bytes of RAM with other data. By default, the stack on the 6502 is restricted to locations $0100 — $01FF. The effect of using A9 as the RAM Select (RS) signal (Fig. 3) and leaving A7-A8 open is to echo the first four 128-byte blocks of address space repeatedly over the range $0000 — $007F. Thus addresses $0000, $0080, $0100 and $0180 reference exactly the same physical memory location. By setting the stack pointer to $FF, the stack will begin at $01FF (equivalent to RAM location $007F) and grow down. The programmer must ensure that the stack does not grow into data placed near the start of memory.

After initializing the hardware, the program waits to receive a command byte, which is immediately echoed to ensure that the serial channel is functioning and that the correct command has been received. Four basic commands are implemented, with enough EPROM left for many more.

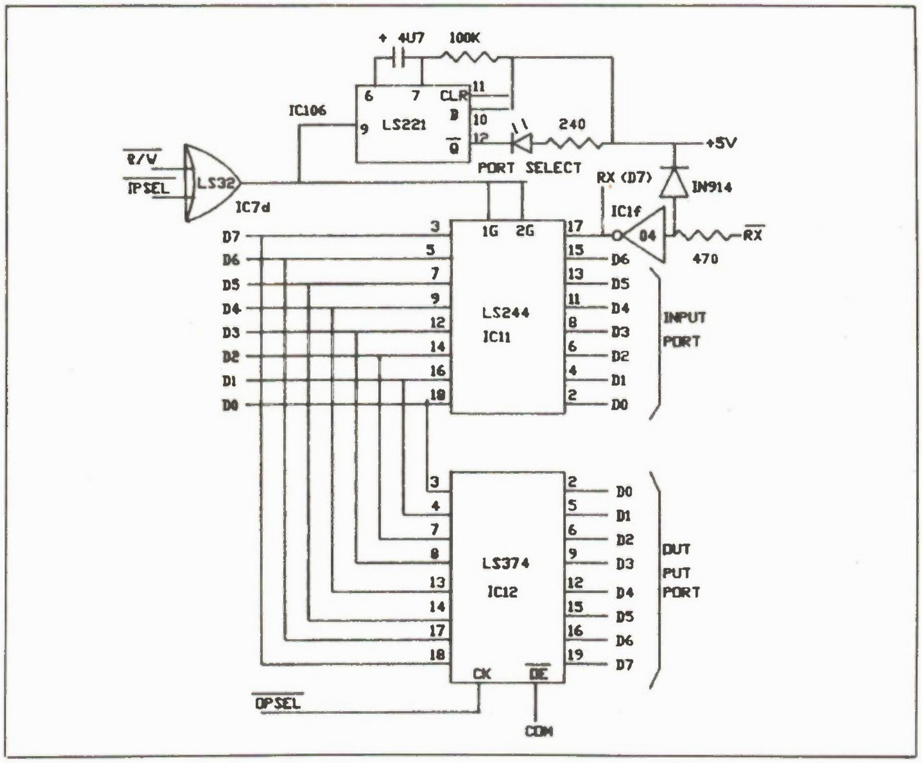

Fig. 4 Adding peripheral ports.

Subroutines

Subroutine 'RRAM' (command byte = $02) receives 2 kilobytes from the host and writes it to the 2K static RAM, after which it returns a checksum to ensure that all data was read correctly. Even though the new program is loaded at $D800 — $DFFF, it should be assembled to run at $F800 — $FFFF, just as it will appear in EPROM in the final circuit. This even applies to the RESET vector at $FFFC-D, that is, it should point to a memory location in the range $F800 — $FFFF and not $D800 — $DFFF. The RAM will be mapped onto the top 2K of memory before execution — this reduces the chances of error by eliminating the need to assemble one program during development at one address and the final version at a different address.

As the name suggests, subroutine 'EXEC' (command byte = $00) executes the new program loaded into RAM by 'RRAM'. 'EXEC' refers to the RESET vector to determine where to jump to begin execution — in effect it precisely simulates a hardware RESET in the final circuit. A software trick is used to map the RAM onto $F800 — $FFFF in place of the EPROM. Refer to listing 1 and follow the execution of the 'EXEC' subroutine (lines 194-212). First the object code for an indirect jump to $FFFC (the RESET vector) is written to RAM at $DFF7-9 (lines 202-207). The instruction at line 209 then switches the MODE bit to 'EXEC' which disables the EPROM, and maps the RAM in its place at $F800 — $FFFF. The CPU, ignorant of the fact that the 2K RAM has just been slipped in by the previous instruction, proceeds to execute the next one, which is the strategically placed indirect jump just described. This in turn directs program execution as per the RESET vector and the program in RAM is executed. Pressing the RESET switch restores the original state with the EPROM again occupying $F800-$FFFF (MODE bit set), and the monitor in control.

Subroutine 'SRIOT' (command byte = $04) transmits all 128 bytes of RAM from the 6532 RIOT chip. This is very useful for monitoring the accuracy of variables or data generated by a program during execution.

Finally, more useful as a hardware test than as a debugging tool, the 'OPTEST' subroutine (command byte = $06) will write to the output port (IC12) any byte that is subsequently received. An $FF terminates its execution.

Communications

The prototyping microcomputer communicates with the host via the serial channel made up of IC4b (transmit) and bit 7 of IC11 (receive). The baud rate is set by BAUDRT (line 26, listing 1); this in turn determines the counter for one full bit time, FULLBIT, which then equals 200,000 divided by BAUDRT for a 1 MHz clock (the extra step in line 27 is needed to avoid overflowing the assembler's variables). FULLBIT and HALFBIT are used by the receive and transmit subroutines, RX and TX8, to generate the proper timing through software. The serial port on the host must be initialized to one start bit, two stop bits, no parity bits and a baud rate of 9600. At this speed, the entire 2K can be transferred in about two seconds. I use a serial board with a 2661 communications interface chip from Signetics, but any serial IC will do provided you write the necessary software routines to drive it.

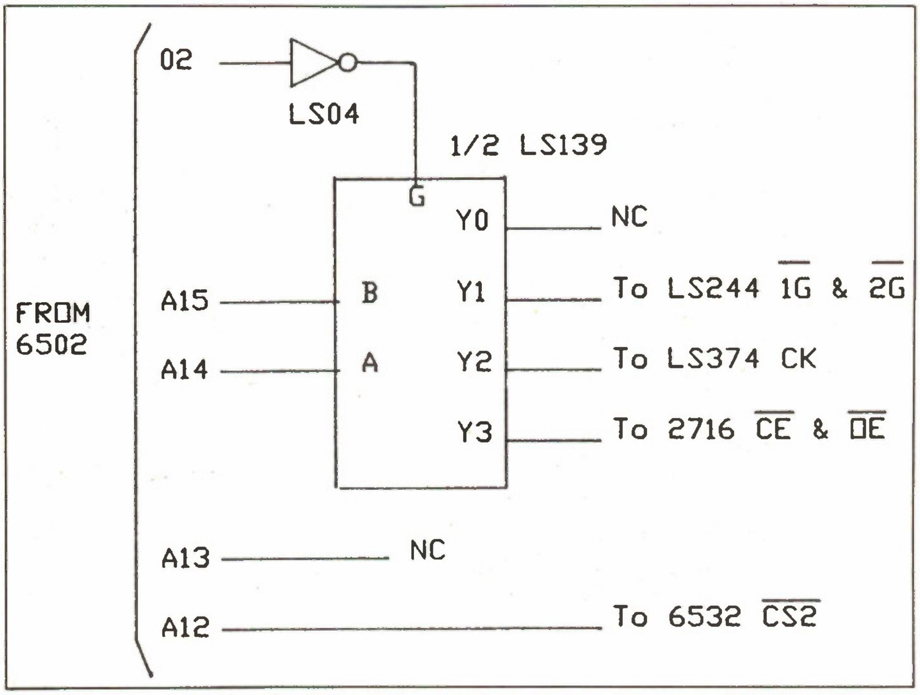

Fig. 5 The two-to-four line decoder.

Applications

The circuit illustrated in Fig. 1 through 4 was specifically designed for developing and troubleshooting new programs. Hardware provisions guard against signal conflicts and perform bank switching and simple monitoring of device access using LED's.

Once a program is debugged, however, this extra logic becomes superfluous. **Fig. 5** shows how the same address decoding can be performed with only a single 2-to-4-line decoder (half of a 74LS139). The new enabling signals are generated as shown. All other pins are wired exactly as before. This scheme supports the four original devices described: the 2716 EPROM, the 6532 RIOT, an input port (74LS244) and an output port (74LS374). The 2K RAM is no longer included since its only function was to hold test versions of the program under development. Once debugged, the final version is stored in the EPROM. Note that all device addresses remain unchanged — if your program ran correctly during development, it will run in the final circuit. If you do not need the extra I/O ports, then simply leave them out, or connect different devices in their place. For example, a high speed analog-to-digital (A/D) converter might replace the input port and you can wire a 2K static RAM in place of the output port (connect enable signal Y2 from the 74LS139 to the CE pin on the RAM). The RAM can be used as a high speed buffer for readings obtained from the A/D converter, which can later be transmitted to the host at a lower rate.

The microcomputer is now simple enough that it can be incorporated quite easily into virtually any piece of equipment. I recently designed a timer/counter for research in neurobiology. The counting is done by a dedicated IC, whereas the microcomputer performs tasks such as scanning all front panel switches and enabling the appropriate functions on the counter IC, status indication, decimal point adjustment and autoranging, as well as compiling the display and transmitting the reading in ASCII format to a computer. The latter task alone would require considerably more circuitry than the entire dedicated microcomputer. In the near future, the same micro will be part of a "smart" intruder detector, monitoring remote sensors, analyzing signals from a microwave motion detector, and so on.

Conclusion

This article describes the hardware and software aspects of a simple, "universal" microcomputer that can easily be incorporated into any circuit or device. It was by no means intended as a "build your own microcomputer" project. Instead it presupposes that the reader is involved in the development or use of other devices, whose efficacy and flexibility can be greatly enhanced by the addition of a dedicated microprocessor.

Dr Peter Stys is presently training in clinical neurology at the Toronto Western Hospital. He is especially interested in the application of computer technology to the neurosciences.

Optional Software Package

For those readers who do not wish to type in the code, or do not have the facilities to burn the EPROM, Polytek Research has agreed to supply the following package:

An Apple DOS 3.3 disk containing the source textfile, assembled binary file and BASIC main program to run on the Apple II or IIe. All software is fully documented on disk and is unprotected to encourage the user to create his own additions.

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■

The Art of the State

An examination of the effects of the electronic revolution on modern society, with particular attention given to miniaturization and the Hostess DingDong.

E. Penn, left, visits the Electronics Today editorial offices with his brothers, Edgar and Johann.

HEY, they gave me a whole page to do an editorial and I'm not even an editor. Talk about the electronic revolution, they said. I didn't even know there was one, not so's you'd notice; nobody got me out of bed or anything, shouting that it's all arrived and I'm better come downstairs and have a look at it.

What happened, I guess, is that a whole big bunch of stuff crept over us ever since Mr. Edison threw the switch and now we're so used to it all that it isn't any kind of revolution; it's more like a great huge pile of doodahs that sort of work. Not even the microchip was a revolution. They went around my neighbourhood banging on doors and yelling 'Thirty thousand transistors on a chip! Repent ye! The end is nigh!' and so forth.

Nahhh. Listen, on my birthday I got a card with a microchip and piezo-thing in it, and it cost less than ten bucks retail, and I opened it up and it started to play 'Silent Night'. Now that's high-tech for you.

A friend of mine bought a car with a microchip in it that talked at you and told you there wasn't any gas left and stuff like that, and being a computer whiz, he reprogrammed it to say 'Hey you on the right! Your fly's open!' but when he went out on dates there was no return engagement, as you can imagine.

Computers, too. Same thing. They told us that if we didn't buy a computer we'd be out of a job with the kids starving and everybody pointing at us and smirking because we didn't know how to program in assembler, but like, they sort of overdid it and got too desperate, you know? The other day I saw a computer executive sitting at the corner of Yonge and Dundas with a pile of Adams and a tin cup.

So the problem is not that we can't *make* things real cute and small, it's that we don't know what to *do* with them. Must be a lot of people out there with computers slung in the closet with the old shoes and the skateboard.

But it gets worse than that. Because we're swamped with gadgets all the time, and we're used to all the guff that the Public Relations people sling at us, we accept just about anything, at least for a while. Gadgets get whipped onto the market as soon as they look as if they might work, and nobody in the design department even understands what "user-friendly' means, and that's not just for the computer people, either. I have a wire shelf in the kitchen and it tilts out from the wall at an angle and things fall off it because the yoyo who designed it didn't allow room for the mounting screws. My car has a wealth of features that make you uncomfortable, pained, or injured when you push, pull, or turn the knobs.

I know what the excuse will be, yes sir. They're gonna say: 'We are turning out the highest possible quality consistent with a mass-market price structure. Our manufacturing methods, allowing for the limitations of price and mass productions, are second to none.'

Yo de do. My vacuum cleaner is a canister type with three tiny little wheels mounted close together and if they hit a piece of lint the whole thing tips over and spills the attachments out of the accessory tray and it's because somebody tried to work around the Law of Gravity and Mr. Newton already said that you can't do that.

It doesn't cost money to fix these things. It only takes time and care. Nobody has time. Nobody cares. Except....

Ta da!!! Enter the Oriental countries. They took a look at their export trade which used to consist of trinkets and souvenirs and wondered how they could improve things, and they improved things by taking cars and stereos and cameras and vacuum cleaners and taking out all the dumb, annoying features put there by arrogant designers over here and then put in some small changes to make the thing easy to use and soothing to the temperament.

Someday we may be out of coal and wood and they'll have all the well-designed thingmees and we'll have nothing to offer them.

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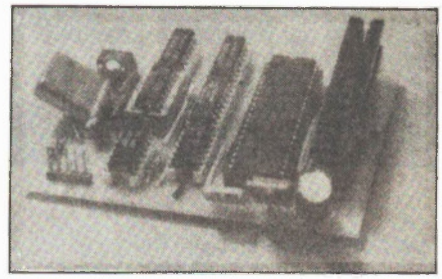
ZX81 RS232



A project that will let your ZX81 or Timex 1000 communicate with serial printers or other equipment.

By Peter Moore

THIS RS232 interface provides a wide range of software programmable baud rates and a true positive/negative swing at its output. The facility is provided for a "ready" signal from external equipment to be read by the computer and the interface provides its own ready signal for external equipment. The interface plugs into the rear edge connector of your ZX81.

Construction

All the components used in this project are mounted on the PCB. There are 15 links to be made on the PCB, not counting the pads marked A, B, and C. These pads are used to select either an active high (logic 1) or an active low (logic 0) ready signal from the RS232 interface; if you link A to C the ready out signal will be active high, and linking A to B will select an active low signal.

Solder the remaining 15 links in position; note that three of these are located beneath ICs 1, 2, and 3; you may wish to solder these on the copper side using insulated wire.

Next insert and solder the two diodes D1 and D2 and Zener diodes ZD1 and ZD2, making sure they're the right way around. Solder resistors R1, 2 and 3.

Now insert and solder the IC sockets one at a time taking care to ensure that all pins are soldered and there are no solder bridges.

Solder IC9 in position taking care to mount it with the flat, all-metal side facing the nearest edge of the PCB. Insert and solder capacitors C1 to C6; C3, 4 and 5 are electrolytics and must be in the right way around. Insert and solder crystal X1 and socket SK2.

Finally, insert the edge connector and solder it, leaving a gap of 5 mm between the body of the connector and the PCB surface.

Before inserting ICs, make a final check of the soldered joints, making sure there are no bridges. Insert the ICs, checking that they're in the right way around and that there are no pins bent underneath.

Pin	Function
1	'Ready' line input
2	'Ready' line output
3	0V/GND
4	Serial output (TX)
5	Serial input (RX)

Table 1. Connections to SK2.

Programming

The RS232 interface provides software control over the transmission/reception baud rate, the number of data bits per character and the number of stop bits. Programming is accomplished by means of a data byte written to the board's logic port (see table 2). A logic 1 in bit 7 (TSB) will select two stop bits, while logic 0 will select one stop bit.

NB1 and NB2 select the number of data bits per character (see Table 3). Where the number of data bits per character is five and the number of stop bits selected is two, 1 1/2 stop bits will be appended. To select, for example, two stop bits, eight bits data at 1200 baud: 1111 1011 = 251. D4 is unused and can be either 0 or 1.

Three bits read from the interface's status port indicate the current state of the UART and the equipment it is communicating with by means of the ready line. DAV is the UART Data Available flag; this will be logic 1 when data (which has not yet been read by the computer) has been received by the UART. DAV connects to data bus line D0 during status read operations.

TBMT is the UART **transmitter buffer empty** flag and is at logic 1 when the UART can receive further data for transmission. TBMT is connected to D7 during status read operations.

The ready line (RDY IN) indicates the state of the devices with which the RS232 is communicating; depending on the piece of equipment, RDY will be either 1 or 0 when further data can be transmitted. RDY connects to D6 during read operations.

Programming

Since the ZX81/Timex 1000 has no IN and OUT commands, three short machine code routines are used. Before being used to transmit data, the UART should be read (to reset DAV if necessary and also the ready output line) and the required baud rate number of data bits per character and number of stop bits should be written to the status port, e.g.:

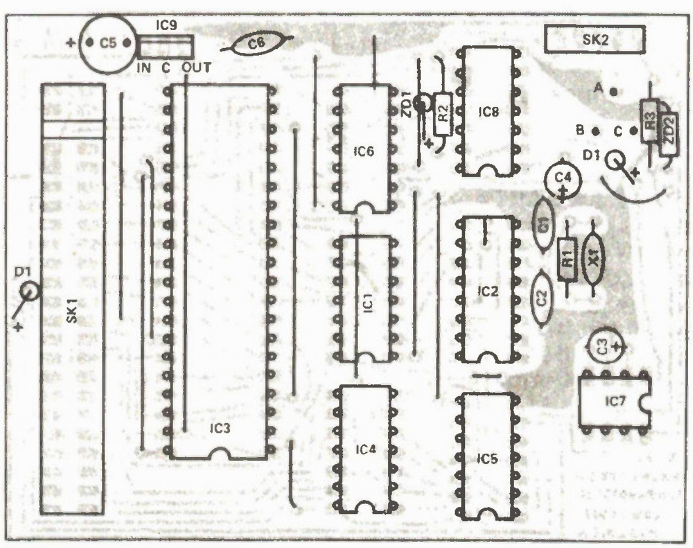
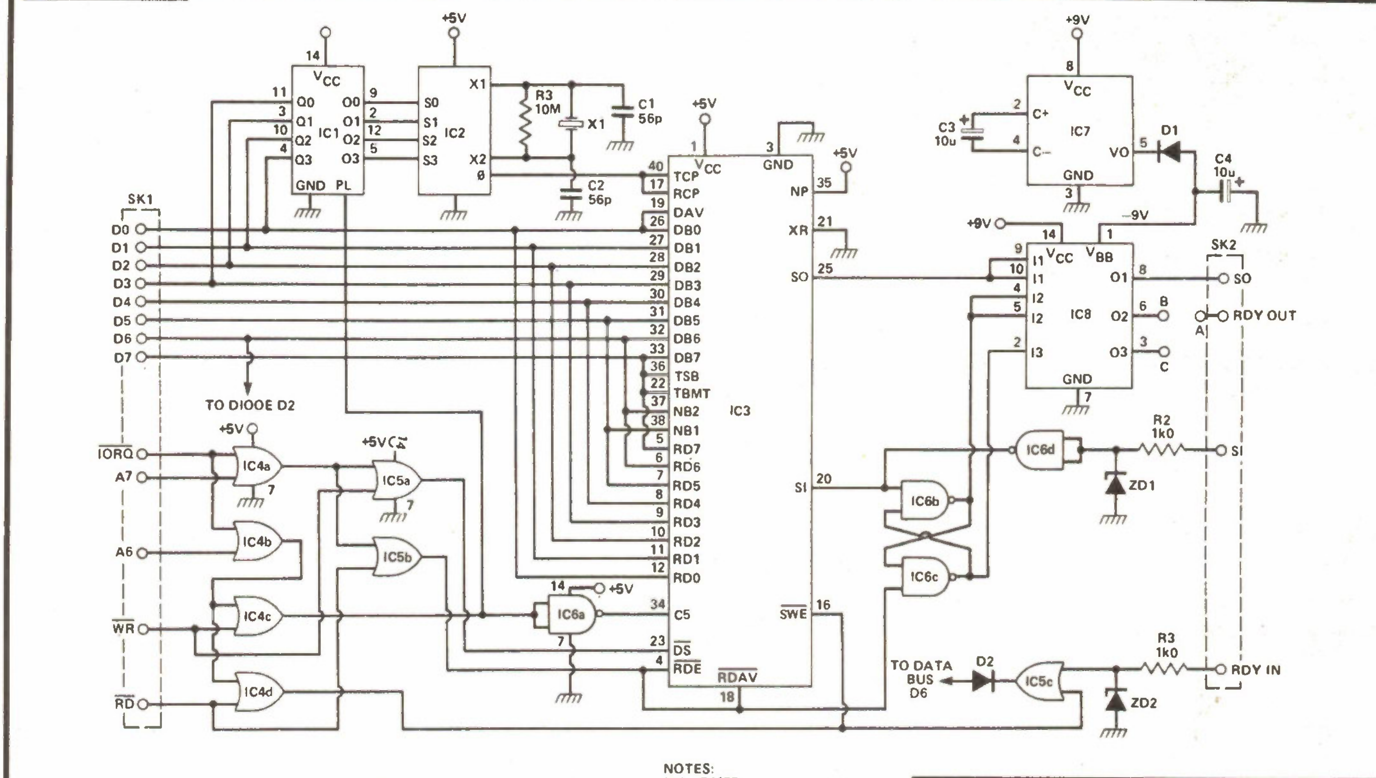
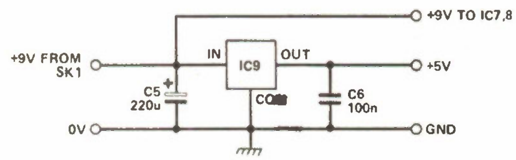


Figure 1. Overlay diagram of the interface board.

HOW IT WORKS





NOTES:
IC1 = 74177
IC2 = 4702B
IC3 = AY-3-1015
IC4,5 = 74LS32
IC6 = 74LS00
IC7 = 7660
IC8 = 1488
IC9 = 7805
D1,2 = 1N4148
ZD1,2 = BZY88C4V7
X1 = 2.4576 MHz XTAL

Figure 3. ZX81 BASIC machine code subroutine with a program to get it into the memory. If RDY is active low, data for 16536 should be 191.

IC3 is an AY-3-1015 UART (Universal Asynchronous Receiver Transmitter). It is designed to interface serial to parallel and vice versa.

IC3 consists of two main sections: a transmitter which converts parallel data into serial, adds start and stop bits and transmits from its serial output, and a receiver which converts data appearing at the serial input into parallel.

The UART requires a clock rate 16 times faster than the baud rate. IC2 is a programmable baud rate generator which, in conjunction with crystal X1, R2, C1 and C2, supplies a range of software controlled baud rates.

UART flag TBMT (Transmitter Buffer Empty) is at logic 1 when the UART can receive further data. The state of TBMT and the ready input line RDY (for transmitting) and DAV (data available) for receiving data are read into the computer by a read from the status port (A6 = 0).

When such a read is made, the output of IC4d is taken to logic 0; this line is taken to IC5c whose output is an open collector connected to D6. IC5c then communicates the current state of the ready input to the computer data bus.

Data to be transmitted in serial form is latched into IC3 by DS being strobed to logic 0. When IORQ, A7 and WR are at logic 0, DS will be taken low, latching the data into the UART. The UART converts this to serial form, adding start and stop bits (no parity - NP is connected to Vcc) and outputs it to the SO line.

IC8 is an RS232 line driver which inverts the serial data, providing positive 9V for a logic 0 and negative 9V for a logic 1. IC7 is a voltage converter IC powered from the positive 9V computer unregulated supply and produces a negative voltage at its output.

Serial data appearing at the input is clipped to TTL levels by ZD1 and R2. The start bit a this point is a logic 0; data arriving at the UART serial input resets the latch formed by IC6b and c to indicate a "not ready" state to the transmitting equipment. When data is read from the UART (by taking RDE, Read Data Enable, to logic 0) this latch is set once again, indicating "ready". Both outputs of the latch are made available to provide a choice of either active high or active low indication, selected by means of a wire link on the PCB.

```
1000 REM Spectrum subroutines - input data
1010 PAUSE 1: LET a=IN 65471: IF a/2=INT (a/2) THEN GO TO 1010:
REM loop if DAV=0
1020 PAUSE 1: LET a=IN 65407: RETURN
1030 REM Outputting data
1040 PAUSE 1: LET a=IN 65471: IF a<192 THEN GO TO 1040: REM loop
 if RDY or TBMT =0
1050 OUT 65437,n: RETURN


1035 REM Alternative line 1040
1040 PAUSE 1: LET a=IN 65471: IF a<128 OR a>191 THEN GO TO 1040
```

Figure 2 ZX81 BASIC machine code subroutine with a program to get it into the memory. If RDY is active low, data for 16536 should be 191.

D7	D6	D5	D4	D3	D2	D1	D0
TSB	NB2	NB1	not used	Baud rate selected			

Table 2. Significance of bits used to program the interface.

NB2	NB1	Bits/char
0	0	5
0	1	6
1	0	7
1	1	8

Table 3. NB1 and NB2 programming. Note that the Bits/Char figure excludes stop and start bits.

D3	D2	D1	D0	Baud rate
0	0	1	0	50
0	0	1	1	75
1	1	1	1	110
0	1	0	0	134.5
1	1	1	0	150
0	1	0	1	200
1	1	0	1	300
0	1	1	0	600
1	0	1	1	1200
1	0	1	0	1800
0	1	1	1	2400
1	0	0	1	4800
1	0	0	0	9600

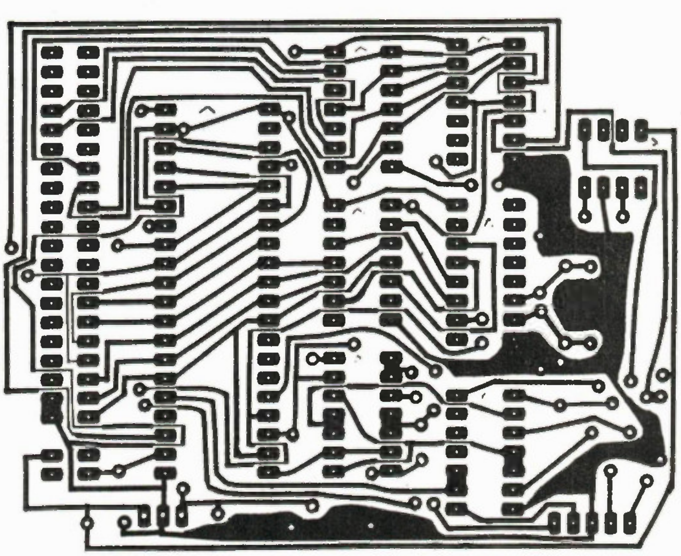
```
1       REM xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx (reserve
                                                   37 bytes)
1ø      FOR F = 16514 TO 1655ø
15      PRINT F ,
2ø      INPUT N
25      PRINT N
3ø      POKE F , N
35      NEXT F

16514   1     LD BC,nn      Entry point for data input
16515   191   c             status port
16516   1     b
16517   237   In r , (c)
16518   12ø   r = A
16519   2ø3   Bit b,r
1652ø   71    b=Dø, r=A
16521   2øø   RET Z
16522   5     DEC B
16523   14    LD C,n
16524   127   data port
16525   237   In r,(c)
16526   72    r=C
16527   2ø1   RET
16528   1     LD BC,nn      Entry point for data output
16529   191   c             status port
1653ø   1     b
16531   237   In r,(c)
16532   12ø   r=A
16533   246   OR,n
16534   63    n             mask
16535   254   CP,n
16536   255   n             test for TBMT = Rdy = 1
16537   192   RET N2
16538   5     DEC B
16539   62    LD A,n        data to be output
1654ø   ø     POKEd
16541   211   OUT (n),A
16542   127
16543   2ø1   RET
16544   62    LD A,n
16545   ø     POKEd  UART program data.
16546   211   OUT (n),A        program UART
16547   191   n
16548   219   IN (A),n
16549   127   n                clear DAV
1655ø   2ø1   RET
```

Fig. 4 ZX81 BASIC machine code subroutine, with a program to get it into the memory. If RDY is active low, data for 16536 should be 191.

```
1øøø   REM INPUT DATA SUBROUTINE
1øø5   LET A = USR 16514
1ø1ø   IF A   255 THEN GOTO 1øø5
1ø15   RETURN
1ø2ø   REM OUTPUT DATA SUBROUTINE -
       N HOLDS DATA BYTE TO BE OUTPUT
1ø25   POKE 1654ø , N
1ø3ø   LET A = USR 16528
1ø35   IF A   255 THEN GOTO 1ø3ø
1ø4ø   RETURN
```

Fig. 5 ZX81 machine subroutine



RS232 Interface foil pattern.

Parts List

Resistors (all ¼W 5%)	
R1	10M
R2, 3	1k0
Capacitors	
C1, 2	56p
C3, 4	10u 16V electrolytic
C5	220u 16V electrolytic
C6	100n ceramic
Semiconductors	
IC1	74177
IC2	4702B
IC3	AY-3-1015
IC4, 5	74LS32
IC6	74LS00
IC7	7660
IC8	1488
IC9	7805
D1, 2	1N4148
AC1, 2	BZY88C4V7
Miscellaneous	
X1	2.4576 crystal
SK1	23 + 23 way ZX81 Spectrum edge connector
SK2	5 way 0.1" PC plug and in-line socket

PCB; rear edge connector strip; IC sockets: 1 off 40 pin, 1 off 16 pin, 5 off 14 pin, 1 off 8 pin; wire, solder, etc.

```
10 POKE 16545,X
15 RAND USR 16545
```

where X is the UART program data.

To read data in from the RS232 input port, use:

LET A = USR 16514

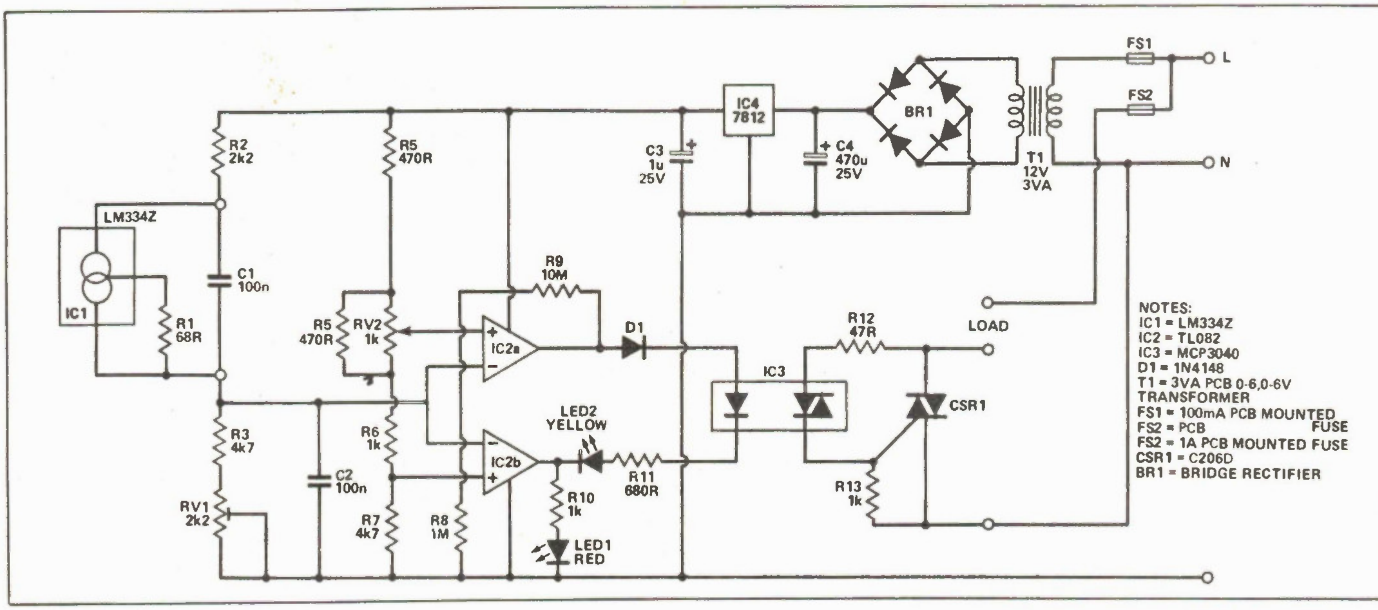
The subroutine checks the state of DAV and if DAV = 1, inputs the data and returns it in variable A. Since it is highly undesirable (from the user's point of view) for the computer to enter a machine code loop (if DAV = 0) the subroutine returns whether or not new data has been received; if it has, A will return holding a number greater than 255; otherwise A will be less than 256.

Listed is a BASIC subroutine that could be used to wait for the input of a byte of data. To output data to the RS232 port, use:

POKE 16540, X
LET A = USR 16528

where X is the data to the output.

As before, the subroutine does not cause the computer to enter a loop of TBMT and/or RDY is inactive. The number returned in A will be less than 256 if the data has been output; otherwise A will be greater than 255. ■



IC4 (omitted from the notes) is a 7812.

Aquarium Thermostat

By Phil Walker

This is a simple application of the LM3342 temperature-sensitive constant current IC. It also protects against sensor faults. Internally, the project can be set to operate over a wide temperature range, and compensate for different sensors. An external control allows a fine adjustment +/ −8 °C relative to the internal setting.

The Circuit

IC1 IS A constant current IC. That is, the current it passes is virtually independent of the voltage across it. The value of this current is determined by the value of R1. For an ideal current source, the current passed would be independent of temperature as well as voltage, but in this case, and fortunately for us, the current is directly proportional to the absolute temperature. This means, that if it is set to 1mA at 27 °C, the current will change by 3.33uA for each degree of temperature change. In this circuit, the current passes through R3 and RV1, which are nominally 6k. This results in a voltage of 6.0V, which changes by 20mV per °C.

This voltage is presented to the inverting input to IC2a. When it is compared to the voltage set by RV2. The values of R4, RV2, R5, R6 and R7 are such that RV2 nominally straddles 6.0V with about 300mV across its track. This gives a nominal control range of +/−8°C with R5 at 470R. The actual operating temperature range is set by RV1 and also compensates for variations in the LM334Z and R1. Capacitors C1 and C2 are present to reduce the effects of noise pickup.

IC2a has R9 connected from output to non-inverting input in order to provide a little hysteresis, effectively about 0.25°C. R8 will cause the output of IC2a to go low if RV2's wiper comes open circuit due to wear, etc. This will turn the heater off — safely, we hope. In operation when the temperature is below the set point, IC2a output will be high and when above it, the output will be low.

IC2b is connected as a safety circuit to detect when the sensor is open circuit. It does this by comparing the sensor voltage with a fixed voltage which is lower than the lowest set voltage by 1000mV — equivalent to 20°C below the operating range. If the sensor voltage is above this fixed voltage all is well, IC2b output is low, and LED1 is off. If not, the output will be high, LED1 will be on, and the power control disabled.

Two conditions are needed to switch on the power control section. The first is that IC2a's output should be high while the second is that IC2b's output is low. If these conditions are met, then current fill flow through D1, IC3 input, R11 and LED2. LED2 is to show you that the circuit is working, R11 is to limit the current through the LEDs, while D1 is to protect the LEDs from possible reverse voltage.

Once current flows through the input of IC3, its output will turn on when the voltage next falls to zero. This is because it is a special optocoupler which incorporates a circuit which will only allow it to turn on when the mains voltage is at or near OV — useful to reduce switching clicks and interference with the hifi and so on. The output of IC3 can only switch 100mA directly, so it is used to turn on CSR1, which can handle up to 3A. If either of the conditions is not met, then the output will stay off.

The protection aspect ensures that both open and short-circuit conditions on the probe will result in the heater being off, as likewise will a faulty potentiometer.

The power supply section is absolutely standard using a 7812 regulator. This also provides the reference voltage for the circuit. Fuses are included on the PCB for both the electronics and the heater.

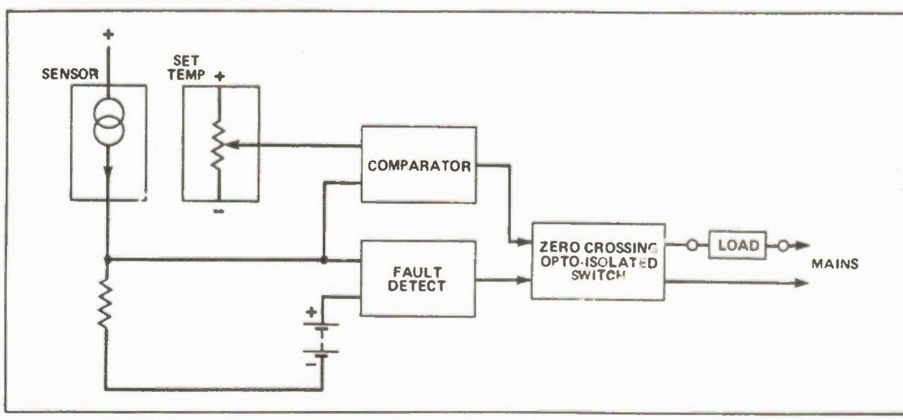


Figure 1. A block diagram of the thermostat.

continued on page 60

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By James McGuigan

Single-chip Microprocessor

Single-chip micros are alive and well, and will soon be living in washing machines and TVs. A look at Motorola's 6804.

Computing Today

Motorola's involvement in single-chip micros started when they second-sourced MOSTEK's MC3870. Motorola's first "home-grown" single-chip device was the MC6801, on the market by 1978.

As you might expect, the MC6801 had quite a lot of the same circuitry as the MC6800 micro; why re-invent the wheel when you can use something you know works? Additional circuitry included program memory (ROM) and data memory (RAM), besides input/output ports, a serial communications interface, and a multi-function timer.

Also in 1979, Motorola introduced the MC6805P2. This was essentially a development out of the 6801; it had been found that most applications did not require as sophisticated a register set as the 6801 provided, and so these were reduced. The RAM and ROM were reduced in size, the timer was simplified, and the serial interface was dropped.

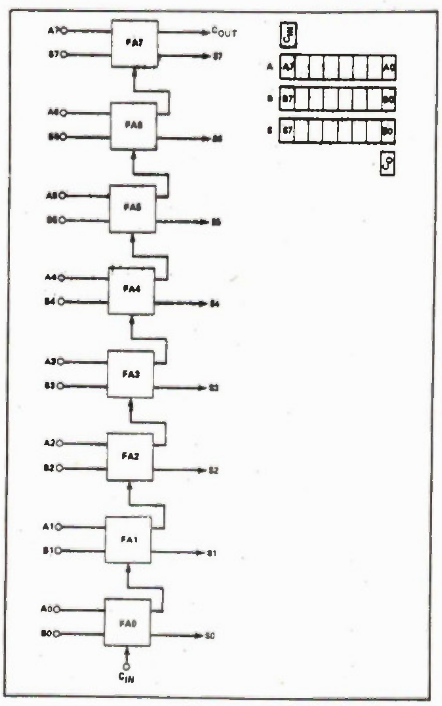

Fig. 1 Eight-bit adder with ripple-through carry.

All Change

The MC6804P2 represents a major change in direction for Motorola's single-chip computers. Not only has any resemblance to the 6800 been abandoned, but the whole basis for the architecture has been changed. The major difference is that the 6804 uses serial rather than parallel architecture. However, Motorola have managed to work the trick of making the 6804 appear to be an 8-bit device to the user. The whole purpose of this is to reduce the die size, which, as we've observed, reduces the cost of the finished IC. Let's take a closer look at what having serial architecture actually means.

Conventional micros manipulate data in lots of eight bits, or one byte. For example, the CPU and data bus are eight bits wide. An address bus and program counter (PC) of 12 bits wide can access up to 4096 (4K) bytes of data.

With the 6004 family all the hardware is actually only one bit wide. All data transfers, arithmetic and address operations are carried out serially one bit at a time. This means that the CPU, data bus, address bus, program counter, timer and prescaler are only one bit wide.

Consider, for example, an eight-bit arithmetic and logic unit (ALU). Within this ALU we have an eight-bit adder to carry two eight-bit numbers and possibly a carry-in bit as well. The adder will have eight sum bits and a carry-out bit as its output.

The eight-bit adder will be made up of eight separate single-bit full adders as shown in Fig. 1, which shows a "ripple-through" adder configuration. First of all, the least significant bits A0 and B0 are added to Cin. The sum appears at SO and any carry ripples through to be added to the sum of A1 and B1. This carries on until the eight-bit sum of A and B is calculated.

The eight-bit adder described above uses eight single-bit full adders plus three registers to hold A, B, and their sum; this is a lot of hardware and consequently expensive. However, it is possible to make do with just one single-bit full adder as shown in Fig. 2. This serial adder is made up of one single-bit full adder, three shift registers and a D-type flipflop.

When two eight-bit numbers are to be added, they are loaded into shift registers A and B. The LSB is to the right and the MSB to the left. On each clock pulse, registers A and B are shifted one bit to the right. The bits which fall out of the registers provide the inputs to the adder along with Cin. The adder's sum output is shifted into the SUM shift register. Any carry from this single-bit addition is latch-

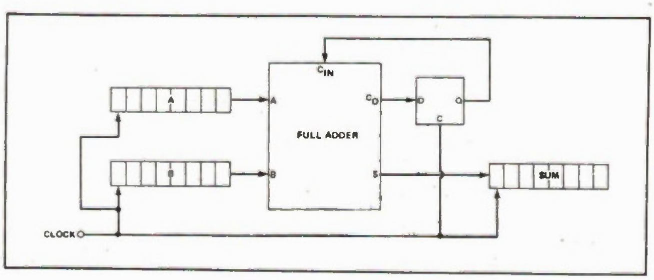

Fig. 2 Eight-bit serial adder using only one full adder.

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ed by the D-type flipflop.

Obviously, this serial method is somewhat slower, but it offers an enormous saving in hardware and space. Consider now the above principles applied to microprocessors. If we can reduce the amount of on-chip hardware, then considerable savings can be made in chip size.

Of course, the serial approach is always going to be slower than parallel design, but there are many applications where speed is not critical. In any case, with the 6804 provision has been made to permit the use of very high clock speeds: the maximum external clock frequency for the 6904P2 is 11MHz.

The following description applies mainly to the 6804P2 version with mask-programmed program ROM; however, the soon-to-be-released MC68705P3 EPROM version is similar to the point of pin-compatibility. Also, a wide range of CMOS (as opposed to NMOS) devices are planned and will also be very similar.

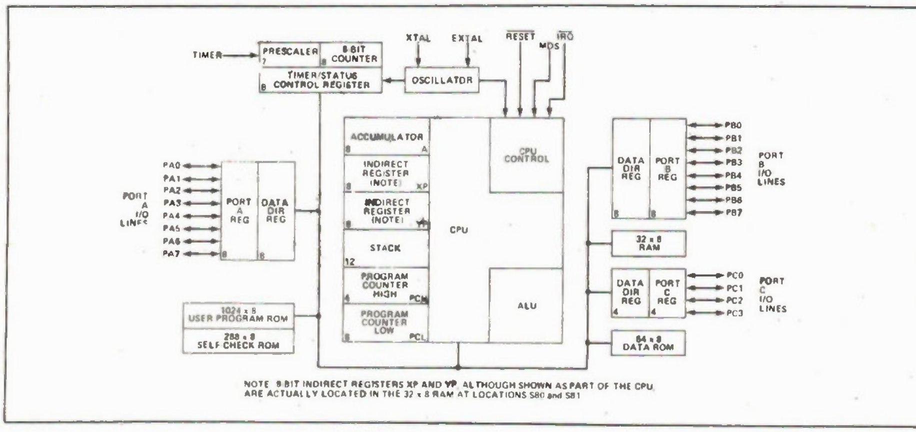


Fig. 3 MC6804P2 block diagram.

In More Detail

Figure 3 shows the MC6804P2 block diagram. The CPU contains the ALU, control, stack, and registers. Memory consists of three areas: program ROM (1K), data memory (64 bytes ROM and 32 bytes RAM) and the stack. The timer circuitry is made up of prescaler, counter and control registers and oscillator circuitry. The 6804P2 also has 20 versatile I/O lines.

The CPU is similar to that of the 68705P3. However, there are some differences. The eight-bit accumulator is memory-mapped at address $FF and has indirect registers which replace the index register on the 68705P3. The indirect registers are memory-mapped at location $80 and $81.

There are only two condition code flags on the 6804P2, C and Z, and there is no condition code register. The flags used for normal processing and interrupts are different. With interrupts, the processor automatically uses the interrupt-mode flags and, on return from interrupt, the normal-mode flags are used. Previous flag states will be used when switching from one set to another.

The stack is used to store subroutine and interrupt return addresses. It is a hardware stack, 12 bits wide and four levels deep (equivalent to a 48-bit shift register). Its last-in, first-out (LIFO) configuration eliminates the need for a stack pointer.

A crystal, RC network or external

signal can be used to generate the system clock. A mask option selects either the crystal or RC network.

The oscillator frequency is divided by four internally to produce the internal clock. This in turn is divided by 12 to produce a machine cycle. A machine cycle is the smallest unit needed to execute any operation and an instruction may need two, four or five machine cycles.

To facilitate testing, a signature analysis circuit has been included on the chip. The circuit consists of two eight-bit shift registers (memory-mapped at addresses $OA d $OB) configured to perform a Cyclic Redundancy Check on the ROM. The CRC registers can also be utilized as a pseudo random number generator as a result of continuous CRC calculations being performed.

Memory

The 6804P2 has 1K of program memory which contains all instructions to be executed, immediate data and interrupt vectors. Figure 4 shows the memory map. Data space consists of 64 bytes of ROM for constants and tables, all 32 bytes of RAM and the I/O, timer and CRC registers. This configuration is different from the 68705 where program and data memory are combined in a von Neumann architecture (there is no distinction between program and data storage except that some areas, the EPROM sections, cannot normally be written to).

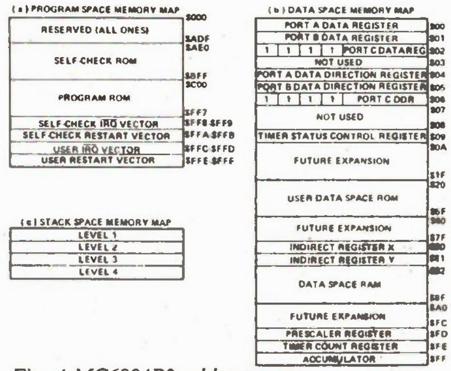


Fig. 4 MC6804P2 address map.

Note that only the PC is stored on the stack. Any other registers have to be saved in RAM by means of software and reloaded at the end of the subroutine or interrupt routine. On a stack push, the bottom register always "falls out" of the bottom of the stack. The stack should not be pulled more than three times in succession without any pushes.

Interrupt

Processing can be interrupted by applying a logic low signal to the IRQ pin. Whether a negative-going edge or the actual low level is sensed is determined by a mask option. With the 68705, however, we have a choice of three interrupts, external, timer and software.

On power-up the interrupt mask is set. This blocks any "ghost" interrupts from occurring. To clear the interrupt mask, the programmer should jump-to-subroutine (JSR) to an initialization routine as the first instruction in a program. This routine should be terminated with an RTI instruction instead of TRS since RTI will not only restore the PC but will also clear the interrupt mask.

During power-up a short delay to allow the internal oscillator to stabilize is needed before allowing the RESET line to go high ■

"That's really amazing. I remember when those mainframe computers were as big as footballs.

Troubleshooting Guide

You can spend more time debugging a project than designing and building it; here's a timesaving guide.

By Bill Markwick and ET staff

I RECALL a telecom instructor in my early stages who stuck two meter probes into a circuit and instantly revealed a fault that had stumped me for half an hour.

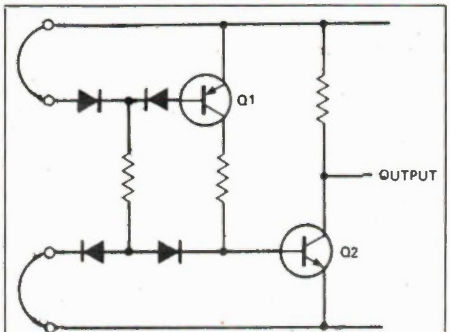
"Battery looking for ground," he said. "That's really all there is to it."

As any frustrated beginner will attest, there's a lot more to it than that, but I've never forgotten the importance of the lesson: work systematically. Leaping here and there accumulating readings will get you a pile of measurements, but they may not tell you anything of value, and most of them may be unnecessary. Make sure the power supply voltages are what they should be, and then trace out what works and what doesn't.

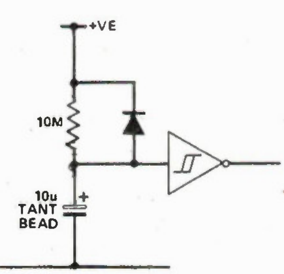
Tools

Anyone who's had to trace a circuit with headphones and clips will agree that you can't beat having the proper equipment. Also, you need *reliable* equipment. If your test gear is intermittent or unpredictable, you're compounding your troubles. You don't really need equipment with super precision, but some sort of calibrated readings will give you a lot more useful information.

I think it's safe to say that the oscilloscope is the absolute winner in the general-purpose category. No other instrument can tell you as much as quickly. It's also invaluable for watching a circuit while you use some other type of instrument; it can reveal hum, noise, oscillation, etc., that can distort readings.



OUTPUT NOT HIGH WHEN INPUTS SHORTED DUE TO LEAKAGE IN Q1 BEING AMPLIFIED BY Q2 (NEEDS BASE-EMITTER RESISTORS ON Q1,2)



LEAKAGE OF TANTALUM BEAD MAY PREVENT CIRCUIT SWITCHING

USE LOWER VALUE RESISTORS OR SPECIAL TIMER

Figs. 1 and 2 A couple of design traps here, both due to not allowing for leakage current.

Interaction

Ideally, any measuring equipment should appear to be absolutely invisible to the circuit under test. This isn't always true in practice. Even the best of equipment may cause some interference.

With voltmeters, the ideal would be a meter with infinitely high resistance. If you're using a digital multimeter, you'll probably find the input resistance to be between one and ten megohms; this is generally high enough to prevent drawing current from the circuit being tested. However, if you're using an analog meter, the resistance may be a good deal lower. They're usually rated in ohms per volt; to find the resistance that appears across the meter jacks, multiply this number by the full scale setting of the meter dial. For instance, a 20k per volt meter on the five volt range presents a resistance of 100k to the circuit. If you're measuring the voltage on a 100k resistor, you're now going to get a considerable error as the meter drags the resistor's voltage down. Go to a higher range, or change meters.

The milliammeter, while used less often, can cause problems. Ideally, it has zero resistance, but low-cost analog meters may insert quite a few ohms in series with your circuit; this resistance may cause unwanted coupling and attendant oscillation. Monitor with a scope if you think this is happening.

Don't forget that test leads have inductance and capacitance; they may be causing your circuit to oscillate or distort, and you may have to change to high-frequency probes or 10:1 attenuator types to get rid of interaction. A 10K resistor in series with the probe tip is a quick fix (sometimes).

Minimize the Variables

You'll get confused if you measure a dozen unrelated things while twisting controls here and there. First, take voltage and/or scope readings with the circuit controls set to normal with no signal. Now add the signal and re-measure. Now change *one* thing and measure again. This, with luck, will tell you that one particular condition affects the trouble, and

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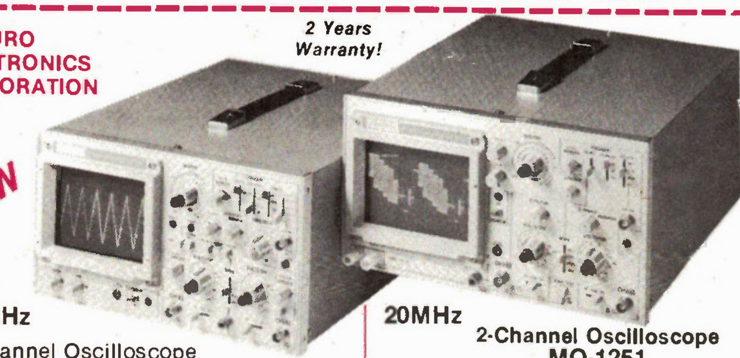

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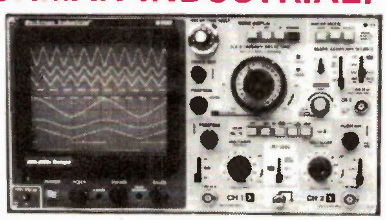

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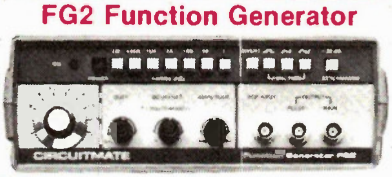

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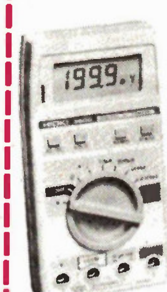

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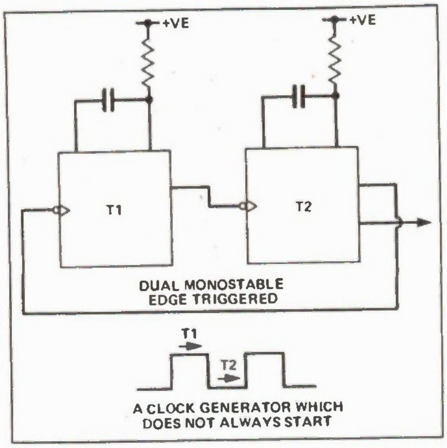


Fig. 3 A problem with oscillator start-up due to undefined logic states at switch-on.

now you have a clue. So, if possible, *change only one thing at a time.*

Direct Coupling

This'll drive you crazy. Many solid-state circuits, particularly power amplifiers, have a continuous DC operating path from input to output; a failure or change anywhere causes voltage shifts in the entire circuit. Some time can be saved with an in-circuit transistor tester; in the majority of cases a semiconductor has failed, and you can get rid of this problem right away. Some caution is required with power amps: the low circuit resistances may fool the tester. If the circuit has its semiconductors in sockets, you're laughing.

One of the most useful voltage tests is checking the output. In the case of bipolar supplies (positive and negative rails) with op amps or power amps, the output should be within 100 mV of zero. Chances are a faulty amp will have whole bunches of positive or negative volts on the output. It's really a subject for an entire article (hmmm!), but in general, you now can go looking for a semiconductor or bias circuitry that's pulling the output off zero. If the op amp or power amp has a single supply, the output will usually be at one-half the supply voltage.

Have you ever replaced what you thought was the defective part in a power amp, switched it on, and had the thing make smoke? One way to avoid this is to use a variac, a variable power transformer which lets you bring up the power line voltage slowly; when things start cooking, you can shut it off without damage. Another way is to insert low valued resistors (say, 100 ohms) in series with the DC power supply leads. If there's a short somewhere, they'll fry before the expensive stuff goes.

Noise

Generally, noise will be hiss, crackling, or hum. Hiss and crackling can usually be traced to defective semiconductors, so if you don't have sockets, get the desoldering stuff ready. The various wick-type desoldering braid is super for this. Less often, electrolytic capacitors can produce noise, but look for anything else first.

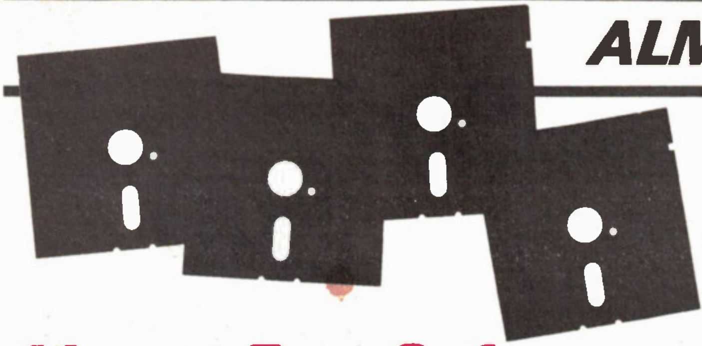
I've had some luck using cooling spray. This is an aerosol can that instantly cools down suspect parts; if the noise goes away, you're getting warmer (what?). It's also good for some digital ICs; they may come back to life during the low temperature period.

Project Debugging

This is the process of getting a new design working correctly; much more difficult than working on a gadget that at least used to work properly.

It's advisable to check power supply lines for shorts and incorrect hookups. Other wiring should also be checked, but wait a day or so or get someone else to do it to avoid repeating the same mistake twice. Judging from reader's problems, the number one fault is improper component placement in a PCB, or track faults in the PCB itself.

When all appears to be correct, the



ALMOST FREE SOFTWARE CATALOGUE

Moorshead Publications

Almost Free Software

Almost Free Software (CP/M) ....#1

Almost Free Software #1, #2 and #3 are for CP/M and are available in a variety of formats: Apple // + CP/M, 8 inch SSSD*, Access Matrix, Morrow Micro Decision, Superbrain, Xerox/Cromemco*, Epson QX-10VD, Sanyo MBC 1000, Nelma Persona, Kaypro II, Osborne and double densities, Televideo, DEC VT-180, Casio FP-1000, Zorba.

Modem 7. Allows you to communicate with any CP/M based system and download files. Complete details were in Computing Now! November 1983.

PACMAN. You can actually play PACMAN without graphics, and it works pretty fast.

FORTH. A complete up-to-date version of FIG FORTH, complete with its own internal DOS.

DUU. The ultimate disk utility allowing you to recover accidentally erased disk files, fix gorched files, rebuild and modify your system. A real gem.

D. A sorted directory program that tells you how big your files are and how much space is left on the disk.

USQ/SQ. Lets you compress and uncompress files. You can pack about 40% more stuff on a disk with this system.

Finance. A fairly sophisticated financial package written in easily understandable, modifiable Microsoft BASIC.

BADLIM. Ever had to throw out a disk with a single bad sector? This isolates bad sectors into an invisible file, making the rest of the disk useable.

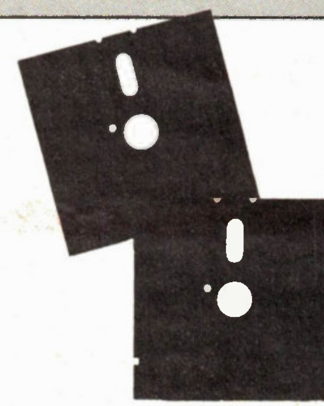
DISK. Allows you to move whole masses of files from disk to disk without having to do every one by hand, you can also view and erase files with little typing.

QUEST. A "Dungeons and Dragons" type game.

STOCKS. This is a complete stock management program in BASIC.

SEE. Also known as TYPE17, will TYPE any file, squeezed for not allowing you to keep documents in compressed form while still being able to read them.

Order as AFS #1, and specify system



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Almost Free Software (CP/M) ....#2

BISHOW The ultimate file typer, BISHOW version 3.1 will type squeezed or unsqueezed files and allow you to type files which are in libraries (see LU, below). However, it also pages in both directions, so if you miss something, you can back up and see it again.

LU Every CP/M file takes up unneccessary overhead. If you want to store lots of ata in a small space, you'll want LU, the library utility. It permits any number of individual files to be stored in one big file and cracked apart again.

MORTGAGE This is a very fancy mortgage amortization program which will produce a variety of amortization tables.

NSBASIC Large disk BASIC packages, such as MBASIC, are great . . . and very expensive. This one, however, is free . . . and every bit as powerful as many commercial programs. It's compatible with North Star BASIC, so you'll have no problem finding a manual for it.

RACQUEL Everyone should have one printer picture in their disk collection.

Z80ASM This is a complete assembler package which uses true Zilog Z80 mnemonics. It has a rich vocabulary of pseudo-ops and will allow you to use the full power of your Z80 based machine . . . much of which can't be handled by ASM or MAC.

VFILE Easily the ultimate disk utility, VFILE shows you a full screen presentation of what's on your disk and allows you to mass move and delete files using a two dimensional cursor. It has heaps of features, a built-in help file and works extremely fast.

ROMAN This is a silly little program which figures out Roman numerals for you. However, silly programs are so much fun . . .

CATCHUM If you like the fast pace and incredible realism of Pacman, you'll go quietly insane over Catchum . . . which plays basically the same game using ASCII characters. Watch little "C"'s gobble periods while you try to avoid the delay "A's" . . . it's a scream.

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Almost Free Software (CP/M) ....#3

OIL. This is an interesting simulation of the workings of the oil industry. It can be approached as either a game or a fairly sophisticated model.

CHESS. This program really does play a mean game of chess. It has an on-screen display of the board, a choice of colours and selectable levels of look ahead.

DEBUG. The DDT debugger is good but this offers heaps of facilities that DDT can't and does symbolic debugging... it's almost like being able to step, trace and disasemble through your source listing.

DU87. The older DUU program does have some limitations. The version overcomes them all and adds some valuable capacities. It will adapt itself to any system. You can search map and dump disk sectors or files. It's invaluable in recovering damaged files too.

ELIZA. This classic program is a micro computer head shrinker... it runs under MBASIC, and with very little imagination, you will be able to believe that you are conversing with a real psychiatrist.

LADDER. This is... this program is weird. It's Donkey Kong in ASCII. It's fast, bizarre and good for hours of eye strain.

QUIKKEY. Programmable function keys allow you to hit one key to issue a multicharacter command. This tiny utility allows you to define as many functions as you want using infrequently used control codes and to change them at any time... even from within another program.

RESOURCE. While a debugger will allow you to disassemble small bits of code easily enough, only a true text based disassembler can take a COM file and make source out of it again. This is one of the best ones available.

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Almost Free Apple DOS Software

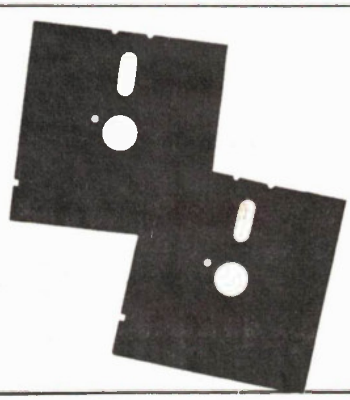
Almost Free Apple DOS Software ....#1

While CP/M is a wonderful thing in its own right, the Apple computer can also, and usually does, operate under DOS. For this reason, there's a multitude of programs available for it. Below, we offer a mini-multitude of our own.

The following programs will operate on any Apple //+, //e, //c, or true compatible operating under DOS 3.3. Apple users operating only under ProDOS may have to make alterations to some programs.

Picture Coder: All Apple HiRes pictures take up 36 sectors in their binary form. This program creates a textfile of a program in memory, squeezing out the zero bytes, that can later be EXECd into memory. The textfile often takes up less room on the disk.

DNA Tutorial: Operating under Integer BASIC, this program might appeal to 'clone' owners. In actuality, though, it's an interactive low-res graphics tutorial of DNA in its inherent forms. And you thought your Apple was only good for games...



Toad: Speaking of games, this program is an Applesoft BASIC implementation of 'Frogger' that can be controlled with either a joystick or the keyboard. The user's high scores are saved to disk.

Function Plotter: A fairly extensive Applesoft BASIC program that takes any inputted function and plots it on the HiRes Screen.

Data Disk Formatter: Apple DOS disks need not be bootable to be useful. This binary program formats a disk without setting DOS on the tracks, conserving useful disk space.

BASIC Trace: A program for the advanced Applesoft programmer, this file, when EXECd, displays the hexadecimal locations of each Applesoft line number of a program in memory.

Gemini Utility: A word processor pre-boot for Gemini printer users, this BASIC program initialises the printer's font or pitch before you boot your word processer.

Payments: This BASIC program allows you to keep track of payments and credits to and from up to 100 accounts on a single disk. A sample account is included.

Databox: A small but useful database program in Applesoft BASIC. Sample files are included to get you started.

Nullspace Invaders: A quick BASIC HiRes game testing coordination and judgement as you manipulate a monolith through mysterious gates.

Fine Print: The majority of this software has been obtained from on-line public access sources, and is therefore believed to be in the public domain. Any remaining programs were written in-house. The prices of the disks defer the cost of collecting the programs, debugging them, reproducing and mailing them, plus the cost of the media they're supplied on. The software itself is offered without charge.

Moorshead Publications warrants that the software is readable, and if there are any defects in the medium, we will replace it free of charge. While considerable efforts has been made to ensure that the programs have been thoroughly debugged, we are unable to assist you in adapting them for your own applications.

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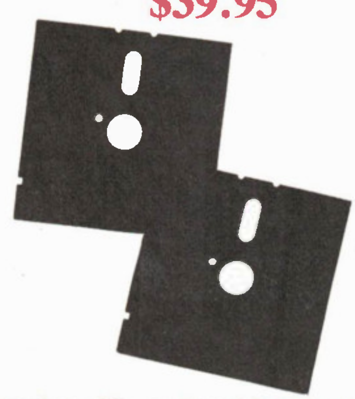

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Almost Free Apple DOS Software ....#2

Amort: A monthly amortization program that calculates monthly payments to an inputted figure, calculates principle, interest on every balance, and prints out the resulting chart.

Voiceprint: An unusual program that uses the HiRes screen to sample sounds inputted through the cassette jacks at the back of your Apple. Sampling rate and other variables can be controlled, and two sounds may be compared side-by-side.

Calc NOW!: Written in BASIC, this spreadsheet program is somewhat slower than VisiCalc, but still offers the power you expect from a spreadsheet. With sample files.

Cavern Crusader: A mix of BASIC and binary programming, winning this HiRes game is difficult, to say the least. For every wave of aliens shot in the cavern, there's always a meaner bunch in the wings.

Newcout: With source file. This binary program replaces the I/O hooks in the Apple with its own so you can operate your Apple through the HiRes screen. Comes with a character set.

Charset Editor: A utility to help you create your own character sets to use with Newcout.

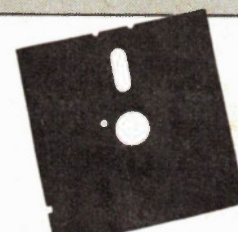
Calendar: A BASIC utility useful for finding a particular day of any inputted month and year, or for printing out any given year.

LCLODR: With source. This binary utility BLOADs any given file into the 16K language card space at $D000. The source is useful in showing how to use DOS commands through assembly language.

Cristo Rey: An animated HiRes BASIC program showing Cristo Rey by moonlight. For apartment-bound romantics.

ATOT: That's an acronym for 'Applesoft to Text'. EXEC this textfile to produce a textfile of your program.

Applesoft Deflator: This program takes a textfile made by ATOT and squeezes it, replacing PRINT statements with '?' and removing unnecessary spaces from the listing.



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Almost Free Apple DOS Software ....#3

General Ledger: A fairly massive BASIC General Ledger program. This program creates a number of files, so it's best put on a separate disk before implemented.

EE-Design: A shape design aid program written in BASIC. Allows the user to plot shapes in HiRes and either save them to disk or print them out.

Quickzap: A disk sector utility that reads a given track and sector into memory and allows you to alter it, and optionally write it back to disk.

Softgraph: A complete graphing program written in both Applesoft and binary that enables you to see your data done up professionally in pie, line or bar charts.

IntelliCalc: An intelligent calculator with three memories and a 'paper tape' readout. Data may be inserted at any point.

Poker!: An Applesoft BASIC implementation of the game that has ruined many a marriage. Fortunately, you can afford to lose your electronic paycheque to you Apple... for now.

Polar Graphics: Similar in some ways to Function Plotter, this Applesoft program supplies a number of attractive functions in REM statements that you may utilize to plot out on the HiRes screen.

Clock and Clock II: Two Applesoft digital clocks. When your Apple's doing nothing better, it can now remind you of the time you're wasting. One has an alarm function.

Flowers: With source. A binary program that prints a border of flowers to the HiRes screen. The source is invaluable in showing how to handle HiRes shapes in assembly language.

Convert Utility: A BASIC program that converts numbers between decimal, hexadecimal, binary and disk sectors.

ProDOSfix.TXT: Apple clone users who've purchased ProDOS will note that it doesn't work on their machines. This text tutorial explains why, and how to remedy the problem.

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Almost Free PC Software

Almost Free PC Software ....#1

Our Almost Free Software disks, volumes one through three, for systems running CP/M have been so thunderingly popular that we have assembled a volume for IBM PC users. The considerably greater power of a sixteen bit system, coupled with its larger capacity disk drives, have enabled us to offer a collection of programs that will knock the socks off virtually any sentient life form booting the disk. Be warned... wear sandals when you unwrap this thing.

This software will run superbly on genuine IBM PC's and compatible systems.

PC-WRITE While not quite Wordstar for nothing, this package comes extremely close to equalling the power of commercial word processors costing five or six bills. It has full screen editing, cursor movement with the cursor mover keypad, help screens and all the features of the expensive trolls.

SOLFE This is a small BASIC program that plays baroque music. While it has little practical use, it's just a kick to toodle with. It's also a fabulous tutorial on how to use BASICA's sound statements.

(continued overleaf)

(continued)

Almost Free PC Software ....#1

PC-TALK Telecommunications packages for the IBM PC are typically intricate, powerful and huge. This one is no exception. It has menus for everything and allows full control of all its parameters, even the really silly ones. It does file transfers in both ASCII dump and MODEM7/XMODEM protocols and comes with... get this... 119424 bytes of documentation.

SD This sorted directory program produces displays which are a lot more readable than those spewed out by typing DIR. It's essential to the continued maintenance of civilization as we know it.

FORTH This is a small FORTH in Microsoft BASIC. It's good if you want to get used to the ideas and concepts of FORTH... you can build on the primitives integral with the language.

LIFE This is an implementation of the classic ecology game written in 8088 assembler. While you may grow tired of watching the cells chewing on each other, in time the source will provide you with a powerful example of how to write code.

MAGDALEN This is another BASIC music program. We couldn't decide which of the two we've included here was the best trip, so we wound up putting them both on the disk. Ah... the joys of double sided drives.

CASHACC This is a fairly sophisticated cash acquisition and limited accounting package written in BASIC. It isn't exactly BPI, but it's a lot less expensive and suitable for use in most small business applications.

DATAFILE This is a simple data base manager written in... yes, trusty Microsoft BASIC.

UNWS Wordstar has this unusual propensity for setting the high order bits on some of the characters in the files it creates. Looks pretty weird when you try to do something other than Wordstar the file, doesn't it... Here's a utility to strip the bits and "unWordstar" the text. The assembler source for this one is provided.

HOST2 This is a package including the BASIC source and a DOC file to allow users with SmartModems to access their PC's remotely. It's a hacker's delight.

Moorshead Publications warrants that the software will be readable. If defects in the medium prevent this, we will replace your disk at no cost. While we have made every effort to assure that these programs are completely debugged, we are unable to assist you in adapting them for your application.

The disk also includes various support and documentation files needed to run the software.

We can provide the Almost Free PC Software Disk volume one on either one standard double sided disk or on two single sided ones.

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and specify system.

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or $22.95
for two single sided disks.

Almost Free PC Software ....#2

A good program is like a good politician . . . no, wait, we've succeeded in finding some good programs. However, it did take a lot of searching. Presented here is a selection of some of the best utilities, games, programmers' tools and business applications ever to order the bytes on a disk.

Sweep is a turbocharged Ferrarri of a disk utility which makes the COPY command look like a goat herd by comparison. It allows one to do mass copying, deletion, renaming and other disk functions all in menu driven comfort. It supports essentially the same command structure and behavior as the CP/M Sweep and Disk programs.

Worldmap is a sophisticated graphics program which draws a very detailed picture of the planet we live on and daily endeavour to blow up. It will display its wares on the tube or send them out to a printer.

Anitra plays Anitra's Dance by Edvard Grieg. PC music programs are a gas . . . everyone should have a disk full of them.

Ramdisk is among the most useful of all the utilities you'll ever plug into your PC. It creates a virtual drive on your system out of memory. You can pop your files over to it when you boot the beast and thereafter experience disk accesses that take less time to complete than real drives take to turn on their LEDs.

Alien plays a bizarre adventure game. It leads you into some pretty warped places. It comes with a massive data file for an adventure that you won't get tired of 'til the dragons come home for the evening.

FOS is a personal financial manager which will, among other things, make your cheque books into servants of humanity as opposed to denizens of the aforementioned adventure game. It's thunderously slick.

Jukebox represents yet another PC music system. This one comes with a host of songs to play and some really electric graphics.

Asmgen is one of the best text disassemblers we've come across. It takes any executable COM or EXE file and produces an assembler listing. It's surprisingly good at distinguishing between code and imbedded data or text. If you have need to patch or modify code this thing will outdo DEBUG by light years.

Struct will appeal to the rabid programmer in everyone. It allows MASM to be used to assemble a sort of higher level language. Included also is a test file to illustrate the syntax.

Prtsc replaces the internal PC screen dump code with something more suited to reality. It allows one to hit the PrtSc* key and then select what the screen dump will look like from a menu. It supports a number of popular printers.

Breakout plays a PC version of the popular game. It will accept input from either a joystick or the keyboard. The graphics are good and the action is adjustable from a beginner's level right up to fast and nasty.

Util is a collection of system utilities all under one menu driven roof. Among its many talents are a sorted directory, keyboard redefinition and the facility for scrolling up and down through a text file.

All of this software is available on a single disk. It comes with extensive on disk documentation to explain how to make it do its things.

Only
$19.95
or $22.95
for two single sided disks.

Fine print:
There has to be fine print sooner or later, or the typesetting machine forgets how to do it. All of the software on the Almost Free PC Software Disk #1 has been obtained through public access bulletin boards and is believed to be in the public domain. Some of it is "freeware", and users will find messages imbedded in the code asking for donations on the part of the authors. This is between you and your conscience... hit RETURN and it usually goes away.

This software is offered free of charge. The cost of this package serves only to defer the cost of postage, handling and the disk itself.

Order as AFPC #2
and specify system.

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Almost Free PC Software .... #3

Without software even the slickest computer is nothing for more than a foot stool for dwarfs. With the high cost and general funkiness of commercial software being what it is you may be a bit loath to go pop for the expensive stuff. We can relate to this.

No one with any measureable amount of sense enjoys buying a pig in a poke for six hundred dollars knowing full well that its previous owner may not have been able to successfully identify which was the pig.

Almost Free software does away with a lot of the bad vibes inherent in buying software. It offers a rich variety of applications, it's devoid of copy protection and licencing agreements and it's so cheap that if even one of its applications proves useful to you it's well worth the twenty bucks.

This disk consists of some of the finest stuff we could find. We sorted through about four megabytes of software to compile it and, even if you were to allow for the countless hours it would take you to find it all and two keyboards with their control, alternate and delete keys worn clear through, it would cost you more than twenty bills in disks to duplicate.

Included on the disk are:

FIXWS. WordStar, the etherial Martian of word processors, has a propensity of leaving odd bits set in its files. This makes them look remarkably like high tech confetti if you type them or otherwise try to stick 'em in other applications. This program effectively turns them back into ASCII.

WRT. DOS 2.0 allows for each file to have a read only flag . . . although it lacks a way of manipulating them. This pair of utilities allows you to set and unset this flag, protecting important files from accidental erasure.

BROWSE. If you type a text file chances are that the part you want to see will scroll past you before you have a chance to see it, and you'll have to type it several times as a result. BROWSE allows you to scroll in both directions, much as you might if you were using a word processor.

CAT. If the DIR display is too dull for your tastes you obviously need CAT, which will tell you everything you could possibly want to know about the files on your disks.

CGCLOCK This is a simple little program which displays the running time in the upper right hand corner of your screen. However, it has lots of display options and works with the colour graphics card.

CURSOR. This program makes the cursor big. It's pointless, but it's only twenty four bytes long.

CMP. This program does a very elaborate comparison of two files and reports their differences. It can for example, spot corrupted files, and has a multitude of uses when dealing with files created by redirection.

JUMPJOE. A bit like Miner 2049'er, this game is certain to damage your mind. You get to be the janitor of a space station. Deal with berserk robots and other weirdnesses. It's a hoot.

CASTLE. This is unquestionably the best public domain we've ever come across . . . when we got it productive work stopped here for about two days. Wander around a deserted castle collecting treasures . . . but mind you don't get killed by the nasties. A solution is included should frustration set in.

78INT. This is a small BASIC program to calculate interest using the rule of seventy eight.

MOON. One of the nicest lunar lander games we've come across, this little beast uses high resolution colour graphics and decent sound effects to hurl you to your doom in style.

PERCHT. This is another serious BASIC program, this time to print Pert charts.

DATNOIDS. As games go, this one is highly strange. In fact, mere words don't serve to describe it . . . you'll have to try it for yourself.

NUKE-NY. This is one of the nastiest bits of software we've ever seen. It produces a full colour high resolution simulation of a nuclear attack on New York city. It's just the thing to give to paranoid people you don't like very much.

NUDE. Yes, it's a bit exploitive and probably in questionable taste, but it's just so well done. This program uses high resoltuion graphics to draw this chick with great . . . huge . . . pixels.

Also included on the disk is an extensive READ ME file which contains documentation for the programs.

The third volume of almost Free PC Software is available on a double sided disk in your choice of ten attractive colours . . . all of which are black . . . for a mere

Only

$19.95

or $22.95

for two single sided disks.

Order as AFPC #3
and specify system.

A Teacher for the Apple

Specifically developed for the educational market, this 5-1/4" disk introduces both teachers and students to the Apple+, IIe and compatible systems.

It is designed to show you how to make the computer work for you.

After introducing you to the computer, it goes on to explain the BASIC programming language and step-by-step instructions show you the ins-and-outs of programming this system and using its many features including disk operating systems and high resolution graphics.

This program is designed for the total novice and it is designed to work accordingly. All you do is turn the computer on, slide in the disk and it takes over!

Requires Applesoft BASIC, 48K RAM and one disk drive.

Available for: AppleDOS only

$35.00

Order as Teacher

DOSDIAL

The Apple Terminal Package

There are plenty of terminal programs for the Apple II and its emulators. Some dial, some download. However, only DOSDIAL is this splendidly cheap.

DOSDIAL is a hybrid Applesoft and machine code package for fast operation and easy modification. It features a phone number library and automatic dialing. It operates on any fruit with a PDA 232C serial card and an autodial modem. A complete source file of the assembler code is included to allow it to be quickly patched for other serial cards.

Will work on any Apple+ or compatible system with a PDA 232C serial card and an autodial modem.

Available for: Apple II+

$16.95

Order as DOSDIAL

Apple DOS Wunderdisk

Over the last few years . . . as the story goes . . . we've written a lot of programs for the Apple which we've published in Computing Now!. Most of them have taken a lot of work . . . they've all been thoroughly debugged.

Typing in programs . . . especially extensive ones, like Blort! in this issue . . . is a long, cold mouthful of tedium. As such, we've gathered together a collection of some of the best Apple code we've created, all on one disk. Enshrined here are some of the classics of the past.

You get DOSdial, the dialing terminal program, Clef Hanger, an Apple music box, Skyhook, a radio teletype converter, Fruit Crate, a small bulletin board system, MuGraph, an experimental sound program, Hashit, a sorting routine, JoyGraph, a graphics program and, of course, Blort!, as seen in this issue.

The whole works is just

Order as Apple DOS Wunderdisk

$16.95

MDM730

MDM730 is one of the most powerful MODEM7 programs available . . . and the Computing Now! version of MDM730 incorporates features not available in the public domain editions. If you are into telecommunications, bulletin boards and downloading software your life will be full and meaningful with this code. For background on MDM730, see July 1984 Computing Now!. Consider the facilities.

- Terminal program which works at any baud rate.
- Ten programmable macro function keys.
- Thirty six number phone library.
- Christensen software transfer protocol.
- User settable toggles for line feeds, ON-XOFF and so on.
- Extensive help menus.
- Baud rate selection on the fly (or the spider).
- ASCII dump and capture.
- Status menu
- Many more features.

In addition to all this splendor, however, we've added dialing support for the Apple version. While the standard MDM730 cannot dial unless it's hooked to a Hayes Smartmodem, we've added patches to it to allow it to do pin twenty five pulse dialling and to dial through the Hayes Micromodem II and the SSM card. The Computing Now! MDM730 will also

- Select a number from the library and dial it
- Accept a hand entered number and dial it
- Wait for carrier
- Log you onto the remote system if it's free
- Optionally autodial if the remote board is busy.
- Count the number of attempts at dialling the remote BBS.

The Computing Now! MDM730 package is available for

- The Hayes Micromodem II.
- The SSM 300 Baud modem card.
- The PDA 232C serial card with external modem.

The PDA 232C package includes versions supporting both the Smartmodem and a dumb modem with pin twenty five line control, such as the Novation AutoCat.

Also included with each package are utilities to permit easy alteration of the phone number library and the function key macro strings plus an extensive documentation file.

The source code file for this program is over a hundred and fifty kilobytes long. It cannot be hacked on a standard Apple. We patched it on a larger machine and downloaded it. As such, we're pretty sure that MDM730 with these features is unavailable elsewhere.

Available for: Apple][+ CP/M

Please specify modem version from above list.

$29.95

Order as MDM730

Apple Wordstar Fixer

Apples and Wordstar are not entirely friendly. Apple compatible systems equipped with Videx type eighty-column cards do a number of unpleasant things to this popular word processor. While there are simple cures for this... they all involve some delicate code hacking.

The Fixer solves this problem. Place it on the same disk as your copy of WS.COM, type FIXER and after a suitable amount of disk noise, you will have APWS.COM on there too. This version of Wordstar includes special patching and unhooking code which runs each time you boot Wordstar, and makes your fruit behave as it should. It releases the control K's, translates the left arrow key to a delete character, and patches Unitron keyboards.

In addition, the fixer allows you to set some of the defaults of Wordstar which the MicroPro INSTALL package doesn't really get to. All of these features are menu driven in English for absolute non-technical operation.

Will run in either 44K or 56K CP/M.

Available for: Apple II+ CP/M only.

$19.95 Order as Fixer

Gemini WordStar PRESS

The WordStar printing function is agonizingly slow. It's also not very obliging in regards to where it puts its page numbers and things like headers.

PRESS is a utility which handles the formatted printing of all sorts of text files, be they manuscripts, drafts, program listings . . . anything that you'd normally want printed out in page form. It installs the header of your choice at the top of each page and slaps the page number beside it.

It also gives you a running count of the number of characters, lines and pages having hit the printer as you go. It allows you to have your documents printed out in a variety of type size and style permutations, commensurate with the capabilities of your printer.

Most important, however, PRESS will send text to your printer, formatted and all, as fast as your printer can accept it. It will even adjust the high bits of WordStar files to avoid selecting the Sanskrit character set.

PRESS comes configured for the Gemini 10X and 15X printers. It will, in fact, be quite happy with most Epson compatible dot matrix printers. A version is also supplied for use with letter quality daisy wheel printers.

PRESS is a simple to use package which communicates with you in plain English.

Available: for CP/M

$19.95

Order as PRESS and specify system. See Almost Free Software (CP/M) for available systems.

Stockboy Inventory

When we first advertised this program, we would have been pleased with a fraction of the orders we received. On reflection we should have appreciated what a bargain it is. Inventory programs are generally pretty expensive and some of them are inflexible and some even badly engineered. You may find that even small inventories generate enrormous files.

Stockboy is a good, powerful, flexible bargain-priced package which will handle inventory for small businesses. We use Stockboy within Moorshead Publications for our own inventory control and it has stood the test of time.

Stockboy can:

- **Maintain an inventory database with current, maximum and minimum stock reporting when an item needs re-ordering.**
- **Be a point of sale terminal, adjusting the stock data base on line.**
- **Produce individual packing lists.**
- **Generate a customer list to be used in mass mailings.**
- **Run on any CP/M or MS-DOS based computer, even an Apple II running with a softcard.**

Stockboy is written in Microsoft BASIC, and is designed to be easily altered to suit your needs. It can be compiled using BASCOM if you desire. It is designed for use by non-technical operators.

Available for: CP/M and PC formats

$29.95 most systems

$34.95 for 8"

Order as Stockboy and Specify System

Steve's CP/M Wunderdisk! Volume the First

In the course of doing the last year or so of Computing Now! we've generated a lot of code. We've collected all the programs we've written... some of which have never been published in any of our magazines... and put 'em all on one disk. Included are things like STAR, the Gemini 10 printer setup, the Last Wordstar Unhook, CPMAP and the CP/M HOST program, complete with several unreleased support programs.

The Wunderdisk is the best collection of tricky CP/M routines on the planet, ideal for anyone who wants to get inside this powerful operating system and sing. It's also the best documented... the programs, for the most part, are written up in issues of Computing Now!

The Wunderdisk is available for: CP/M

$19.95

Order as Vol. First and specify system. See Almost Free Software (CP/M) for available systems.

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moment of truth arrives. Switch it on. The lights dim. The curtain rises. Three things are now possible: it appears to work, it doesn't work, or it emits a cloud of smoke. These have been listed in order of increasing cost.

If it's the first possibility you can proceed with your tests to make sure that all the parts of the circuitry work as designed. Be very wary of circuits that work but you can't explain why. In the second case, it's debugging time. With logic circuits, you may be able to start it by switching it on and off a few times; if so, your problem is undefined states at power-up. This can be avoided by a power-on reset

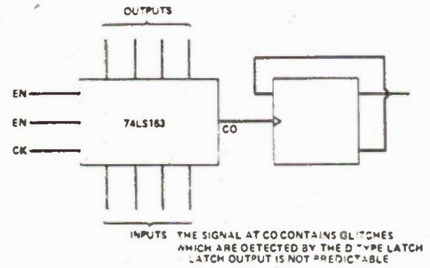


Fig. 4 A design problem with glitches; this particular problem took about 6 hours of frustration to find; when eventually located, the glitch pulses were only a few nanoseconds wide and very difficult to see. The basic problem here is using a device designed for synchronous logic in a non-synchronous application.

circuit at strategic points. If this is not possible, then you must redesign the logic so that it has no hang-up states, often easier said than done.

Analog circuits often exhibit this type of problem if the power supplies turn on in the wrong sequence. This is usually due to parasitic thyristor action in some ICs and can only be avoided by changing the type of device or including circuitry to prevent it. A more common problem is that analog circuits often contain capacitors for smoothing, decoupling and response shaping. At power-up these must charge up to their operating voltage; this can put potentially damaging strains on other parts of a circuit or output devices. This is particularly true in some types of audio amplifiers.

If you're unfortunate and your circuit produces clouds of smoke, well, sigh, turn it off. Before everything cools make note of which components were involved. Then you can test all the active devices connected to these components and see if they're still functional. If not, replace them tearfully, checking the component's connection a second time. Now study the circuit and see what could cause excess power, not forgetting that high frequency oscillations have killed many a homebrew amplifier with incorrect compensation.

Digital circuits can suffer from a particularly awkward type of problem as they as they operate very quickly but not instantaneously. The problem occurs when signals change state, especially where the outputs from a multi-bit counter are being decoded. What happens is that after a clock pulse the outputs begin to change state, but not all of them change at exactly the same time and the signal paths through the decoding logic can take different times. This means that the decoding logic sees a series of logic combinations which, though of short duration, can give rise to spurious outputs. This doesn't matter too much where the output drives a slow device. These spurious outputs are called glitches, and the usual method of preventing them is to prevent any action being taken until the decoding logic has had time to settle down - the result is stored in a latch and held while the next change occurs. Glitches and timing errors are the most common causes of faulty operation of logic circuitry. Most of the remaining faults are caused by the designer not fully understanding the full purpose of the circuit in the first place.

When designing logic circuits, keep in mind that individual devices may respond to pulses narrower than those specified for reliable operation on the manufacturer's data sheet. In most logic families, the delay caused by one gate can produce a pulse which can clock a latch or counter.

Once you get to the state where nothing is actually destroying itself, you can start finding out where the signal stops. The process from now on is very similar to fault-finding.

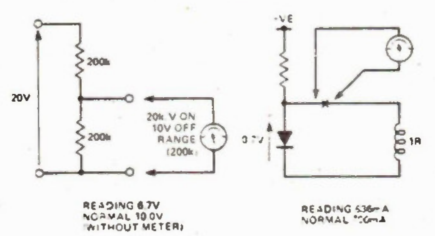


Fig. 5 and 6 Classic problems with meter's finite impedance.

Real Bugs

The worst, the absolute hair-puller, is the intermittent fault, one that only happens sometimes. Mother Nature usually arranges things so that the circuit works beautifully on the testbench, but starts crackling and shorting as soon as you give it back to your friend who wanted it fixed in the first place.

A scientifically designed, carefully engineered thump with your fist will often reveal intermittents due to cold solder joints or other poor connections. Some faults only manifest themselves after a period of operation; these are almost always due to heat; tube equipment is notorious for drying out electrolytic capacitors and altering resistor values.

More Bugs

We've already covered the problems that can be introduced by voltage and current measuring; some of these are illustrated. Another one that'll trip you up is trying to

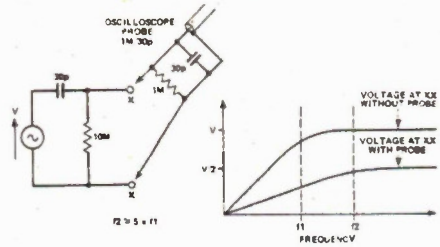


Fig. 7 Don't forget that oscilloscopes apply a load to the circuit which is not always negligible. Frequency counters, too, can also give significant circuit loading.

measure DC current where you shouldn't: if you put your ammeter between a rectifier bridge and the filter capacitor, you'll get very strange readings indeed. The reason is that the current only flows for a portion of the cycle as it tries to charge the capacitor back up to the peak value again. Another tricky situation occurs if you try measuring DC in the presence of a non-symmetrical AC waveform. Parts of the AC will add or subtract from your reading. It's best to disconnect any AC signal if you can, or at least make sure it's a symmetrical wave, such as a sine.

And lastly, grandly, the infamous ground loop, or hum loop. These are easy

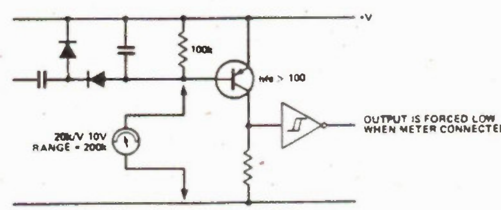
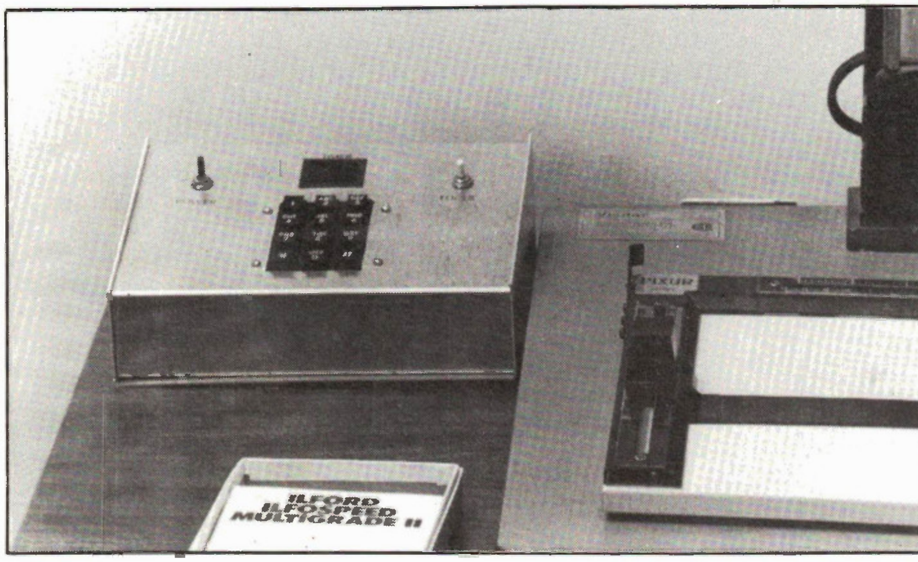


Fig. 8 An example of a test instrument stopping a circuit from working at all.

to create: if you have two amplifiers connected to two different ground points, a tiny current can circulate between them. Sometimes it only causes hum in line-powered equipment, and sometimes it causes high frequency oscillation. Sometimes it's just unpredictable. The best prevention is to keep ground points (i.e., power supply common points) as close together and as low-resistance as possible■

Darkroom Timer



Use a Z80 to operate an accurate, inexpensive darkroom timer.

By Hagen Kornberger

ONE of the most useful gadgets a photographer can have is a darkroom timer. One quickly realizes this after spending several hours in a darkroom squinting a clock for some 30 seconds at a time. But most darkroom timers suffer drawbacks. The ones using potentiometers and rotary switches lack accuracy, and the ones that use presettable counters with BCD switches are quite expensive to build. This microprocessor controlled timer can be built for under $70, including case and PCBs.

The features of this timer include a 2-digit display that can count down from 1-100 seconds, a telephone type keypad that makes setting the time easy, and a triac switch that is more reliable than a mechanical relay. There are no potentiometers to adjust because the timing is taken from the power line frequency, and finally, a focus switch is provided to turn on the enlarger manually.

The timer uses a Z-80 CPU and PIO instead of complex logic gates to count down time. Listing 1 is the software, in Z80 assembly language, contained in IC 3. Also provided in Listing 2 is a hex data dump of the EPROM. For convenience a preprogrammed EPROM can be ordered by mail; information on ordering the EPROM is contained in the parts list.

Construction

The darkroom timer is built on two printed circuit boards, figures 3 and 5. The larger printed circuit board, measuring 20.5cm by 9.8cm, contains all the parts including the power supply and the triac switch. There are 23 jumpers on the component side. All the traces on this board are 1 mm wide and none of them pass between the pads of the ICs. The second board contains the two 7-segment displays, and again there are no traces passing between the pins of the LEDs. There should be no problems in making these boards.

When drilling the holes on the larger PCB please note that there are no holes for pin 23 and 28 on IC1. These pins can be snipped off or bent back on the socket. Of course, sockets should be provided for all the ICs. Once the two boards are completed, you can begin interconnecting the components.

The line voltage is connected at points A and B on the large PCB as shown in fig 4. A fuse should be inserted before point A for safety reasons. The socket for the enlarger is connected at points A and C. If a second socket is desired for the safelight, it can be connected at points A and B. This socket will be on at all times.

When connecting the LED display board and the keypad to the main board, be sure use long enough wires so the project can be easily assembled into the case. If a focus switch, SW2, is not desired, then a jumper can be connected between SW2b and SW2 common on the main board.

And finally a suitable case should be drilled and punched to house the project. A sloped front style case is recommended for easy viewing of the LED displays.

Operation

When the power is first applied, the darkroom timer should display 30 seconds; this is the default setting. To

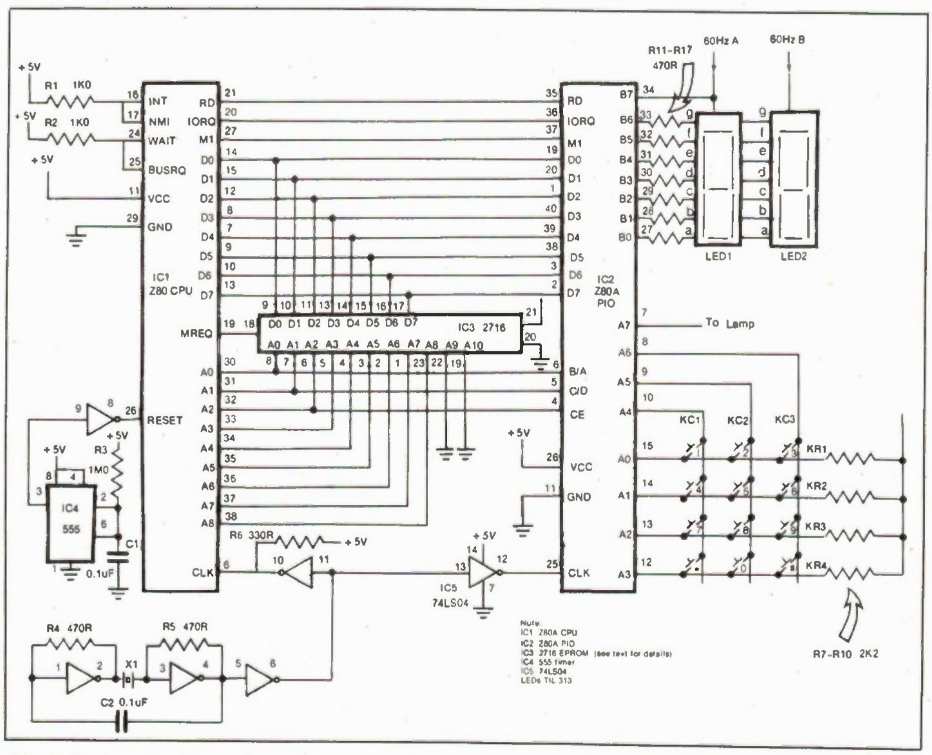


Fig. 1 Darkroom timer schematic.

change the number of seconds to count down simply use the numbers on the keypad. The display will automatically update after each number is pressed.

Pressing the start button, the one with the star or asterisk, starts the timer. The enlarger lamp will turn on and the display will start counting backwards. When the count reaches zero the enlarger will turn off and the display will return to the original count.

The stop button, the one on the right with the hash mark, can be pressed at any time to abort the count. The counter can be restarted by pressing the start button or a new start time can be programmed into the timer. And finally, the focus switch can turn on the enlarger at any time.

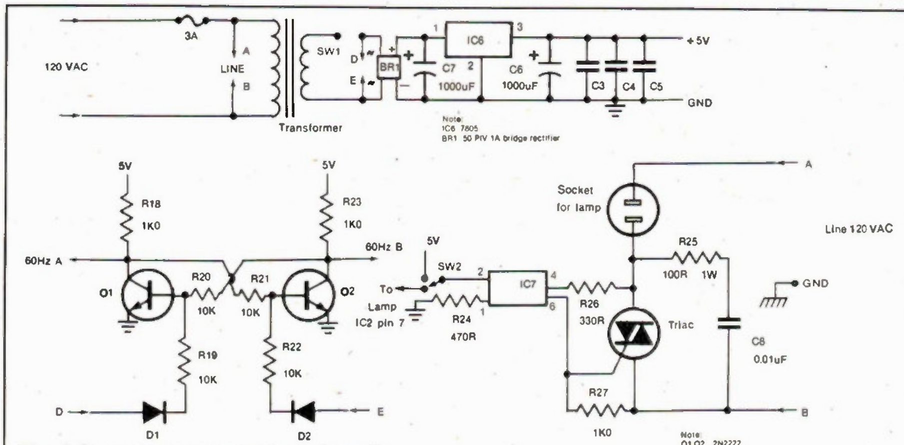


Fig. 2 Power supply and triac schematic.

PARTS LIST

Resistors

R1, 2, 18, 23, 27	1K0 1/4W
R3	1M0 1/4W
R4, 5, 11-17, 24	470R 1/4W
R6, 26	330R 1/4W
R7-10	2K2 1/4W
R19-22	10K 1/4W
R25	100R 1W

Capacitors

C1-5	0.1uF ceramic
C6, 7	1000uF electrolytic
C8	0.01uF 600V ceramic

Semiconductors

BR1	50 PIV 1A bridge rectifier
D1, 2	1N914 diode
IC1	Z-80A CPU
IC2	Z-80A PIO
IC3	2716 Eprom
IC4	555 timer
IC5	74LS04
IC6	7805
IC7	M0C3010
LED1, 2	TIL 313
Q1, 2	2N2222
TRIAC	SC141 200V 6A

Miscellaneous

SW1	SPST toggle
SW2	SPDT toggle
TRANS	12VAC 300ma Radio Shack #273-81385
X1	4.0 Mhz crystal

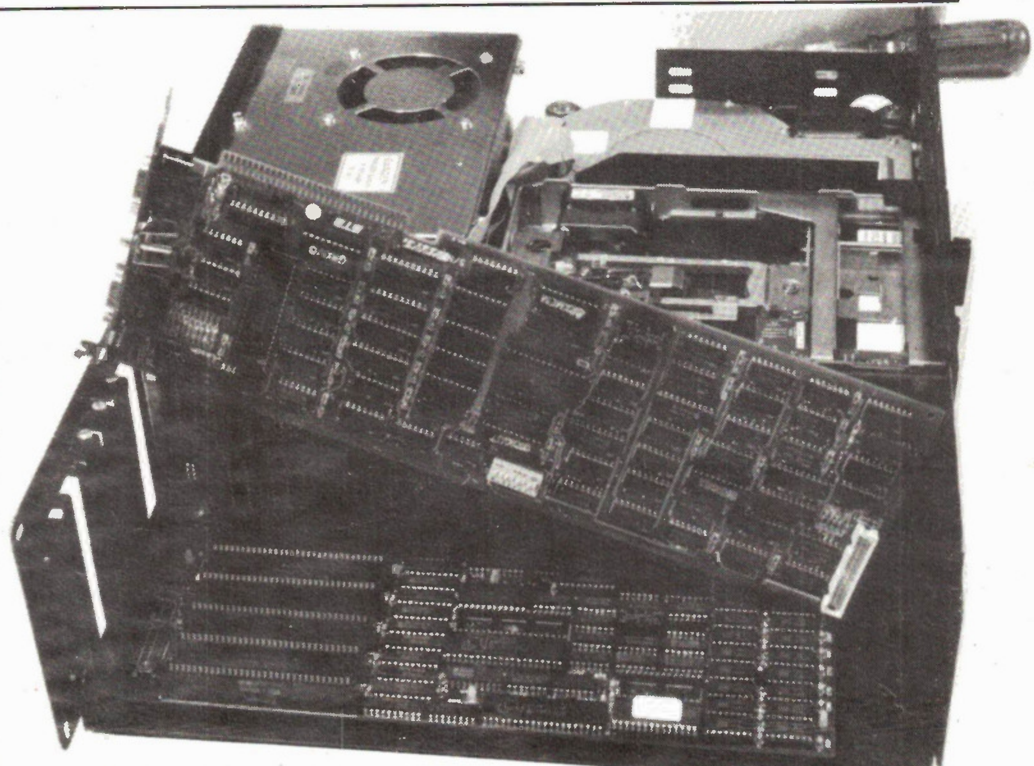
4 x 3 keyboard, 120VAC socket for enlarger, case and mounting hardware, PCB and materials Note: A preprogrammed 2716 Eprom can be obtained from Hagen Kornberger, 2121 Roche Court #121, Mississauga, Ontario L5K-2C7. Price: $12.00 includes postage and handling.

continued on page 47

ACS-1000 Board

A look at the ACS-1000 IBM-compatible motherboard; build yourself a work-alike with nothing more than a screwdriver.

By Bill Markwick



WE first set eyes on the ACS-1000 IBM-compatible computer board in the first part of this year, and it was initially written up in the February issue. This month we put it through its paces in an IBM-style case, complete with 640K of RAM, two 360K floppy disk drives and a 10 meg Xebec hard drive. This is only one of the various configurations that you can use with the ACS-1000.

Inside

A quick refresher in case you missed the ACS-1000 preliminary review: the motherboard is a compact 8 1/2 by 12 multi-layer type (power and ground lines are actually inside the PCB) and it sports RAM space for 1 MB (the manufacturing quality of the board, incidentally, is second to none). The CPU is an 8088-2 running at the standard speed of 4.7 MHz and easily changed to 8 MHz operation, plus socket space for an 8087 arithmetic coprocessor. There's a real-time clock with battery back-up, a 4-drive floppy disk controller, a SASI hard disk controller interface, 2 serial ports, a Centronics parallel port, and six expansion slots.

It looks a bit lonely inside the case: all the functions you'll need are on the motherboard with the exception of the colour graphics card (in the model tested, we had a Xebec hard drive which did not have the SASI interface and required a controller card). You'll have 5 slots left over for peripherals.

The various I/O lines terminate in dual pinstrips; adapter cables are readily available for connecting to drives, D-type connectors, etc. The exceptions are the power supply connector and keyboard connector; both are IBM-type. In other words, to build yourself a computer compatible with the IBM PC or XT, all you need is a case, an IBM-type power supply, up to four floppy disks, a video card, and a few minutes to plug it all together. That's it.

Expansion of memory is as simple as plugging in more ICs; up to 256K can be obtained with 64 kbit chips and up to 1 MB with the 256 kbit chips. The memory is divided into four banks, and the two sizes of memory ICs may be mixed; for instance, you could have two banks of 64K bit chips and two banks of the 256 kbit type. A DIP switch is used to tell the board which variety of RAM chips is fitted. 64 kbytes of ROM space is fitted (not the 32K mentioned in the March article), of which 10K is taken by the ACS-1000 BIOS.

The power supply connector and keyboard connectors are IBM-types, simplifying installation. There's a Reset button for rebooting the system, and a modem interface which will run an optional modem on a small printed circuit board.

Booting

In our early write-up, you may have noticed that the ACS-1000 can be set to a clock operating speed of 8 MHz instead of the usual 5 MHz (actually 4.77 MHz); I set the internal jumper to the higher speed and fired it up with PC-DOS in Drive A. The screen announces the ACS BIOS Version 1.5, the clock speed, and the beginning of a RAM check. This RAM check is not interruptible with a keypress, but at 8 MHz it finishes in about 8 seconds. A few more seconds to load the system and the prompt appears.

Trying It Out

PC-DOS and MS-DOS programs ran perfectly with no problems. The 8 MHz clock speed is a delight; a 15K textfile listed in about 25 seconds. It was certainly a change to have a speeded-up version of WordStar, a program that has a rather lazy screen refresh at best. There was a marked improvement when the software had to look something up on the disk and scroll it onto the display (I also couldn't resist transferring WordStar to the hard disk and trying it out; now that's *fast.*).

We scrounged around the place and came up with a fair number of large business programs that required lots of memory for integrated applications such as spreadsheets, word processors, databases, and so forth; we managed to find a few video games as well. All of them ran without a hitch with the possible exception of Deskmate, included with the Tandy 1000; this is because Tandy has added two more function keys to IBM's ten, and F12 is required to exit parts of the Deskmate program. There may be a way around this, but for now owners of IBM work-alikes will have to check carefully before using the Tandy software.

In the March article, it was noted that the ACS is compatible with software written for the IBM PC, XT, and AT. In fact, this reference was meant for the graphics controller card, not the motherboard itself. However, we weren't able to stump the board with any software, including the Microsoft Flight Simulator. It should be kept in mind, though, that any IBM software that requires BASIC in ROM will be thwarted unless you can get hold of the necessary chips and plug them into the

ROM space. This problem won't occur with disk BASIC, such as GW-BASIC from Microsoft.

Ports

The board has two serial ports. Both use short ribbon cable jumpers to convey communications data from the motherboard to D-type connectors on the rear panel. One port can be jumpered to either TTL or RS232 operation, and the other is RS232; two more ports can be added with a optional adapter card, and the interrupt priority for the ports can be assigned using jumper packs.

The parallel port originates on the motherboard, terminates on an inline strip in a similar way to the serial ports, and is carried to the rear panel D-connector via ribbon cable. The port is Centronics compatible.

The SASI interface simplifies connecting a hard disk. Of course, you have to make sure that the hard disk has the SASI controller on-board, though this eliminates the external controller and frees up one more expansion slot.

The modem interface allows connection (via ribbon cable) of a small optional PC board containing the rest of the hardware necessary for external communications via phone lines or hard wiring, less than the cost of an outboard modem.

Graphics

The review model was equipped with the Soltech GraphAx 2020 graphics controller card. This plugged into one of the expansion slots, sporting at the rear a 9-pin RGB socket and an RCA-type phono jack for colour composite video. I used an RGB monitor for the review, and compared the performance with several other compatibles available at the time. It's safe to say that the 2020 has one of the very best graphics card I've ever seen. Graphics displays were crisp and clear with minimum colour bleed at the borders. I think that the ultimate test of colour sharpness would have to be running a word processor; concentrating on text soon fatigues the old eyebones if it isn't topnotch. I set WordStar to a violet background with red lettering, certainly a putrid colour combination, and the 2020 displayed it cleanly and sharply. After that, white on black was a breeze.

Two software-selected formats are available: 1280 by 800 and 1200 by 900 pixels. There are four 512-colour palettes for colour animation, as well as five pixel planes for 32-colour capability.

Made in Canada

In conclusion, I'd have to say that I'm putting pennies in the piggybank toward an ACS-1000 board. There are two applications for which it would be mainly used: word processing and computerized drafting. Both require high speed and sharp graphics, and I have yet to see anything that can equal the 1000 at 8 MHz with the 2020 graphics card.

Manufacturing of the ACS-1000 has already started in Canada. You may have noticed the ad in *Electronics Today* for the "S-1000" from Soltech Industries. This is one and the same; the board's name has now formally been changed. Research for the board is carried out by Solkan Research, with manufacturing and distributing of the board done by Soltech Industries. Kaltron Industries Inc., a manufacturer of computer cables and accessories, will also be distrbuting the board. All are related companies.

The ACS-1000 board is presently available in single quantities for $799 from Soltech Industries Inc., 9274-194th St., Surrey, BC, V3T 4W2, (604) 888-2606. Quantity pricing is available. ■

Designer's Notebook

Audio Design
Clearing a path through the complex numbers used in audio design.

By John Linsley Hood

ONE of the features of audio circuitry, with the partial exception of audio power amplifiers which are largely flat frequency response devices, is that some modification of the gain/frequency characteristic is needed to correct for uneven recording or replay frequency responses, or to emphasise or exclude desirable or unwanted parts of the frequency spectrum. This is done by inserting a combination of resistors and capacitors (or inductors) in the signal path, or, possibly, in the feedback path around an amplifier. This is a very powerful technique, and with sufficient ingenuity in the circuit design, all sorts of shapes of frequency response can be achieved. However, it requires the ability to do reasonably accurate calculations of systems using capacitors or inductors in combination with resistors, and this immediately runs into the problem of the phase shifts which occur within such networks. I will explain.

If one passes an alternating current through a series combination of a resistor and a capacitor or a resistor and an inductor, the voltages developed across the two components will be 90° out of phase with each other. I have shown this graphically in Fig. 1a and 1b. Also, while the voltage developed across a capacitor will 'lag' in phase in relation to the current flowing through it, (because the voltage across a capacitor depends on the charge within it and it takes time for the capacitor to charge up or discharge), the opposite is true of an inductor, in which the voltage will 'lead' in phase with reference to the current (due to the instantaneous generation of a 'back EMF' in an inductor which seeks to oppose any change in current).

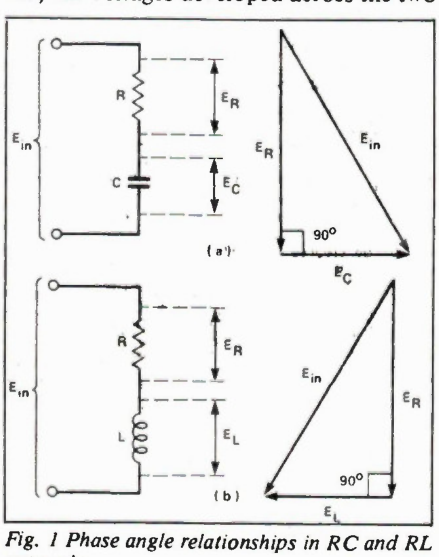


Fig. 1 Phase angle relationships in RC and RL networks.

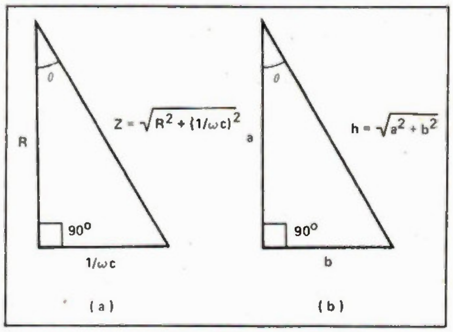


Fig. 2 Impdeance diagram for an RC network.

We have seen earlier in this series that the impedance of a capacitor (Zc) is related to its capacitance and the operating frequency by the equation $Z_c = 1/2pifC$. Similarly, the impedance of an inductor $Z_L = 2pifL$, where f is the frequency and C and L are in Farads and Henries respectively. Because of the effects of phase shifts, any calculation we made, say, of the attenuation of an RC or LC network based on these formulae for impedance would probably give incorrect answers. We therefore need a better method.

The j Symbol

There is, conveniently, a mathematical trick which enables us to do calculations which take into account the phase shifts produced by inductors and capacitors, and this is the operator i or j, which is numerically the square-root of -1. Pure mathematicians call this i to denote the fact that it is an imaginary number, since all real numbers give positive values when they are squared. However, since electrical engineers have already adopted the symbol i to denote electrical current, we refer to the square root of -1 as j instead. The use of this j operator is not as ridiculous as it might seem, as a way of describing a 90° phase shift, for the following reason.

In DC systems, the opposite of a positive voltage +V is a negative voltage -V. In an AC system, the opposite of an instantaneous positive potential (and it is convenient to refer to such AC potentials as E to distinguish them from DC voltage ±V) is the same potential half a cycle (180°) later when it has swung from positive to negative. A 180° phase shift in an AC signal therefore has the effect of multiplying the potential by -1, provided always that the signal we are talking about is sinusodial.

Now, if we have two RC (or LC) networks in series, both of which produce a 90° phase shift (and two such networks in series will have a multiplying effect on the signal just as ½ x ½ = ¼), the final effect is a 180° phase shift (= x -1). If we want to represent these phase shifts mathematically, we must find something which, when multiplied by itself gives the result -1. The square-root of -1 is just such a thing. It can therefore be used in our calculations as a way of denoting 90° phase shift.

The other bit of shorthand which circuit engineers normally use in these calculations is Greek symbol Omega which appears here as *w* to denote 2*pif*, since these terms nearly always occur together. The true impedance of a capacitor or inductor is, therefore, not $Z_c = 1/2pifC$ or $Z_L = 2pifL$, but $Z_c = 1/j2pifC$, and $Z_L = j2pifL$. In shorthand form this becomes $Z_c = 1/jwC$ and $Z_L = jwL$.

Since the phase shift produced by the L or C elements in RC or LC networks is 90°, we can represent the behaviour of this circuitry in a graphical form as shown in Fig. 1, as a right angled triangle, where the "j" term denotes the right angled limb, and this allows us to derive some further bits of information. Taking the case of a simple RC series network, as in Fig. 1a, the circuit impedances can be represented as in Fig. 2a, in which the vertical and horizontal limbs represent the resistive and capacitative impedances R and 1/jwC respectively. It is unnecessary to write the "j" symbol in the capacitance impedance limb of the drawing; that is implicit in its position at right angles to the R limb. From the theorem of Pythagoras, the length of the hypotenuse, h in Fig 2b, is the square-root of $a^2 - b^2$, and from fairly simple trigonometry, the angle $\theta = \text{Tan}^{-1} b/a$, a calculation which a lot of pocket calculators will do very quickly.

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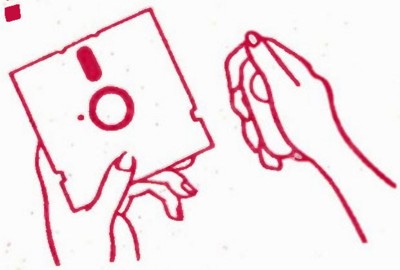

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Returning to our impedance diagram of Fig 2a, the resultant impedance of our network is therefore

$$\sqrt{R^2 + \left(\frac{1}{\omega C}\right)^2}$$

We can also determine the phase angle, θ, between the voltage developed across the network and the current flowing through it which will lag by θ, which is $\mathrm{Tan}^{-1}\ 1/wCR$. (If C were very large indeed, or R were very large, the phase shift would be nearly zero.)

To recapitulate, we can identify the phase shifting characteristics of Cs and Ls by coupling the symbol j to their impedance equations, and we can derive the resultant impedance and phase angle of these 'complex' networks by sorting out the terms with and without the j symbols, and using them in simple geometric or trigonometric calculations. This process holds good no matter how many Rs, Cs and Ls we have in our network, it just becomes more complicated if there are more phase shifting elements.

The thing, however, which we must watch, is that we keep the real and the imaginary (j containing) parts separate in the final equation at which we arrive. Now let us look at some real life examples.

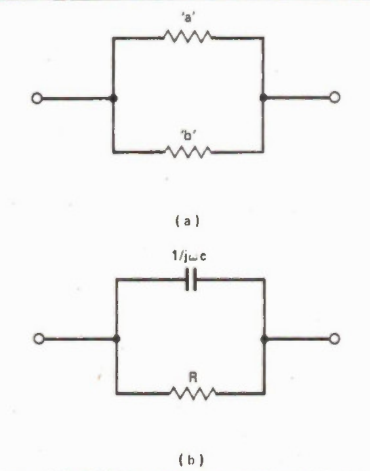


Fig. 3 Impedance of an RC parallel network.

Impedance Of RC Parallel Network

If the components were a and b as in Fig 3a, their impedance, when in parallel, would be

$$\frac{ab}{a+b}$$

Therefore, if they are R and $1/jwC$, as in Fig. 3b, their parallel impedance will be

$$Z = \frac{(1/j\omega C).\ R}{1/j\omega C + R}$$

if we multiply the top and bottom of this equation by jwC, we can get it into the much more manageable form

$$Z = \frac{R}{1 + j\omega CR}$$

The next mathematical dodge is to get rid of the js in the bottom line of this equation, so that we can divide it up into two separate parts, one without js and one with them representing the in-phase and the 90° 'quadrature' components.

This can be done by using the relationship

$$(a+b)\ (b-b) = a^2 - b^2.$$

If it was $(a + jb)\ (a - jb)$ the result would be $a^2 + b^2$, bearing in mind that $j^2 = +1$. The important thing is that j terms have disappeared. We can, therefore, multiply the top and the bottom of an equation containing a j term in the bottom line by a $-$ jb and eliminate these terms from the denominator leaving two separate fractions, which meets our original requirement for a usable equation. Treating the

$$Z = \frac{R}{1 + j\omega CR}$$

equation like this, we end up with

$$Z = \frac{R}{1 + (\omega CR)^2} - \frac{j\omega CR^2}{1 + (\omega CR)^2}$$

which allows us to calculate both the impedance and the phase angle between current flow and voltage, in our CR parallel network.

Attenuation Of An RC Network

The circuit shown in Fig. 4b is a very versatile one in that, as it stands, it is a useful 'step' attenuator network, while if R2 = 0 it is a simple HF attenuator circuit. Looking at the resistor network of Fig 4a, the attenuation of this would be

$$\frac{Eout}{Ein} = \frac{Rb + Rc}{Ra + Rb + Rc}$$

By analogy, therefore, the performance of Fig. 4b will be

$$\frac{Eout}{Ein} = \frac{1/j\omega C + R2}{R1 + 1/j\omega C + R2}$$

and this can be simplified to

$$\frac{Eout}{Ein} = \frac{1 + j\omega CR2}{1 + j\omega C\,(R1 + R2)}$$

by multiplying top and bottom of JwC. Doing the necessary mathematical manipulation extracts the in-phase and quadrature components as

$$\frac{Ein}{Eout} = \frac{1 + \omega^2C^2R2\,(R1 + R2)}{1 + \omega^2C^2\,(R1 + R2)^2} - \frac{j\omega CR1}{1 + \omega^2C^2\,(R1 + R2)^2}$$

and if we make R2 = 0, the right hand side of this equation simplifies to

$$\frac{1}{1 + \omega^2C^2R1^2} - \frac{j\omega CR1}{1 + \omega^2C^2R^21}$$

In this case also we have separated out the in-phase and quadrature components, so that the transmission factor is obtained by doing a square-root of the sum of the squares of these, and the phase angle of the output is given by

$$\mathrm{Tan}{-1}\left(\frac{\text{quadrature}}{\text{in-phase}}\right)$$

It is always useful, when one comes to the end of an algebraic manipulation like this, to check that one hasn't done anything wildly silly by putting in some limit values. For example, in the equations above, consider the effects of C = 0. This causes the equation to become

$$\frac{Eout}{Ein} = 1$$

which is what we would expect, (assuming the load is infinitely high in resistance). On the other hand, if C is extremely large, the first example gives

$$\frac{Eout}{Ein} = \frac{R2}{R1 + R2}$$

and the second gives

$$\frac{Eout}{Ein} = 0$$

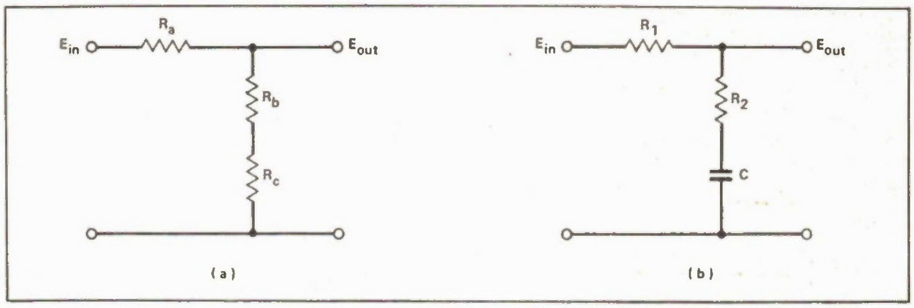
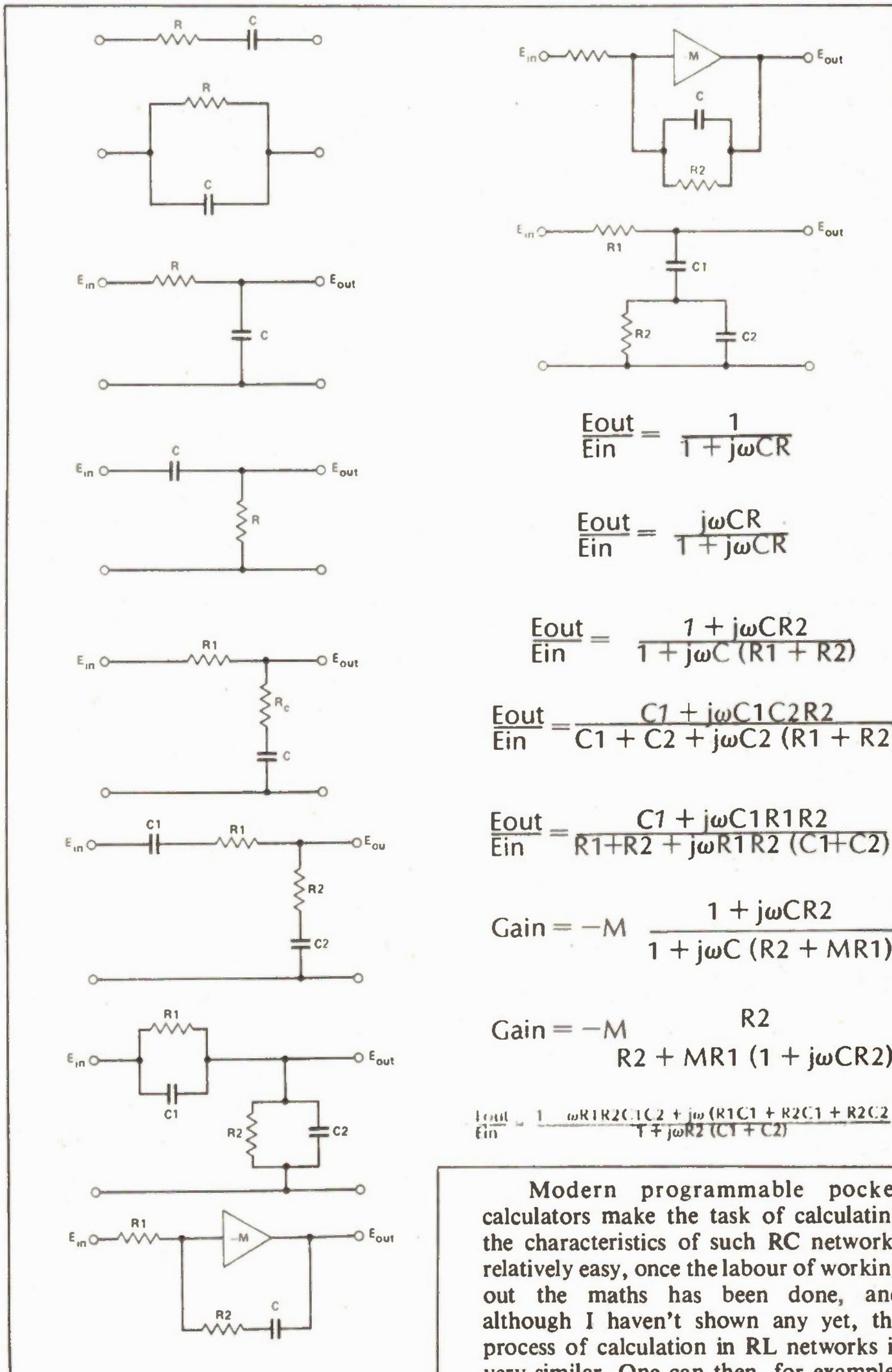


Fig. 4 Attenuation of an RRC network.



$$\frac{Eout}{Ein} = \frac{1}{1 + j\omega CR}$$

$$\frac{Eout}{Ein} = \frac{j\omega CR}{1 + j\omega CR}$$

$$\frac{Eout}{Ein} = \frac{1 + j\omega CR2}{1 + j\omega C\,(R1 + R2)}$$

$$\frac{Eout}{Ein} = \frac{C1 + j\omega C1C2R2}{C1 + C2 + j\omega C2\,(R1 + R2)}$$

$$\frac{Eout}{Ein} = \frac{C1 + j\omega C1R1R2}{R1+R2 + j\omega R1R2\,(C1+C2)}$$

$$\mathrm{Gain} = -M\,\frac{1 + j\omega CR2}{1 + j\omega C\,(R2 + MR1)}$$

$$\mathrm{Gain} = -M\,\frac{R2}{R2 + MR1\,(1 + j\omega CR2)}$$

$$\frac{Eout}{Ein} = \frac{1 - \omega R1R2C1C2 + j\omega\,(R1C1 + R2C1 + R2C2}{1 + j\omega R2\,(C1 + C2)}$$

Fig. 5 Characteristics of some common RC networks.

Modern programmable pocket calculators make the task of calculating the characteristics of such RC networks relatively easy, once the labour of working out the maths has been done, and although I haven't shown any yet, the process of calculation in RL networks is very similar. One can then, for example, write a suitable programme with the component values held in the calculator memory, and let the calculator go through the process for any frequency value which one enters before pressing the run button.

To remove some of the labour in calculation I am showing in the composite Fig. 5 a selection of RC networks with their impedance and transmission equations.

Resistor-Inductor Networks

The method of calculating the performance of these is identical to that for RC networks, except that one uses jwL instead of 1/jwC in the equations. For example, the circuits of Fig. 6a and 6b have transmissions

$$\frac{Eout}{Ein} = \frac{j\omega L}{R + j\omega L} \text{ and } \frac{R}{R + j\omega L}$$

respectively, which can be broken down into the in-phase and quadrature components as

$$\frac{(\omega L)^2}{R^2 + (\omega L)^2} + \frac{j\omega LR}{R^2 + (\omega L)^2}$$

and

$$\frac{R^2}{R^2 + (\omega L)^2} - \frac{j\omega LR}{R^2 + (\omega L)^2}$$

In all the equations shown, it is possible (as I am sure you will have spotted) to change one kind of network into a simpler one by putting value of R or C or L equal to 0. As an example, if we make network (7) of Fig 5 have values of 0 for Cl and C2,

$$\frac{Eout}{Ein} = \frac{R2}{(R1 + R2)}$$

which is what we would expect. Or, by just deleting Cl (Cl = 0) we will end up with the equation of a type 3 network, when there is a resistor across the output.

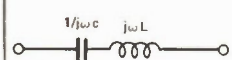
Some Practical Examples

A lot of the above may have been a bit dull reading for the non-mathematically inclined (which, I suspect, is 99% of us) and may tempt the reader to ask 'Well, that's all very nice, but what real use is it'. So I propose to show a few examples where there are some slightly surprising outcomes from the calculations.

(1) The LC series circuit.
Let us take first the LC series circuit of Fig. 7. Now it's impedance is just the sum of the two bits, Z = 1/jwC + jwL. If we multiply through by 1 (=jwC/jwC), we get

$$Z = \frac{1 - \omega^2 LC}{j\omega C}$$

This has an interesting characteristic, that if $w^2LC = 1$, Z = 0. This condition is met if $w^2 = 1/LC$ or $w = 2pi$ square of LC. So, at resonance, this series LC network looks like a short circuit. Away from resonance, there is a quadrature component due to the jwC term in the bottom line, which causes the phase of the transmitted signal to swing from + to - as the input passes through resonance.



$$\text{at } f_0 = \frac{1}{2\pi\sqrt{LC}}$$

$$Z = 0$$

Fig. 7 LC series resonant circuit.

(2) The Wien network.
This interesting and useful circuit, shown in Fig. 8, and the basis for a lot of oscillator designs is basically a network of the type shown in Fig. 5 (1) in series with one of the 5(2) type, with both Cs and both Rs being of the same value. Since we have already worked out the impedance characteristics of 5(1) and 5(2), we can write down the output, as a proportion of the input using the familiar a/(a+b) form, where 5(2) is a,

$$\text{at } f_0 = \frac{1}{2\pi\sqrt{CR}}$$

Eout = ⅓ Ein

with no phase shift.

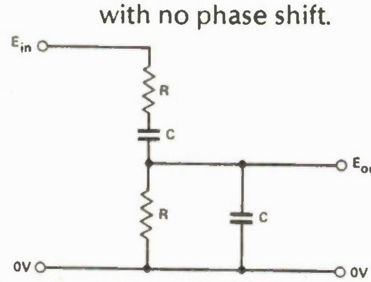


Fig. 8 The Wien network.

and 5(1) is b.

This gives the rather unwieldy looking equations

$$\frac{Eout}{Ein} = \frac{\frac{R}{1 + j\omega CR}}{\frac{R}{1 + j\omega CR} + \frac{1 + j\omega CR}{j\omega C}}$$

$$= \frac{\frac{j\omega CR}{1 + j\omega CR}}{\frac{j\omega CR}{1 + j\omega CR} + 1 + j\omega CR}$$

fortunately, this simplifies to:-

$$\frac{Eout}{Ein} = \frac{j\omega CR}{1 - (\omega CR)^2 + 3j\omega CR}$$

when $(wCR)^2 = 1$ 'or wCR = 1, since (square root of 1 = 1)' this becomes,

$$\frac{Eout}{Ein} = \frac{j\omega CR}{3j\omega CR} = \frac{1}{3}$$

with no 'j' terms left. Now wCR (= 2pif-CR) = 1 when f = 1/(2piCR), which gives the frequency at which the Wien network output is in phase with the input, and has a magnitude of 1/3 that of Ein.

(3) The Sallen and Key active filter.
This is one of the archetypes of the class of circuit known as active filters, and is valuable because it can be built with a single op-amp in the form shown in Fig. 9a or 9b. These are high-pass and low-pass versions of the filter. The behaviour of the circuit is such that the gain is subtaintially level (and x1) at frequencies above, or below, some critical turnouver frequency — depending upon whether we are using a high-pass or low-pass arrangement — but beyond this frequency the gain falls at -12dB/octave, as shown in 9c and 9d. If we substitute impedance 'blocks' for the Rs and Cs, as shown in 9e, we can work out a model for the analysis of the circuit using the 'j' techniques described above. However, to simplify your calculations we will assume that our amplifier is an ideal one with unity gain, and has an infinitely high input impedance and a negligibly low output impedance.
We can derive the following relationships.

$Ein = Eout + (i_1 + i_2)Z1 + i_2Z2$. . . . . (1)

and $Eout = i_2Z4$ therefore $i_2 = Eout/Z4$ . . . . (2)

also il=(Ex−Eout)/Z3 and $(Ex + Eout) = i_2Z2$

Therefore $il = i_2Z2/Z3$. . . . . (3)
From (1) and (3)

$Ein = Eout + i_2Z1\,Z2/Z3 + i_2Z1 + i_2Z2$
. . . . (4)

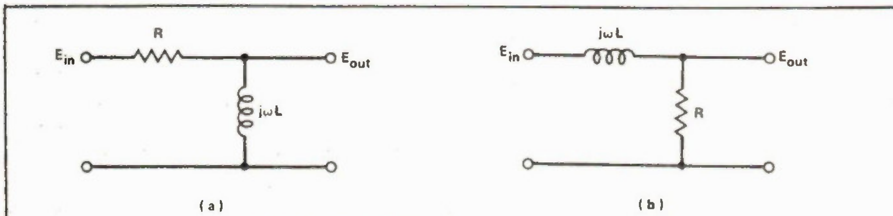


Fig. 6 RL networks.

and from (4) and (2)
$E_{in} = E_{out}(1 + Z1Z2/Z3Z42 + Z1/Z4 + Z2/Z4)$ ..... (5)

Therefore

$$\frac{E_{in}}{E_{out}} = \frac{1}{1 + \frac{Z1}{Z4} + \frac{Z2}{Z4} + \frac{Z1Z2}{Z3Z4}} = \frac{Z3Z4}{Z3Z4 + Z1Z3 + Z2Z3 + Z1Z2} \cdot (6)$$

We can now fit in the Rs and $1/jwCs$ in place of the Zs, and get the formulae for the real circuits. In the case of the low-pass filter, (9b and 9d), where Z1 = R1, Z2 = R2 and Z3 = $1/jwC1$ and Z4 = $1/jwC2$,

$$\frac{E_{out}}{E_{in}} = \frac{1}{1 + j\omega C2(R1 + R2) - \omega^2(C1C2R1R2)} \quad (7)$$

Several things can be deduced from this: where f = 0 (w = 0) the output is 1/1 (unity gain at VLF), where w^2(C1 C2 R1 R2) = 1 the denominator is at its smallest, and the output is therefore at a maximum. This is the turn-over frequency where f = $1/2pi$ square root of R1 R2 C1 C2, and at this point the output of the circuit is $1/jwC2$ (R1 + R2), which can call the 'Q' of the circuit.

There is one further small trick which can be done with this calculation. Suppose we say that x = R1/R2 and y = C1/C2, then R1 = xR2 and C1 = yC2, and suppose that we call the frequency at which w^2(C1 Cr R1 R2) = 1, w_0, then w_0^2 = $1/xy(C2R2)^2$ and w_0 = 1/C2 R2pixy. Also, our middle term $jwC2(R1 + R2)$ becomes $jwC2R2(1 + x)$.

Let us now express our equation for frequncy as a fraction of w_0, the turn-over frequency, we can find that . . .(7) becomes,

$$\frac{E_{out}}{E_{in}} = \frac{1}{1 + j\frac{\omega(1 + x)}{\omega 0\sqrt{xy}} - \left(\frac{\omega}{\omega 0}\right)^2}$$

and the 'Q', or gain at f_0, (when $\omega = \omega_0$) $\frac{\sqrt{xy}}{1 + x}$

This gives us a means of calculating the performance of this filter circuit over a range of frequencies, of determining what its turn-over frequency will be, and of predicting the circuit Q at that frequency (for an optimally flat response from a 2 element filter of this type, Q should be 1/square root of 2 or 0.707).

I have only gone through the calculations for a low-pass filter in this instance, but the high pass version will follow if appropriate R2 and Cs are put in place of the Zs.

Conclusions

The use of the "j" operator, to simulate mathematically the effect of the phase shift in an inductor or capacitor allows useful and instructive calculations to be made on networks which contain Ls and Cs as well as resistances. With a programmable calculator, to take the labour out of the repetitive calculations, it becomes practical to calculate a frequency response — and phase shift — for any network which one has the patience to work out. This then, should allow us to explore the performance of our circuitry, while it is still at the 'drawing on paper' stage, and thus avoid surprises! ■

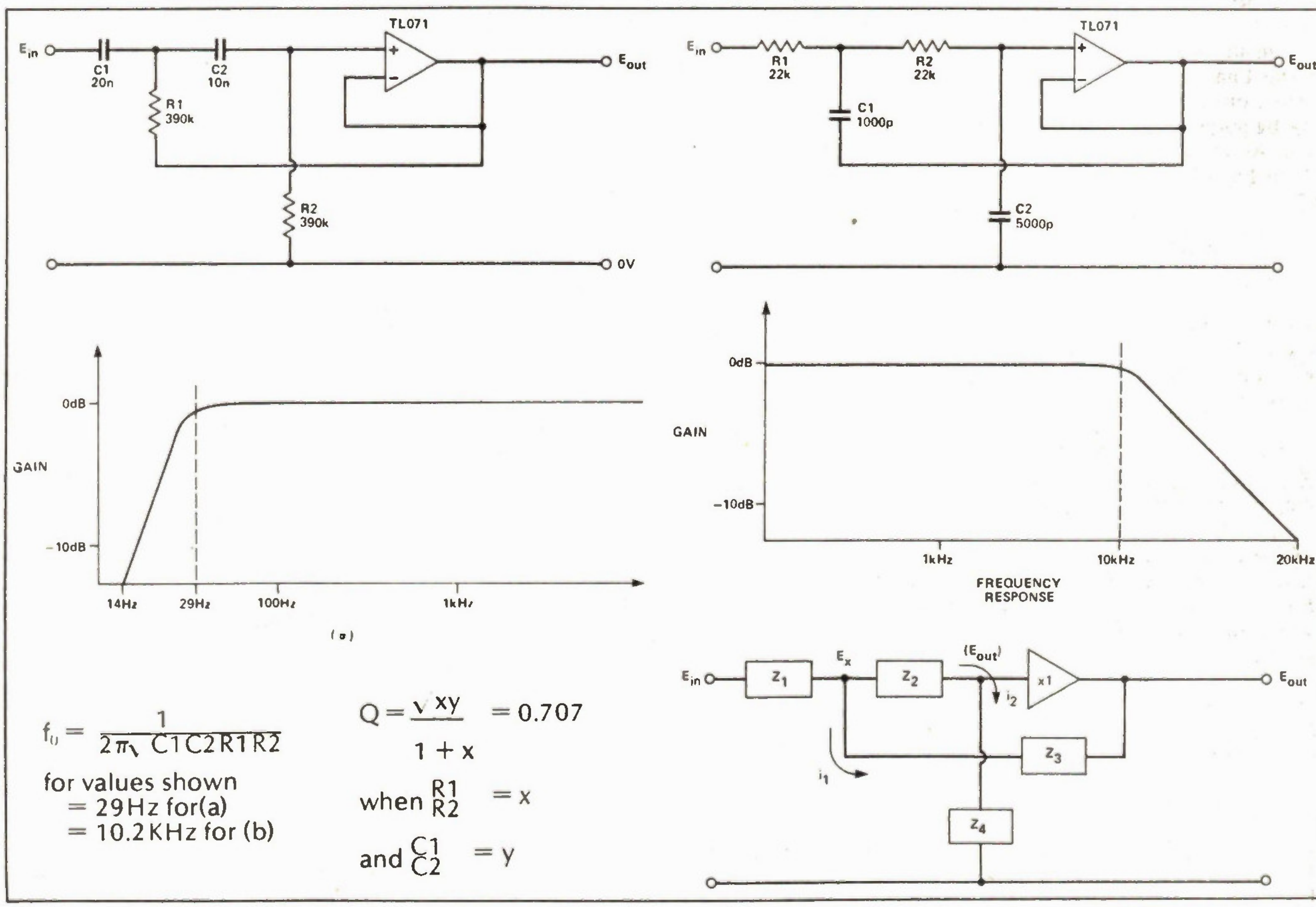
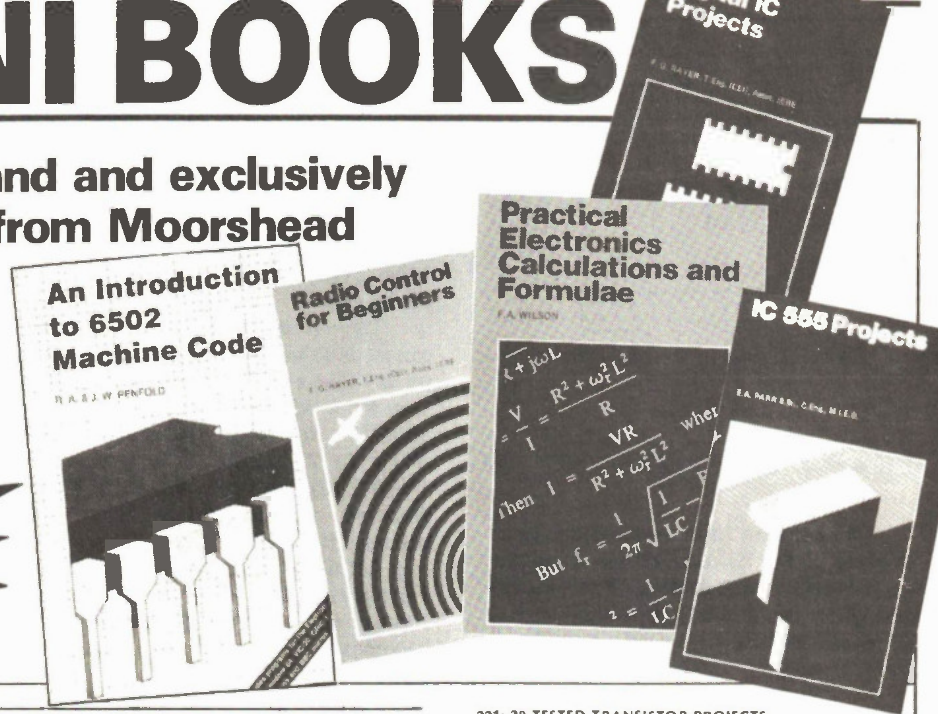


Fig. 9 Sallen and Key type active filters.

BABANI BOOKS



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Although one of the more recent branches of amateur electronics, electronic music has now become extremely popular and there are many projects which fall into this category. The purpose of this book is to provide the constructor with a number of practical circuits for the less complex items of electronic music equipment, including such things as a Fuzz Box, Waa-Waa Pedal, Sustain Unit, Reverberation and Phaser-Units, Tremelo Generator etc.

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Every so often a device appears that is so useful that one wonders how life went on before without it. The 555 timer is such a device. Included in this book are Basic and General Circuits, Motor Car and Model Railway Circuits, Alarms and Noise Makers as well as a section on the 556, 558 and 559 timers.

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

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R.A. Penfold $8.85
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A "Solderless Breadboard" is simply a special board on which electronic circuits can be built and tested. The components used are just plugged in and unplugged as desired. The 30 projects featured in this book have been specially designed to be built on a "Verobloc" breadboard. Wherever possible the components used are common to several projects, hence with only a modest number of reasonably inexpensive components it is possible to build, in turn, every project shown.

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R.N. SOAR
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This book is designed to aid electronics enthusiasts who like to experiment with circuits and produce their own projects rather than simply follow published project designs.

The circuits for a number of useful building blocks are included in this book. Where relevant, details of how to change the parameters of each circuit are given so that they can easily be modified to suit individual requirements.

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

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REFERENCE

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continued from page 35

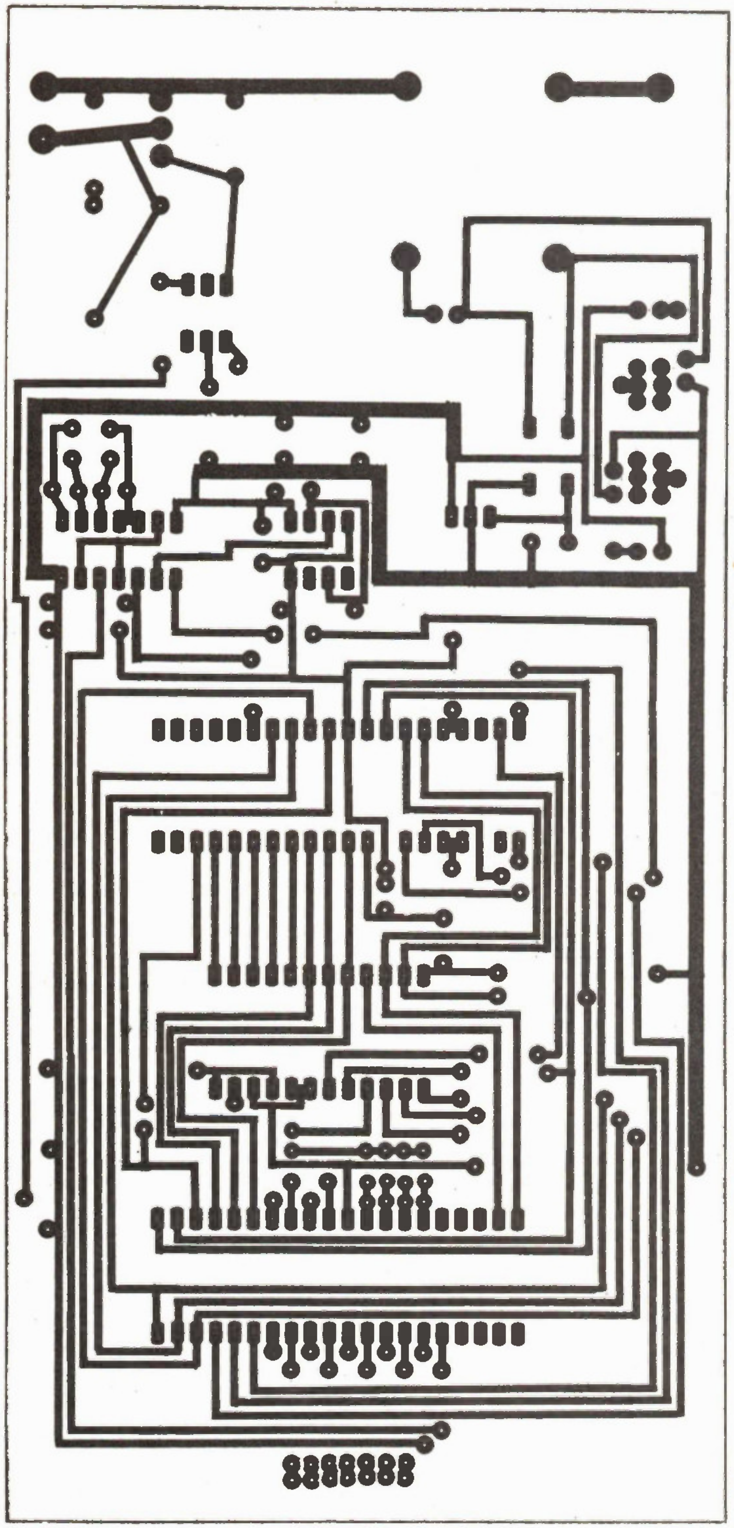


Fig. 3 Main P.C.B. for the Darkroom Timer.

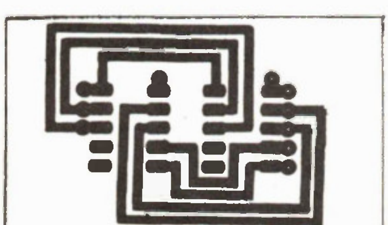


Fig. 5 LED display P.C.C.

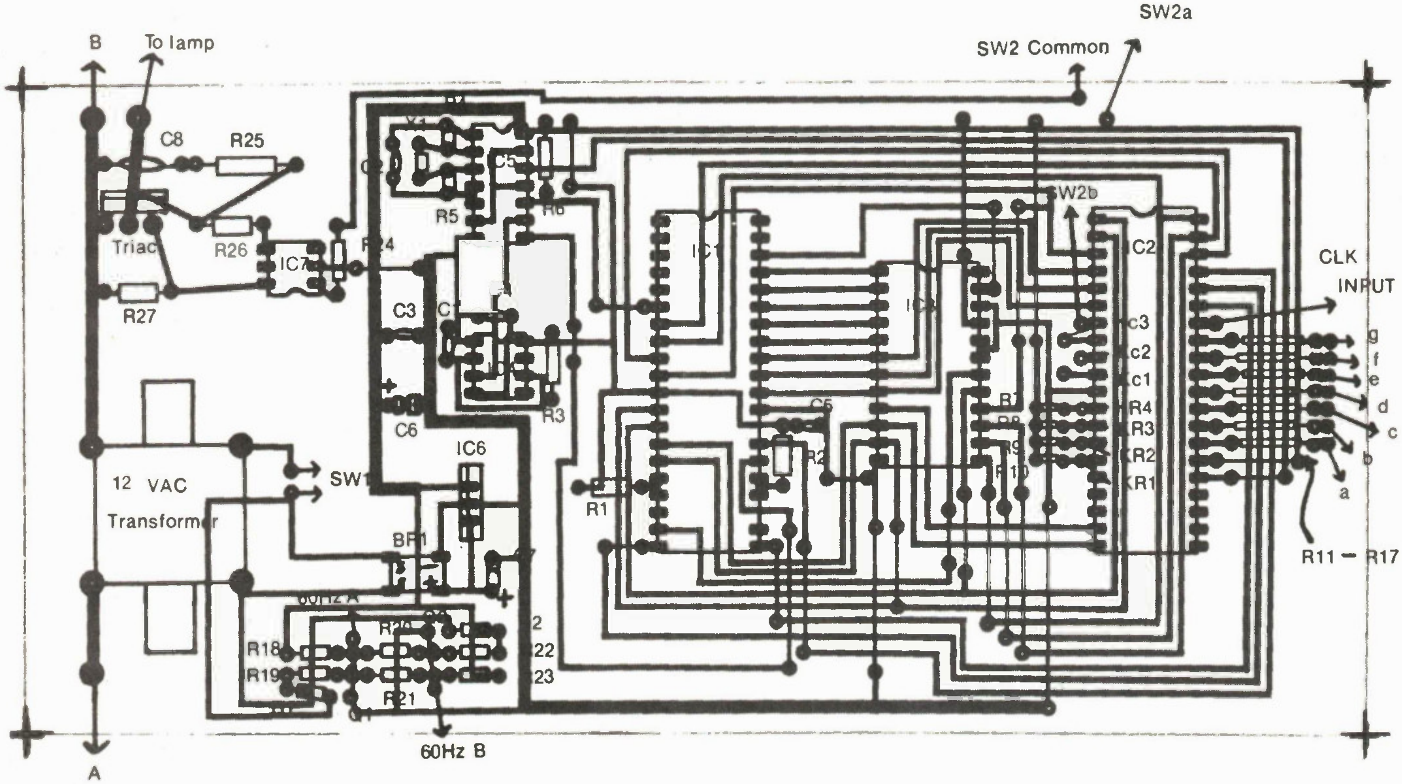


Fig. 4 Parts overlay for main board.

HOW IT WORKS

The heart of the circuit is IC1, the Z80 CPU. IC4 provides the CPU with a reliable power-on reset signal. IC5 generates the clocking requirements of the CPU and the PIO. The software to run the dark room timer is contained in IC3, a preprogrammed EPROM.

The Z80 PIO, IC2, interfaces the LED display, keyboard, triac switch and the line frequency waveform to the CPU. Bits 0-6 on port B are programmed for output operation and drive the LED displays. Bit 7 is used to input the line frequency. Bits 0-6 on port A are used to scan the keypad. And finally Bit 7 on port A is programmed for output operation and turns the triac switch on and off.

Q1 and Q2 form an SR flip flop that converts a 12VAC sine wave to a TTL compatible square wave. The inputs of the SR flip flop are connected so that every time the current changes direction the state of Q1 and Q2 changes from on to off or off to on. The result is a clean 60Hz output. Q1 and Q2 are also used to multiplex the LED displays. Each display is turned on for one half of the 60Hz cycle.

The triac switch is made up of IC7 and TRIAC. IC7 isolates the dark room timer from the power line, and also drives the triac. SW2 overides the output from the PIO by simply placing a logic level 'one' on pin 2 of IC7, thus turning it on.

And finally the power supply is a typical 5V regulated supply using a 7805 regulator.

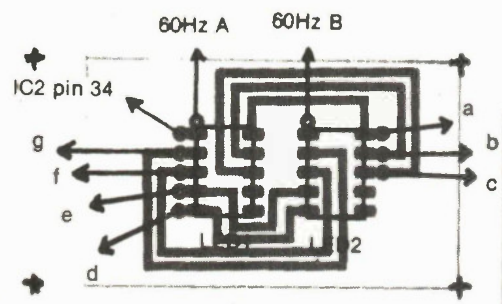
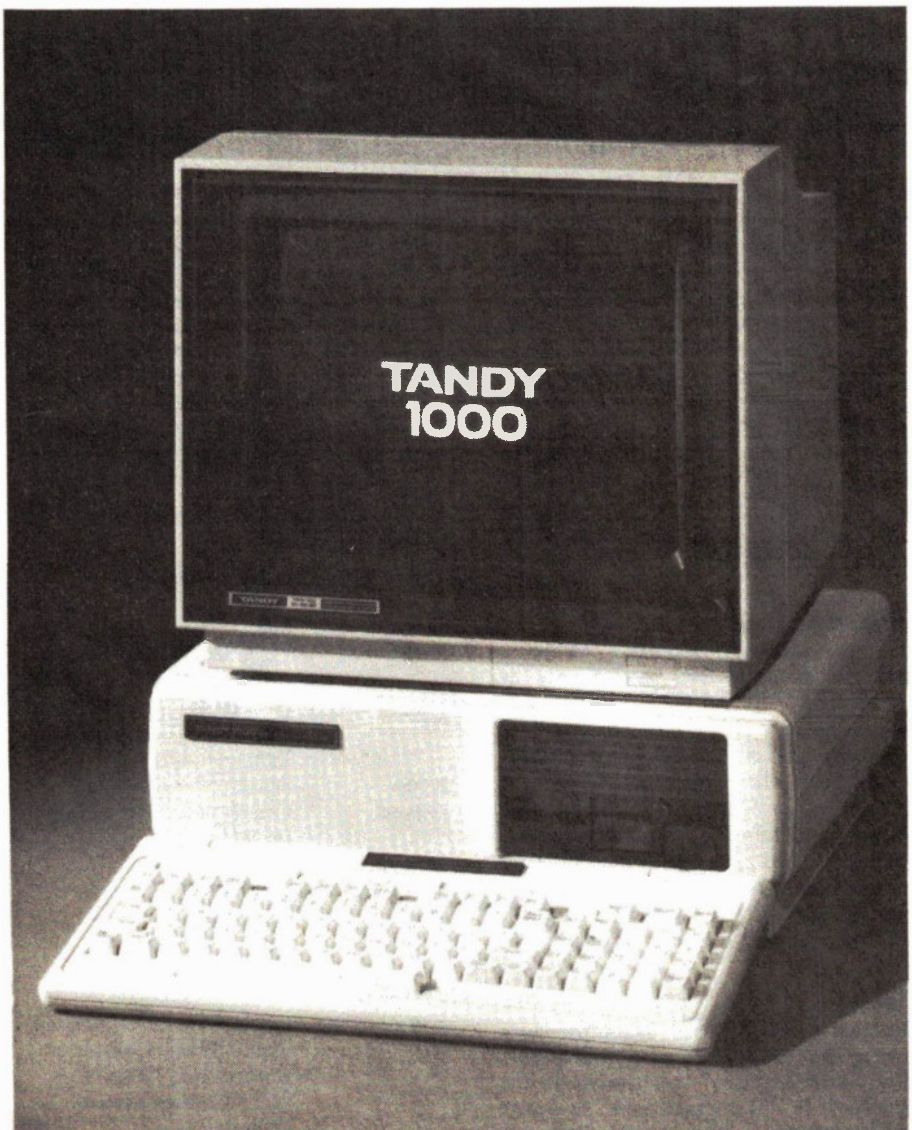


Fig. 6 LED display overlay

Tandy 1000

Radio Shack's low-cost entry into the world of MS-DOS micros offers good value for the computing dollar.

By Edward Zapletal



THE CURRENT wave in computing is, without a doubt, being compatible with you-know-who. It's for a good reason, though; the industry standard has been set and any microcomputer manufacturer with half a CPU knows that to stay profitable you have to ride the same wave. At a time when computer companies are falling like pins down at the local alley on a Saturday night, many can't afford to do otherwise. Radio Shack, a longtime veteran of the industry who up until recently were riding their own TRS-80 wave, have made what would appear to be a smart move in offering a very competitive $1750 alternative to the IBM PC and other work-alike machines: the Tandy 1000.

Let's Have a Look

Once removed from its cardboard packing case, the Tandy 1000 looks much like any other PC-compatible computer. The cover is a one-piece white moulded plastic with a fairly plain looking front panel. DIN style connectors for the detachable keyboard and two joysticks are conveniently located along a recessed lower edge of the front of the case. This makes considerably more sense than having your coil cord wrapped around the computer. There are six additional connectors on the rear for standard video, audio, RGB video, a lightpen, parallel printer, and power.

To get at the interior of the 1000 simply requires the removal of two screws on the front panel. Once inside, there are three expansion slots; this may not seem like much, but when you consider that the RGB, parallel port and colour are included in the motherboard, there should be plenty of room for expansion. Installing the second drive is simple, because there's lots of room to work with a screwdriver; as well the ribbon cable and power supply connectors are easily accessible. Some additional poking around revealed the absence of a socket for the installation of the 8087 numeric processor. However, this should not pose too much of a problem for those who are not into spreadsheets and other software requiring heavy-duty number crunching.

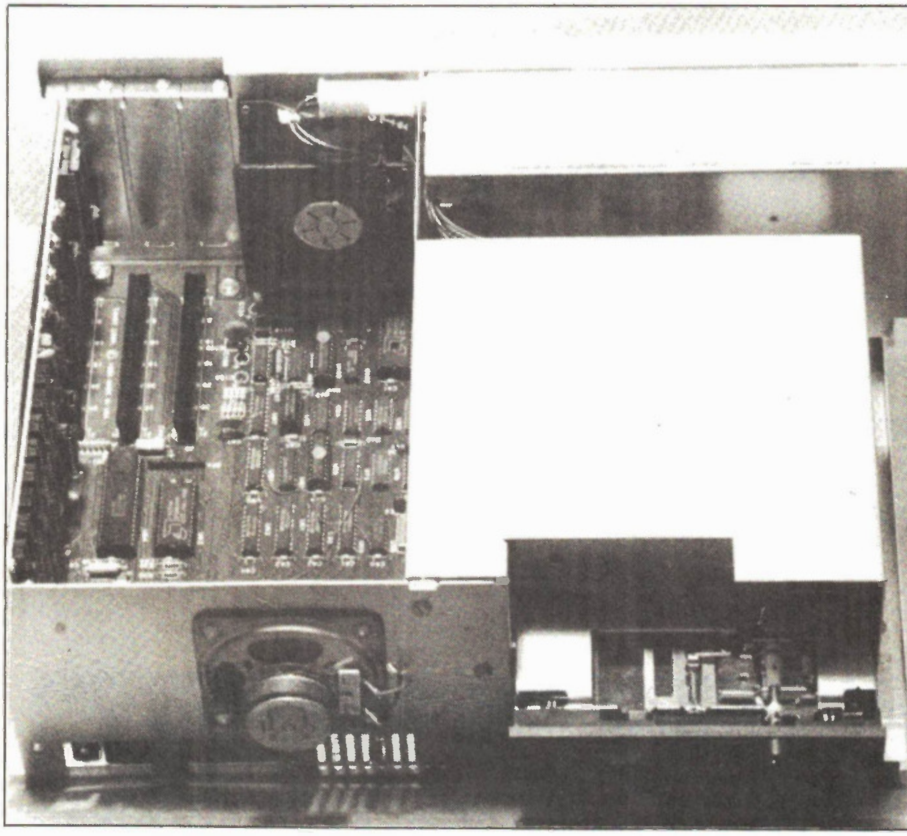
Powering Up

The standard Tandy 1000 comes equipped with 128K of memory, one 360K double-sided drive, and all the previously mentioned goodies. The 1000's BIOS appears to be jointly developed by Tandy and the Phoenix Compatibility Corp. Phoenix presently supplies the BIOS for several PC work-alikes on the market today.

Upon applying power, the 1000 immediately displays the current amount of memory installed in the system and proceeds to do the standard memory check. Once complete, all systems are go for using just about any MS-DOS/PC-DOS software you can get your hands on. Also, the fan runs so incredibly quietly that you'd wonder if it was even there, a definite plus in comparison to some of the wind machines used to cool other computers.

As keyboards go, the Tandy 1000's 90-key layout is not much different from any of the thousands of keyboards in existence with the exception of two extra function keys, numbers 11 and 12. The necessary CTRL, ALT, and DELETE are present for accommodating PC-type software.

The monitor which Radio Shack sent along for the review was their CM-2 RGB high resolution monitor. Its 13 inch display was crisp and the colours were sharp. WordStar on a red background with white lettering was definitely a different touch.



Speaking of Software . . .

The standard Tandy 1000 comes with MS-DOS, GW-BASIC, and an integrated software package known as DeskMate. The MS-DOS and GW-BASIC are Microsoft versions 2.11 and 2.02 respectively, licensed to Tandy. There are no real surprises here. In addition to the usual MS-DOS stuff there is an installation program, LPINST, for configuring the 1000 to any of a number of printers.

The Deskmate is actually a very impressive package covering a wide range of functions such as: word processing, spreadsheet analysis, electronic filing and mail, telecommunications, and appointment scheduling with an audible alarm. The electronic mail part of the package can be used in remote site applications with a host computer.

Integrated packages are not necessarily for everyone, and when they come as part of the deal, most people feel as though they have to use it or they're not getting their money's worth. If you decide you want a word processor separate from the integrated one, you may also decide on another spreadsheet or telecom package as well. The whole idea behind the integrated package begins to crumble, if you know what I mean. However, if you're looking to get into an MS-DOS based system quickly and don't care to evaluate all the various software available, Deskmate is just the ticket to get you up and running in a relatively short time.

Compatibility?

We tried a variety of software designed for the PC and its compatibles and found them all to work as promised. There are a number of packages, such as DBase III, which require at least two drives and 256K, but most of what's out there will take to the 1000 nicely.

One quirk worth noting was that the Tandy MS-DOS disk would not boot up on any other MS-DOS system. The message: 'This disk is bootable only on the Tandy 1000' is displayed and the computer then slips into a coma. Considering that a good portion of the disk's contents are licensed from Microsoft, one has to wonder as to why this limitation. However, you're not likely to be running your Tandy MS-DOS disk on anything but a Tandy, right?

Manual Labour

It seems as though whenever we get a computer in for review, the majority arrive with little or no documentation. In the case of the Tandy 1000 we received only the manuals for the Deskmate software, memory expansion, and colour monitor; no docs on the machine itself. For those of us who are familiar with computers this is not a problem, but one hopes that Tandy is shipping manuals with those computers going out to first-timers who might find some printed instructions useful.

Finally

Floating amidst a sea of MS-DOS computers, the Tandy 1000 is not excitingly different in any way. It performs all the necessary PC-like operations flawlessly and is definitely well worth the $1749 price tag. Radio Shack claims that this is $1300 less than the comparable IBM PC model. A PC model with the equivalent features (256K RAM, and a colour monitor) retails for approximately $4500-$4700, while the 1000 comes in at around $2900. The Tandy 1000 is certainly a good value when you consider the cost of other MS-DOS machines with like features. If you're considering a computer for your small business, you might well take a serious look at what the 1000 has to offer.

Quick Reference

Tandy 1000 Personal Computer

CPU:	8088
RAM:	128K to 384K with optional 256K exp. card
I/O:	parallel printer, RGB and std. video, two joysticks, light pen and audio.
DOS:	Microsoft MS—DOS
Drives:	One 360K, second is optional
Screen:	40/80x25
Resol'n:	320/640x200
Sound:	Yes
Colour:	Yes
Price:	$1749
Distributor and Retailer:	Radio Shack Canada, all Radio Shack Computer Centres and 'Plus' Computer Centres across Canada.

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A look at Xanaro Technologies, the makers of the Ability integrated software package.

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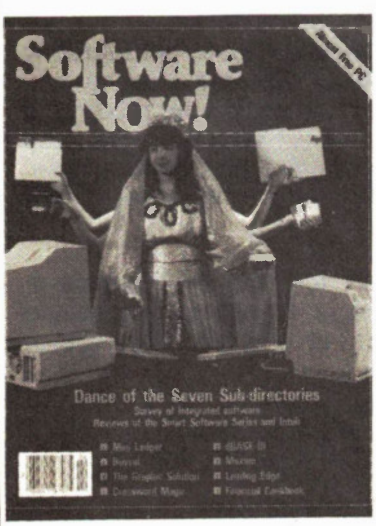

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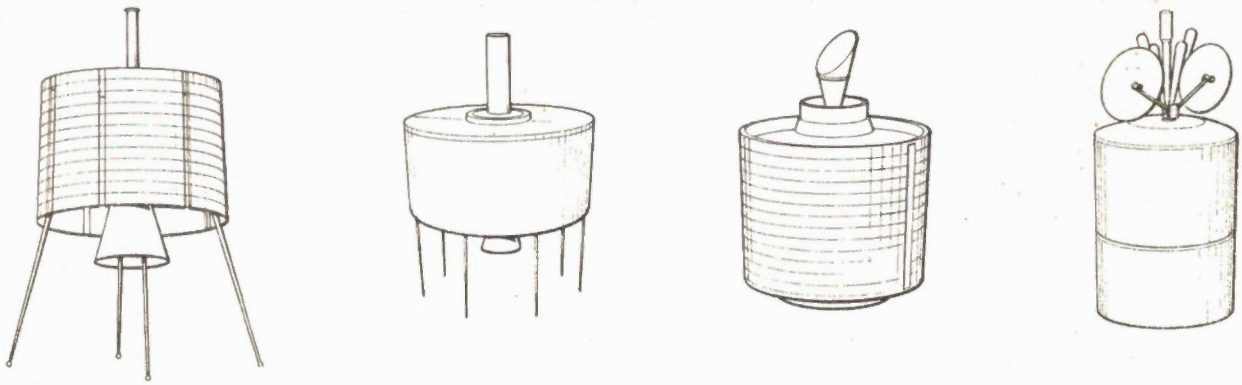


Fig. 1-4 The changing face of satellites: (from l to r) INTELSATs I, II, III, IV. Shown at the top fo the page is Telstar (photo by courtesy British Telecom).

Communications Satellites

A look at the real world of communication satellites — some history and how they work.

By Roger Bond

ANY space enthusiast will tell you about Telstar and any school boy will tell you of the killer breed of satellites pranging each other on the big screen. In between these two extremes is the reality of modern satellite communications.

In 1962, Telstar was the first, in circular orbit around the earth and at a height of about 250 miles. So it was visible for only about half an hour from any given earth station, and Goonhilly's first aerial weighing 1100 tons had to be quite a smooth operator in order to track this fast-moving busybody.

In June 1965 Early Bird (INTELSAT1) went into geostationary orbit over the Atlantic. INTELSAT stands for INternational TELecommunications SATellite and a geostationary orbit is an orbit stationary with respect to a point on the earth, ie. the satellite is moving with the earth's rotation and so staying in the same position with respect to the earth's surface.

Two other satellites took up station over the Pacific and Indian Oceans in 1967 and 1969 respectively and earthlings were fully covered by eyes in the sky. These three satellites formed the INTELSAT I network working to Andover (USA) Raisting (Germany), Goonhilly (UK) and Pleumeur Bodou (France). These satellites provided 240 circuits but could work to only one ground station at a time. INTELSAT II removed this limitation. The signal strength from these satellites was so low that receiving equipment had to be cooled in liquid helium (4.2 K, −268.8 °C) to suppress background noise. Receiving signals from these satellites was like trying to pick up heat from a one killowatt electric heater stationed as far away as the moon.

In 1968 Aerial 1 at Goonhilly was joined by a second and in 1972 by a third aerial. Aerials are located in the south of England because the further south the antenna is, the less ground-generated interference it will 'see'; the further north the aerial, the closer to the horizon the satellite gets, until it vanishes from sight!

In 1977 INTELSAT IV was launched with a life of seven years but in this short space of time the demand had increased so much and technology had advanced so rapidly that the IVA was launched in 1978 followed by today's INTELSAT V in 1980. The main difference between the IV and IVA apart from an increase of circuit capacity (4000 to 6000), was assignment by demand, SPADE, on the IVA — but more about that later.

Modern Satellites

To understand the trend and thinking towards modern satellite communications we need to start with INTELSAT IV. Figures 1 to 4 show the profiles of INTELSATS I to IV. Intelsat IV like all modern satellites is positioned 36,000 km above the earth and produces a 0.5 sec delay in a two way conversation. That is the time it takes for radio waves travelling at the speed of light to 'bounce' off the satellite. These signals are transmitted upwards at a frequency of 6 GHz and down at 4 GHz, so inside the satellite is a transponder which is a receiver, a frequency changer and a transmitter.

In fact there are twelve transponders each with a bandwidth of 36 MHz and a guard band of 4 MHz between transponders. Therefore the total satellite bandwidth is about 500 MHz. There are two types of aerials:—

a) The global beam, which is a horn type and radiates a beam of 17° width;

b) The spot beam, which is a parabaloid dish radiates a much narrower beam, only 4.5° in width, which covers a smaller area on the earth. The effective power is 35dBw (that is, to the receiver on earth, the signal is 35dB up on what would be radiated by a dipole aerial radiating 1 watt of RF power); by comparison, the effective power of the global beam is 23dBw.

The spot beams, with their focussing are used for high-density traffic, from one point and another, eg USA to UK. The global beams, being unfocussed, carry signals of interest to many countries; so one small user-country can communicate with another by extracting at the earth station and carrier that is of particular interest to it and rejecting all the other carrier; this facility is used mainly for television.

Compared to INTELSAT III, INTELSAT IV has a smaller bandwidth for the same channel capacity and this is achieved by reducing the frequency deviation of the FM (Frequency Modulated) carriers. The guard band is 10% to 20% of the occupied bandwidth for IV compared to 60% to 90% for III. The FM carriers can cope with 24 channels up to 960 channels depending on the carrier chosen. These channels are 4kHz audio channels which may be used to carry data or speech.

INTELSAT IV Earth Segment

Engineers use the jargon 'space segment' for the earth station. Usually restrictions on the launch rocket payload limit the size of aerials that the satellite can carry and the power available to feed those aerials.

Hence the burden of picking up weak signals from satellites and radiating strong signals back becomes the responsibility of the earth segment.

To keep the earth station costs down, the number of different sizes of carrier frequency is restricted to nine. The carrier to noise ratio is about 10dB so expensive threshold demodulators, also used in INTELSAT III, are still needed.

One kind of threshold demodulator is the frequency modulated feedback type, in which a fraction of the output signal from the demodulator is fed back to a voltage controlled oscillator which is controlled by a phase comparator. This helps to reduce the deviation of the centre frequency to zero, and the accurate centering of the signal gives an improvement of the carrier-to-noise ratio.

We shall look at the transmit and receive directions of the earth segment separately but they do have certain aspects in common. For instance, they both use travelling wave amplifiers.

One kind of travelling wave tube (TWT) is the helix type (Fig. 6), in which a spiral coil or wire is used to propagate the signal. The pitch of the spiral turns determines the speed of signal propagation. A magnetic field parallel to the axis of the tube prevents spreading of the electron beam. Reflection at the output could cause oscillations and an absorber is used to prevent this.

The other thing that they have in common is that they both use an IF of 70MHz, although transmit and receive frequencies are different, these being 6GHz and 4GHz respectively.

Transmit Direction

The intermediate frequency is 70MHz which is converted to 6GHz. There are two stages of power amplification using travelling wave tubes. The first TWT gives 39dB gain over its 500MHz bandwidth and the second TWT gives about 30dB gain. For a single carrier the power of the transponder can be concentrated; for several carriers the power must be distributed. If multiple carriers are used with, say, an output of 1kW each, the minimum gain will be 30dB and, because of the manner in which TWTs operate, this will be at the top of the spectrum. The maximum permissible variation is 10dB over the 500MHz satellite band.

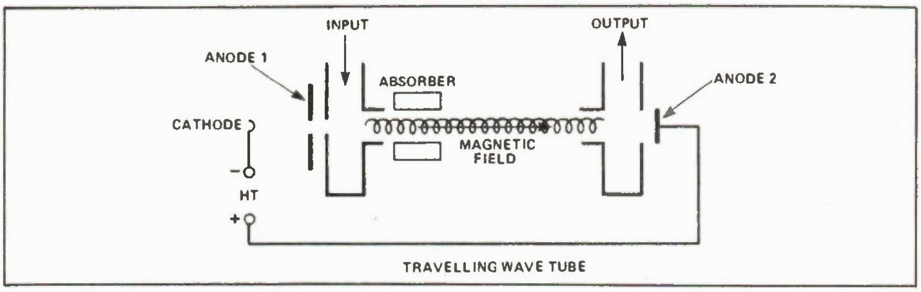


Fig. 6 A travelling wave tube.

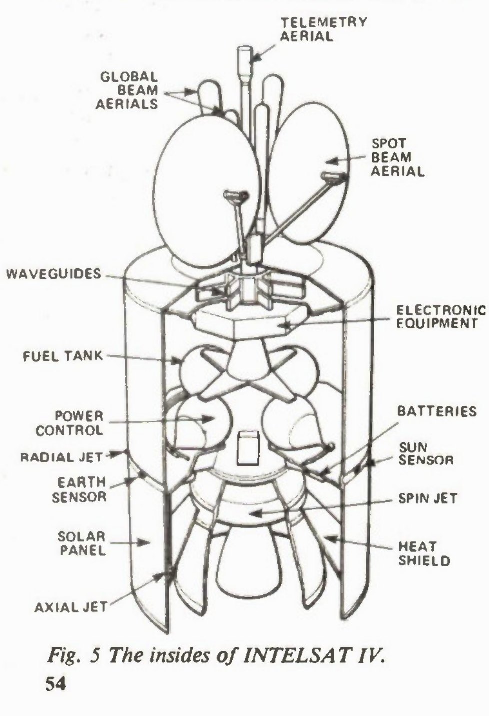


Fig. 5 The insides of INTELSAT IV.

Supergroups, which are blocks of twelve channels each 4kHz wide, are reassembled at the earth station depending on their destinations. The supergroups occupy the bandwidth 60kHz to 108kHz. Groups on landlines occupy the bandwidth 60-108kHz = 48kHz and it is possible to fit another group in the spectrum space below 60kHz, starting at 12kHz ie 60-12 = 48kHz.

A 60kHz pilot is inserted at the earth station and failure of this pilot will cause changeover to standby equipment at the earth station. The sub-baseband 4 to 12kHz is used in 4kHz lots for engineering services. Each 4kHz has a speech channel in the range 300-2600Hz and the rest of the 4kHz slot is used by five telegraph channels.

The portion below 4kHz is used for energy disposal. A symmetrical triangular wave form is applied to the modulator during light traffic periods to spread the energy across the spectrum and prevent peaks of high energy.

Low capacity equipment will have less standby than high capacity equipment. For instance, for 24-channel telephony, there is one lot of standby equipment for every five in use. For high capacity carriers, say 900 channels between the UK and USA, the RF equipment that is usually duplicated is demodulators, baseband equipment ie equipment which assembles groups of channels, and double down converters which are explained in the next section.

Receive Path

Figure 8 shows the receive path of earth station equipment illustrating double down conversion. The first IF is at 770MHz and the second at 70MHz. But before it gets to this stage it passes through three stages of parametric amplifiers, cooled to a temperature of 16K. These amplify a weak signal of typically — 120dBW by 30dB. The signal then passes through a travelling wave amplifier which supplies another 40dB amplification over the whole 500MHz bandwidth. We can now develop the picture in Fig. 8 to that in Fig. 9.

There is a choice of power amplifiers. Travelling wave tubes are more flexible but the multi-cavity klystron is more efficient. The TWT needs to work about 10dB below full power to avoid intermodulation distortion. On the other hand the klystron needs time for tuning up and there can be long breaks if a frequency change is required.

Threshold extension demodulators lower the threshold of the impulsive noise. The threshold is the point at which the signal-to-noise ratio becomes unacceptable and too much information is lost. The semiconductors used have specially doped junction with reach-through effects which enables low power signals to be recovered.

With the present state of art of transistor technology, a total noise figure of 10,000pW has been chosen as a design limit for a satellite link. Any signal greater than this can be detected, any signal below this figure is lost. All the time designers are developing new methods of reducing noise in equipment enabling the detection of weaker signals.

Most of the noise comes from the aerial itself and the first stage of amplification and if we take G as the gain of the aerial and T as the temperature in degrees absolute then G/T gives a rough rule of thumb relating aerial gain to temperature in order to detect a signal in the presence of noise. We can see that increasing the value of G gives an improved figure hence the large diameter aerials at earth stations. We can also improve this figure of merit by reducing T which is why the equipment is cooled reducing thermal agitation and hence reducing the noise contribution from thermal noise.

Earlier we mentioned the need to limit the number of different carriers to nine. However by 1975 these had increased to twenty and the early frequency splitters used circulators but now stripline

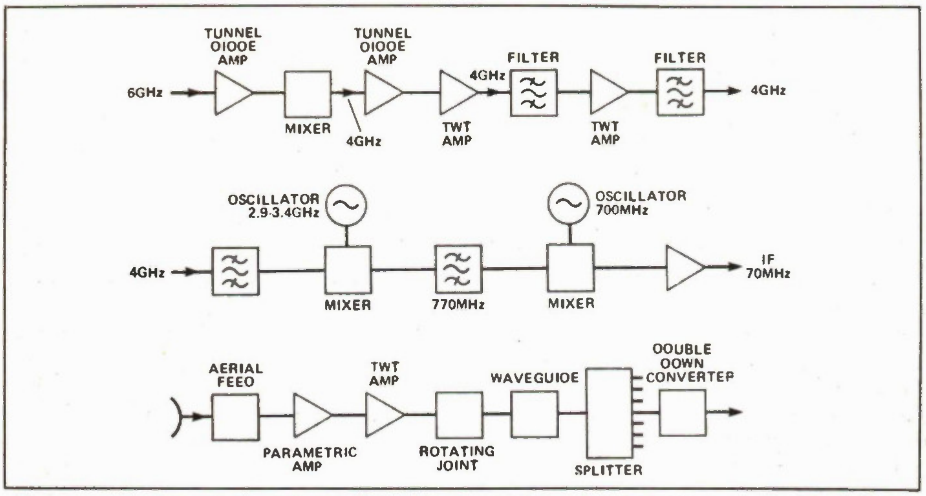


Fig. 7 (top) Signal path through a satellite. Fig. 8 (middle) A double down converter. Fig. 9 (bottom) Full receive path of an earth station.

couplers giving two outlets each are available. A circulator is a wave guide with a ferrite rod at the axis of the waveguide and if an external magnetic field is applied to rotate the wave then a wave perpendicular to port one will exit at port three, a wave perpendicular to port 2 will exit at port 4 and so on.

A stripline is a metal conductor embedded in dielectric. It's all part of the move away from the bulkiness of waveguid 'plumbing' and towards the compactness of semiconductors-like devices and integrated circuits if possible. Because of the large power outputs already available, the manufacturers of microwave devices have been slow to take advantage of developments in integrated circuits.

SPADE

Time is big money on a satellite link so what better way to use it than to assign speech slots only when demanded? This of course makes it expensive for the earth station which needs to have computer controlled equipment. SPADE stands for Single channel per carrier, Pulse code modulation, multiple Access, Demand assignment Equipment.

The 12 transponders of Intelsat IV each had a bandwidth of 36MHz, 5MHz, 7.5MHz, 10MHz, 15MHz, 20MHz, 25MHz and 35MHz. These could carry speech channels from 24 up to 960. For instance, if a carrier with a 35MHz bandwidth is chosen, the transponder's 36MHz is taken up. Alternately for fewer channels a combination of the smaller bandwidths can be chosen. This can be wasteful if a country wants say 35 channels. The carrier giving 2.5MHz bandwidth and carrying 24 channels is not sufficient so a carrier with a 5MHz bandwidth with a 60 channels used, the rest is wasted. In any case these channels are active for only a few hours each day because of for instance time differences between the two countries involved.

In addition, only one half of a circuit is working at any given time since usually one party speaks while the other listens. Taking all this into account there is only 40% activity during a conversation and a channel unit on the SPADE system transmits a carrier only when speech is present (ie, the power is turned off when not needed). This must not be confused with TASI (time assigned speed interpolation) which is used mainly on submarine cables (in TASI, the channel is reallocated to another talker when the user ceases speaking). A transponder can support the power requirement of 400 channels but with 40% activity this can be doubled to 800 channels since the channel unit conserves satellite power.

One 36MHz transponder is divided into 800 channels each 45KHz wide, ie. a 4KHz audio channel when frequency modulated, occupies 45KHz. Eight hundred channels equals 400 circuits since two channels are required for two-way conversation.

The king-pin of SPADE is the demand assignment signalling and switching unit (DASS) which controls the setting up of calls with up to 49 terminals at other earth stations. Communication between earth stations is over common signalling channels (CSC). These are shared by all stations on a time basis as follows.

When a request is made for a call, the DASS unit selects a pair of frequencies from its bank and informs the distant station via the CSC of the chosen frequencies. Then all DASS units immediately update their channel records.

When the call is finished the DASS unit releases the circuit and returns the carriers to its bank. DASS units can be programmed to record the duration of calls for charging purposes and any failures for engineering purposes. It is quite remarkable, the amount of work that computers could handle as long ago as ten years!

The 4kHz analogue channels are converted to digital form and transmitted at 64Kbit/s. This can easily handle data at 1200 bit/s, 2400 bit/s and 4800 bit/s which are the normal data rates over a 4kHz audio channel when used for data transmission.

Calling All Shipping

Around 1974, when SPADE started operations, the need was felt for a satellite service vice to ships, mainly because the MF and HF radio service was starting to get congested. Moreover, radio is subject to fading for hours, even days.

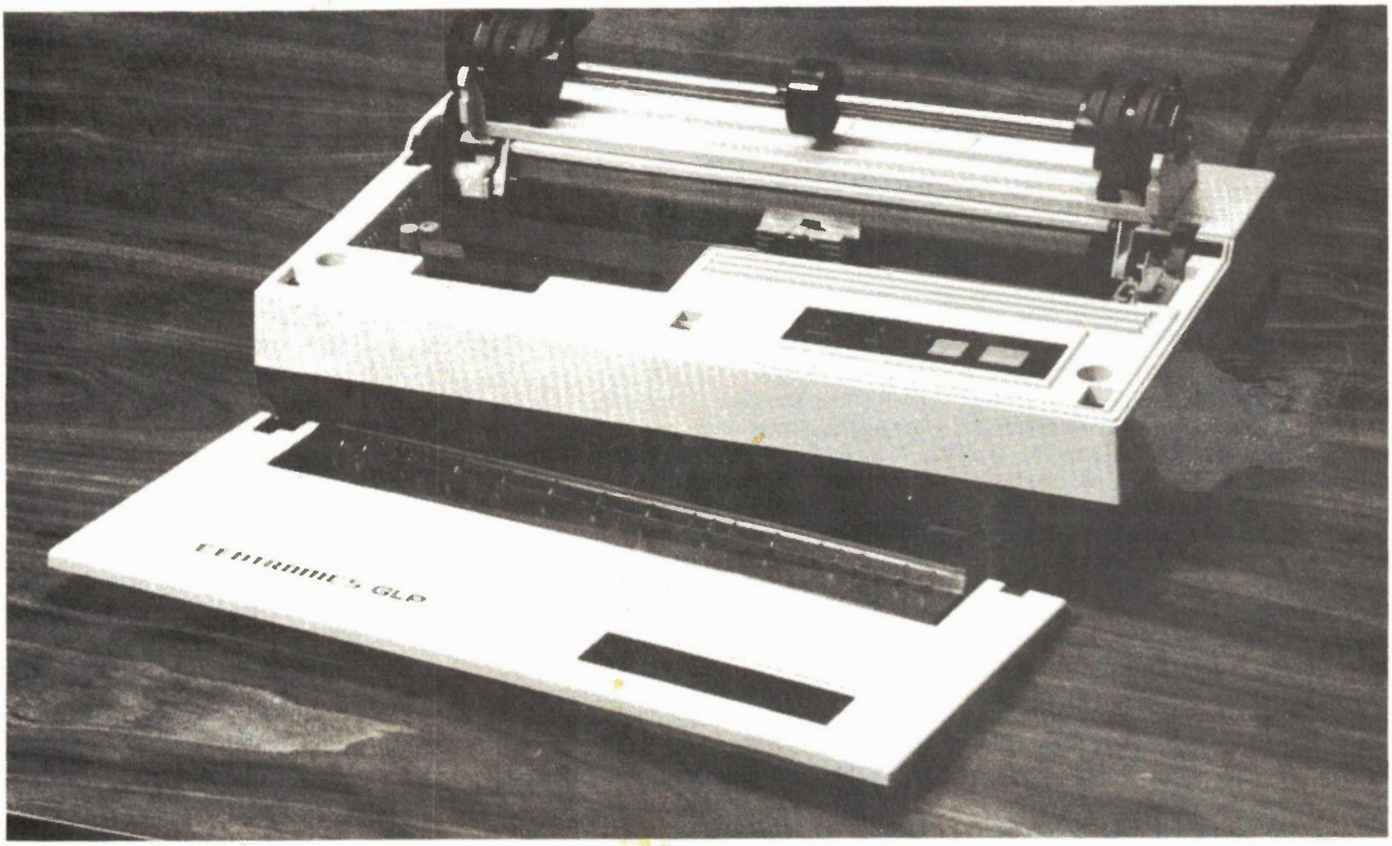
Transmission started in the L band at 1.5 GHz from satellite to ship and at 1.6GHz. from ship to satellite. A bandwidth of 7.5MHz was allocated and in the Atlantic region 80 channels would be required by 1990. At 50kHz bandwidth per channel, 4MHz out of the allocated 7.5MHz would be used and 7000 ships were expected to use this service.

In 1978 the USA launched MARISAT (MARItime SATellite) and Europe MAROTS (MARitime Orbial Test Satellite). MARISAT operated at 6/4GHz (C band) between satellite and coast station and MAROTS at 14/11GHz. These were experimental satellites. MARISAT changed to INMARSAT in 1982 and this stands for INternational MARitime SATellites. MAROTS is now MARECS, MARitime European Communications Satellite. All very confusing.

Initially satellites will be power limited rather than bandwidth limited but future satellites will have high speed data at 9.6Kbit/s for facsimile (transmission of still pictures like weather maps, newspapers etc), ship operating information, navigation, rescue and fleet messages.

Since there is more than one coast earth station (CES) in each ocean region there is a need for a network coordination centre for each region. These are at Southbury (USA) for the Atlantic Region, Iberaki (Japan) for the Pacific Ocean and Yamaguchi (Japan) for the Indian Ocean INMARSAT headquarters are in London■

Centronics GLP Printer



A small Centronics matrix printer that features excellent quality and a wealth of control codes for formatting.

By Bill Markwick

LOOKING for a printer that won't take up much room, but still offers professional quality, various fonts, and reasonable speed? The new Centronics GLP may be just the hardware. It's available in two models: one with a serial port and one with both serial and parallel ports, both of which are standard D-type connectors. I guess you can safely assume that the parallel port is Centronics-compatible. External controls are limited to buttons for online and linefeed plus a roller knob and paper release. The suggested retail price is $410 plus federal tax for the dual-input model and $390 plus tax for the serial-only.

Unwrapping

The diminutive size of the printer is remarkable: 330 by 190 by 70 mm (13 by 7.5 by 2.75 inches); despite this, it can load paper up to 10 inches wide. The basic printer is a friction-feed type, but a tractor feed is an optional extra for about $30.00.

The ribbon is a fabric type and comes in a cartridge about half the width of the printer. It's claimed to be good for 500,000 characters. If you spring for the tractor feed (a good idea - I find that fanfold paper always wanders), it snaps easily into slots near the roller. The cover (with a cutting edge for roll paper) is best removed for loading up.

The print head is a 9-pin, giving 9 by 9 resolution for alphanumerics and 8 x 6 for graphics characters; it prints 80 characters per line in the normal mode, 40 in enlarged, and 132 in condensed. Speed is 50 characters per second in the normal mode, and about half that in the near-letter-quality mode.

There are two 8-pin DIP switches accessible just below the front of the roller. These are factory set to make the printer compatible with most computers, but if you have to, you can use one of the switches to change data parameters such as baud rate, parity, number of bits, etc. The other can change the default settings for paper length, character set, etc. Incidentally, the GLP control codes are compatible with the Epson RX-80.

Booting

If you hold the Linefeed switch down and power up, you'll get the entire set of characters printed out. If you hold both Linefeed and Online, you'll get your file printed out in hexadecimal, good for hackers who are debugging a file. Loading the paper isn't particularly easy; it tends to get caught on the print head and get carbon on it.

On powering-up, the printer just hiccups once and waits silently for some bits. I sent it some by way of a WordStar text-file out of Apple CP/M. It prints quietly and accurately; 50 characters per second isn't the fastest, but it's adequate, and seems infinitely better than daisy wheel performance. Printing is bidirectional, and impact is sufficient for the original and two carbons. The mechanism that moves the carriage along is rather slow and may partly account for the 50 cps speed.

Naturally the alternate characters had to get a workout, and some of the many are reproduced here. The first surprise you get is that some word processors (including WordStar) delete the necessary control codes from the printer stream. This can be got around by printing directly from CP/M; I used the DISK.COM utility, though PIP or TYPE would do as well. If you're using some other operating system you may have to do some research if your computer traps control codes. By the way, you can use several control codes together to get various effects.

The manual gives a very good explanation of how to use these codes from BASIC, but is silent on how to use them with word processors. Most of the BASIC codes consist of CHR$ plus an ASCII number; word processors would much rather have CONTROL plus an alphabetic number. If you have an ASCII chart, you can look these up; otherwise you can find them by writing a short BASIC program using INPUT or GET and the ASC function to return the value of control codes. For instance, CHR$(14) embedded in the file turns on the Enlarged mode. This turns out to be CRTL-O. However, you'll have to find out which control code your word processor uses to allow you to embed the codes in the text. In WordStar it's CRTL-P.

Sadly, there's no italic character set. However, an interesting substitute is the NLQ, or Near-Letter- Quality, which looks like a good-quality typewriter image, though it's done by overprinting and slows things down to about half- speed. I rather like the name, with its ring of honesty. Maybe all products should be described like that: "Your new Ford has been rated AAC (Almost A Car)" or "This Woolco guitar has been designated a GSO (Guitar Shaped Object)".

```
THIS IS the normal Centronic GLP print.
THIS TEXT is the Centronic GLP Condensed Character Mode.
This is ENLARGED PRINT.
This is EMPHASIZED LARGE.
This is the underlined mode.
This is the 7/72 inch line spacing.
This is the 7/72 inch line spacing.
This is the 7/72 inch line spacing.
This is the EMPHASIZED print mode.
This is the DOUBLE-STRIKE print mode.
This is the NEAR-LETTER-QUALITY print mode.
```

Fig. 1 Some of the various fonts available by using control codes; the near-letter-quality is unusually good.

Graphics

The GLP has both 8 by 6 dot graphics characters built in and the ability to print computer graphics in three densities: 8 by 480, 8 by 960, and 8 by 1920. The example shown is in the 8 by 480 mode, and was printed from an Apple binary graphics picture. The manual doesn't explain much about getting the graphics to work, presumably because there are so many different approaches from computer to computer. The first problem noted with the Apple graphics was that the normal linefeed was too large for the graphics print and left white lines through the picture. We've included the BASIC program which used the GLP's code to adjust linefeed size.

```
5  PR# 1
10  PRINT  CHR$ (27);"A": CHR$ (6
    )
15  PRINT  CHR$ (27);"2"
20  PRINT  CHR$ (9);"GRE"
```

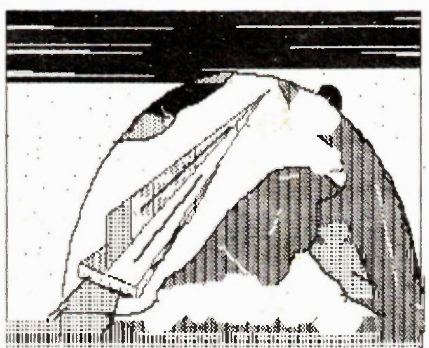


Fig. 2 A graphics print by our talentless author (it's supposed to be a rocket); the Apple BASIC print routine is included (see text).

Summary

With its 96 ASCII characters, 64 European characters, and 69 graphics symbols, plus the NLQ mode, the GLP lives up to its nickname of "Great Little Printer". Its price puts it in the same bracket as the Gemini 10, a popular dot-matrix printer with higher speed but without the letter--quality mode; the GLP's superb construction and performance will let it give the Gemini a run for its money. ■

continued from page 8

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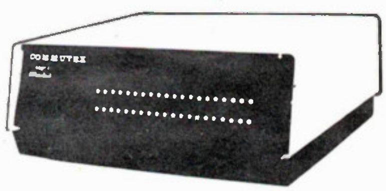

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ACT #		Pkg'd Qty	Pkg. Price
05500	7400	3	1.70
05502	7400	5	2.75
05504	7401	3	1.70
05506	7402	3	1.70
05508	7403	3	1.70
05510	7404	3	1.70
05512	7404	5	2.85
05514	7405	3	1.70
05516	7406	2	1.50
05518	7407	2	1.50
05520	7408	3	1.70
05521	7409	3	1.70
05522	7410	3	1.70
05526	7414	2	1.50
05528	7416	2	1.50
05530	7417	2	1.50
05532	7420	3	1.70
05534	7422	3	1.85
05536	7423	3	1.85
05538	7425	3	1.70
05540	7426	3	1.70
05542	7427	3	1.70
05546	7430	2	1.50
05548	7432	3	1.70
05550	7438	2	1.50
05552	7439	2	2.00
05554	7440	3	2.10
05556	7442	2	2.70
05562	7445	1	1.40
05564	7446	1	1.50
05566	7447	1	1.50
05568	7447	5	7.30
05570	7448	1	1.50
05572	7450	3	1.70
05574	7451	3	1.70
05578	7454	3	1.70
05586	7473	10	6.29
05888	7474	2	1.50
05590	7474	5	3.85
05592	7475	2	1.50
05594	7476	3	2.20
05602	7485	1	1.25
05604	7486	2	1.50
05606	7489	1	3.69
05608	7490	2	1.50
05610	7490	5	3.85
05612	7491	2	2.20
05614	7492	3	1.99
05616	7493	3	1.99
05618	7493	5	3.30
05622	7495	2	1.69
05624	7496	2	1.98
05626	7497	1	4.00
05628	74100	1	2.55

ACT #		Pkg'd Qty	Pkg. Price
05630	74104	1	1.50
05632	74105	1	1.50
05634	74107	2	1.50
05636	74109	2	1.50
05638	74116	1	2.25
05640	74121	2	1.50
05642	74122	2	1.90
05644	74123	2	1.50
05646	74123	10	7.70
06648	74125	2	1.90
05650	74126	2	1.90
05652	74132	2	1.98
05654	74136	2	1.85
05656	74141	1	1.85
05658	74142	1	5.75
05660	74143	1	7.10
05662	74144	1	6.15
05664	74145	1	1.40
05666	74147	1	2.55
05668	74148	1	1.69
05670	74150	1	2.45
05672	74151	2	1.85
05674	74153	2	1.85
05676	74154	1	2.10
05678	74155	2	1.69
05680	74156	2	2.15
05682	74157	2	1.85
05684	74160	2	1.85
05686	74161	2	2.30
05688	74162	2	2.40
05690	74163	2	2.30
05692	74164	2	2.30
05694	74165	2	2.55
05696	74166	1	1.75
05698	74167	1	4.90
05700	74170	1	3.10
05702	74172	1	7.70
05704	74173	1	1.69
05706	74174	1	1.12
05708	74175	2	2.00
05710	74176	1	1.50
05712	74177	1	1.50
05714	74179	1	2.00
05718	74181	1	3.69
05720	74182	1	1.50
05722	74184	1	3.65
05724	74185	1	3.65
05726	74190	1	1.40
05728	74192	2	2.25
05730	74193	2	2.25
05732	74194	1	1.40
05734	74195	2	2.15
05736	74196	1	1.50
05738	74197	1	1.50
05740	74198	1	2.30
05742	74199	1	2.30
05744	74221	1	1.40
05746	74251	1	1.50
05748	74276	1	3.85
05750	74279	1	2.30
05752	74283	1	2.00
05756	74285	1	4.69
05758	74365	2	2.00
05760	74366	2	2.00
05762	74367	2	2.00
05764	74368	2	2.0L
05766	74390	1	2.30
05768	74393	1	2.30

74LS

ACT #		Pkg'd Qty	Pkg. Price
05770	74LS00	4	$1.85
05772	74LS00	10	4.25
05774	74LS01	4	1.85
05776	74LS02	4	1.85
05778	74LS03	4	1.85
05780	74LS04	4	1.85
05782	74LS04	10	4.40
05784	74LS05	4	1.85
05786	74LS08	4	1.85
05788	74LS08	10	4.40
05790	74LS09	4	1.85
05792	74LS10	4	1.85
05794	74LS10	10	4.40
05796	74LS11	4	1.85
05798	74LS12	3	1.50
05800	74LS13	3	1.50
05802	74LS14	2	1.60
05804	74LS15	2	1.60
05806	74LS20	4	1.85
05808	74LS21	4	1.85
05810	74LS22	3	1.50
05812	74LS26	3	1.50
05814	74LS27	4	1.85
05816	74LS28	3	1.50
05818	74LS30	4	1.85
05820	74LS32	4	1.85
05822	74LS33	3	1.50
05826	74LS37	3	1.65
05828	74LS38	3	1.65
05830	74LS40	3	1.50
05832	74LS42	3	2.00
05834	74LS47	2	2.15
05836	74LS48	2	2.45
05838	74LS49	2	2.00
05840	74LS51	4	1.85
05842	74LS54	3	1.40
05844	74LS55	3	1.40
05846	74LS73	3	1.65
05843	74LS74	3	1.50
05850	74LS75	3	1.75
05852	74LS76	3	1.69
05854	74LS78	3	1.69
05856	74LS83	2	2.30
05858	74LS85	1	1.65
05860	74LS86	3	1.65
05862	74LS86	5	2.75
05864	74LS90	3	2.00
05866	74LS92	3	2.00
05868	74LS93	3	2.00
05870	74LS95	2	1.60
05872	74LS96	2	1.69
05874	74LS107	3	2.00
05876	74LS107	5	2.90
05878	74LS109	3	1.85
05880	74LS112	3	1.85
05882	74LS113	3	1.69
05884	74LS114	3	1.69
05886	74LS122	3	1.50
05888	74LS123	2	2.00
05890	74LS123	5	4.75
05892	74LS125	3	1.85
05894	74LS126	3	1.85
05896	74LS132	2	1.85
05898	74LS132	5	4.40
05900	74LS133	2	1.50
05901	74LS136	3	1.69
05902	74LS138	2	1.50
05903	74LS138	5	3.65
05904	74LS139	2	1.50
05905	74LS139	5	3.65
05906	74LS148	1	2.30
05907	74LS151	2	1.50

ACT #		Pkg'd Qty	Pkg. Price
05908	74LS151	5	3.65
05909	74LS153	2	1.50
05911	74LS155	2	2.00
05912	74LS156	2	1.75
05913	74LS157	3	2.10
05914	74LS158	2	1.50
05915	74LS160	2	2.00
05916	74LS161	2	2.00
05917	74LS162	2	2.00
05918	74LS163	2	2.00
05919	74LS164	2	2.00
05920	74LS165	2	2.15
05921	74LS166	1	2.10
05922	74LS169	1	1.50
05923	74LS170	1	2.00
05924	74LS173	2	1.60
05025	74LS174	2	1.75
05926	74LS174	5	4.15
05927	74LS175	2	1.75
05928	74LS181	1	2.69
05929	74LS190	2	2.25
05930	74LS191	2	2.25
05931	74LS192	2	2.25
05932	74LS193	2	2.25
05933	74LS194	2	1.50
05934	74LS195	2	1.50
05935	74LS197	2	2.15
05936	74LS221	2	2.59
05937	74LS240	1	1.45
05938	74LS240	5	6.95
05939	74LS241	1	1.40
05940	74LS241	5	6.50
05941	74LS242	2	2.45
05942	74LS243	2	2.45
05943	74LS244	1	1.45
05944	74LS244	5	6.95
05945	74LS245	1	1.69
05946	74LS245	5	8.00
05947	74LS247	2	2.15
05948	74LS248	1	1.40
05949	74LS249	1	1.40
05950	74LS251	1	2.59
05951	74LS253	2	1.50
05952	74LS257	1	1.69
05953	74LS258	2	1.69
05954	74LS259	1	1.50
05955	74LS266	3	1.50
05956	74LS273	1	1.50
05957	74LS279	3	1.75
05958	74LS283	2	1.75
05959	74LS290	2	1.85
05960	74LS293	2	2.00
05961	74LS298	2	2.30
05962	74LS323	1	4.60
05963	74LS352	2	2.15
05964	74LS353	2	2.15
05965	74LS365	3	1.99
05966	74LS366	3	1.99
05967	74LS367	3	1.99
05968	74LS367	5	3.10
05969	74LS368	3	1.99
05970	74LS373	1	1.50
05971	74LS373	5	7.30
05972	74LS374	1	1.50
05973	74LS375	3	1.99
05974	74LS386	3	1.50
05975	74LS390	1	1.30
05976	74LS393	2	2.30
05977	74LS399	1	1.45
05978	74LS624	1	1.99
05979	74LS629	1	3.45
05980	74LS640	1	2.25
05981	74LS670	1	2.25

74S

ACT #		Pkg'd Qty	Pkg Price
05S02	74S00	2	$1.50
05S04	74S02	2	1.50
05S06	74S04	2	1.50
05S08	74S08	2	1.50
05S09	74S10	2	2.25
05S10	74S20	2	1.50
05S12	74S32	2	1.69
05S35	74S38	1	1.50
05S40	74S51	2	1.50
05S13	74S64	2	2.25
05S14	74S74	2	1.69
05S15	74S85	1	2.69
05S16	74S86	2	2.10
05S17	74S109	1	2.25
05S19	74S112	2	2.10
05S45	74S124	1	3.75
05S18	74S138	1	1.95
05S50	74S157	1	1.75
05S20	74S158	1	1.75
05S21	74S163	1	4.00
05S55	74S169	1	5.89
05S60	74S174	1	1.95
05S22	74S175	1	1.95
05S24	74S188	1	2.30
05S65	74S189	1	5.59
05S70	74S201	1	7.49
05S75	74S225	1	7.49
05S25	74S240	1	3.39
05S27	74S244	1	3.39
05S30	74S260	1	2.39
05S26	74S373	1	3.39
05S32	74S374	1	3.39
05S28	74S387	1	3.10

74F SERIES FAST

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05F01	74F00	2	$1.50
05F03	74F02	2	1.50
05F05	74F04	2	1.50
05F07	74F08	2	1.50
05F09	74F10	2	1.50
05F10	74F11	2	2.30
05F11	74F20	2	1.50
05F15	74F32	2	1.85
05F16	74F64	2	2.30
05F17	74F74	2	1.69
05F19	74F86	2	2.15
05F20	74F109	1	2.10
05F22	74F112	1	1.90
05F24	74F113	1	1.90
05F26	74F114	1	1.90
05F28	74F138	1	1.90
05F30	74F139	1	1.90
05F32	74F148	1	2.10
05F34	74F151	1	1.90
05F36	74F153	1	1.90

ACT #		Pkg'd Qty	Pkg Price
05F38	74F157	1	1.90
05F40	74F158	1	1.90
05F42	74F160	1	4.59
05F44	74F164	1	3.00
05F46	74F174	1	3.00
05F48	74F175	1	3.95
05F50	74F181	1	5.90
05F52	74F182	1	3.00
05F54	74F189	1	7.50
05F56	74F190	1	4.60
05F58	74F191	1	4.60
05F60	74F192	1	5.35
05F62	74F193	1	5.35
05F64	74F219	1	7.15
05F66	74F240	1	3.39
05F68	74F241	1	3.39
05F70	74F244	1	3.40
05F72	74F245	1	7.30
05F74	74F251	1	1.90
05F76	74F253	1	1.90

ACT #		Pkg'd Qty	Pkg Price
05F78	74F257	1	1.90
05F80	74F258	1	1.90
05F81	74F280	1	2.20
05F82	74F283	1	4.05
05F83	74F350	1	4.15
05F84	74F352	1	1.85
05F85	74F353	1	1.85
05F86	74F373	1	4.55
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05F88	74F378	1	2.75
05F89	74F379	1	2.65
05F90	74F381	1	5.93
05F91	74F382	1	6.40
05F92	74F384	1	14.69
05F93	74F385	1	13.25
05F94	74F398	1	4.90
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New HF-Antenna from GARANT

The new GARANT GD-6 is a 6-band dipole for 80-40-20-17-12-10m. The GARANT GD-8 is basically a GD-6 but uses two additional tuned wires to work the 30m and 15m bands. The GD-6 and GD-8 are at most 41.5m (137') long and fit into most backyards. If this space is not available the GD-6 and GD-8 may be used as Inverted-V antennas. Both antennas are rated for 500 W PEP and permit the use of all currently manufactured transmitters and transceivers.

Principally the GARANT GD-6 and GD-8 are windom type antennas. Instead of using a high impedance feedline which is a must for a windom antenna, the GD-6 and GD-8 can be operated with regular coax cable ranging between 50 and 60 Ohm. Therefore RG8/U or RG213/U will work fine with these antennas. This low impedance feedline is possible through the special GARANT BALUN that these antennas use. Although the GD-6 and GD-8 are high impedance antennas, this special balun matches the low impedance feedline to the high impedance antenna.

The introductory price for the GARANT GD-6 will be $89 and for the GARANT GD-8 $99. A conversion kit that upgrades the GD-6 into a GD-8 will cost $20. All prices include shipping, handling and insurance. These antennas are only available from GARANT ENTERPRISES, 227 County Blvd., Thunder Bay, Ontario, P7A 7M8, Tel. (807) 767-3888. Ed, VE3LML, the general manager of Garant Enterprises has promised to mail free literature on these and other GARANT-antennas to all interested hams.

ZX81 RAMpack Update

In our April '85 issue we featured an expansion project for the ZX81. In figures 2 and 3, certain labels mysteriously went missing. The correct diagrams appear here. Our apologies.

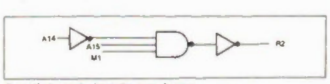


Figure 1. Logic expression for selecting the new RAMpack.

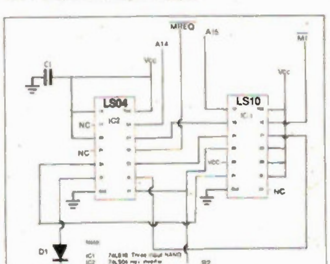


Figure 3. Circuit of the RAM selector using a three input NAND and a hex inverter.

New Addition to Beckman Circuitmate line

The Instrumentation Products Division of Beckman Industrial Corporation has added to its Circuitmate™ line the DM10, a new 3-1/2 digit multimeter that retails for $58.00 Canadian, weighs only 4-1/2 ounces, and is the same size as a pocket calculator.

The DM10 has a rotary switch, half inch high digits on the LCD display, five DC voltage ranges from 200mV to 1KV, overload protection to 1KVDC in all ranges above 200mV, and 500VDC for the 200mV range. In AC volts, the ranges are from 200 to 500VAC, with overload protection in all ranges to 500VDC and VAC.

Five resistance ranges are 200, 2K, 20K, 200K, and 2000K, and are overload protected to 250 VAC/VDC. A diode test function is also included. The DC current ranges are 200uA, 2mA, and 200mA, all protected by an .8A/250V fuse. Test leads are included. Battery life is 150 hours with an ordinary zinc-carbon battery.

For further information contact Doug Pettifer, Lenbrook Electronics, Unit 1, 111 Esna Park Drive, Markham, Ontario. L3R 1H2. Phone 477-7722.

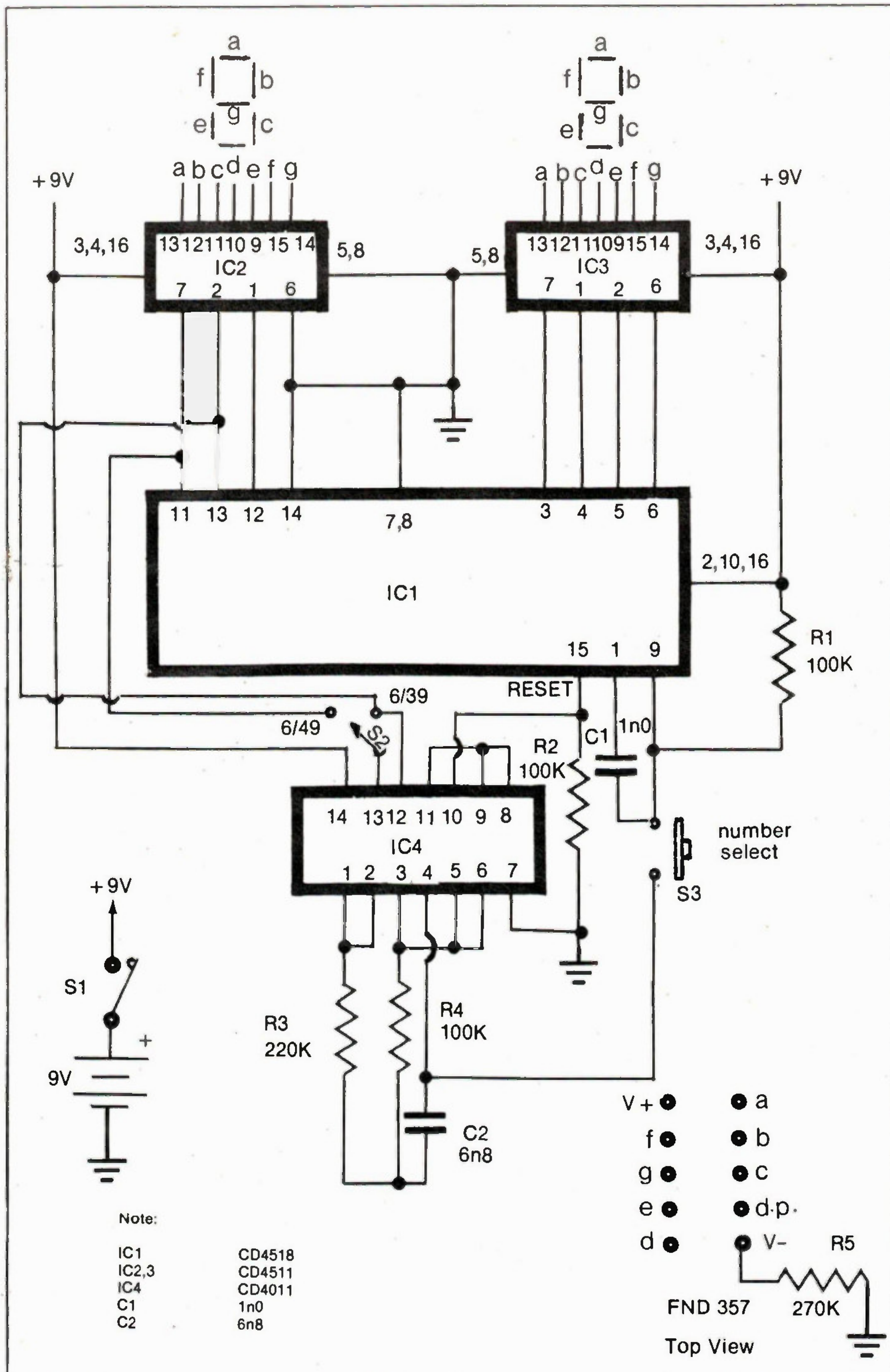
continued from page 24

Random Number Selectory

By Dick Choy

THIS is a very simple circuit utilizing four common CMOS ICs, three switches, and a handful of resistors and capacitors. The LEDs used were FND 357 common cathode type but any similar LEDs could just as well be used. It was designed to select numbers for either the 6/49 or 6/39 lotteries.

IC1 is a 4518 dual BCD counter, and IC2 is a 4011 dual input quad NAND gate. Two of the gates are used for an oscillator which permits the number to change after each selection. The other two are used to reselect the left digit in the event it exceeds four in the 6/49 mode and three in the 6/39 mode ■



Regulator For DC Generators

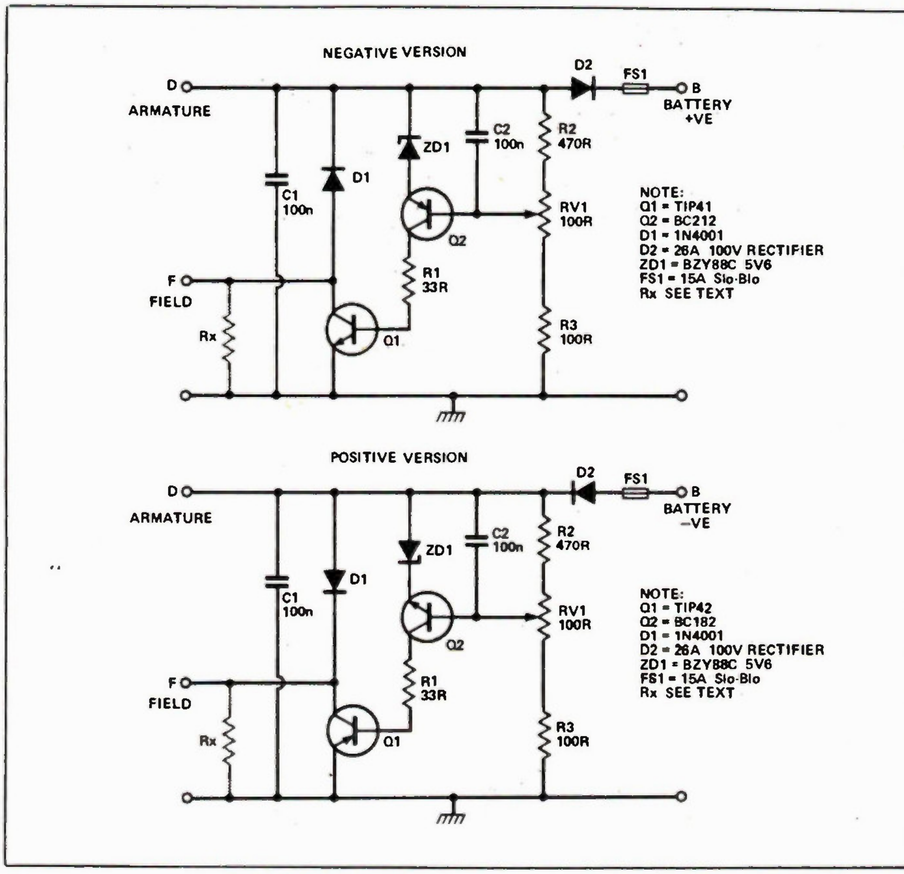
By J. Michael

This circuit was developed to replace the regulator on a motorcycle when the original component failed and a replacement proved impossible to obtain, as original components do and are. It is designed to control the output voltage of a 6V generator used for charging a lead-acid battery, but it could just as easily be adapted to suit other voltages. Both positive and negative ground versions are illustrated and in either case the circuit will replace the original regulator without modification of the existing wiring.

Rx is the field current control resistor. On the original unit this was incorporated in the generator, but for most applications a separate resistor may have to be fitted in the regulator. The exact value will depend on the generator in use. A 10W wirewound type should be used. The series diode D2 replaces the cutout relay in the original regulator. D2 and Q1 should be mounted on a small heatsink.

The BC212 may be a 2N6015 or similar, and the BC182 may be a 2N5825 or similar. The 5V6 Zener diode should be a 400mW or larger unit.

To set up the desired charging voltage, which is 6V9 in the case of a 6V lead-acid battery, set RV1 fully clockwise (i.e., at minimum output voltage) and run the generator at maximum speed with a fully-charged battery connected. RV1 should then be adjusted until the battery voltage is correct.



NOTE: Time flies like an arrow, but fruit flies like a banana.

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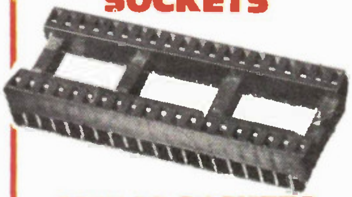

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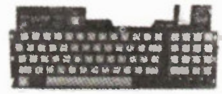

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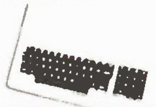

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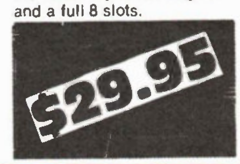

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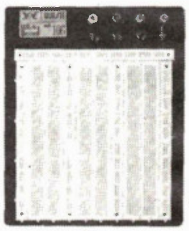

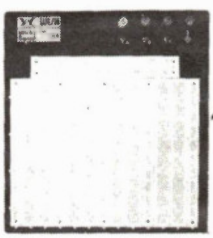

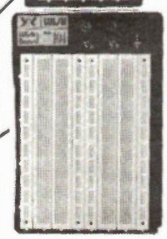

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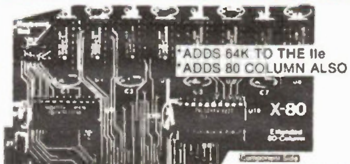

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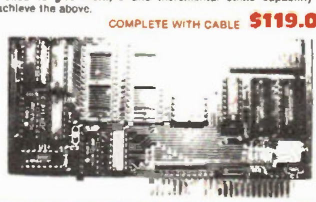

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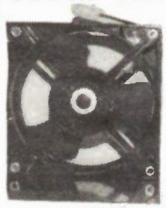

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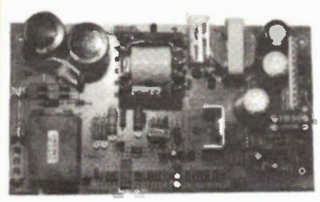

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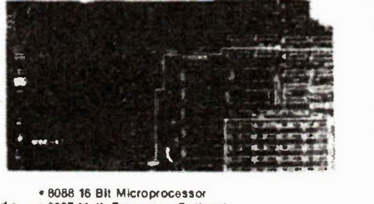

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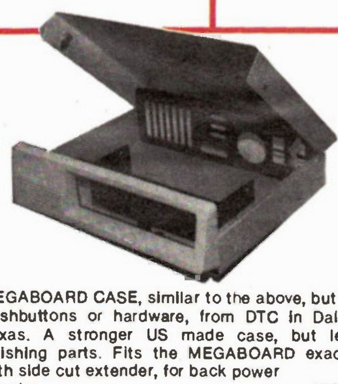

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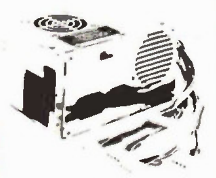

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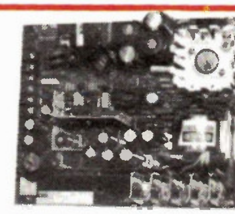
130 WATT + 5v-14A; + 12v-4.2A; ± 12V-1/2A $169.00
Please specify, side or back switch

8" DRIVE SWITCHING POWER SUPPLY

$39[95]



The greatest 8" Drive supply we have ever found. Has 24V-2.2A 5V-3A and -12V-.17A. All you need for a dual 8" Drive system. A switching power supply by ASTEC ... $39.95

PARTS, PARTS, PARTS, PARTS, PARTS

Hard to get parts for your IBM compatable (8088) systems and peripherals

8088 CPU $14.95
8087 Math Processor $219.00
8237A-5 Prog. DMA Cntrl. $14.95
8250 Serial Port $11.50
8253A-5 Prog. interval timer $7.50
8255A-5 P.I.A. $8.95
8259A Prog. Interrupt Cntrl. $6.95
8284A ADC clock gen & driver $7.75
8288 Bus Controller $15.50
8272 Floppy Disk Controller $14.95
NEC 765 Floppy Disk Controller (equivalent to 8272) $14.95
Set of 8088, 8255A-5, 8237A-5, 8288, 8284, 8253A-5 and 8259A $69.00

All parts (except NEC765) are prime parts made by Intel.

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100ns delay line $6.00
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62 pin edge con (high quality) $2.40
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Power conn $1.25
Dip switch 8 pos $2.49
4.7k x 6 sip .... $ .69
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8.2k or 10k 16 pin Resistor or network .... $ .99
33ohm x 8 network $1.10
Small speaker $1.99
.1 uf 50V high quality bypass capacitors .... $ .10
Trimcap .... $ .99
34 pin card edge con. $5.95
for your floppy controller

LS for IBM Systems

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02 .... $0.39
04 .... $0.39
08 .... $0.39
10 .... $0.45
20 .... $0.45
27 .... $0.45
30 .... $0.45
32 .... $0.80
74 .... $0.50
138 .... $0.70
158 .... $0.75
175 .... $0.80
243 .... $1.20
244 .... $1.25
245 .... $1.50
273 .... $1.50
322A $6.00
323 .... $3.50
373 .... $1.40
374 .... $1.40
377 .... $1.25
670 .... $1.75
7407 TTL $1.00

S SERIES

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S02 .... $0.75
S04 .... $0.75
S08 .... $0.75
S74 .... $0.85
S138 .... $1.75
S157 .... $1.85
S158 .... $1.85
S374 .... $3.25

MISC

75477 .... $1.25

Hard to get parts for your 6502 Systems and Apple Compatible Peripherals.

6502 CPU .... $ 5.50
6845 CRT controller .... $ 9.50
68A45 CRT controller .... $ 9.95
Z80A CPU (4 MHz) .... $ 4.99
MC3242 .... $11.95
74LS367 .... $ .62
74LS259 .... $ 1.39
74LS161 .... $ .99
74S74 .... $ .82
74S174 .... $ 1.70
74LS323 .... $ 4.55
Card edge connector (50 pin) .... $ 2.49
RCA jack PC mount .... $ .69
6 pin power square connector .... $ .99
Phono jack (small) .... $ .99
MPSA 13 trans .... $ .55
2N3904 trans .... $ .19
2N3906 trans .... $ .27
MPSU51 trans .... $ .79
2N4258 transistor or equiv .... $ .69
1K SIP 10 pin .... $ .69
1K SIP 8 pin .... $ .69
10K SIP 10 pin .... $ .75
4 pos dip sw .... $ .95
20 pin female header for disk drive .... $ 1.79
20 pin male .... $ 1.69
50 pf trim cap .... $ .89
220 ohm trimpot .... $ .69
20 conductor ribbon cable .... $ .89/ft.

MONOLITHIC CAPS

MONOLITHIC CERAMIC CAPS
We bought 100,000 of em dirt cheap, they are very good quality, 63V, 0.2" lead spacing. Now only 10¢ ea.
50 pcs. .... $ 5.00
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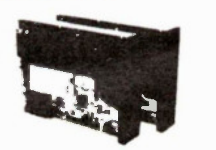
more? ask!

WE'VE GOT EM!

5-1/4" HALF SIZE DRIVES! For IBM PC, TI PC, XEROX 820



Shugart/Panasonic ½ size SA455-3AEC $189.00

TEAC (A Cadillac Drive) ½ size FD55B $189.00

Canon MDD210 2/3 size, a real buy with, red/green led, head load and door relay. With all data $129.00

- 40 Track per side 48 TPI
- Double-sided, double density
- Same as SA455
- Latest head & drive technology
- Fast access time

TEAC

TEAC ...... the nicest drive FD55F .... $219.00 with free DOS patch for 80 track.

- 80 Track per side 96 TPI
- Double sided, quad density
- Same as SA465
- Latest head & drive technology
- Fast access time

Circle No. 33 on Reader Service Card

HAMEG OSCILLOSCOPE HM 204-2

Test Cable — 4mm Banana 126074

Coaxial test cable; length 1.15m, characteristic impedance 50 OHM, cable capacitance 12pF. Input voltage max. 500V_p.

$10.40

Test Cable BNC-BNC 126023

Coaxial test cable; length 1.2m, characteristic impedance 50 OHM, cable capacitance 126pF. Input voltage max. 500V_p.

$9.48

Adapter 4mm Banana to BNC T627

Two 4mm binding posts (19mm between centers) to standard BNC male plus. Input voltage max. 500V_p.

$11.50

50 OHM Through-Termination 805-53-000

For terminating systems with 50 OHM characteristic impedance. Maximum load 2W. Max. voltage 10V_{ms}.

$26.17

Carrying Cases

For HM203-1 and HM203-3	HZ42	$66.00
For HM312, HM412, HM512, and HM705	HZ43	$48.00
For HM307, HZ62, and HZ64	HZ44	$39.00
For HM103	HZ45	$39.00
For HM203-5, HM 204 and HM605	HZ46	$73.50

Viewing Hoods HZ47

For HM203, HM204, HM208, HM605, HM705, HM808, HM312, HM412, HM512, and HM812

$14.00 ea.

Scope Tester HZ60

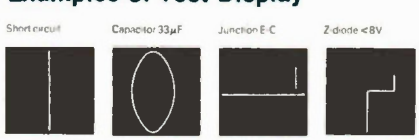
For checking the Y amplifier, timebase, and compensation of all probes, the HZ60 provides a crystal-controlled, fast-rising (typ.3ns) square-wave generator with switchable frequencies of 1, 10, 100kHz, and 1MHz. Three BNC outputs provide signals of 25mV_{pp} into 50 OHM, 0.25V_{pp} (open circuit for 10X and 100X probes); accuracy ±1%. Battery-powered or AC supply operated (optional).

$63.75

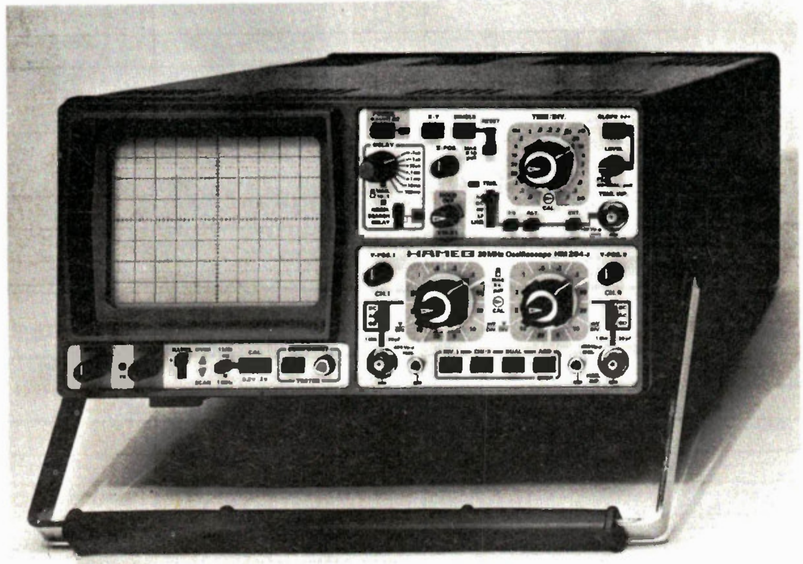
Component Tester HZ65

Indispensable for trouble-shooting in electronic circuits. Single component and in-circuit tests are both possible. The HZ65 operates with all scopes, which can be switched to X-Y operation (ext. horizontal deflection). Non-destructive tests can be carried out on almost all semiconductors, resistors, capacitors, and coils. Two sockets provide for quick testing of the 3 junction areas in any small power transistor. Other components are connected by using 2 banana jacks. Test leads supplied.

Examples of Test Display



LIST $75.00



20MHz Multifunction Oscilloscope

Y: 2 channels, DC-20MHz, max. 1mV/cm, delay line;
X: 1.25s/cm-10ns/cm incl. x10 magnification, delayed sweep; triggering up to 50MHz; var. hold-off time; Component Tester.

Particularly the **HM204** demonstrates the **high performance** standards and design philosophy found in **HAMEG's 20MHz-Oscilloscopes**.

The most outstanding features of this instrument are the maximum **time resolution** of up to **10ns/div**. (incl. 10x magnification) and the built-in **signal delay line** for viewing the trigger edge – features not found until now in this class and price range. Like instruments with a second timebase, the HM 204's **variable sweep delay** enables detailed signal analysis by expanding any section of a waveform.

Other key features of this oscilloscope are normal and **peak-value triggering** up to **50MHz**, alternate trigger for display of two asynchronous signals, and single sweep operation. The **variable hold-off time** facilitates stable displays of complex and aperiodic waveforms.

A **Component Tester** for checking electronic components individually or in-circuit is also incorporated as an indispensable asset for troubleshooting. Yet another unique feature is the switchable **1kHz/1MHz calibrator** for checking transient response of scope and probes.

Despite its versatility, the HM204 has been specifically designed for durability and ease of operation. Operators comfort is increased by **LED indicators** for overscan, delay mode, single sweep, and trigger action. The overscan LEDs indicate if any part of a waveform passes the vertical screen limits. A fully shielded and burn-in resistant rectangular CRT with **illuminated internal graticule** and trace rotation underline the quality of this oscilloscope.

APPROVED

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