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ACS NEWSLETTER

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AMATEUR COMPUTER SOCIETY

FIRST ISSUE OF
VOLUME TWO

HERE WE GO AGAIN

Enough money has finally been sent in to guarantee publication of at least eight issues of Volume II of the ACS Newsletter.

A LETTER OF COMMENT

Along with his check, Allyn Rothman writes that he "thought he might add some comments and observations concerning the ACS Newsletter and members' activities." What he adds is quite constructive:

"Let me preface my remarks by stating that I can't help getting the impression that many members are having considerable trouble with their machines mainly because they don't seem to be aware of the huge work effort involved. Commercial computer manufacturers expend tens of thousands of manhours designing their products, and with all their engineering talent, computer aided design, etc., they still have problems! I think that for anyone without advanced technical training, knowledge about (or even access to) computers and programming, designing a computer may prove impossible altogether. This leaves, in order of decreasing difficulty, improving on the design of an existing computer, copying an existing computer, or depending on some type of computer kit. I also think that, in general, members ought to concentrate more on technique, organization, and planning instead of diddling around a flip-flop at a time and considering the soldering of an IC into a circuit a "real" accomplishment as far as the progress of their machine is concerned. A computer is considerably more than the sum of all its hardware. Getting a particular shift register to function is not the major stumbling block; integrating the system is the problem. Now some more specific comments.

In past issues of the Newsletter, some rather ingenious instruction sets have been devised which either simplify hardware, decoding, or subsequent programming. It should be borne in mind, however, that the use of an instruction set which is already implemented on a commercial machine means a great reduction in problems with software, which would then be readily available. Remember that commercial manufacturers also look for instruction sets which tend to optimize both hardware and software, and many machines have instructions worth copying. If you've never written an assembler or Fortran compiler, don't just laugh it off as an easy project; it may well take you longer than to build the machine itself. Coming up with a new, unique instruction set may be a thrilling idea, but getting someone else's instruction set to function with your hardware is no small feat either.

The report on the PDP/8 in issue #10 of the Newsletter was most informative. As to the feasibility of a PDP/8 kit, you laughed off the possibility of having to do the back panel wiring yourself as being an invitation to insanity. It seems to me that this is what amateur computer building is all about (the wiring and the insanity). Furthermore, I think that some important points were missed in the discussion. The implication was that a kit would contain the standard DEC circuit boards and components. The savings in cost would certainly not accrue from the amateur merely completing the back-panel wiring for a bunch of commercial (and expensive) circuit boards. The list of logical components which was provided was impressively small. Implementing this logic with, say Fairchild Micrologic would mean:

a) a real money saving—like you would be talking about a few hundred dollars for all the ICs required;
b) a large saving in space, since the PDP/8S, small enough as it is, is still not an IC machine;
c) not merely copying an existing machine, but turning a good second-generation one into an improved third-generation model.

I think that the PDP/8S is an excellent machine to either improve or consider as a basis for a kit. While on the subject of kits, I will also add that the concept of a modularly expandable kit is completely unfeasible since, again, it does not solve the major problem, which is system integration; not just implementing a particular register. For those who do not have the background or the test equipment to design their machine, just the logic schematic of a small computer consisting of a few hundred cheap ICs would be more than a start. Provide a few circuit boards, and there's a kit. The PDP/8S is small, serial, and slow, but I think that none of us would mind having one, finished, working, and usable for whatever limited capabilities it would have.

As for the question of "what to do with your machine when it is completed," I would like to state that if I had no use in mind for it, I wouldn't be wasting my time trying to build one. First of all, I am already using a computer to help me with both my logic design and my circuit-board layout. I am also attempting to simulate my entire micro-instruction sequences for my read-only memory on a computer to make sure that the machine's logic will really work. By the time I start plugging in actual components, I want my only problem to be noise, not logic organization. Anyone in the electronic design business, as any computer builder must be to some extent, would much rather substitute a few minutes of computer button-pushing for hours of slide-rule pushing. With all due respect (honest!), anyone who would have his home-built machine control his house's heating system is insulting his own creation. When I have programs which will enable my machine to completely design its successor, then I will wonder what to do with it (including whether or not to pull its plug out in a hurry to be on the safe side). Software development alone ought to keep most of our machines pretty busy.

A few odds and ends now. I am seriously dabbling with the idea of a PDP/8S kit, since the logic for the machine is rather simple, and thousands of PDP/8's are being used in industry for data collection and process control, and they all use the same software. Someday it might serve as a useful auxiliary computer for my main CPU, but it still is a very "spare" time project. If anyone else is interested in pursuing this, it might be fun; it certainly will be easier than anything else anyone is building.

Members may find the following manual very useful: "A Pocket Guide to Hewlett-Packard Computers," available from H-P, 395 Page Mill Road, Palo Alto, Calif. 94306. It contains detailed hardware descriptions of the H-P series of small computers (detailed logical organization, that is), as well as complete specifications for H-P Assembly language, Fortran, and Basic, programming techniques, algorithms, etc. Well worth the $3.00 they're asking for it. I am interested in obtaining any information that is available on CRT displays. Are any members working on them? A kit for one of those wouldn't be a bad idea. They can be built cheaply.

What I'm trying to do now is to get a computer to design my computer. It doesn't seem to be saving time, but it sure does save energy, not to mention hardware."

* * * * * * * *

Incidentally, DEC now manufactures the PDP-8/S only on order, with a 4-month lead time. As a DEC salesman put it, "The 8/L is cheaper and does more than the 8/S."

COMPUTER SCHEMATICS?

A quick check with half a dozen IC manufacturers (Motorola, Signetics, Amperex, National, TI and Fairchild) showed that not one of them has a demonstration IC computer of any size, and thus no schematics for any such machine.

For one reason, these IC manufacturers don't have CPU designers. The computer manufacturers design their own circuits, often with computer-aided design that is beyond the means of IC makers.

Signetics says the most they do is try a little component-count reduction. In a couple of years, Signetics intends to market LSI building blocks, about 6 inches square, with a complete subsystem on each, so that a computer could be built by connecting several together. But right now Signetics is concentrating on bringing out MSI circuits, to keep up with the competition.

Amperex has no more copies of "Build Your Teaching Computer With M.E.L. Subassemblies," mentioned in an early Newsletter. Although there were requests for the booklet (which Amperex bought from M.E.L. in England), nobody was buying the subassemblies.

CURRENT MAGAZINE ARTICLES

Quite a few magazine articles of interest to ACS members have come out lately.

<u>Customer Engineering Clinic</u>

For some months now, <u>EDN</u> has been running a department by this name, presenting problems that customer engineers have had, and showing how to solve them. So far, most of the problems have been with digital ICs. Examples of problems are "One-Shot Circuits Driven from Decade Counter Give Multiple Pulses," (Feb. 1, 1969, p 59-60); "8-Bit Serial Register Shifts Unpredictably (Apr. 15, 1969, pp 73-74).

<u>Power Supplies</u>

A design article, "Power Supplies for Solid-State Circuits -- a Quick Method for Designers in a Hurry," appears in the April 15, 1969 <u>EDN</u> (pp 61-68).

<u>Universal Frequency Counter</u>

The most ambitious digital construction article <u>Popular Electronics</u> will probably ever print was given in two parts (Mar. 1969, pp 33-47; Apr. 1969, pp 41-45).

As is often the case with PE, a kit of parts (26 ICs, 43 transistors, 14 diodes, etc.) is available; this runs to over $200, for a 2-Mc counter, typical accuracy of 0.1%.

The decimal counting units are not

described in either article, but only in the Winter 1969 edition of Electronic Experimenter's Handbook.

Segmented Digital Readout

Also in Popular Electronics (Feb. 1969, pp 43-49) is a construction article on the Dialco 7-segment readout, "Third-Generation DCU." The article shows how to use the Dialco segmented display panel ($5.46) with an IC decade counter and decoder (kit of parts, $13.50), and how to make a similar segmented display panel yourself.

Program Loading

"Read-Only Memory Loads Process Computer," by Marcon and Rosborough (Control Engineering, Feb. 1969, pp 89-91), shows how one group of users solved the problem of setting the initiating code by building a read-only memory (ROM) to enter the read-in mode (RIM) instructions into a PDP-8 or 8/S.

You probably aren't in a position to really need this ROM, but the details are interesting, and "readers are invited to contact the authors for more detail."

Solid-State Optoelectronics in '69

Want to know more about phototransistors, laser arrays and photo SCRs? Read the special report with the above name in EDN (Feb. 15, 1969, pp 49-64), available as a reprint.

Output Circuits

"Which Output Circuitry Should You Use?" (EEE, Feb. 1969, pp 68-71), discusses briefly five types of output circuits: resistor pull-up; complementary; totem-pole; diode-clamped totem pole; and transistor-clamped totem pole.

Universal Digital Interface

This very brief circuit-design item is in the Jan. 1969 EEE (pp 115-6), and shows how to use the two halves of a 914 IC to "interface with many different types of logic, both positive and negative."

Tutorial 1

"Single building block proves logical choice for custom ICs" (Electronics, Apr. 28, 1969, pp 88-93) contains good tutorial information on logic. It is part of a study made by NCR to "determine some of the characteristics desired in the design of the IC used in the single building block for its Century Computer series."

Tutorial 2

"A Primer on Priority Interrupt Systems," by Van Gelder and England of SDS (Control Engineering, Mar. 1969, pp 101-105), is an excellent tutorial, with four logic diagrams, to show interrupt hardware.

Delay Line

"Ultrasonic delay line needs no power supply," (Electronic Design, Aug. 15, 1968, pp 231-232), shows a 64-µsec delay line using a seven-inch glass rod driven by an r-f oscillator, designed by an AEG-Telefunken engineer.

Design Aid

"Bond Graphs for Designing Logic Circuits," by Krigman of Battelle (Control Engineering, Feb. 1968, pp 91-92), gives an interesting and seemingly useful graphical method for designing logic circuits.

How to Delay

"5 Ways to Delay a Signal," by Bauer of Digital Devices (Control Engineering, April 1968, pp 92-94), briefly discusses magnetostrictive delay lines, torsional delay lines, glass and quartz delay lines, distributed and lumped-constant transmission lines, and mechanical methods (tape loops, etc.).

No Bounce

"Get Bounce-Free Digital Inputs From Switches," by Walker of Fairchild Semiconductor (Control Engineering, Mar. 1969, p 65), shows four simple circuits for eliminating switch bounce, using ICs such as the 9946.

Arithmetic Hardware

"Arithmetic Functions Using MOS Registers" is the title of MOS Brief 6 in the National Semiconductor series of ads (Electronic Design, Apr. 26, 1969, among many others), and shows very briefly how to use the MM515 triple 64-bit MOS shift register (a 16-pin DIP) in three arithmetic circuits.

Driver

"Use a voltage regulator as a lamp/relay driver," (Electronic Engineer, Apr. 1969, p 81) is a very short item on using, for example, the General Instrument NC531 voltage regulator as a lamp, relay or motor driver.

Logic Probe 1

Newsletter #11 mentioned three commercial logic probes. A construction article on such a probe, "IC Telltale," appears in the Apr. 1969 Popular Electronics (pp 69-74).

The probe actually consists of two assemblies: a probe and a test set. The probe is a simple two-transistor lamp driver. The test set has a 2-cps and 10-cps trigger pulse generator, with 14-pin DIL and 8-pin round sockets. The socket pins are brought out to spring-clip test terminals.

The probe will test, in or out of circuit, "RTL ICs such as the Motorola MC700P and the Fairchild μL900 series."

Logic Probe 2

An inexpensive logic-level test probe is described in the Jan. 1969 Electronic Engineer (p 96). It uses a TI 14-pin DIL, SN15 844N, and a lamp, mounted in the body of a felt-tip marking pen.

Small-Scale Integration

"New Logic Meets Needs of Advanced Integration," (EEE, Apr. 1969, p 52), describes some really indescribable SSI circuits such as the flop-flop, unigate, NON gate, make-shift register, and the half-fast adder. Some of the chips used are so small that they can include no more than half a diode.

Computer Simulation of Logic

"Computer-Aided Design: Simulation of Digital Design Logic," by Gwendolyn G. Hays (blond, 26, and married), in the IEEE Computer Transactions (Jan. 1969, pp 1-10) gives details of a program (written in Fortran IV and used on a Univac 1108) that can simulate around 3000 logic elements, for debugging digital designs.

Building Your Own Acoustic Coupler

Few if any of us will ever need to couple a Model 33 or 35 Teletype with a time-shared computer, but the article with the above title makes interesting reading, in the Mar. 1, 1969 Electronic Design (pp 68-73).

Delay-Line Memory for CRT Display

"Standard Glass Memory Modules For Low-Cost Computer-Driven Displays," (Computer Design, Apr. 1969, pp 118-122) is really an ad for a Cor-

The Amateur Computer Society is open to all who are interested in building and operating a digital computer that can at least perform automatic multiplication and division, or is of a comparable complexity.
For membership in the ACS, and a subscription of at least eight issues of the Newsletter, send $3 (or a check) to:
Stephen B. Gray
Amateur Computer Society
260 Noroton Avenue
Darien, Conn. 06820
The Newsletter will appear about every two months.

ning Electronics product.

The glass memory (maximum capacity, 4K bits) is used to store all the characters to be displayed in a single horizontal row, and is input to a character generator that controls the Z axis by brightening the proper parts of the raster display.

The computer places a frame of data in the display-system buffer memory. One full row of characters is then transferred from the buffer to the delay line; this data recirculates in the "single line storage device" to refresh the display.

HARDWARE ON THE MARKET

IC Breadboard

Although this IC breadboard (by EL Instruments Inc, 61 First St., Derby, Conn. 06418) is too expensive ($650) for any of us, the brochure is something to drool over. The breadboard will accept DILs of any size (14, 16, 24 or 36 pins) and will also accomodate resistors, capacitors, TO-5 cans, etc.; it contains a pulse generator, power supply, a dozen lamps, 9 switches. Interconnections can be made by plugging in lengths of #22 hookup wire.

IC Pliers

Techni-Tool, of 1216 Arch St., Philadelphia, Pa. 19107, has pliers for removing 10- and 14-lead flatpacks when desoldering. The coated jaws allow use with live circuits.

Phototransistor Array

Fairchild has a "low-cost" array, the FPA-700, with 9 npn phototransistors in an 18-lead package for electronically reading standard 8-channel punched paper tape. Cost: $12.50 (1000 up).

HELP!

One of our newest members is a math teacher whose school is gathering components for a computer. They have a Remington Synchro Tape from an early Univac. Sperry seems to have run out of schematics and operation manuals. The 8-level paper-tape punch and reader work fine, but the information is needed just in case of trouble.

If any ACS member has access to a schematic and/or manual, and would sell it or let it be copied, please write to: Richard P. Filchock
Box 124
Hiller, Pa. 15444

The school also has a core memory from an IBM 1401. A number of ACS members have also acquired one of these; no doubt many of them could also use help. If any of you have worked out drivers and sense amplifiers and so on for this particular 16-plane, 4K memory, then please send in details.

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PDP-8/L
ISSUE

THE PDP-8/L

Many ACS members are interested in the PDP-8 family, so let's look into these best-selling small computers.

The PDP-8 and 8/S are no longer made on a production basis. The current models are the 8/L and the 8/I, both built with Texas Instruments TTL integrated circuits, by Digital Equipment Corp.

The 8/L is the cheaper model, at $8500 for 4K of memory and ASR33 Teletype. Maximum core is 8K. The 8/I has the same capability plus an internal peripheral control and data-break panel for plug-in expansion. The 8/I is faster, costs $12,800 (in rack-mounted version) for 4K of memory and ASR33 TTY, and is more flexible than the 8/L. The 8/L was "designed for those who don't need plug-in expansion."

Maintenance Manuals

To obtain the two-volume maintenance manuals (containing schematics) for either the 8/L or 8/I, send $50 to the Field Service Department, Digital Equipment Corp., 146 Main St., Maynard, Mass. 01754.

The 8/L contains 360 TI TTL DIP ICs, if no options are included, and if my count is right. These 360 ICs, if bought from Texas Instruments in the quantities for building one computer, would cost $1243.

One big problem is the core memory; DEC will sell you one for $2,000. Nobody in the ACS has reported any success in hooking up drivers and sense amplifiers to any suitable used IBM (or other) core stack.

The sense amplifiers in the 8/L are Motorola MC1540G types, at $31.50 each for 12 of them. This is the full count, as I figure it:

81	SN7400N	4 NAND 2-input
26	SN7402N	4 NAND 2-input driver
17	SN7410N	3 NAND 3-input
13	SN7420N	2 NAND 4-input
8	SN7430N	1 NAND 8-input
52	SN7440N	2 NAND 4-input driver
5	SN7450N	2 AND-NOR
53	SN7453N	4 AND-NOR
29	SN7460N	2 Gate expanders
58	SN7474N	2 D-type flip-flops
6	SN7482N	1 Adder
12	MC1540G	Core Memory Sense Ampl

Another big problem is the "undefined" components, such as the DEC-3009B transistors and the D664 diodes, as well as a few transformers. The 8/L uses about 314 transistors and 959 diodes, of half a dozen different types each.

The 8/L contains four card racks, with 22 slots each, holding one double-height or two single-height cards in each slot. Total number of cards: 104. There is room for option cards, which are needed for the high-speed reader, power-fail circuits, memory parity, and data-break options.

Half the 8/L cards are standard DEC M-series cards, as described in recent DEC Logic Handbooks. These include:

5	M111	Inverter
6	M113	NAND 2-input
5	M115	NAND 3-input
2	M117	NAND 4-input
2	M119	NAND 8-input
5	M160	AND-NOR

6	M310	Delay line
1	M360	Variable delay
1	M452	Variable clock
5	M617	NAND 4-input driver
2	M660	Positive level driver
1	M706	Teletype receiver
1	M707	Teletype transmitter
1	M901	Flexprint cable conn.
7	M903	Flexprint connector
3	M906	Cable terminator
1	M002	Logic source
54		

The other cards seem to be special for the 8/L model:

5	M216	D-type flipflops
6	M220	Major registers
2	M516	Positive bus receiver
3	M623	Bus driver
1	M700	Manual timing generator
6	G020	Sense amplifier
8	G221	Memory selector
5	G228	Inhibit driver
1	G610	Diode board
1	G611	Diode board
4	G624	RC board
1	G785	Power connector
1	G826	Regulator control
2	G921	Control panel
2	W025	Cable connector
1	W076	Teletype connector
1	----	Memory stack
50		

These 104 PC cards contain the 360 ICs, 314 transistors, 959 diodes, some transformers, etc.

ICs Cheaper than TI 74N

Several members have expressed an interest in the Motorola MC700P series of ICs. There are 45 different circuits in this RTL line. However, the M series of DEC logic modules, used in the PDP-8/L and 8/I, are built with the Texas Instruments 74N series, which has only 19 circuits in it.

Eleven other manufacturers have a TTL series similar to TI's 74N: Amperex, Hughes, ITT, Motorola (MC7400P), National, Nucleonic Products, Philco-Ford, Raytheon, Signetics, Sprague, and Transitron. However, although the type numbers may be the same (or about the same), the circuits are not always electronically equivalent. For example, the Sprague ICs are said to have differences in clamping and fanout.

Texas Instruments recently announced a price cut of about 30% in the 74N line, which may bring the cost of those 360 ICs for an 8/L down to just below $1,000. But Motorola has also cut the cost of the MC7400P line, for a Motorola total cost of $932, but still using the TI adder, which has no Motorola equivalent, and using the prices for 100 of each DIP. (DIP, for Dual In-line Package, seems to be more universally used than the DIL we've been using up to now.)

PDP-8 Simulation

If you have access to Applied Logic Corporation's AL/COM timesharing system, their SIM-8 program simulates the PDP-8, as well as the PDP-5.

NOTES FROM ACS MEMBERS

Here are what a number of members have to say about their current efforts:

Millard McVay, Illinois

"So far I'm sticking to discrete circuitry, using DTL NOR gates of very standard design. I originally bought (from Meshna) 2N706's at 7 for $1.00, less 20% in quantities of 1000, but they graded out at just under 50% good enough for the job, so I'm looking for something better here. I bought diodes from Solid State Sales at 30 for $1.00, less 30% in 1000 quantities, and they graded out about 87% good, which isn't bad. I'm etching my own circuit cards, and use Amphenol 15-contact card sockets. I've decided that silk-screen process is much simpler than Kodak photoresist techniques for my purpose, where very many cards of the same type have to be made.

"My logic levels were chosen to be compatible with integrated circuits so they can be mixed if I decide to later. In fact, I already have purchased a couple hundred Fairchild type 914 gates, a hundred 923 flipflops, and some 900 buffers to play with when I find time."

Al Sinclair, Ontario, Canada

"I recently acquired three IBM back panels with almost 500 SMS sockets, and some 250 SMS cards complete with contacts (mostly 3 and 4 gates per card), also a considerable number of broken cards with contacts. I have been cutting the contacts off these latter cards and epoxying them onto other cards, mostly double height. Removing all the wiring off the back panels was a heart-breaking job, but I could not make use of it.

"This acquisiting resulted in a complete rebuild of my computer to eliminate all the plugs and jacks, and complete the conversion to the SMS system, soldering all connections. As you can imagine, this is a monstrous job, and it will be many months before I can use my machine again. I also took some damaged core-memory frames and rewired them to 1024 words of 14 bits, which took two months of steady work. So now my machine will be 14 bits (4 instruction, 10 address), all parallel operation, clock speed 1 Mc. I have also made a new front panel to spread out the indicating lamps for easier reading. The socket panels swing out like the PDP-8 for easier working on."

Norman Saunders, Mass.

"I've just spent 30 hours getting the last bugs out of the modem (modulator-demodulator) for going to and from magnetic tape and the Teletype. The original design probably took about as long to work out. This is a good device and probably ought to be used by others. But how to recover part of my costs so that I can eat while I go about developing other goodies? [Norm is a consultant in circuit engineering.] Even if all the ACS members bought copies of the paperwork (schematics, theory, layouts, etc.) to reproduce the modem, it would take about $10 a set to recover costs. I could supply printed circuit boards, raw but etched, but this would run about another $10 apiece; and for parts, another $10. If someone were to take over the last two items, they would each be half as much.

"I have a 33 Teletype TD, with one 11-part character every 100 msec. The modem uses the Teletype supply, and typing is normal without switching when the magnetic-tape recorder is not playing back. If it is playing back, the keyboard can be used to intersperse characters, but if the keyed and played-back characters overlap, you get gibberish. The computer itself is required also to get the lockout function. If the recorder is recording while keying is done, a record of the keying is made, which can then be played back to give machine operation identical to that which was caused by the keying. For time compression, to have the retyping at maximum machine rate, and/or for editing, etc., the computer itself must also be called into play.

"Even though the modem is limited to literal key-to-magnetic-tape and magnetic-tape-to-print, it is quite useful. It also serves to clean up the keyboard pulse-train output, which is horrible in noise and hash for one used to electronic signals. Another feature of this modem is that it requires a bandwidth of only about one kilohertz at one or two kilohertz, which is all that the recorder I've assigned to the job has, being one of the earliest tape recorders sold for the home market. Any recorder using a capstan would probably be all right, and those without might do if the tape were not cut or spliced, and were always played back on the same recorder."

Myron Calhoun, California

"At Fairchild R&D we have quite complete and complex CAD (computer-aided design). Interested ACS members might be able to get a copy of FAIRSIM (Fairchild Simulator) User's Manual by writing to:
  Fairchild Semiconductor
  Distribution Services
  440 Middlefield Road
  Mountain View, Calif.

"We can go from equations to finished PC boards without touching anything more "hardware" than a keypunch (and I let the keypunch service do most of that). Unfortunately, most of our CAD is proprietary.

"As for software: a compiler can get quite complex, but assemblers are easy. My dissertation, "Machine-Independent Assemblers for Computing Systems," (order number 68-1647 from University Microfilms, 300 N. Zeeb Rd., P.O. Box 1346, Ann Arbor, Mich. 48106; microfilm $3.20, Xerox $11.05) describes how to produce an assembler fast (using another computer -- by hand it would take a little longer). It gives complete flowcharts, listings, etc.

"I still have my original source decks around (as run on the GE-225 computer at Arizona State University) and will send tape copies made on a 360/44 if anybody wants to pay our computer center fee of $25.00 (includes tape and mailing) for the reproduction.

Out here the dual inline package is called a DIP, not DIL. For what it is worth, the DIP is generally acknowledged to have been developed in my department (back before I got here, to be sure).

"I notice that Fairchild does not now actively sell RTL (or even make it, unless a large order is received), so don't plan on using it forever. It was nice stuff, though; low power, etc.

"I have shown your comment about 'these IC manufacturers don't have CPU designers...' to my boss. It amused him, since my department is full of engineers who either have worked, or are working, on advanced computer designs. Normally, however, our efforts are either proprietary or else directed to the manufacture of better components, LSI, etc."

Lt. Cdr. Lyle Pellock, New York, NY

"I am afraid my projects have come to a halt with the needs of my new assignment. Being the executive officer of a destroyer is a full-time job plus. However, maybe one of these days I can get moving again."

Bill Mitchell, Ontario, Canada

"The most interesting idea for the central processor I've seen lately is 'A Proposed Minimum Hardware Central Processor with General Purpose Computation Capability,' by Robert W. Ehmann of Airborne Systems, which was obtained as memo #R-68-155 from the Computer Repository of the IEEE (345 East 47 St, New York, N.Y. 10017).

"Basically, the idea is that a 16K 24-bit computer could be built by using some of the memory (128-256 words) to store data, which would be used as microprogram instructions for the sequencing of the processor. The resulting design, the logic equations of which are spelt out in the 23-page memo, would be quite complete with interrupt capability, normalizing logic for handling floating point, indirect and index addressing.

"Another article worth a mention is "Causes and Cures of Noise in Digital Systems," which was published in three parts in Computer Design, Sept. - Nov. 1964. It has also been reprinted as a separate booklet by Computer Design for $1.75."

(The IEEE memo costs $1.50 for microfiche, $3 for photocopy.)

Wade White, California

(Wade is now working for a new company, Electronic Arrays, in Woodland Hills; they make MOS devices such as dynamic registers; their latest is a 2560-bit read-only memory containing the basic 64 characters of ASCII format, for CRT display.)

"I plan to use my company's products, as they are introduced, in the construction of my computer. The first project is a memory employing high-speed shift registers. After the memory I'll tackle the control logic, then the arithmetic unit, and last the I/O. With the availability of MOS devices and the assistance I can obtain from the rest of the company, I hope to develop a modular computer kit as a result of my playing around.

"I want to use the computer for stock analysis, game-playing and automated logic design. I am working at present on an interface for use with a cassette tape recorder (a Sony 124) to allow my computer some easy and inexpensive means of bulk storage."

QUERIES AND ITEMS FOR SALE

Buffer Memory and Readout

Dave Vednor offers for sale a Telemeter Magnetics 144-B buffer memory; and a Sylvania electroluminescent 7-digit, 7-segment readout. Write:

David Vednor
2801 Willow Avenue
Fullerton, Calif. 92631

Dave also says: "I have been using Signetics JK flip-flops at work, and they have proven far superior to the Motorola MRTL with respect to noise immunity. The DCL line is not that much more expensive, and more functions are offered.

"Have any members had any luck with the MOS registers or other MSI MOS devices? I would like to try some, but the cost is a big high at this time."

Memory and Decimal-Point Query

Ted Naydan writes from New York State: "The availability of Motorola ICs encouraged me to get away from paper studies to hardware. Still, memory systems were not available to me!

"An opportunity to get my feet wet with a complete memory system, purchased from John Meshna of Lynn, Mass. for $25, has kept me busy for some 3 months. It is a 64-word, 7-bit random-access unit, with no schematics available. It consists of 3 boards, containing all of the X, Y and Z select functions. The core plane is a Univac C-164. Anybody have any information on these units?

"Anyone have any ideas on how decimal point is selected in the electronic desk calculators now appearing on the market?

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Stephen B. Gray
Amateur Computer Society
260 Noroton Avenue
Darien, Conn. 06820
The Newsletter will appear about every two months.

I'd like to hear more from Don Tarbell, as his activity parallels mine, as far as complexity is concerned. In addition, details on his 4K memory, as he implements it, would be appreciated."

Patchcords for Sale

A member has about 3000 patchcords for sale, in lengths of 4, 7, 9, 12 and 15 inches. They are IBM types, of two kinds: one is the self-contacting type, with plugs an inch long and more than 1/8" in diameter; the other is the fixed-wiring type, with plugs 5/8" long and about 3/32" in diameter. Cost is 5¢ each, minimum order $10, postage extra, from:
Johan Svanholm
Svanholm Research Laboratories
3205 Stanford St.
Hyattsville, Md. 20782

Help Offered on SMS Cards

Don Paddock writes: "I've drawn about 100 circuits of the IBM SMS cards to date, and have identified about 30 of these in the manual (see Issue 3, page 4).

"If I could help any of the members in identifying their cards, I would be happy to do so. I would need the two or three letters given at the lower left-hand corner of the card on the side the parts are mounted.

"The letters definitely do not identify the use of the card. For example, a CW and a JZ card are triggers, with the same components and circuit, escept that one has two more diodes for the S&T function; the other has a direct connection to the bases for use as extender leads."

For help, write: Donald Paddock, Rt. #2, Box 54, Vero Beach, Fla. 32960.

THE WANG LOGARITHMIC CIRCUIT

Several members have asked about the log circuit used in the Wang calculators. The patent was issued to An Wang last Fall, and is number 3,402,285, "Calculating Apparatus." For a copy, send 50¢ to the Commissioner of Patents, Washington, D.C. 20231.

The calculator generates the log of numbers by a series of successive approximations, using stored constants of the log to the base e of 10, 2, 0.9, 1.01, 0.999, and 1.0001. The antilog conversion works in the same manner, by successive approximations, using the same stored constants.

According to one of the top men at Wang, the log conversion technique is original with Dr. Wang, and was not known previously.

If anybody figures out how to make that log circuit work, how about telling the rest of us?

SENSE AMPLIFIERS

The July EEE (pp 64-75) has three articles on sense amplifiers and comparators, used with core memory.

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(Serial Issue 14)
October 1969

ACS NEWSLETTER

a publication of the
AMATEUR COMPUTER SOCIETY

MORE ON
TELETYPE

MORE ON TELETYPE

One of our newest members is Gordon White, who edits the Surplus Sidelights column in CQ magazine. Gordon writes:

"After a quick skim through Vol. I, I can offer these observations: I doubt if there are many model 12 Teletypes still around. I've never seen one in amateur hands, although they were the first RTTY machines, 23 years back.

Models 14, 15 and 19 are still very common, and if usable (60 wpm is pretty slow and they are not very flexible in other ways), are the cheapest good machines now available. I'm going to sell my complete #19 (tape perf, keyboard, reader, printer, table and power supply, pretty fair shape) for $65, as I go to all #28 and later gear.

The 28, 33 and 35 models are of course faster -- to 107 wpm, and 150 wpm on the model 37. Most of the latter are pretty costly for amateurs, however. A complete 28 ASR (roughly equal to the 19) is commercial-surplus priced at $1300 up, though some MARS members get them free, and I have been able to provide some reassembled out of parts and surplus stuff for rather less.

The RTTY amateur wants <u>serial</u> machines, and parallel units are no use to him. On the other hand, I can see that for ACS use, parallel units are more easily used. This is fortunate, since the parallel units are a drug on the market most of the time.

For example, there is a parallel-fed tape perforator (LARP) by Teletype that will perf to 100 wpm (1200 opm). It might be possible to parallel-feed a unit which prints on the tape, though I doubt the mechanism would take much more than 100-wpm speed. These LARPs were recently selling for $5 each, plus motors. There are 8-level LARPS too, though the 8-level gear is newer and more rare than 5-level.

There are several Western Union readers for parallel operation, most of them going cheaply. There is a Teletype LBXD reader which offers serial <u>or</u> parallel output, but has 7.00 unit serial code cams (Western Union type) which make it less useful to hams. I doubt an ACS member would care if the serial stop pulses were .00, .42 or .50, so these ought to be useful.

If one had a complete model 28 printer, he could put contacts on the code bars to generate parallel signals at the same time he gets hard copy from the serial keyboard (or parallel contacts could be put on the keyboard itself).

Further, you can code the "stunt box" of the 28 printer to give multi-wire output; that is, open or close a contact for up to 36 different characters (72 characters considering upper case/lower case). This might make the computer design easier -- read-in multi-wire, and read-out parallel to a 1200-opm perf, using the tape loop as buffer storage, reading from tape to the printer where 5-level parallel signals would be generated or, again, multi-wire.

I doubt that anyone would want to invest in the model 37 PC boards, as prices are rather astronomical."

Gordon has a Frederick 670B Morse-to-Teletype translator, and "some 5:8 storage gear for communications handling." He adds:

"Using the model 28 typing unit, you could get a modified ASCII parallel input rather easily by using code-reading contacts and a latching contact on the letters-figure stunt level. ASCII, of course, uses five levels for character identification and level 7 for US (spacing) and LC (marking), which could be derived from contacts on the 28.

You would not get even-parity on the 8th bit (you would have to be content with steady mark), nor the non-printing control functions on the 6th bit, but this might still be useful. It would be possible to arrange a separate button on the 28 keyboard to provide the 6th-bit information, I suppose.

On printout, you would have to provide a parallel-to-serial conversion to drive the printer, or use parallel-fed punches and a serial printer, as suggested previously. You'd have to rearrange the typebox if you used the actual ASCII coding as, for example, A in Baudot is bit 1 and 2 marking, the rest spacing, and in ASCII, A is bit 1 marking and the rest spacing. You'd have to put the A type-pallet in the place where the E normally is found.

This could be done in outrigger fashion on older stuff like the model 15, but I shudder to think of the haywire involved; the 28 is designed for that sort of thing -- the 15 was not.

There are several military surplus units which contain rather straightforward serial-to-parallel and parallel-to-serial modules. The AN/FGC-5 and AN/UGC-1 multiplex sets (the former built with tubes; the latter virtually the same set-up with transistors) are coming into surplus, and contain these units. The FGC-5 is larger, but its components are really a drug on the market -- useful for little else than the small parts. The UGC-1'is later, but is also becoming available.

There are sources here which have a lot of identified, undamaged computer parts: SASCO Electronics, 1009 King St., Alexandria, Va. and Ritco Electronics, Box 156, Annandale, Va. have this material. I have seen flip-flops, matrixes, PC card racks, etc. in quantity. Also, I have a man who wants to sell computer DC power supplies, 100, 180, 210, 280 volts, etc. -- anyone have any interest? I will supply the address on request. (Write to Gordon White, 5716 N. Kings Highway, Alexandria, Virginia 22303.)

I'd like to hear reaction from members on my suggestions for the model 28, as I am a Teletype man, not a computer expert, and I may not have made myself clear."

Gordon also sent a notice of a sale of government property, by sealed bids, several months ago in New York. The item was a Philco 2000 computer. If, by some odd chance, a bidder managed to get this at some low price, he'd have to have quite a bit of room to put it in, as there were 21 tape transports with it, two printers, etc.

The 2000 was offered on an "as is, where is" basis, located at Westinghouse Electric in West Mifflin Borough, Pa. (the Bettis Atomic Power Lab.).

A MEMBER'S PROGRESS

Bill Greene of New Jersey reports on his progress:

Last summer I made the decision to

switch from delay-line memory to core, after fighting long-term temperature stability problems and marginal operation for about six months. I have discovered that to start with a surplus core plane and end up with a working memory is no minor undertaking, especially on a spare-time basis. I am using a 16K plane with four sense windings and will go through a double cycle to end up with a 2K byte memory. The complete unit is on five 8-by-8-inch Vero boards. One board contains the core plane, two contain the drivers, one contains the address registers, data registers, packing and unpacking logic and level shifters to drive the drivers, and the last board contains the sense amplifiers and timing logic. At the moment it looks like it will take about two more months of spare time to completion.

I still feel that a delay line is the best answer to many amateur memory needs, if the line is purchased from the manufacturer, rather than relying on surplus lines that were produced several years ago, before the state of the art improved.

With the switch to core and the exposure to more and better machines in the line of duty, came a change in system design for my computer. I will use an 8-bit instruction format, of which four bits are set aside for the op-code, one of which is sub-coded, allowing a total of 31 instructions. The key is in using four 8-bit registers that are selectable by the instruction. One of these serves as the program counter. Two of the remaining four bits in the instruction select one of these registers, which at the time contains the memory address to be accessed by the instruction. The remaining two bits select which of these registers contain the data to be transferred. By allowing the register selected by the memory address bits in the instruction to be incremented during the instruction, transfers of blocks of data become simple. Furthermore, if this register is #3 (the program counter), the program will skip one byte and its contents can be transferred from memory to one of the registers, thereby giving a double word instruction capability and a means of loading a constant by program.

I have written several programs using this instruction set, and find that a program that takes 100 12-bit instructions in PDP-8 language can be written using 100 8-bit instructions in this format. Since 8 bits allow us to address only 256 addresses, a scheme of using a field register (as per PDP-8) of four bits gives a maximum memory size of 4096 locations. Two double-word instructions, namely a Jump to Subroutine and a Jump Indirect, allow simple access to all of memory.

I guess you can conclude from the preceeding paragraphs that I have become convinced that the smallest feasible computer for amateur purposes is not a 12-bit machine, but that it can be squeezed down to 8 bits.

Like many others, I am using Motorola RTL for all logic, and have found an excellent transistor for all-around use: the Motorola MPS 2923. Although it is listed in the category of a small-signal amplifier, I have found that it can switch over 500 ma at one microsecond with no apparent harmful effects. It makes an excellent lamp driver, since you can put a 6.3-volt 50-ma lamp on the collector side and connect the base thru a 610-ohm resistor to the RTL element or even directly to an inverter output, if that inverter drives nothing else. Best of all, it is priced at 43¢ in small quantities, or 29¢ if you buy more than 100.

I have also found a good buy on teletypewriter page printers. Atlantic Surplus Sales, 300 7th St., Brooklyn, N.Y. 11215, has on hand some model 10-15 machines built in West Germany. Many parts are interchangeable with the model 15; it is set up for the European standard of 63 wpm, although gears are available for conversion to 60 wpm. The unit is of much more recent vintage than the standard model 15 and is of lighter and more attractive construction. The price is $80, and when I purchased mine in the middle of January, it was the tenth one sold within a week, out of a lot of 46.

ANOTHER RESPONSE TO THE SURVEY

Dave Digby recently sent in the ACS computer survey, from Texas. The computer he has planned will have two registers, and will be built with RTL MC700P DIPs. The memory: 512- to 1024-word wire delay line. I/O: Teletype model 26 printer, MXD tape reader, RPE-26 tape punch. There will be 64 instructions, 6 to 10 bits long. Data words, 16 to 20 bits long, 1.6-Mc clock. Add speed, 10 to 20 msec (he must mean usec). Special features: lowest cost for off-the-shelf components (except for surplus I/O); plans to develop it into a construction kit if there is any demand for it. Includes indirect addressing and one or more index registers (in memory); automatic multiply and divide optional at extra cost. Estimated complete cost less than $1,000, total of 50 to 75 DIPs.

Dave's four-register relay computer uses U and Y types from surplus telephone equipment, plus multi-contact and stepping switches. The relay memory holds 16 words, of 15 bits each. I/O: switches and lamps, and maybe TTY. Add speed, 1/5 sec, clock speed 1/10 sec, about 50 instructions, programmed by plugboard only. Present size, about 50 relays; 400 when complete.

Dave also says, "I ran a 'free hamshop' ad in CQ to survey interest in a computer kit. The enclosed letter is what I sent the dozen replies I received (in late 1967):

"Thank you for your interest. I hope the early state of my project will not discourage you. This is what you might call a 'market survey' -- I hope to get as much information from you as I have to give you right now. And the ad was published a month earlier than expected, so the following data leaves much to be desired. But here is the basic story and some tentative specifications...

"A few years ago, some computer fans indulged in fanciful speculation as to whether one could build a 'kilobuck computer,' a real digital computer to cost less than a thousand dollars. It was naturally assumed that all sorts of surplus and homemade parts would have to be used at that price. But today there is a tempting possibility that it can be done with new, off-the-shelf components.

"I have toyed with the idea of building my own computer for several years, but until recently I stuck to using free relays and helping to design computers for others to build. Early this year, stimulated by the trends in component prices, I sat down with a simple serial computer plan, and tried to further reduce it, throwing out every feature that could possibly be spared or substituted for. The only active registers I retained, for instance, were those clearly required in order to get information into and out of memory.

Then I devised means for substituting memory storage for most of the remaining registers required for useful computing. The result was so promising that I embarked on the current project to actually build such a machine.

"Subsequent work, although agonizingly slow as a part-time effort, has been even more encouraging. It would appear now that our kilobuck will buy the materials to build quite a respectable little computer. With luck we might have enough change left over to buy a surplus Teletype for I/O.

"Having acquired a great deal of my computer education through direct access to a modest-sized computer, and having subsequently taught programming to students with similar privileges, I am convinced that even a very small computer, close at hand, can be a very large asset to the learning process. And, although I recognize that any computer buff worth his salt will aspire to bigger and more glorious gadgets, I also believe that small machines can perform many useful tasks.

"If you and/or enough other people agree with me as to the utility of such a small, slow but cheap computer, then there is every reason to expect that a kit for home or school construction of this design can be produced. It should be no more difficult to construct than most of the hi-fi and ham kits on the market.

"I cannot make any definite quotes on price or delivery dates at this time, but I am offering you a chance to express your wishes before it is too late to consider them in the initial model.

"The big question is this -- what are you willing to do without, in order to get a useful machine at a minimum price??? If you can wait until sometime next year for a small, slow digital computer at a price in the vicinity of one kilobuck, let me know what you think of the enclosed tentative specifications, and tell me which of the optional features you must have, and which ones you don't want to pay extra for. In particular, how much memory do you need, and what instructions are most vital?? I/O is also a major concern, of course. Any additional suggestions you might have are equally of interest. I have already received a suggestion that circuits be explained in an educational manner, which I certainly hope to use, and there seems to be considerable interest in the Teletype angle, which I would like to explore further.

"MEMORY -- This will probably always remain the most costly item in any small-scale processor. The least expensive seems to be of the wire delay line variety. A single such line can store up to perhaps 20,000 bits, although the lowest cost-per-bit may occur at less than the maximum value. Larger storage capacity calls for more than one line. This introduces more complexity into the addressing structure, as well as the additional recirculation electronics for each separate delay line. This adds up to more than a minimal-sized computer, but is not otherwise incompatible with the proposed logic design.

"SPEED -- We are talking about a memory circulation time on the order of ten milliseconds. In the simplest version, most memory accesses would use up a whole 10-msec cycle. Since both instruction and data require access, this gives a typical speed of about fifty instructions per second. The addition of an extra address counter, plus a judicious allocation of memory between program and data, could

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just about double this -- 100 instructions per second -- by permitting an instruction and its addressed data both to be referenced during the same cycle. In either version, special programming techniques could be used to make important routines run several times as fast as this, but such programs can be very tedious to write.

"Glass delay lines have shorter cycles -- on the order of a few hundred microseconds -- so are naturally that much faster -- several thousand instructions per second. But the bit rate is faster, too, and more expensive logic elements may be required. Each line stores fewer bits, also, so that more than one may be required, even for a "minimal" machine.

"Any delay line constitutes "volatile" memory, meaning that all stored information is destroyed when the power is shut off. This is most annoying in a small computer, since the power may very well be shut off frequently, and since input devices fast enough to reload memory conveniently are somewhat expensive. In many cases, however, one may wish to reload memory frequently anyway, due to its small size. In this case, a volatile memory may not be unduly inconvenient.

"If a non-volatile memory is required, this would most likely be a rotating store -- disk or drum. The cost would be somewhat higher than wire delay lines, and slower operating speeds would be probable. However, no high-stability oscillator is required, since the "clock" is usually derived from a recorded track on the device.

"Rotating memories can have cycle times as short as 10 msec, but the cheaper ones run to two or three times as long as that. Speeds as low as 15 to 30 instructions per second could easily result.

"INSTRUCTIONS -- There are successful computers on the market with extremely limited instruction sets. I am planning a somewhat more extensive repertoire, wherever this will substantially improve the utility of our small memory and slow speeds. Some otherwise borderline instructions and other features will be provided because they are also needed for internal functions.

"Probably the most controversial category is that of multiply and divide. Do you insist on having one or both of these at a decided increase in cost? A full-word-length operation definitely requires more registers than are needed by the basic machine. On the other hand, to program or simulate these instructions using memory for storage is very much slower than a wired-in instruction using active-element registers. Let's consider three preliminary choices in order of cost -- No multiply or divide; half-word instructions; or full-length, full-speed multiply and divide. We might package this as a separate option to be added to the basic kit."

(TO BE CONCLUDED IN NEXT ISSUE)

[A|C|S] NEWSLETTER

Volume II, Number 4
(Serial Issue 15)
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DECOUPLING FILTERS

COMPUTER KIT

The previous issue contained most of a letter from Dave Digby in Texas, which contained a letter he'd sent to those who inquired about his computer-kit notice in CQ magazine. The letter ends:

"Index registers are fairly easy to include, if they occupy memory locations, rather than active registers. I favor at least one, possibly three. They can greatly facilitate loops and iterated algorithms.

"WORD LENGTH -- On the order of 20 bits. This would mean about 1000 words using a 20,000-bit delay line. The general idea is a word long enough to contain one complete instruction, including a full memory address. This is not too large in terms of data, representing about six digits in decimal, but will handle many useful problems. And double precision is not completely out of the question.

"INPUT/OUTPUT -- I have mentioned only Teletype, so far, but other devices are not impossible. In particular, a small photoelectric tape reader would facilitate reloading the memory. Thus larger programs or data tables can be contemplated. These come as low as a few hundred dollars, I am told. The general limits on other devices might be described as: only character-by-character devices, no faster than 100 characters per second. The number and complexity of control and synchronizing signals is also a factor."

Dave says he's still working on the computer kit, and is trying to build a small prototype. He's got a couple of delay lines, which he says are a little short, as they hold only 100 words (he's considering words of 16 to 20 bits length). Dave hopes to cut the number of registers to a minimum, and says two might be used, one to address the memory location, the other to contain data. He's using Motorola RTL ICs. With the right backing, Dave would consider producing the computer kit commercially, but that kind of money is scarce.

RC DECOUPLING FILTERS

Our newest member is Louis Frenzel of Maryland, who has a working computer with minimum I/O, and who also gives some very helpful information on RC decoupling. He writes:

"I have build a complete working digital computer. It is in operation now, and as you might expect, is gradually undergoing various modifications and improvements as time, money and ideas permit. The machine uses an 8-bit word, and serial 2's complement arithmetic. It has 8 basic instructions, with multiply and divide being performed by subroutine. The computer is implemented with a mixture of DTL and TTL ICs, including some of the MSI units. The basic add time is 3 milliseconds. So far I use only binary switches and lights for I/O.

"I'd like to comment on ... Problem 5-1. I don't really think that there is a set procedure for calculating RC decoupling (low-pass) filters for use in digital circuits. Every system I've seen has been different. Some use series resistors; some don't. I recently saw a small RF choke used as the series element on one system.

That's going almost too far, but for this system it may have been needed. As for capacitor values, I've seen values from .01 mfd to several thousand mfd. Almost anything works, but there are a few simple rules to follow.

"First, if possible, do decouple each PC board of circuitry. You won't go wrong if you use a fairly large tantalum or electrolytic, say 100 mfd, shunted by a .01 to .1 mfd disc. The 100-mfd unit takes care of most noise problems and is large enough so that no series element is needed. However, the inductive reactance of this large capacitor is pretty high at switching frequencies, so it does not get rid of all the high-frequency stuff. The parallel disc takes care of this. I've used this successfully for years.

"In some systems the larger capacitor just isn't needed. The only way to find out is to experiment. Take a scope and look across your ground buss between the power supply terminal (scope ground) and a ground point in the system. You will probably see a lot of high-frequency junk here. Experiment by connecting capacitors at the point under observation and notice any change. Use the smallest capacitor that best minimizes the noise. A .1-mfd disc fixed my problem in a recent design.

"Decouplers are a necessary evil in digital systems, but their need can be minimized or even eliminated in some cases, if the reason for the noise problem can be found. In other words, treat the cause, not the symptoms. Noise on the ground and power busses generally means poor busses. These busses must have a very low impedance at high switching frequencies. This doesn't mean just low resistance; it means low inductance too. Thin solid or stranded wire just doesn't make it. Try using some fat braid. The multiple strands keep both resistance and X_L low. I recommend at least a ¼" braid, and even bigger if you have a high power consumption system with lots of circuits. Use it for both power and ground. This approach will often reduce the noise to a point where filters are unnecessary. If any noise is left, a .1-mfd disc on each board will get it.

"Good noise suppression is a must if you are using low noise immunity circuits. You can get away with murder if you use DTL or TTL, since their noise immunity is relatively high. But if you use RTL, like a lot of guys do for low cost, you can literally be "eaten up" with noise problems. False triggering, erratic operation, and unusual logic problems will result.

"As a general word on wiring, don't bundle, cable or lace wires in parallel. Scramble-wire all circuits point-to-point. Use the biggest stranded wire you can stand and keep it short."

MOUNTING ICs

A recent look at the various ways of mounting ICs shows that prices are still high, no matter who makes the device, or how they make it.

Augat's Universal IC Packaging Panel, which accepts 14-, 16-, 24- and 36-lead DIPs, and has Wire-Wrap terminals on the back, costs about $1.50 per position to mount 14-pin DIPs. Other Augat packaging panels cost $1.00 per position. Augat DIP sockets are about 25¢ each. Breadboards for flat-pack or TO-5 ICs cost $5 to $6 per position.

Cambion DIP sockets for 14-pin ICs cost 75¢ each in small quantities, or $550 per thousand. The high-density Wire-Wrap circuit boards cost from $1 to $3 per position. Breadboards are $4 to $5 per position.

Vero PC boards holding up to 20 14-pin DIPs cost $16 in lots of 100, or 80¢ per position.

ELCO DIP sockets cost from 80¢ each (1-19) to 55¢ (200-999).

Vector Micro-Vectorboard is one of the cheapest methods of mounting DIPs (if permanent mounting is desired), by inserting the ICs thru the holes in the board and soldering directly to the leads. Vector also makes sockets, but they are not cheap: a solderless DIP socket for 14-pin ICs costs $4 for 1-19.

DISPLAYS

Alco Electronic Products has some interesting displays:

Incandescent readout indicators, using a stacked set of plastic edge-lit plates with a dot-pattern number engraved on each; about $8 each, for 6, 14 or 24 volts.

Seven-segment incandescent readouts cost $6.45 each; a "matrix-driver module" costs another $25, plus $1 for a connector.

Seven-segment neon readouts cost $5 each; a "decode-display module" is $30, plus $1 for a connector.

BOOKS AND MAGAZINE ARTICLES

What To Do With Your Computer

Anyone wondering what to do with his computer after finishing it is referred to "Problems for Computer Solution," by Fred Gruenberger and George Jaffray (John Wiley & Sons, 1965, 401 pages, paperback $5.95), probably the only book of its kind. The book contains 92 problems, ranging all the way from "The Game of Dice" to "Economic Lot Size," and includes problems in primes, games, random numbers, puzzles, geometry, and many others.

Even if your computer may never be able to handle Dartmough Basic, the paperback by the parents of Basic, John G. Kemeny and Thomas E. Kurtz, contains some interesting sidelights in computer programming: "Basic Programming," John Wiley & Sons, 1967, 121 pages, $4.95.

After a thorough discussion of Basic, the authors present chapters on number theory, simulation (dealing a bridge hand, baseball, the knight's tour), games (NIM, ticktacktoe), business problems (compound interest, tax depreciation, decision trees), statistics, vectors and matrices, calculus, and special topics (teaching machines, codes and cyphers, and music harmony).

Software

Control Engineering has an interesting reprint of a series of 14 articles on programming (which ran from Oct. 1967 to Dec. 1968) and available for $3. Although mainly about programming for process control, there is a lot of meat here, especially the article on "How Hardware Responds to Software" (Dec. 1967), which is recommended reading for those who are not too familiar with the subject.

Multiplexers and Logic Circuits

"Multiplexers double as logic circuits," by James Anderson of Fairchild (Electronics, Oct. 27, 1969, pp 100-105) is about using the dual four-input 9309 and the eight-input 9312 multiplexers in place of interconnected gates.

The technique requires a good knowledge of Boolean, truth tables and Karnaugh maps, which are required for translating a function into multiplexer inputs. The author says the multiplexer "is so versatile that it takes on the aspect of a universal logic circuit."

"The multiplexers are electronic switches that sequentially connect input-data lines to a single output. On the dual 4-input unit, the two select lines are common to both halves of the multiplexer, so that it behaves like a two-pole, four-position switch. On the 8-input multiplexer, three select lines control the eight input lines, and the device resembles a single-pole, eight-position switch.

"Applied as a universal logic circuit, the 4-input multiplexer can handle as many as three variables; two are applied to the select terminals, and the fourth variable or its complement goes to each of the input lines.

"Any of the possible functions of three variables -- there are 256 -- can be generated with one-half of the dual, 4-input multiplexer. And any of the possible functions of four variables -- which amount to a prodigious 65,536 -- can be handled by just one 8-input unit."

As an example, the function $F = XY\overline{Z} + \overline{X}YZ + X\overline{Y}Z + \overline{XYZ}$ can be implemented on half of a dual 4-input unit, whereas, if it were built with discrete NAND gates, this even-parity function would require five 2-input and two 3-input gates.

MOS Memories

"MOS Memories Save Power" is the title of an article by Dale Mrazek of National Semiconductor in The Electronic Engineer (July 1969, pp 49-53). It is about the advantages of MOS shift registers over magnetic cores, for data storage in low-power digital systems, and includes schematics for data input select circuits and for the data alighment section (for aligning the serial output of the parallel registers).

Inexpensive Pulse Source

"Inexpensive pulse source has 'high-priced' features," in The Electronic Engineer for Oct. 1969 (p 78) describes a circuit using only two Fairchild TTµL 9601 one-shots, yet it has adjustments for period/delay and for pulse width, switches for output-pulse polarity, for pre-trigger output-pulse polarity and for internal or external trigger, a button for single pulses, and inputs for gate and for external trigger.

Reduce IC Package Count

"Cut binary-to-BCD conversion costs," by Roland B. Anderson of Bunker-Ramo, in Electronic Design (Oct. 11, pp 104-110), tells how to reduce your IC package count with a nonsequential circuit using full adders and TTL gates, rather than a static converter.

Application Memos

Signetics Corp. (811 East Arques Ave., Sunnyvale, Calif. 94086) recently put out a small book of several hundred pages, "Application Memos," which you may be able to get on a letterhead.

The book covers a lot of ground. The first section includes guidelines for selecting a digital IC family (relative comparisons), and a fine, illustrated glossary of logic terms.

The second section, on digital considerations by family, is the largest section, and includes applications in counters, shift registers, adders, comparators and decoders. Section 3 is on decoding and steering; 4 on counters, shift registers and memory ICs; 5, interface and display elements; 6, linear considerations; 7, timing circuits; and 7, parallel data handling.

This book seems well worth obtaining, which may not be so easy, as is usually the case with such publications, except for those that DEC gives out in such quantities.

Understanding Core Memories

Two recent publications by Ferroxcube are about core memories. "Taking the Mystery Out of Memory" is a 5-page brochure that covers the basic facts. Much of this information is contained in "How to Use Ferroxcube Digital Magnetic-Core Memories," a 28-page booklet (Bulletin No. 666) well worth reading. After a brief review of how memories work, it gives some memory control techniques, and then goes into applications: data links, instrumentation, small business-data machines, process control and monitoring, telemetry and digital communications, and data organizers.

A letterhead might be required to get either of these, from Ferroxcube Corp., Systems Division, Englewood, Colo., or from a local office (Annapolis, Burbank, Cleveland, Denver, Minneapolis, Northlake, Orlando, Phoenix, San Francisco, Union (NJ), Waltham, or Toronto).

Logic Display

The "Wireless World Logic Display Aid" is described in a series of construction articles in the British magazine, Wireless World, by assistant editor B.S. Crank (May 1969, pp 196-202; June pp 255-264; July pp 311-316; Aug. pp 372-377; Sept. pp 419-422; Oct. pp 466-470; Nov. pp ??). The logic display aid produces, on a standard oscilloscope, the Venn diagram, Karnaugh map or truth table of any gate or logic circuit that is connected to the display aid. The display is a 16 X 16 dot matrix.

Author Crank priced out the components, and lists half a dozen British sources for the various groups of parts, at low cost. The ICs, for example, are by Ferranti, and cost £33.15.0, or about $80. Total parts cost, including cabinet, is £74.17.6, or about $180.

SEQUENTIAL CIRCUITS -- INQUIRY

Don Fronek writes: "I have just finished some research in the area of sequential circuits and wonder if anyone in the ACS uses sequential programming. It's not a bad way to go for these smaller machines. Gives a cheap method of calling subroutines with only the basic commands (add, subtract, etc.).

I'm about ready to tear down my machine and re-do it in a parallel fashion (was series addition for process control).

Am interested in obtaining a cheap printer -- any suggestions?"

Later, Don writes: "Have obtained some core planes for the heart of a small 17-bit-word memory. Would like to know if anybody has a simple read-write circuit (including elementary circuits for transistor line drivers). I would like very much to obtain this information. These core planes are 16 X 16, and I'm planning on stacking them 17 deep." Don Fronek, 520 E. "B" Street, Moscow, Idaho 83843.

QUOTRON MAGNETIC TAPE UNITS

Bill Pfeiffer sent some notes he

The Amateur Computer Society is open to all who are interested in building and operating a digital computer that can at least perform automatic multiplication and division, or is of a comparable complexity.
For membership in the ACS, and a subscription of at least eight issues of the Newsletter, send $3 (or a check) to:
Stephen B. Gray
Amateur Computer Society
260 Noroton Ave.
Darien, Conn. 06820
The Newsletter will appear about every two months.

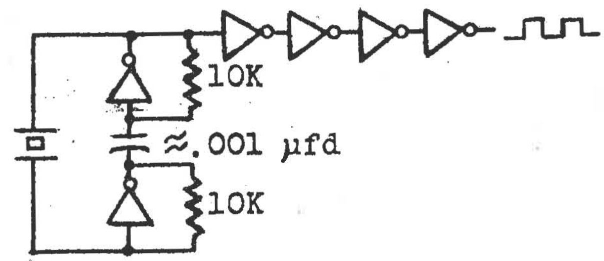
wrote up on the Quotron tape handlers, which are available for about $100 in California. Also, he says, the modules and other parts are available. If anyone is interested, write to Bill for a copy of his notes: William F. Pfeiffer, 932 Via Del Monte, Palos Verdes Estates, Calif. 90274.

WHERE TO BUY IT

B&F Enterprises, P.O. Box 44, Hawthorne, Mass. 01937, has a catalog showing a memory core stack (12 planes with 2048 cores each) for $90; PC logic boards at 10 for $3.50 with connectors; one-µsec delay line for $1.50; and a magnetic drum with 146 heads for $95, if you have 115 VAC 400-cycle.

IDEAS AND INQUIRIES FROM SHOSTAK

Bob Shostak has several ideas and questions: "Modification of a _Popular Electronics_ circuit makes a stable, simple yet reliable clock for any frequency up to around 3 Mc. Use one Motorola MC789P hex inverter IC (about a dollar) and a few components on a PC board. Four series inverters square up the oscillator output. Harmonic suppression may be required, depending on your luck -- a tuned circuit before the four squaring inverters should do the trick.



"Solution to the serial-parallel, vice-versa conversion problem with TTY I/O: software! The computer can wait around and pick off each serial bit as it comes (it might even do some calculation while waiting out the 22 msec between TTY pulses). I doubt many members have plans for interrupt systems, I/O buffers, etc., that would allow the CPU not to be tied up during I/O anyway.

"What is a source of cheap taper-pin terminals to be crimped or soldered to the end of plugwires?

"What is a source of surplus neon drivers or indicators driven from ICs? What cheap transistor would brave the 90 V DC?

"Possible memory idea: a small tape loop on a regular tape recorder used as a delay line. Read, write heads must be spaced very closely for good access time; one could probably get bit densities of about 1000 bpi using just audio tones."

DON'S TRADING POST

Don Tarbell (11200 Hillwood Drive, Huntsville, Ala. 35803) would like to trade, for items of equal value: 2 SN7483N (4-bit adder, cost $13.43 each); 6 MC778P (dual D FF, cost $2.35 each); 2 MC784P (dual half shift register, cost $2.30 each). Don needs: MC717P, MC789P, MC790P.

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February 1970

ACS NEWSLETTER

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THOSE ADDRESS LABELS

If there is a machine-printed address label on the envelope this newsletter came in, the program used to print it was written in Cobol, for an IBM 360/30.

The addresses are keypunched into cards, three cards per address, with a maximum of six lines per label. The program deck consists of 105 cards. The 360/30 puts all the addresses on magnetic tape, then prints as many sets of labels as called for by a control card.

Another control card permits the labels to be printed "three up" (three across), or two up, or one.

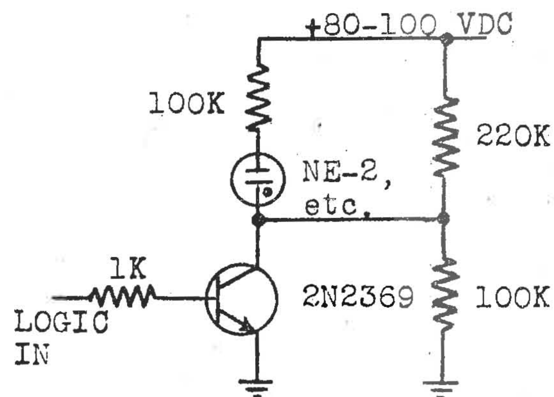
LAMP DRIVERS

Louis Frenzel, the new member who contributed the item on RC decoupling filters to the previous issue, now comments on lamp-driver circuits. He says:

"This is an area usually neglected or taken for granted, as it is one of the less interesting and rather simple circuit requirements. I did dig into this area when I designed my computer, and found some interesting things.

"First, with all the sophisticated indicator lamps available today, you can literally spend a fortune on simple off-on indicators. Most of them look good, of course, but still do nothing more than go off and on. There are several good, cheap ways to make indicators that will serve your purpose and still look good. They are not as fancy as some of the commercial units available, but their low cost permits you to use more of them.

"My initial thought was to use neons because of their low cost and availability. Besides, I had a batch of NE-2's on hand. But I quickly found that I needed some high-voltage transistors to drive them. These I didn't have, and since they are expensive, I didn't get them. However, I did find that high-voltage transistors weren't needed if care was taken to limit the collector voltage on a low-voltage transistor to a value within its ratings. I used this circuit:

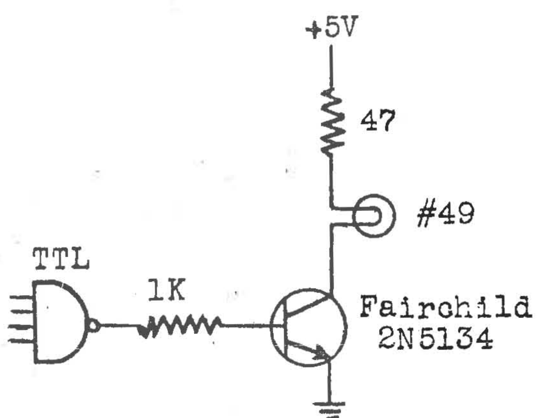


"The voltage divider keeps the voltage on the collector below the breakdown level when the transistor is off. The transistor is a 2N2369, whose breakdown is 40 volts. Almost any switching transistor can be used. Just set the R_1-R_2 divider to a value high enough to prevent the lamp from remaining on when the transistor is off. The lamp sustaining voltage is lower than its ignition voltage, and when the transistor is off, the potential voltage across it is the supply voltage less the divider voltage.

"I mounted the lamps by pushing them through a 3/8" grommet in a panel. It's a snug fit, so no further support is needed.

"While this works fine electrically,

it does leave something to be desired in appearance. Frankly, I hate neons and the high voltage they need. So I went to a standard incandescent. The cheapest is the old bayonet-base type. I used a #49 (cheap), rated at 2 volts and 60 ma. I drive it with a 2N5134 Fairchild npn (19¢) through a 47-ohm dropping resistor. The supply voltage is the existing 5-volt regulated logic supply. The driver transistor base can be fed directly from TTL or RTL gates or flip-flops. Inexpensive bayonet sockets can be used to mount the lamps behind a panel. No jewel or colored filter is needed. Just drill a hole in the panel a hair smaller than the diameter of the bulb. Then let the bulb end poke through the hole slightly. The effect obtained is unusual but pleasing in appearance, and ever so cheap. Try it.



"I highly recommend a book titled, 'Digital Computer Design Fundamentals,' by Yaohan Chu. This is a McGraw-Hill book, and it outlines detailed design procedures and even describes a small hypothetical computer that could be easily modified or added to, and built by an amateur."

NEWS FROM A MEMBER

Richard Dickey of California says:

"I have a nice full decimal one-digit adder/subtractor built and tested. It takes just 69 NAND gates. I found that the inclusion of direct subtraction takes so few extra gates that the nuisance of complementation is unnecessary. It is to go into a serial-by-digit, parallel-by-bit arithmetic unit based on the delay lines I got thru the ACS Newsletter.

"The price of the adder/subtractor, by the way, was 6 boards of 12 NAND circuits per board, at 69¢ per board, for $4.14 plus tax, plus a few hours of design.

"I plan to start out using this, at first, with the four-bit I/O register doubling as the MQ register. As a calculator, each digit of the multiplier, as it enters from the keyboard, can be counted down as the multiplicand is accumulated. On division, as each digit of the quotient is produced, it can operate the Flexowriter, thus printing the quotient as it is produced.

"Later I hope to get my drum memory working, and convert the kludge into a computer.

"I could get more done on my little computer if the big ones would stop breaking down. At the college we may have established some sort of record last week, with all six of our G.P. computers down for one reason or another (one 360, one B205, three G-15's, and an Athena)."

MORE ON ECHO IV

Some new information about Jim Sutherland's computer, ECHO IV, appeared in the February 11 issue of <u>Computer World</u>.

ECHO IV has 17 machine-language instructions, 15-bit words and an 8K core memory, to which is being added 2K words of read-only memory to eliminate bootstrapping. Another expansion will be two tape drives, adding 1.5 million characters on each drive.

Instead of punching up cards or tape, ECHO IV goes directly from keyboard to core, and then will transfer the programs onto the mag tape after debugging.

Control keyboards can be plugged in at any of 16 receptacles scattered around Jim's house, using an 18-wire data trunk.

Jim plans to hook the TV picture tube to ECHO IV so the machine can communicate with the family thru an unused channel. On school nights, the set will switch to that channel at a certain time and remind the children to go to bed.

* * * * * * * * *

Incidentally, by what may not be a coincidence, there was a book published in 1965 by Little, Brown & Company, "The Tin Men," by Michael Frayn, a reporter for the London Observer; in this comic novel, a small part is played by a computer named ECHO IV.

HARDWARE

Semiconductor Memories?

The technical magazines and journals are full of articles and news items about semiconductor memories. For instance, Motorola showed a 8192-bit random-access memory at the 1969 Fall Joint Computer Conference in Las Vegas. A hybrid, it contains both MOS and bipolar LSI circuits. The MOS circuits provide the high density and low power dissipation for the storage arrays, and the bipolar circuits provide the high speed for driving, sensing and decoding.

The memory access time is about 120 nsec; the cycle time about 150 nsec. But how about cost? Motorola expects a price of about 10¢ per bit "when the memory goes into mass production." By 1972, the price may be reduced to "about 5¢ a bit." That would be about $800 now, and $400 in a couple of years. Cheap for an 8K memory, if you can wait.

Electronic Typewriter Actuator

Here's an idea that may be worth borrowing from:

Colorado Instruments, Inc. (One Park St., Broomfield, Colo. 80020) has designed an actuator for use with an IBM Selectric typewriter. The ETA-14 is a long, slim box containing 14 solenoids, and which clips on the Selectric to actuate the 0 to 9 keys, plus tab, dash, return and equal signs. A separate coupler provides the power and drive circuits.

Viatron has gone this one better: they will offer (or intended to at one time) a "solenoid robot" with 50 solenoids, for operating a Selectric at 12 characters a second, using an OCR font.

U-Shaped Cores

U-shaped cores are coming into use for read-only memories, with the sense wires strung through or around the cores, depending on whether a 1 or 0 is desired. However, these U-shaped cores do not seem to be available off-the-shelf yet; companies such as Indiana General and Ferroxcube make them only to order.

Cheaper ICs by 1973?

Toshiba will build a $19-million plant to produce 100 million integrated circuits annually by 1973, according to Business Week.

Mitsubishi will also make ICs; by

1973 the two will be producing more than 250 million ICs a year, which is about 20% of U.S. production.

For years, U.S. semiconductor manufacturers have been saying that only strong Japanese competition could thwart their continuing, dramatic growth. If the tariffs are not changed, Japanese ICs may become as prevalent in the U.S. as Japanese transistor radios. (Presumably, nearly all these ICs will be for entertainment products at first, but digital ICs may come along a little later.)

Nixie Readout at $15 per Decade

The February 1970 Popular Electronics (pp 33-47) has a long construction article, "Build Numeric Glow Tube DCU" by Don Lancaster, based on the Burroughs B5750 Nixie.

The counter operates from DC to 8 or 12 Mc, depending on whether RTL or Signetics Utilogic is used. The article describes the 8-Mc RTL model (Motorola MC700P series). Complete information on the Utilogic version is available from a Texas address.

As usual with Lancaster articles, kits are available. A complete kit of all parts for a 2½-digit counter costs $43.50; for 3½ digits, $59.50; 4½ digits, $75.00. Etched and drilled PC boards are available alone, at $4, $5.75, and $7.50. That half-digit is a neon lamp that indicates a one, permitting counts up to 199 with the 2½ digits. At the 200th count, an over-range neon indicates that the counter has gone beyond its limit. A power-supply kit is available at $6.50.

Expensive Breadboard

The breadboard mentioned in Vol. II, No. 1 (page 6), now has a big brother, Elite 2, which has three power supplies instead of one; a waveform generator that outputs sine, triangle and square waves, and positive and negative pulses. The cost is twice that of Elite 1: $1300.

The "universal matrix" that is the heart of both Elite models can be bought from AP Inc., 72 Corwin Dr., Painesville, Ohio 44077. The AP breadboard consists of 8 groupings of 64 terminals each, with 4 tiepoints per terminal, making 2048 tiepoints, plus two groups of 27 four-tiepoint terminals, for a total of 2264 tiepoints. Any DIP from 10 to 128 pins plugs in, also 8- and 10-pin TO-5 cans, and standard discrete components. Interconnection is by any piece of wire, from size 10 to 30. Cost: $85 each. Seems expensive for five acetal copolymer terminal strips on a glass epoxy base, even with a "gold-plated copper ground plane" on the back, and "spring-loaded beryllium copper, gold-plated" tie-point contacts.

Lower-Cost Fairchild 7400 ICs

During the last week in January, Fairchild Semiconductor started offering 7400-series ICs at what they say are the lowest prices in the industry. And their ad compares prices (the first column gives the basic IC number):

	TI	Signetics	Motorola	Fairchild
7400	1.26	1.20	1.10	.85
7404	1.58	--	1.36	1.07
7450	1.26	1.20	1.10	.85
7474	2.52	2.40	--	1.88
7472	1.77	1.69	1.50	1.31

These are the 0° to 70° C types, in quantities of 100; only several of the 24 types are shown.

Fairchild is aiming at producing 2 million circuits a month. There are 17 gates, 6 flip-flops, and a BCD-to-decimal decoder/driver. Fairchild also aims to produce at least two 7400 MSI elements every month.

Core Memory Drivers and Amplifiers

Texas Instruments published, last October, two applications reports of interest. "The Operation and Use of Series 7520N Sense Amplifiers," CA-101, has 25 pages of not-too-technical information on the 7520N, a 16-pin plastic DIP family of three threshold-and-strobe circuits.

The SN7520/21N sense amplifier has dual sense-input preamplifiers with independent strobing of each sense channel. The outputs of the two sense channels are combined in a common-output circuit composed of two cascaded TTL gates. It is compatible with standard TTL.

The SN7522/23N also has dual sense-input preamplifiers with independent strobing of each sense channel. The outputs of the two sense channels are combined in a double-inverting open-collector output gate. It can be connected with logic gates with the wired-OR capability, such as most DTL gates and the SN7401 TTL gate.

The SN7524/25N is two separate single-preamplifier sense amplifiers. Each sense-input channel can be independently strobed. The output circuit of each channel features a simple TTL gate with a high fan-out capability. This is designed primarily for small memory applications where performance and cost are important considerations.

TI Bulletin CA-107, on the SN75 324 monolithic memory driver, is a 5-page item adapted from the 1968 Spring Joint Computer Conference proceedings. The SN75 324 was designed specifically to replace the traditional discrete transistor-transformer circuits. However, it can also be used as a lamp driver, relay driver, or high-fan-out logic gate. It consists of four fast, high-current switches controlled by seven logic inputs that are compatible with 54/74 TTL and other standard logic systems.

TI Bulletin CA-122, "Monolithic interfacing in computers," briefly describes (in 10 pages) the 75 109 line-driver circuit, 75 107 line receiver, 75 308 transistor array, 75 324 memory driver, and core memory sense circuits.

Printed Circuits Without Photography

The "negative drafting system" of Bishop Graphics, Inc. (7300 Radford Ave., North Hollywood, Calif. 91605) permits making printed-wiring boards without photography.

The secret is PC-component patterns on black matte acetate film, called "B Neg," with which one can make up the equivalent of a photographic negative. This eliminates two steps: making a photo positive, and photographing it.

A PC board is made by spraying a clean copper-clad laminate with Bishop Resist, placing the B Neg on the sprayed board and exposing it to ultraviolet, developing the pattern, and etching it.

Bishop sells a complete kit, containing 5" by 7" trays, photo resist, developer, stripper, etchant, contact pressure frame, and three 4" by 6" boards, for $28.70. For $36.80 you get an 8" by 10" kit. All items are available separately. B Neg artwork patterns (1:1 scale) cost $7.55 a roll of 100 patterns, and include DIP, flat-pack and TO-can types.

Cheapest Commercial Computer?

For $1800, Unicom Inc sells the CP-8A, with a 1.5-μsec-cycle pro-

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For membership in the ACS, and a subscription of at least eight issues of the Newsletter, send $3 (or a check) to:
Stephen B. Gray
Amateur Computer Society
260 Noroton Avenue
Darien, Conn. 06820
The Newsletter will appear about every two months.

cessor, 512 bytes of read-only memory, 4 scratchpad registers, and 40 byte-oriented instructions. Core is extra. The D model, with a million bytes of tape-cassette storage and 1K of core, is "under $5,000."

Unicom is at 1275 Bloomfield Ave., Fairfield, New Jersey

BOOKS AND ARTICLES

Computers for Amateurs?

"Computers for the Amateur Constructor," by R.H. Warring, was published in England in 1966, and is available from Sportshelf, P.O. Box 634, New Rochelle, N.Y. 10802 (102 pages, $6.75).

Although the title is misleading, the book is of some interest, mainly because it is about the only one of its type. It tells how to build a counter, adder/subtractor, decade scaler, NAND, AND, NOR, OR, and lamp driver. These seem to have been designed by Mullard, and use transistors such as the OC71 and OC78 (there are substitution manuals that give the American equivalents).

However, the book tells nothing about how to connect the basic modules together, except for a couple of simple logic circuits.

Semiconductor Memories

The November 1969 EEE contains an interesting section, on pages 52-67. After a brief introduction and a list of 40 manufacturers, there is an article, "MOS Memories," by Leonard of TI, mainly about content-addressable memories and read-only memories. "Bipolar Memories," by Snyder of Raytheon, mainly describes the operation of a memory array, and has almost a page on LSI memory subsystems.

An Electronic Digital Slide Rule

A fascinating article with this title, by Schmid and Busch of GE Avionic Controls, appeared in The Electronic Engineer for July 1968 (pp 54-64). This hand-size calculator, weighing less than two pounds, measuring 5x7x1½ inches, contains 40 standard digital ICs, 8 rotary input switches, and four Nixie tubes.

The EDSR is based on integration, and has three basic sections: a pulse rate generator, output integrator/timing circuit, and function selector switch. The switch provides the proper interconnections for add, subtract, multiply, divide, square, square root, exponential, logarithm, and sine-cosine functions.

The EDSR has not gone into commercial production, according to one of the authors, but has been offered for licensing to outside manufacturers. If nobody picks up this item, the authors may be able to release the detailed schematics. However, it looks possible to figure out the construction of the EDSR from the schematics in the article.

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May 1970

ACS NEWSLETTER

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THOSE UNDEFINED DEC COMPONENTS

As the ACS Newsletter of July 1969 noted (page 1), one of the big problems in copying a PDP-8/L is that many of the components bear DEC numbers only.

One of the DEC District Managers very kindly provided some help.

For the transistors and diodes with no commercial equivalent, a DEC part number is given.

Transistors	
DEC 2	(15-05369)
DEC 1008	(15-02155)
DEC 2904	2N2904 or 2N2905
DEC 3009B	(15-03100)
DEC 3568	2N3568
DEC 3790	(15-03399)
DEC 6534B	(15-034090-1)
DEC 6534D	(15-03409)

Diodes	
D662	1N645
D664	1N3604,1N914,1N3606
D671	1N3653
D672	1N3653
MR2064	1N4001

No information was received on the two delay lines (DEC 16-05530 and 500), rectifier (11-05397) and transformer (T2037).

A NEW MEMBER'S COMMENTS

Our latest member is Steve Wiebking in Nebraska, with the USAF. Among his interesting comments are these:

"I have bought so-called tested ICs from Polypaks in the past. Their linear devices seem to be generally OK, but I have no confidence in the quality of their digital devices. At any rate, tested surplus is usually only marginally cheaper than brand-new devices, and is not really worth it from the viewpoint of difference in quality.

"Polypaks also asks ridiculous prices for their unsorted devices. Mike Quinn and Electronic Components Co. (also known as General Sales Co.) are the only companies I know of that sell unsorted ICs in the 5¢ each range. I cannot deny that getting these into usable condition involves a lot of work, but as one of your correspondents pointed out, "insanity and wiring is what computer building is all about."

"So far I have built a tester for series 53 (TI) DTL, and also a device which allows me to easily identify unmarked ICs. At present, I am working on a more general tester, which will be able to handle TTL as well as a number of other lines of ICs.

"I also have a couple thousand ICs in a narrow-gage TI DIP that I would like to sell once I get them tested. Prices would be 30¢ for a 5360, 60¢ for a 5302 (dual FF), and I also have some series 74 in this package, as well as many other series 53 types.

"Gadgeteers Surplus sells a number of panels of lights at about 10¢ per lamp assembly. These are generally low-current incandescent lamps; the ones I have are 10 v, 20 ma.

"On the subject of making your own PC boards, I presently use a technique given to me by Bill MacBeth of Austin. I draw my layout on graph paper, tape the paper to the PC board, and use a scratch awl to center-tap the hole positions, which I drill with a number 70 drill for ICs. This makes a fairly tight fit on IC leads, but it makes soldering easier. After drilling the holes, I dip a draftsman's bow pen in airplane dope and use this to draw resist lines on the board. I etch the boards by gripping the board with pliers and stirring the etch solution, using the board as a paddle. This gives me a better etch factor than merely laying the board in the tray and rocking it. The improvement is especially great with double-sided boards.

"The book, 'Circuit Design of Digital Computers,' by Hawkins (John Wiley & Sons), contains a discussion of the transmission-line aspects of a core memory, and also takes a practical approach to many other aspects of discrete component design. As for the logical end of computers, my introduction to the subject was 'Understanding Digital Computers' by Siegel (Wiley), about 1961 or 1963.

"Fairchild has a nice application note on using the uA711 as a sense amplifier. However, things are getting to the point where 711s have only a marginal price advantage over straight sense-amplifier ICs. In the latest Electronics, National Semiconductor advertises dual sense amps for $4.80 each in 100-up.

"In answer to question 4-2 (Feb. 1967, p 6), 'The Logic of Computer Arithmetic' by Ivan Flores (Prentice-Hall 1963) contains the most information on floating-point hardware I have seen.

"You may already be aware that the Selectric typewriter can be converted for automatic operation using only about 10 low-power solenoids to operate the control rods under the keyboard. These rods can also provide coding of the keyboard for input to a computer. There is a company which does this commercially and has advertised in Computerworld.

"On breadboarding ICs: I haven't tried this yet except in a single-IC version, but I think I have a good arrangement. Mount three IC sockets side-by-side. Solder the leads of the two outside ones to the adjacent leads of the center socket. You now put your IC in the center socket and plug #24 solid tinned wire into the two contacts that are connected to each pin of the IC. This is a little cheaper than commercial breadboards, almost as dense, and requires no special plugs.

"A possibility for an I/O device that no one seems to have mentioned yet is a FAX transmitter/receiver set changed to provide a digital output instead of an analog one. Through the use of software, the transmitter could be used to input ordinary typewritten material, or carefully lettered handwriting. The I/O of graphs and curves would be possible. I remember reading several years ago of an Australian university that converted a standard FAX machine for use on their computer. Also, the Visicon company is now making a device of this type for computer input.

"I have bought a great quantity of surplus ICs for 5¢ each, from Mike Quinn Electronics. In December I spent $750 on 15000 ICs and expect the following yield of perfect devices, based on small samples: 7400 - 1500; 7410 - 500; 7420/7440 - 1100; 7441 - 90; 7473 - 300; 7474 - 150; 7475 - 650; 7442 - 50; and a handful of other types."

If you're interested in buying some of those narrow-gage TI DIPs, write: Stephen A. Wiebking, 5802 South 14, Apt. 6, Omaha, Nebraska 68107.

Inexpensive T/S Terminal

Within a year, one of the electronics hobby magazines may publish a construction article on a time-sharing terminal to cost less than $200. It will use a CRT (for off-line editing), a 21-inch tapo loop with a cheap Japanese tape recorder, and one of the new Flex Key "integrated" keyboards.

A read-only memory will be used for ASCII conversion. Future options may include a color adapter, cassette storage, and a solenoid matrix for typewriter hard copy.

Two reasons for the long lead time are the metalworking problems, and the fact that no two Japanese tape-recorder heads (of the cheap variety) are alike.

Flex Key Integrated Keyboards

Those Flex Key keyboards got a lot of attention at the March IEEE show in New York, because they are so simple, and the button travels only about 0.02 inch.

In the thin version, the keyboard is only 1/8 inch thick; the exterior is all plastic. It uses a "proprietary structure of conductive elastomeric membrane, deformed under pressure through a thin aperture film on a printed circuit board, to accomplish effectively bounceless switching." This seems to mean that pushing the surface will force a conductive plastic up against a rigid PC board, after which the plastic returns to its original position.

The thick keyboard, with raised numbers (0 to 9 and decimal point), is ¼ inch thick. Both measure 2¼ by 3 inches. The thin model is $9.95; thick, $12.95 each, from: Flex Key Corp., 1277 Main St., Waltham, Mass. 02154.

An Even Cheaper PDP-8

Another version of the PDP-8 is slated to come out this summer. The PDP-8E, a 12-bit computer slimmed down to compete with the small 8-bit computers, will sell for about $4000 in quantities, with 4K core and no Teletype.

Arithmetic Unit in a 24-Pin DIP

In March, Texas Instruments introduced the SN54/74181 arithmetic logic unit, claimed to be "equivalent to 75 TTL gates ... it is the closest thing yet to a 4-bit CPU in a package."

The SN54/74181 performs 16 arithmetic binary manipulations on two 4-bit words, including add, subtract, compare, decrement, direct transfer and shift right. It will also perform all possible 16 logic functions of two Boolean variables, including AND, NAND, exclusive-OR, OR and NOR.

Four of the SN54/74181 can be hooked up with a SN54/74182 carry look-ahead generator (also new) to add/subtract two 16-bit words in 36 nsec, more or less.

The SN74181 is $16.50 in quantities of 100-999; the SN74182, $3.63. The 1-24 price is about 50% more than those prices.

IC Plugboards from Vector

New at Vector this year are the 3677 series DIP plugboards, which provide universal mounting for DIPs, flat packs, transistors and discrete components. The longest board in the series (3677) will hold up to 24 of the 14-pin DIPs, and costs $9.89 for 1-19, $8.90 for 20-99. There are 22 tabs per side at the plug-in end. The 3677 is 9.6" X 4.5" with two sides; 3677-1 has only one side; 3677-2 is a 6.5" X 4.5" version of the 3677.

The 3682 DIP plugboard holds up to 54 14-pin DIPs. The size is the same as the three boards in the

3677 series, but the layout is different, and the prices are slightly less.

Within the last year, Vector has brought out two breadboard kits for IC experimenters. The 29K, costing $59.75, includes a 4.5" X 13.9" perforated Vectorboard with side and end rails, five 14-pin DIP sockets, two 16-pin DIP sockets, four 4-lead TO-5 sockets, two 10-lead TO-5 sockets, four flatpack adapter plates, ten 12-hole mounting pads, and contacts, wire, terminals, lugs, bus strips, tools.

Another kit, for $17.95, comes in two versions: 30X and 31X. The main difference is that these two kits contain no sockets. The 30X has two 4.5" X 8.5" Vectorboards with side and end rails; the 31X has one 4.5" X 17" Vectorboard with rails.

These are not the only Vector DIP plugboards; for full information, write to Vector Electronics, Inc., 12460 Gladstone Ave., Sylmar, Calif. 91342.

Cross-Reference Guide for TTL ICs

National Semiconductor has put out a handy one-page cross-reference guide to the series 74N TTL ICs, giving the pin-for-pin replacements (or nearest equivalents) for the 74N ICs made by National, TI, AEG (Germany), Amperex, Fairchild, Ferranti (England), ITT, Motorola, Sescosem (France), Siemens (Germany), Signetics, Sprague, Sylvania, and Transitron.

For a copy, write to National Semiconductor Corp., 2900 Semiconductor Drive, Santa Clara, Calif. 95051. They will also send a chart of "helpful general rules-of-thumb regarding practical uses of standard TTL Series 54/74," plus a list of their own TTL ICs: 16 gates, four flip-flops, six counters, etc.

Heath and Digital Kits

One reason Heath hasn't gone into the digital-logic kit business is due to their designers' insistance on using, for esthetic reasons, decimal readouts such as Nixies, rather than a row of binary lamps. This raises the price to the point beyond "customer acceptance."

In talking with Heathkit men at the March IEEE, it seems that Heath had worked up a prototype kit several years ago for a combination Eput meter, frequency meter and interval timer, which would have been the TB-18 kit. The project was abandoned because the kit price would have been too high, due to such factors as Nixies being specified.

Incidentally, it would seem, at first glance, that Heath has lowered the price of its digital system from $435 to $365, on looking at the Spring 1970 catalog. However, the $435 price, as noted in the August 1968 Newsletter (p 4) was for the 801-A Analog Digital Designer, with 13 plug-in cards. For the $365, you get the 801C Computer Logic Teaching System. This seems to be just like the 801-A, but minus four of its cards: one-shots, relays, comparator, and operational amplifier. These four cards cost a total of $132 (1969 catalog). Yet the 801C is only $70 cheaper.... That's quite a bit of inflation in only one year.

Computer Designer's Conference

Called the "first national conference encompassing all areas of computer design," a Computer Designer's Conference & Exhibition is scheduled for Jan 19-21, 1971, at the Anaheim Convention Center in Anaheim. Calif. Although most of the papers to be presented will be too far out for amateur applications, there may be one or two of interest. "Proceedings will be published and will include all papers."

The conference is being put on by Industrial & Scientific Conference Management, Inc., 222 West Adams St., Room 1098, Chicago, Ill. 60606, from which address is available a "free exhibit entrance badge," along with conference details.

"Low Cost Output Device"

Unicom, Inc., which has offered the lowest-cost computer so far ($1800 -- but without core), offers a "low cost output device for mini-computers," which turns out to be an Olivetti Praxis typewriter with a solenoid box over the keyboard, at $790. The PR-2000A types at 10 characters/second; for another $300, an 8-bit custom code-converter is attached to the back.

The Haynes Cookbook

Jim Haynes, an ACS member in California, recently became the editor of a new department on the Computer Group News (IEEE), called "The Cookbook." This new column "is an attempt to be of service to the practitioner of computer design," and will contain notes, suggestions, comments, "who-is-doing-what-and-where-to-write-for-more-information," "questions, problems, gripes and goofs." Jim is at the University of California in Santa Cruz.

CURRENT ARTICLES

Binary-to-BCD Conversion

"Comparing Binary-to-BCD Conversion Techniques" by MacDonald and Sklar in the Dec. 1, 1969, EDN (pp 33-39) discusses parallel techniques (logic matrices, summation of BCD components, read-only memory), counter techniques, Couleur's technique (BIDEC, integers only), divide by 10 (binary integers only), and multiply by 10 (binary fractions only).

Microprogramming

An interesting semi-tutorial, "System Design of a Dynamic Microprocessor," by Cook and Flynn, was in the March 1970 IEEE Trans. on Computers (pp 213-222).

Nearly all the microprogramming done to date is of the static type, in which a machine instruction repertoire is implemented by a fixed program in a read-only memory. A dynamic microprocessor uses a read/write memory for microinstructions, and permits a computer to be restructured to represent any computer instruction vocabulary that exists (or can be conceived of), by simply writing and loading its microprogram.

The article discusses a hypothetical computer, describes its basic operation, and gives several coding examples. In logical-type operations, the speed is about 10 times as fast for directly microprogrammed logical programs as for the machine-language equivalent, because the actual operation called for by a logical machine instruction is such a small percentage of the overhead operations of instruction-fetching, decoding, and address generation. However, for programs involving arithmetic operations, the time savings is much less (only 20% in the sample square-root program), since the arithmetic instruction's loop will dominate the total execution time.

IC Flip-Flop Control Problem

If you've been applying (or removing) the preset and clear signals simultaneously to an IC flip-flop, you've probably been having troubles. According to a Customer Engineering Clinic item in the Jan. 1, 1970 EDN (pp 74, 74), if the two signals are applied together, both outputs of a JK master-slave flip-flop such as TI's SN7495 will go high; simultaneous removal of both "will permit

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For membership in the ACS, and a subscription of at least eight issues of the Newsletter, send $3 (or a check) to:
Stephen B. Gray
Amateur Computer Society
260 Noroton Ave.
Darien, Conn. 06820
The Newsletter will appear about every two months.

random patterns to set up."

Trouble also arises when applying preset or clear signals while clock pulses are being received, even though IC makers may say "preset and clear are independent of the state-of-the-clock."

The solution is to avoid simultaneously applying or removing opposing control functions. Also, phase-lock all inputs, to prevent nonsynchronized inputs from drifting in their phase relationship.

Poor Packaging of LSI Chips

LSI packages are being delivered with missing leads, broken or warped ceramic, loose caps, and bent pins, according to a March 30 article in Electronics, "The broken promise of LSI: packaging" (pp 123-125).

According to the article, "the problems of packaging LSI devices seem to be growing faster than the market." "Reliability, assembly yield, and delivery problems plague users of large ceramic packages." "With chip makers throwing away two packages for every three deliveries, and using 2.5 packages for every delivered LSI device, price becomes an important issue."

Character Generator

A character generator using MOS read-only memories and shift registers is described in "There's a better way to design a character generator," by Carter and Mrazek of National Semiconductor, in the April 1970 Electronics (pp 107-112). The memories shape the characters for CRT readout; the registers handle refreshment.

A pair of ROM chips, either MM 5240 or MM 5241 (available in June, and designed for generating CRT display characters) generate the raster scan and vertical scan. A 5-by-7 dot matrix is used. The article shows a logic diagram for generating multiple-character lines.

Computer Music

Not recent, but interesting, is a letter from Himelhoch of Martin Marietta in the Jan. 1969 Data Processing Magazine (p 14):

"... I have taken orchestration on a computer with no converter or other type of an adapter. This was accomplished by capacitor-coupling the output of some controllable flip-flop such as "sense light switch" direct to an audio amplifier or home-entertainment tape recorder.

"The flip-flop was turned off and on under program control. Pulse width is produced by the length of time the FF is on, and frequency by the number of times per second the pulse is turned on and off. The pulse width controls the quality of the audio, producing a range of quality from that of clarinet to organ....

"Audible music can be produce directly from a chain printer such as an IBM 1403. I've heard "Jingle Bells" on a 1403 under program control of a 1401 computer."