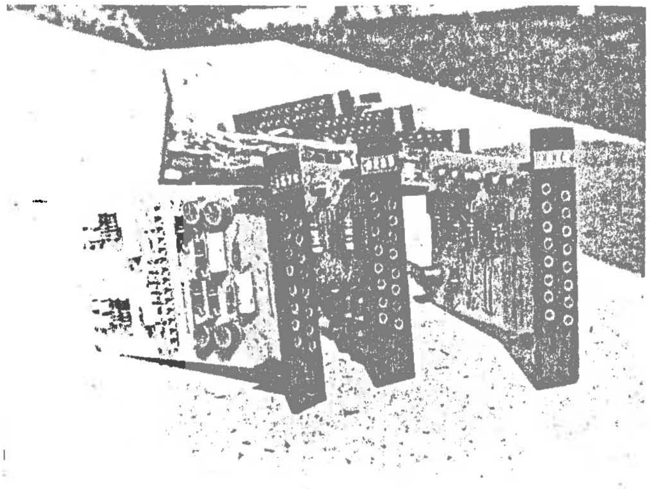
ACS NEWSLETTER

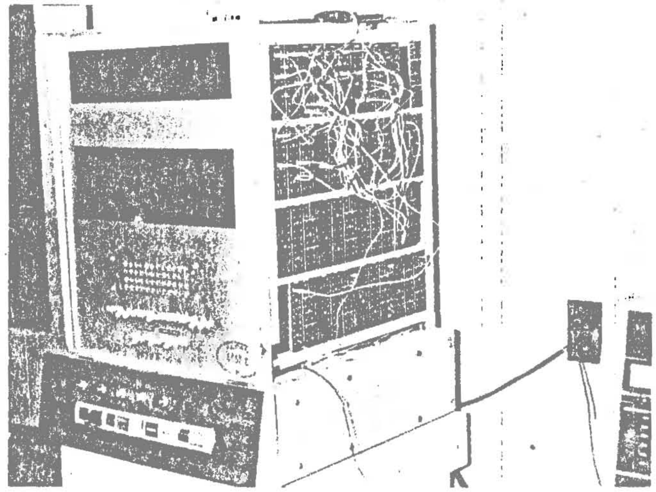
a publication of the
AMATEUR COMPUTER SOCIETY

Number 7 November 1967

MOUNTING AND INTERCONNECTIONS ISSUE



These IBM cards are part of ...



... Allan Sinclair's computer.

CHANGE OF ADDRESS

The new address of the ACS is

Amateur Computer Society
260 Noroton Avenue
Darien, Conn. 06820

Because of this move, and because of a new job (and a new computer to learn), there has been no Newsletter since Number 6 in June.

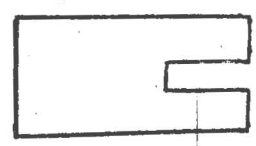
MOUNTING CIRCUIT BOARDS

Because it's seldom possible to buy used circuit cards with matching card cages, mounting such cards is usually a problem. Especially if they are IBM SMS cards, with the contacts broken off.

Card cages are usually expensive, as are printed-circuit connectors. So, unless you've got a lot of money to spend, you'll probably have to invent a mounting system of your own.

The photo at left above shows how Allan Sinclair mounted a number of SMS cards. The front panel is Bakelite, with 16 long brass eyelets pressed into undersize holes, and with wire soldered to the rear of the eyelets. These eyelets will take an AMP terminal (the eyelets I use will also take IBM patch cords).

The SMS card is held to the panel with 2 pieces of Bakelite, as shown at right.



Allan uses General Radio service cement. He says epoxy would no doubt be better, but the cement seems to work, as no strain is involved.

For larger (Univac) cards, Allan bought similar panels, 4" by 5", with 54 jacks already installed, and cut them down. These larger cards are epoxied into either blocks or cylinders of Bakelite, which are then screwed to the front panel. Some of the large panels hold three cards, giving 12 flip-flops for a register.

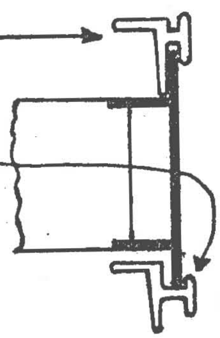
Another mount for the SMS cards is a 15-contact Amphenol plug (which Allan bought for 5¢ each!), which is glued to the card.

Allan uses Dymo tape to put the last four digits of the 37---- IBM number on each panel, for identification.

The photo at right on the first page shows Allan's computer. The permanent stainless-steel front panel is off at the right. The computer operates on 12-bit words, with a 100-word 2½D core memory.

The mounting racks are made from heavy-duty aluminum shaped like this →

One side is bent down to look like this → The aluminum is then turned and mounted as shown at right. By grinding this part nearly off, the cards can be inserted and dropped into the groove to keep them in place. By not using screws, the cards can be slid along to obtain different arrangements.



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Using screws, a cheaper (but less flexible) mounting system can be set up, with similar Bakelite panels that have holes drilled at top and bottom. The panels are screwed to a simple horizontal bar that is drilled and threaded to receive the screws. The bar has two lines of holes: one for the bottom holes of one row of panels; the other for the top holes of the other row. For rack mounting, the two horizontal bars at top and bottom need have only one row of holes. With this system, the full height of the rack is made use of.

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Jim Haynes uses Amphenol 15-pin connectors obtained from junk. When he runs out of junk ones, the new ones are only about 65¢ each, in lots of 100. Jim says there's a very inexpensive edge connector that is not very well known, made by Cinch, and called (as he remembers) the 257 series.

Bill Pfeiffer has found that the most usable female connectors are the bifurcated-edge-type PC variety, made by Cinch-Jones, Amphenol (series 143 and 133 for single and double), and USC type UPCR. Bill has been using the 22- and 44-contact types, mostly. Cost at surplus ranges from 25¢ on down.

MOUNTING INTEGRATED CIRCUITS

Mounting ICs is an even bigger problem than mounting circuit boards. There are several IC mounting boards available commercially, but they cost several times the price of the ICs they mount: $140 for a Motorola 16-IC breadboard; $21 for a Campion PC board that mounts 8 flat packs permanently.

Individual dual in-line sockets are expensive, too. Augat's #314 costs from 40¢ to 90¢, depending on quantity. Texas Instruments has an MPC18A socket in 14- and 16-pin DIL styles, solder-tail and wire-wrap types, for about $1.10 each, or 52¢ in quantities of 100-999.

Fred Strother has come up with a clever and very cheap method of mounting flat-pack ICs. He uses a perforated board with 0.05" hole spacing, and threads thin wires through the holes, in the desired circuit arrangements. The flat packs are then soldered to the wire "pads." The in-line packs have 0.1" pin spacing, so they fit the same perforated board, which is available from Allied Radio (47R509 Micro-Vectorbord, 6½" x 4", $2.92, made by Vector), 100 N. Western Ave., Chicago, Illinois 60680. The wire can be single strands from regular stranded wire. Of course, this system requires that the inter-circuit wiring be laid out completely beforehand, and later changes are difficult. Also, a steady hand is needed for soldering, as the contacts are only 0.05 inch apart. This method could be used for breadboarding, by connecting the wire "pads" of a single IC (or group of ICs) to eyelet panel jacks.

The largest size of Micro-Vectorbord is 17" x 6", smallest is 4" x 2". An 0.1" hole-spacing is also available. Vector also makes a "D.I.P. Plugboard," with pads for mounting 12 dual in-line types, with or without sockets. The plugboards are pre-punched, pre-etched and pre-tinned, in an x-y matrix, with parallel copper lines running horizontally on one side and vertically on the other. Pins are inserted where an x-to-y connection is desired. The copper lines can be broken with a pad-cutter, to make a variety of interconnections. Connections to the pin contacts at the end of the board are made as desired. Several types are available, and cost about $10 each. A similar x-y matrix board for DIL circuits, without pads, is made by Vero, and sells for $8 for a 5" x 8" board; a single-sided 5" x 8" board is $5.31.

Vector Electronics Co., Inc.
1100 Flower St.
Glendale, Calif. 91201

Vero Electronics Inc.
176 Central Avenue, Box 26
Farmingdale, N.Y. 11736

Vero has an IC breadboarding kit for $40, consisting of a single-sided 18" board, a plug-in single-sided board, a double-sided plug-in board, an epoxy glass plain board, 500 terminal pins, a pin insertion tool, a spot face cutter, design sheet, and an edge connector. The holes in these Vero boards are on 0.1" centers, whereas the holes in the similar Micro-Circuit Veroboard kit, for $23, are punched with holes on 0.05" centers, for IC mounting.

INTERCONNECTIONS

There are, as most of you have found out, problems with either fixed wiring or with plugwires. Fixed wiring, of course, is cheapest. But, as Don Fronek pointed out in ACS Newsletter 5 (page 2), when you have close pin spacing, a soldered connection gets very messy when you're trying to keep things neat. The wires get burned, the solder slops over onto the adjacent pin, etc. Because Don finds himself changing circuits all the time, he prefers solderless connectors.

On the other hand, plugwires are expensive. Sometimes they can be bought surplus, such as the Hubbell plugs and plugwires I have. I bought some card cages that had a number of these miniature, automatic-locking, quick-disconnect plugs and jacks attached. The plugs cost $11.60 for 500 if you buy them from Hubbell; the eyelet panel jacks are $2 for 500. Jacks are also available in terminal-post adapter and screw binding-post types, as are crimp-terminal connectors and plug splices. The eyelet setting punch is $1.25, from Harvey Hubbell, Inc., Bridgeport, Conn. 06602. Crimping pliers are $2.40; minimum charge is $5.00.

Eyelets, by the way, are about the cheapest way of mounting anything. Drill holes in a plastic board, press in eyelets and set them with a punch, and solder the item to the eyelets.

IBM plugwires (or patch cords, if you prefer) are plentiful, and are sometimes available cheaply when a punched-card installation is being changed over to a computer and is getting rid of all plugboards and wires. The plugboards can be used for mounting circuits; the only drawback is that it's often hard to solder to the large plugboard contacts, and the contacts are so close to each other that some can't be used and are therefore wasted. Be sure to get the type of plugboard that has contacts on it; the self-contacting type of plugboard has no contacts on the board itself, and is of little or no use to the experimenter. Plugboards are sometimes sold by surplus houses such as Olden and Meshna.

Jim Haynes uses fixed wiring, says plug wiring in a project the size of his would be impractical. However, he notes, one type of Cinch connector has taper-tab terminals, so that one could make up a sort of semi-fixed wiring, using plugwires with the taper tab clips.

Bill Pfeiffer's plugwires cost about 5¢ for each good double-plug type. His plugboard is an IBM 22 x 34-hole type, to the rear of which he solders his fixed wiring. Several rows are used for bunching purposes.

COMPUTER PC SALVAGE

A one-page item on salvaging computer PCs appeared in Popular Electronics (page 66, June 1966). The main item discussed is the type of desoldering iron with a rubber suction bulb attached. Also, five companies are listed as sources of PC boards: Arrow Sales, in Chicago, Radio Shack, Meshna, Poly Paks, and Transistors Unlimited.

BREADBOARDING ICS

An item in Electronics (page 103, July 25, 1966) shows how to breadboard ICs by plugging dual in-line packages directly into the type of connector used as edge connectors for PC boards. The specified connector is the Hughes EMS048DJ000, which has contact rows the right distance apart, and the 0.1" spacing that matches the DIP lead spacing. Pins inserted in the wiring side of the connectors permit connecting the ICs to each other and to external circuits. The cost of the Hughes connector and pins for 54 ICs is about $120, which gets more expensive than the ICs, so perhaps other, cheaper connectors can be found.

TAPEHEAD AND TRANSPORT

A tapehead and transport assembly is offered by Denson Electronics Corp., P.O. Box 85, Rockville, Conn. 06066. Made by ITT, the assembly is 6½" wide (five assemblies were mounted side by side on a rack, on slides), 45" high, 26" deep. Looks like a tape-loop arrangement. The head has 22 tracks, used with one-inch computer tape. Cost: $245.

The Denson 1967 catalog is 90% closed-circuit and amateur tv used gear, some RTTY stuff. Also a page on instrumentation tape and a 20-track recording head.

IBM TO SELL SLT MODULES

IBM has announced that it will market SLT modules, which are the hybrid ICs used in the 360 computers.

Fifty diode-transistor types are available, at $1 to $1.50 each; minimum order $25. The DTL modules include a NAND, NAND/NOR, flip-flop, exclusive OR, transmission-line receivers, line amplifiers and indicator drivers. Switching speeds are from 700 to 5 nanoseconds.

These modules are fallouts from the computer-grade types, and are called "industrial grade." Tolerances are about 3% wider than for computer-grade modules.

Information is available from IBM Corp., Industrial Products Marketing Dept., 1000 Westchester Avenue, White Plains, N.Y. 10604.

SHIFT REGISTERS

National Semiconductor Corp., 2975 San Ysidro Way, Santa Clara, Calif. 95051, is selling a 50-bit shift register for $9.85 in lots of 100, and a 100-bit shift register for $14.80 in 100 lots. Supply voltage is -10 volts, clock amplitudes are 16 volts. Model numbers are MM500 and MM502, respectively.

PORTABLE ELECTRONIC KEYBOARD FOR COMPUTER INPUT BY TELEPHONE

An interesting article by the above name appeared in the June 1967 IEEE Transactions on Electronic Computers (pp 332-334), by Lewin of RCA. Although few if any of us are anywhere near being able to use this type of input, the article makes interesting reading.

The device, which is acoustically coupled to an ordinary telephone handset, generates coded tone sequences representing the full ASCII character set. The characters are input, one at a time, by a stylus, touching the symbols on an electronic keyboard. The tone sequences correspond to those in most Teletype-Dataphone terminals in typical time-sharing systems.

The device is intended for communication with a machine that has voice answer-back.

Production cost is estimated "in the $50 range." The device contains a decade counter, pulser, two-bit analog-to-digital converter, decoder, two-frequency voltage-controlled oscillator, a few logic gates, and a resistor encoder. The transistor types are 2N1307 (2N404) and 2N1306 (2N585); diodes are 1N34.

FAR-OUT MEMORY

The same issue of IEEE Transactions contains a short note (pp 370-371) on an optical-fiber memory, by Filippazzi of Olivetti-GE. The optical fiber is used as a delay line, which is much faster than most of us will ever need, as a light pulse travels through it at over 11 inches per nanosecond. But it is simple.

WIRELESS WORLD DIGITAL COMPUTER

The British magazine, Wireless World, has had a four-part article on building a small computer, in its 1967 issues for August (366-372), Sept. (416-423), Oct. (488-494) and Nov. (543-548).

The WW computer will add, subtract, multiply and divide. There are 28 instructions: 7 for arithmetic, 9 for transfer to store, 6 for transfer from store, and 6 various resets. Multiplication is by repeated addition, without shifting. Two 8-bit numbers can be added at slow speed (4 seconds), high speed (3.2 msec), or bit-by-bit.

Input of instructions is by toggle switches; input of data is by pushbuttons; output is by neon lamps.

The prototype was built for about $160, without cabinet. The transistors were reject germanium types that cost less than 14¢ each (2G371/

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 eight weeks.

D1476, Texas Instruments). Diodes are 1S130 types. The front panel contains 53 neon lamps, with 6 groups of 8 lamps each, for three arithmetic registers and three storage registers.

Basic circuits are NOT, NOR, AND (diode-transistor), OR (diode), comparator and flip-flop.

A subroutine store is described briefly for those those who wish to add it to the computer. It provides 64 words of data or instructions, using wired-in diodes or diode "pegs" in a matrix programming board, or in a stepping switch or a stepping drum. With this store, series of instructions could be carried out.

UNIVAC MEMORY UNIT

Gadgeteer's Surplus Electronics, 5300 Vine St., Cincinnati, Ohio 45217, has one Univac memory unit for $75. No information is available other than that the unit weighs 40 pounds, is "high density stacked," has muffin fans, and cost $40,000 when new. A photo from Ken Hanson shows two stacks mounted one above the other, like a figure 8, attached to a panel 2 feet high. Money back if not satisfied.

BUFFER MEMORIES FOR SALE

Sal Zuccaro has some buffer memories for sale. They are from Collins Radio gear, and were made by General Ceramics (now Indiana General) and by Telemeter Magnetics (now Ampex). Sal has three sizes, from 144 words of 4 bits each to 2048 words of 8 bits each. The memories are complete with core stacks, drive electronics, power supplies, logic, etc., and with Amphenol Blue Ribbon connectors for input/output. The smallest models take up about 10" of rack space, the largest take about 21".

Sal will provide copies of the instruction manuals, which contain specs, schematics, operating procedures, and timing diagrams.

The price per memory is $200 to $300, depending on size, plus the shipping charges. Sal's address is 14442 Elmhurst Circle, Huntington Beach, Calif. 92647.

Sal may also know where to get 75-ips Potter mag tape handlers for $50-60, if there are any left by the time you read this.

ACS COMPUTER SURVEY

The next page is a questionnaire for the ACS survey. Please fill it out (skip the personal data if you'd rather) and mail it in. Results of the survey will be in the next Newsletter if enough are received soon.

NEXT ISSUE will contain, among other things, comments by you on mounting circuits and interconnecting them; that is, if you send them to me as soon as you finish reading this issue. And send along any other information, comments and photographs that other ACS members might like to read or look at.

ACS COMPUTER SURVEY

Serial ___ Parallel ___ Number of registers _____

Transistor types ______________________________

Integrated-circuit types ______________________________

Card types: IBM ___ Univac ___ Other ______________________________

Memory type ____________________ Number of words in memory ______

Input ____________________ Output ____________________

Number of instructions _____ Word length ________ Clock speed ______

Add speed ____________________ Instruction length ____________

Special features: ______________________________

____

____

____

Estimated cost when complete ____________ Cost so far ____________

Estimated size when complete ____________ Present size ____________

How long working on it? __________ Fixed __ or non-fixed __ wiring?

In planning __, begun __ or completed __________?

Source of circuit schematics: Self-designed __ Other ____________

Source of system schematics: Self-designed __ Other ____________

Any other information?

Name ____________________________

Position ____________________________

Company ____________________________

Education ____________________________

Interested in computers since age _____

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Number 8   January 1968

COMPUTER SURVEY RESULTS

ACS COMPUTER SURVEY RESULTS

Although not many ACS members sent in the computer survey forms, those who did are, not surprisingly, the furthest along with their machines. Two have finished.

Memory

Most of those who answered the survey are using core memory, with sizes ranging from 4K to 20K words; the majority are equally divided between 4K and 8K.

One member uses a delay line for memory, containing 512 words. Another uses a delay line (2K bytes), drum (8K bytes) and core memory (4K bytes); 4-bit bytes.

For his small machine, one member uses flip-flops for memory. Another uses punched paper tape, having convinced himself that "tape would eliminate the memory limit."

Input

Teletype is the most common input device. One member, however, uses a Flexowriter. Another uses punched cards, keyboard, magnetic tape, paper tape, and keyboard switches.

Output

Again, Teletype is the most common output device. Others include a Kleinschmidt printer, paper tape punch, IBM Selectric typewriter, lamps, and Nixie tubes. One member uses magnetic tape, paper tape, Selectric typewriter, printer and lamps. And the member with the Flexowriter also uses it for output.

Clock

Clock speeds include 100K, 160K, 250K, 500K, and 1Mc, with one given as 10-100K. The average is 500K.

Serial or Parallel

The situation is about equally divided into thirds: one-third serial; one-third parallel; one-third combinations such as serial character, parallel bit.

Transistor Types

A wide range here, of course. One uses only 2N404. Another, 2N2923, 2N3721, 2N2711 (npn) planar. A third, 2N2923, 2N2925, 2N3906. A fourth, MPS3640, MPS3646, and 2N3641 in core drivers.

Integrated-Circuit Types

(1) uses Fairchild RTL (67¢ FF, 36¢ dual 2-input gate, 36¢ buffer). (2) Fairchild RTμL and CTμL. (3) Motorola RTL (700P series). (4) Motorola and Fairchild RTL.

Card Types

None of those replying use surplus IBM or Univac cards, although one uses surplus Westinghouse RTL NOR gates. Another is considering Wyle modules. A third designs and etches his own PC cards. A fourth makes his cards from Vector boards. A fifth uses Ransom, SEI and Autonetics cards. A sixth uses Teletype etched boards, with his own circuits.

Number of Instructions

Generally speaking, beginning computer amateurs hope to use a large number of instructions, from 50 to 100. Those who have gotten fairly well into the construction use no more than between 11 and 34. The one exception is a member who has spent $1,000 and two years on his machine, and has (or has projected) 67 instructions. The average number, counting all those reported, is 44. Leaving out those over 50, the average is 22.

Data-Word and Instruction Lengths

The data-word lengths specified range from 4 to 32 bits, with the average around 12 bits.

The instruction lengths also range from 4 to 32 bits, with an average of about 12 bits also.

Add Speed

The range of add speeds is from 8 µsec to 10 msec, with in-betweens of (1) 24 µsec, (2) 216 µsec, (3) 100-500 µsec, depending on the length of the binary number, (4) 8 µsec for one memory reference, but circuitry will operate in 1 µsec, (5) 30 µsec add speed, 4 msec memory cycle time with a magnetostrictive delay line, (6) 20 µsec with one number in accumulator, 25 µsec with both numbers in memory, (7) 32 µsec per pair of decimal digits, (8) 1 to 10 msec.

Number of Registers

The range of number of registers is from 2 to 11, with 3 the most popular. One member has 2 memory, 2 data, 1 op code and 5 address registers.

Special Features

Here are some of the special features reported. Not all of these features have yet been translated into hardware; some are only in the planning stage, or partially breadboarded.

(1) Over 100 Sylvania bulbs in strip sockets will monitor the major registers, etc. CRT displays planned. When completed it will be far more versatile than DEC's PDP8 line.

(2) Data-word length 16-32 bits (32-64 for floating). Planning modular op-code decoders (i.e., basic repertoire plus floating arithmetic, hardware stack operations, etc.). Basic structure is bus-oriented.

(3) Has D/A converted output to drive motor position. Machine has two 8-bit registers, one 15-bit accumulator.

(4) Variable-length instructions, variable-length indirect address fields.

(5) Contents of memory address zero and A register are swapped every cycle (inhibited on some instructions). Therefore one register serves as accumulator and program counter. Memory address 1 serves as index register.

(6) Double precision arithmetic; fixed and floating-point numbers; link on all arithmetic registers; full comparator; AND, OR, Exclusive OR registers for logical computations; data bus allows bi-directional transfer between any two registers.

(7) Will use IBM 1620 software, modified to use USASCII code and to get around unimplemented instructions.

Cost

As to "Cost so far," the range is from 0 to $1500, with an average (among those reporting a cost) of $650.

For "Estimated cost when complete,"

the range is from $300 to "over $10,000." with an average of $2,100. Without that "over $10,000" estimate, the average is $1,100.

Wiring

The large majority, over 80 percent, use fixed wiring.

How Long Working On It?

The range of time spent so far ranges from "one month on the present model" to 4 years, with an average of 2 years.

Size

Here are some present sizes: 3-foot relay rack; 6' x 7' x 18"; 35" x 23" x 20"; 1 work bench; 1 board complete; 30" x 36" x 40"; three 19" five-foot racks; 38" x 60" x 12" & TTY. The "Estimated size when complete" is usually just the same.

Education

Most of those responding have at least one technical degree, including BSEE, MEE, BA in Math, PhD EE, "BA and BS and working on MS," and several students.

Because the great majority of those sending in the survey have technical degrees, and because those who sent it in are among those who have advanced the most with their computers, it seems that lack of a technical education is holding back many ACS members from pushing ahead with their machines, or perhaps from just getting started. Unlike amateur radio, there just isn't enough circuit-level information available on how to build computers.

Other Information

(1) Presently supervising 5 Explorer scouts who are doing much of the construction work, such as building PC cards. I became an Explorer advisor at my company's post to get more hands on the project and to force me to get on the ball and make some progress.... I am going to debug the power supply transients and add a line filter. RTL has low noise immunity and my first wired-up register is dropping and gaining extra bits.

(2) Wish disks and line printers were cheaper! Fortunately, I can build my own software -- assembler, compiler (FORTRAN and/or ALGOL) and operating system.

(3) Teletype controller and memory operational. Can presently transfer data from TTY to register to memory and back. Delay-line memory stability problems solved -- successfully retrieved data after eight hours. Using 8½" x 17" Vectorboard with AA pattern, strengthened by chrome-plated angle. Dual Inlines mounted by alternately bending pin pairs inward and outward. Wiring directly soldered to ICs, using #22 wire with high-temperature-resistant insulation.

(4) This has been an evolutionary process without a fixed idea of exactly what the final product would be. Now I have outrun myself in some ways. For example, I know how to get back and forth from memory to TTY. Also, how to add binary numbers. I don't know how to turn TTY characters into binary numbers in any simple manner. I would appreciate any clues you might have on the subject. (ANY MEMBERS ABLE TO HELP HIM ON THIS?)

Interested in Computers Since...

Those who put down a date gave: 1951, 1955, 1957, 1965. Those who put down an age gave: 13, 14, 15, 18, 20, 21. Those who gave the number of years gave 3, 3, 9 and 17 years.

COMPLETED COMPUTERS

Only two ACS members have reported being anywhere near completing their computers:

ECHO-4

Jim Sutherland's ECHO-4 computer, reported briefly in ACS Newsletter 6, is 7 feet long, 1½ feet deep and 6 feet high. It took Jim a year to build it and will take 10 years to program. He says the CPU is complete, but the input/output system is still growing.

ECHO-4 uses 2N404 transistors and RTL NOR logic elements. The NOR gates were used in process control systems built by Westinghouse about 8 to 10 years ago and were declared scrap. They are mounted on etched circuit boards with 35-pin Elco connectors. A total of 120 boards were used in the entire system (input/output control, arithmetic units) but only 16 types of boards were used, so spare boards do not take up much room.

The memory unit, an Ampex 4096-RQ-30A, came from an obsolete process control computer. Memory cycle is 6 usec, but since the NORs require from 1 to 3 usec to switch, the add time suffers (add speed is 216 µsec).

Between instruction accesses, the memory is available as a refreshing buffer for a CRT display, which is planned but not built yet.

Jim says a story about ECHO-4 is tentatively scheduled for the April 1968 issue of Popular Mechanics. He says it doesn't go into much construction detail, "but the pictures should be interesting."

ECHO-4 has 4 flip-flop registers, and three (P, A and X) in core memory. There are 8,192 words in core memory, each 15 bits long.

Clock speed is 160 Kc. There are 18 instructions, 4 bits long.

Special features: one's complement adder with end-around carry. Overflow and carry designators are stored in upper two bits of Program counter (location 0 of core memory). Interrupt automatically stores P and takes next instruction from specified SAVE routine entry. Using 15-pps sync derived from real-time clock. One index register, and also indirect addressing, can be specified by setting flags in the instruction word.

Input: alphanumeric keyboard, six control keyboards, 8-channel paper tape reader, 15 interrupts, 75 contact closures.

Output: Kleinschmidt printer, 60 contact closures, 8-channel paper tape punch, 4 digital clocks.

Interconnections are wire-wrapped.

By the way, ECHO stands for Electronic Computing Home Operator.

EL-65

Hans Ellenberger, who lives in Switzerland, worked a year on his computer and finished it in 1965. A small desk-top machine, looking a little like a Wang calculator with a separate keyboard, EL-65 has a keyboard input and Nixie-tube readout. Size is 40 by 40 by 20 centimeters.

A serial-type computer, EL-65 has 3 registers, 30 words in flip-flop memory, and 15 instructions. The transistors are AC122 (AF pnp germanium) "because of price."

Addition and subtraction times are 1/50 second. The longest multiplication and division times require 1.3 seconds. In addition to these four basic functions, EL-65 can also perform negative multiplication, and accumulate products.

The cost of materials alone was 1500 Swiss francs, which is about $345. Hans tried to market his computer, calling it "der erste Schweizer Pult-Elektronenrechner," meaning the first Swiss desk-top electronic calculator. But the sales price of 6000 SF ($1380) seems to have put it beyond the means of most Swiss and also it may have been too much of a novelty on the market. As Hans notes, "It seems almost impossible for an amateur to build a computer that can compete with commercial machines. (The amateur who can do that would be, before long, employed by a computer company.)"

Hans is working on a new model, with 16 registers, using Philips LTC cores, and ICs by Fairchild (RTL epoxy), TI and Philips.

MAGAZINE ARTICLES

Low-Cost Counters

The February Popular Electronics contains a construction article (pp 27-32) on a decimal counter with readout, which the magazine believes to be a price breakthrough, as the decade costs only $12, complete with counter, drivers and ten lamps. Parts are available from a Texas company at $12 a decade, including a PC board. A power-supply schematic is given. The maximum rate is 10 Mc, although the unit has been used up to 18 Mc.

Later issues will feature items based on the counter: an "Electronic Stop Watch," which is an EPUT (events per unit time) counter; a digital voltmeter; digital multimeter; and a frequency counter.

The ICs used are all Motorola: two MC790P dual JK flip-flops, and one each of the MC724P (quad, two-input) and MC715P (dual, three-input) NAND/NOR gates. And seven transistors.

An interesting coincidence is the appearance by the same author of an Electronics article (Jan. 22, pp 74-76), "For low cost, count on RTL," which compares the $12 decade with a $10 digital display that uses a milliameter with a special scale, calibrated from 0 to 9, and a biquinary 1-2-2-4 code.

The authors says in his last paragraph that the in-line counter is superior in readability, but the meter design is cheaper and smaller.

Basic Digital IC Circuits

Over a dozen simple digital circuits are given in "30 Basic IC Projects," in Radio-Electronics (Jan. 1968, pp 50-53). This second part of a two-part article uses the Fairchild μL914 as the basis for inverters, pulse-enabling and disabling gates, NOR/NAND and OR/AND gates, square-wave generators, one-shot, Schmitt trigger, flip-flop, and others. All that's needed is a 914 and a few resistors and capacitors, plus diodes for the generator.

The article on the following pages (pp 54, 55, 62) describes how to "Build a Low-Cost IC Signal Generator," with the same μL914, to provide square waves from 5 cps to 50 Kc.

The first part of the IC article appeared in the December 1967 issue (pp 43-45), and covered the basic description of the μL914, giving circuits for linear applications such as emitter followers and amplifiers.

Wireless World Digital Computer

The four-part article on building a small computer, described in the

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 eight weeks.

previous Newsletter, has a fifth part now, completing the series. The December Wireless World (pp 601-605) covers the operation of the machine, with coding examples.

Using Miniature Relays?

An interesting comparison of major characteristics of miniature relays appeared in a new-product item in the January 8 Electronics (pp 171-172). Comparisons are made between crystal-case relays, mercury-wetted and dry reed relays, and solid-state switching devices. Each of the four types is said to provide certain advantages. "If speed is needed more than isolation, solid-state switches should be used. When cost is the prime factor and high isolation is also required, the reed relay is the best choice." The new product is a line of dry reed relays, made by Hi-G Inc. (Windsor Locks, Conn.) which sell for about $2, compared with about $8 for solid-state switches.

Would you believe a relay in a TO-5 transistor can? They're described in the January EEE (pp 20 & 24). Not cheap, though; over $20.

BREADBOARDING INTEGRATED CIRCUITS

Wade White says he breadboards in-line ICs with a board that holds 15 of the 14-pin packs, from J.R. Anderson Enterprises, Inc. 3691 Lee Road, Cleveland, Ohio 44120. The board, type MC-1, costs $4.85 for 1-9, $4.50 for 10-24, and $4.25 for 25-49.

No holes are drilled in the board. The components are soldered to the top, for easy removal or change. Size is 3/32" x 8-5/8" x 5-49/64".

For permanent mounting of 12 of the 14- or 16-pin ICs, Wade uses an M-96003-PG board from Dyna Sales Co., 962½ S. Atlantic Blvd., Los Angeles, Calif. 90022. Phone (213) 268-1175, ask for Milt Hollingsworth.

For TO-5 and flat-pack ICs, use board M-96002-PG. The boards have holes drilled for mounting components, and pins to fit a 22-contact connector (Amphenol series 143). The connector costs about $1.55 new, but can be bought surplus for much less.

Price for either board is $6.95, with a discount of 5% for 5-14, 10% for 15 or more.

Wade also notes that the Vero IC board kit listed in Newsletter 7 at $40, is available from Dyna Sales for $29.95, as item MC-10.

NEXT ISSUE

If any of you who have gotten into the construction of your machines fairly well would like to write up your experiences for the Newsletter, several pages are available for the gory details. Tell us all about your problems, solutions, discoveries, failures, components, and your future plans.

ACS NEWSLETTER

a publication of the
AMATEUR COMPUTER SOCIETY

Number 9   May 1968

MORE ACS COMPUTER SURVEY RESULTS

Several survey forms were received too late to be included in the last issue. Here is the data:

1. From Long Island: a decimal, variable-word-length computer, with software similar to that of the IBM 1620. Will make extensive use of read-only storage to hold micro-programs by which regular machine instructions will be implemented. The decimal add and multiply tables will also be stored in read-only memory. Hopes are that the "1620 Model III" will be about 25% faster than the 1620 Mod II and will have its complete instruction repertoire (about 60).

Main memory so far consists of 20K decimal digits (10K X 12 bits), with 10-µsec cycle time, using straight IBM circuits, and semiconductors mounted on PC boards of own design.

There are four two-digit data registers and 32 memory address registers (high-speed core).

"My only consolation in attempting to improve on the IBM 1620 is that if my machine doesn't work right, at least I know that I have software that will."

"It should be emphasized that the popular analogy between the amateur computer builder and a radio ham is simply not valid. The complexity of even a small computer outweighs by at least an order of magnitude [ten times] the design effort necessary to construct an amateur transmitter. This is doubly compounded by the fact that: the nature of basic building blocks is changing at a rapid rate; many commercial designs are proprietary; there does not exist 40 years of computer design history to draw upon."

2. From a Harvard sophomore: 200-Kc machine, with 13-bit words, and instructions two words long. Teletype (Model 19) input/output includes paper tape. Memory is Honeywell TC-M30, 8K words. Add speed, 20 µsec. Six registers.

Built with Motorola 700P series of ICs, and npn silicon transistors from IBM SMS boards.

"Although there are well over 150 instructions, only around 16 are basic. The others come about as follows:

a) Each basic instruction may use a literal operand, or an indirect operand; e.g., ADD1 50 means add the contents of address 50 to the AC, whereas ADD2 50 means add the number itself.

b) Each basic instruction has 5 conditional variations. For example, in addition to the conventional CLA, we have

CLA on AC = 0
CLA on AC less than 0
CLA on AC greater than 0
CLA on overflow
CLA on least order bit of AC.

These are, of course, the conventional transfer conditions. I found that they could be implemented for the entire instruction set with almost no additional hardware: three bits of the OP code, which comprises 13 bits, are devoted just for this purpose. Just before the execution of any instruction, the control checks whether or not the condition is satisfied; if not, the instruction is skipped. (This is one of the advantages of a long op code: certain bits may be devoted to specific functions.)"

"Here are some ideas I found useful in my design. Firstly, if core is used, one can kill two birds with one stone by using the selection matrix decoder as the instruction interpretation decoder; if the memory selection decoder were for a 4K (12 x 12) memory plane, then one 12-bit decoder could be used to hold the op code, while the other could generate the timing signals."

"The scheme of making every instruction conditional extends the effective instruction set, and is cheap to implement. Conditional instructions make the set much more powerful."

"The cheapest SMS cards are sold by Brooks Radio in NYC (Brooks Radio & TV Corp., 487 Columbus Ave., New York, N.Y. 10024). They sell at 100 cards for $10. There are an average of 4 transistors per card, in addition to other goodies."

"Someone should design parallel-serial and vice-versa converters for TTY from integrated circuits; that's one thing a goodly portion of ACS members could use. The converters could be standardized to the point where the ACS could manufacture pre-drilled PC boards."

3. From California: another 200-Kc machine, but with 36-bit words, and instruction lengths the same as the IBM 7090. Input/output: Teletype, paper and magnetic tape. Also X-Y recorder for output.

Memory is 3D core, 32K. Add speed is less than 5 µsec. Over 100 instructions.

"The majority of the logic will be core-diode, which is slow in some respects, but has great flexibility, reliability and power savings."

DO-IT-YOURSELF PROBLEMS

A one-page item on the advantage of buying digital modules instead of building them appears on page 42 of the April EEE. It points out some dandy little problems, including:

1. After final assembly, noise is found in the back-panel wiring and the noise amplitude is greater than the noise rejection of the circuitry.

2. Power-supply specs prove inadequate.

3. Signal reflections appear on back-panel wiring and intercabinet cabling. Unplanned signal delays violate timing requirements.

4. Logic-output current drives are too low to charge and discharge parasitic capacitances fast enough to meet clock-speed requirements. When fan-outs are reduced to compensate for charge and discharge times, the number of logic circuits must be increased, necessitating redesign.

COMPUTER HARDWARE

IC Breadboard

Cambion has announced an IC breadboard for 16, 32 or 64 of the 14-lead DIP ICs. Although too expensive for amateur use, it can be adapted by anyone with enough patience to set 14 small eyelets for each IC, plus 14 larger eyelets just outside the smaller ones, and connected to them, for jumpers.

For a look-see at the pattern, see page 112 of the March EEE.

1024-Bit Memory on a Chip

A 1024-bit MOS read-only memory is now available from Philco-Ford's Microelectronics division, according to Electronics (Feb. 19, page 45). The memory array consists of 128 eight-bit words on a chip, on which is also the decoding circuitry, using 216 more MOS transistors.

Once a customer has paid the initial $750 tooling charge for the coating and etching required for his particular interconnection needs, the chip will be available to anyone for the chip price alone, which will be about $70 in small quantities, and $50 in larger quantities.

A 2048-bit memory is in the works. The read-only memory has applications in subroutine storage, and table-lookup operations such as sine and code conversion.

Adder on A Chip

An article by this title, subtitled "LSI helps reduce cost of small machine," appeared in the March 18 Electronics (pp 119-124).

This 8-bit integrated MOS arithmetic, measuring 86 by 116 mils and containing 200 gates, will be introduced by Fairchild Semiconductor as the 3800. On one chip is an input register, an adder-subtracter, accumulator register, and output buffer. No price given.

Electronic Pocket Calculator

Hayakawa Electric hopes to introduce an 8-digit IC pocket calculator this fall. It will use miniature Digitron readout tubes, circuits with about 250 elements on a chip, total of 8 to 10 chips, and cost about $280, Electronics says.

Photo-Transistor

Fred Strother calls our attention to the General Electric L14B phototransistor, which GE calls a planar silicon photo-darlington amplifier, as well as an Economy Light Detector.

Priced at 97¢ in lots of 100-199, this high-sensitivity device is described by GE as having applications in card and tape readers. Fred says it makes a fine interface.

For many applications, only the collector and emitter leads are used. A base lead is provided to control sensitivity and the gain of the device. The L14B is packaged in clear epoxy encapsulant.

Packaging Hardware

Wade White sent a catalog of packaging hardware (Bulletin 10000B) sent from:

Plug-In Instruments, Inc.
1416 Lebanon Road
Nashville, Tenn. 37210

An interesting variety of hardware. Plug-in cans with transistor circuit blanks, from $3.45 up. Two dozen models of plug-in blanks, such as a board that will accomodate six 14-pin flat-packs, for $2.60 without drilled holes, or $6.55 with. Several types of card-mounting files, and various other hardware.

PUBLICATIONS

Digital Design Aid

A method of designing the detailed logic of a digital system is given in "Flow Chart Methods of Logic Design" in the February Computer Design (pp 72-75). It shows how to make a flow chart from the basic considerations, then develop the chart up to the point where it can be used for deriving equations for the logic.

The author says this method helps keep track of all the different sequences of operation, and minimizes redundancy.

Understanding Logic

"Electronic Digital Components and Circuits," by R.K. Richards (D. Van Nostrand Co., 526 pp, $15), explains how various components and circuits work. It gives the advantages and disadvantages of the major designs, provides alternate approaches, and compares the merits of diodes, transistors, tunnel diodes and super-conducting devices. Amond the topics included are speedup capacitors, DTL components and functions, core structures and accessing methods, film-storage units, magnetic drums, discs, tapes, cards, and various switching methods.

Binary Logarithms

In the March 1968 issue of the British Computer Bulletin (pp 282-285) is an article on "Some Applications of Controlled Shift Registers." No circuits; theory only.

The author shows how to control shift registers in such a way that they perform multiplication, division, and code conversion. The process involves various combinations of shifting, adding (or subtracting) 1 and shifting, and shifting without adding (or subtracting).

One paragraph about binary-logarithm converters may be of interest to several who have inquired about the process involved:

"The use of logarithmic computation eases the extraction of powers and roots and simplifies multiplication and division. Mitchell has shown that the logarithms to the base 2 of binary integers may be derived approximately by a simple shift register and a counter. This can be extended to deal with non-integral numbers as shown in the following example:

Calculate $\log_2 13.625$
Binary $13.625 = 1101.101$

Count number of digits to the left of binary point commencing from zero and write this as the characteristic. Ignore most significant bit of original number and place remainder of number to right of binary point as the mantissa. Thus $\log_2 1101.101 = 11.101101$.

This result is an approximation and techniques are available to reduce the error involved."

The reference to Mitchell is his article, "Computer multiplication and division using binary logarithms," in the August 1962 IEEE Computer Transactions, page 512.

A Computer in the Basement?

A four-page article with this title appeared in the April 1968 issue of Popular Mechanics (pp 77-79, 209, 229), describing the ECHO computer built by ACS member Jim Sutherland, and described in Newsletter 8 (page 4).

ECHO IV will be used for family bookkeeping, by keeping track of monthly budgets and expenditures, so that when tax time comes, deductions can be identified and grouped to simplify filling out the tax forms.

ECHO will also be programmed to keep track of real time, so that events can be scheduled up to a year ahead, with one-second accuracy. It could be used in the kitchen, to increase or decrease proportions for recipes, and print out shopping lists. Jim plans to modify the kitchen cabinets to allow ECHO to take inventory automatically.

ECHO has been connected to the TV set for eventually regulating the schedule of watching. It may also be used to control the house temperature, by first querying the weather instruments outside, then adjusting temperature and humidity inside the house.

<u>What Will You Do With Your Computer?</u>

Even if some of the planned uses for ECHO don't prove practical, Jim Sutherland has obviously thought a good deal about what to do with a computer once it's built.

And that's a question that a great many of us may not have given much thought to. What kind of problems will we run on our machines? Matrix inversion? Hardly. But just what? One non-member is using his for stock-market analysis. It may turn out that finding uses for our computers will be even harder than building them. Unless you've got your own business, there isn't much you'll want to program in the way of business applications. And you'd soon get tired of most of the scientific types of programs, if you have no real use for the output.

If you've done any hard thinking about what to do with your computer when it's finished, let's hear about it.

HOOKUP WIRE

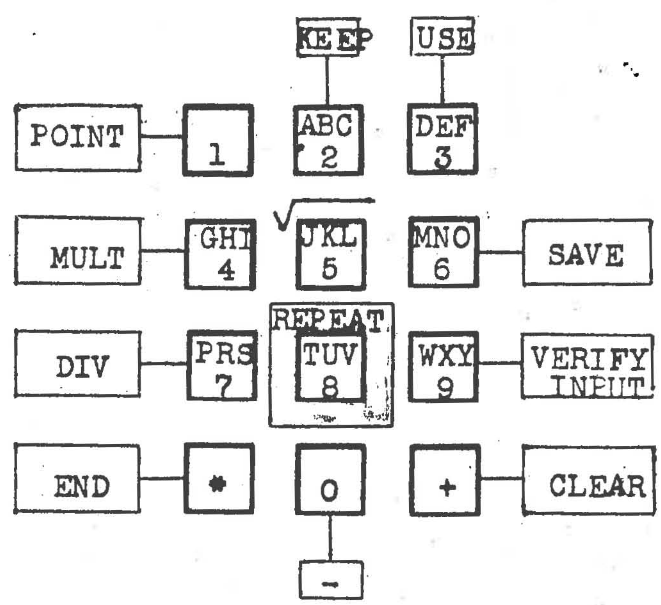
The telephone company uses a multi-conductor cable that is perfect for amateur computer wiring. The next time telephones are being installed where you work, try to get some of the short lengths of cable that are thrown away. Some of these "short" pieces are 20 feet long, and not worth splicing.

Some cables contain only a dozen of these solid 18-gage wires, in twisted pairs; some cables contain 30 or 40. In some cables, the wire insulation is solid-color, with the same 10 colors as used for resisistor coding. Other cables contain parti-colored wires, which have a body of one color, and stripes of another, every inch or so, in several dozen combinations.

MINIMUM KEYBOARD

For those of you interested in a minimum input keyboard, IBM has an "Experimental Home Calculator" that uses a 12-button telephone attachment. At present, the pushbutton attachement is connected to the telephones of six Brooklyn high-school students, who do their math homework on an IBM 1710 computer 50 miles away, in Yorktown Heights, N.Y. The computer's output is voice answerback, from a magnetic-drum prerecorded vocabulary. If a mistake is made in entering the problem, the computer's voice tells the student he's made an error.

There are several versions of the touch-tone coding; here is one:



The mathematical operations are programmed by:

ADD press + only

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The Newsletter will appear about every eight weeks.

SUB	press 0	and *
MULT	4	and *
DIV	7	and *
SQ RT	5	and *
END MESSAGE	*	and *
MINUS	0	and *
CLEAR	+	and **

For example, to multiply 2 times 8, press 2 4 * 8 * *, and listen for the answer.

Pressing VERIFY INPUT will make the computer repeat the entry, by voice answerback.

PLASTICS

There are times when you may want to mount lamps a certain way, such as in a minimum-space decade, and the kind of mounting hardware you want is too expensive, or it just doesn't exist. One solution is to make the lamp-holder yourself, using some of the modern plastics that cure at room temperature.

First, make a model of the holder, from plastic or wood. Then make a mold of it, using something like General Electric's RTV-41 silicone plastic. This is recommended, as it has a "high modulus of elasticity," meaning that it's easy to separate from the original model.

Next best is GE RTV-30, with a lower modulus. At one time you could get samples of both of these silicones with a letterhead. Perhaps you still can, from the GE Silicone Products Dept., Waterford, N.Y.

Several plastics are available for pouring into the mold, to make the holder. A good one is Shell Epon Resin 828, which is mixed with Epon Curing Agent V-40, with a minimum of trouble. The result is an amber-colored plastic. For minimum light loss, the plastic can be colored black by mixing in some carbon black before pouring; other colors could also be used. You might try your local Shell plastics dealer for a sample, by using a company letterhead.

Pour-your-own plastics might also be a cheap way to make segmented readouts, either 7-segment for numeric, or up to 14 or more segments for alphanumeric. You could pour black plastic around long Lucite strips arranged in the segmented pattern, then cut the finished bar into slices and make another mold for a lamp holder that channels the light to the individual segments. Or you could mold the entire segmented display as one piece, Lucite strips and lamp-holder all together.

HELP!

Your assistance is needed to help fill these pages. Please send me:

1. Answers to any of the problems in the early Newsletters.
2. Details of your computer, including problems and solutions.
3. Ideas about what you intend doing with your computer when it's finished. What programs are you going to run?

ACS NEWSLETTER

a publication of the
AMATEUR COMPUTER SOCIETY

Number 10 August 1968

THE PDP-8 ROUTE

Fred Sias likes the Digital Equipment Corporation's PDP-8/S computer enough to borrow a lot of ideas from it. He writes:

"It is a little difficult for me to see a computer sitting around doing nothing. There are plenty of chances to use a machine to teach highschoolers. A number of PDP-8/S are in use for this purpose already. I think there is opportunity to develop low-cost inventory systems for small businesses. These ideas are in the line of income-producing sidelines, but computer time is valuable and anyone with a machine should be able to produce income with it. A particularly fruitful area should be in software development. At the present state of technology, practically any company with an engineer or two can market a computer. Software support is the costly and time-consuming requirement for success in the computer business, however. This suggests that amateur-built machines could provide support to the vast software needs of the computer industry. To do this, an amateur machine would only need the same order structure as some commonly used commercial machine. There are over 2,000 machines in use of the PDP-5, 8, 8/S and 8/I series. These machines vary considerably, but share a common order structure.

The software problem is a two-way street, also. DECUS is a users' society for DEC machines that provides a medium for the exchange of programs and ideas. Probably an amateur computer builder could become a non-voting member of the society. Interested persons might approach their local DEC sales representative. User-developed assemblers, statistical packages, arithmetic subroutines, and special software for peripheral devices is available to any member. For instance, I just recently obtained a software symbol generator for displaying text on an oscilloscope. Text output by this route is very inexpensive. Keyboard input and scope output is probably the most inexpensive I/O system for an amateur computer.

I'd like to present some of the features of the PDP-8 series of computers that make them worth looking at for ideas for amateur construction. Should I eventually construct a machine, it will start out looking like a PDP-8/S and may eventually be changed to a PDP-8. The difference is that the 8/S is a serial machine. That is, all transfer between registers is done through the adder, bit by bit. A serial adder has much less logic than a full parallel adder. Consequently the complete PDP-8/S has the following complement of logic:

- 92 flip-flops
- 2 clock multivibrators
- 2 one-shot delays
- 52 pulse amplifiers
- 161 inverters
- 160 NAND gates
- 62 diode gates
- 70 drivers for displays
- 1 Schmitt trigger
- 1 4K, 12-bit memory, and decoding and driving logic.

The commercial unit uses a 6-microsecond parallel core memory even though the rest of the machine is serial. Data is transferred into the memory buffer register serially and then into the memory in parallel. Consequently, two separate clocks are needed, and run independently, depending on the phase of the word timing. Incidentally, I understand the original design of the PDP-8/S was to use a drum or disc, but the cost of core memories dropped so radically that the machine was marketed with a core memory. That core is available from DEC for $2000. Application notes and driving logic are available, too.

If I were starting to build a machine from surplus parts, I think I would choose the PDP-8 instruction set, construct the serial logic with a disc memory first, later convert to a parallel core memory, and finally convert to full parallel logic. Even using serial logic, the slow version has a respectable 28 to 54-microsecond operation time.

Some other features of the PDP-8 are worth mentioning. The machine has a 12-bit word size. Where analog devices are to be attached to the machine, 12 bits is a natural precision. A-to-D converters are usually 12 or less bits in precision (for a number of reasons) and a resolution of 1 part in 4096 is more than adequate for devices like scope displays. Multi-precision arithmetic software, both fixed-point and floating-point, is readily available, so a longer word length is unnecessary for anyone except a professional computer person who has a requiement demanding higher-speed, multi-precision arithmetic. In support of this statement, one might note that the IBM 360 series equipment has turned to the small basic word size with multiple-byte memory accessing to gain speed.

Early machines required large word size due to the slowness of memory access.

The PDP-8 has only eight basic instructions, but the set can be expanded to a hundred or more by micro-programming the operate and input/output instructions. This permits one to use a simple octal decoder for decoding instructions.

Basic input/output transfer on the PDP-8 is via the accumulator. Transfer is in parallel, both for the standard and serial machines. A party-line bus system is used, with each peripheral device recognizing its own microprogrammed device-select code. The logic to do this is simple, with the commercial device-select logic costing only about $50. This is one of the simplest input/output systems that I have seen, and it is thoroughly described in the DEC "Small Computer Handbook," available free from any DEC salesman. I endorse this handbook as a liberal education in computer design.

Do you think there would be any interest in approaching DEC about supplying a basic kit for amateur construction of a version of the 8/S computer?

The parallel-to-serial conversion device mentioned in your last newsletter is available from DEC for $150. I recommend the free DEC "Logic Handbook" as a second liberal education.

Incidentally, one does not need a separate device for parallel-to-serial conversion. One merely needs to shift the data word out of the accumulator, testing the link bit each shift, and outputting a pulse if a one is present in the link bit. ("The link is a 1-bit flip-flop register attached to the accumulator, and is used primarily in calculations in which 12 bits are not enough to represent the numbers involved," according to the Small Computer Handbook.) See an article by Park and Ohkuma in the Fall 1967 DECUS Proceedings. The article, by the way, describes a magnetic-tape system using an ordinary unaltered audio-tape transport for recording digital data. Cost of the interface is about $200, using commercial logic modules. This is one of the cleverest designs that I have seen for a digital magnetic-tape system at minimum cost.

Perhaps I have over-sold the virtues of the PDP-8 series of machines, but I think they have a number of minimum-cost design features that would benefit an amateur who does not have special reasons for using other, possibly more complicated, approaches.

Here are a few hardware ideas. For a control panel: Drill holes for all register indicator bits. Cover the whole panel with solid translucent plastic, with decals for labels. Insert lamps in holes in back of panel with only wires for connections to a backup mother board. Take a look at the PDP-8/S to see result.

We use strands from telephone cables in our wirewrap tool. The $50-or-so hand wirewrap tool from Gardner-Denver (Part No. 14H-1C with No. 26263 bit and No. 18840 sleeve) is well worth the expense. Wire wrapping is a fantastic improvement over soldering connections. An unwrapping tool for $10 makes changing connections very simple. I would suggest that these are essential investments to ease much future pain.

The ACS member with the TTY code-conversion problem undoubtedly has a five-level Baudot code instead of ASCII. The simplest procedure for input would be to re-label T, CR, O. SP, H, N, M to represent the octal numbers 0 through 7. Larger binary numbers can then be assembled by shifting in the accumulator in the standard way. A hardware Baudot-to-octal conversion matrix could be constructed fairly easily, but once his computer can execute a few simple instructions, a table look-up program is simple to write and won't use up much memory. Output to the TTY would be via table look-up also. Only the 8 numbers in the octal number system need be converted, since text would be stored as is, and an assembler could be constructed by merely changing the symbol table definitions to Baudot, if his instruction set matches some commercial computer sold by a helpful salesman.

Several months ago I noticed IBM 1620 core stacks and drivers available for around $200. It happens that the 1620 accesses 12 bits per memory cycle, even though it is a decimal machine. That is, the memory is a 10K, 12-bit word size, and two BCD characters are accessed each memory cycle. Perfect core for a 12-bit machine. The PDP-8/S uses a 13-bit core, but the parity bit is really unnecessary since the machine comes to a screeching halt if a sense amplifier goes out and the machine starts getting incorrect parity. The 13th bit is probably a carry-over from its serial-memory ancestry. The 1620 memory has a 20-microsecond cycle time, which resulted in a relatively slow decimal machine, but would provide respectable speed in a binary configuration. Converting the decoding and core-driving logic might require some ingenuity.

Where one has some money to spend, I highly recommend the new Tektronix storage scope display Type 601 at $1050. I have just constructed an inexpensive interface, and find it a joy to get text output on the scope instead of waiting for the slow TTY to pound out results. Analog displays with a 35-mm camera for permanent records make this a very general-purpose interface.

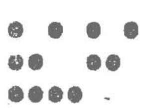
Have thought about getting cheap logic cards. Of course, IBM SMS cards are readily available, but the connector is usually cut off. (Does anyone know where to get intact SMS cards?) Anyway, cut SMS cards probably could be most easily used by cementing on a short extension with an etched male PC connector. [For a cheaper way, see page 1 of the November 1967 ACS Newsletter.] A silk-screen outfit from your local art store is cheaper than the kit from Allied. Silk-screened and etched connectors for dozens of SMS cards could be made in a few hours.

This has been a rather rambling letter, but perhaps there are some ideas that will be of use to ACS members. I will be pleased to communicate with anyone who has chosen to use the PDP-8 instruction set and has programming or interfacing problems."

Fred R. Sias, Jr.
University of Miss. Med. Ctr.
School of Medicine
Department of Medicine
Division of Neurology
2500 North State Street
Jackson 6, Mississippi

* * * * * * * * * * * * * * *

Fred also sent along a short piece of paper tape to show why he chose those particular keys to be relabeled:



MNHSOCT
P R

DEC recently announced the PDP-8/L, a stripped-down model of the PDP-8. The interfacing circuits have been removed, and only a TTY can be used for I/O. The memory is 4K, with a maximum of 8K. Price is $8500, or $1500 less than the PDP-8.

As to a PDP-8/S kit, DEC says that there is the question of their responsability to the kit buyer. What happens if he can't make the kit work? Does he ship it back to the manufacturer, like a Heathkit, and get it fixed up for a price? Also, if the back panel is furnished pre-wired, how can the kit cost much below the assembled and tested price, because there isn't much to the assembly. And if the back-panel weren't pre-wired, how long would it take a man to go crazy trying to wire it all himself? DEC says the only practical place for a kit is the power supply, which is handwired.

HEATH MODULAR DIGITAL SYSTEMS

Speaking of Heath, if anybody has been patiently waiting for Heath to come out with a reasonably priced computer kit — forget it.

Recent Heath Company ads show the new 805 Universal Digital Instrument, which can be used as a frequency meter, events counter, digital voltmeter, time interval meter, etc. The same ads show the 801 Digital Analog System Modules, which include a power module, binary information module (10 neon lamps, 8 SPDT switches, 2 SPDT spring-return switches), timing module (0.1 cps to 10 Kc), and plug-in circuit cards (NANDs, dual JK flip-flops, dual one-shot, relay card, etc).

The 805 sells for $940 without the digital voltmeter function; $1250 with it, assembled. The 801 sells for $435 with a fixed set of 13 circuit cards. Other cards may be bought, at $10 to $40 each. Note that this is not a kit.

The 801 is for breadboarding circuits, using patch-wires that plug into the special connector boards on top of each card, which uses TTL integrated circuits.

At these prices, whatever more sophisticated digital circuits Heath may offer in the future will be quite expensive.

MOUNTING DIL ICS

Don Tarbell writes:

"I noticed some members are having trouble mounting dual in-line packages. A friend and I have gone together to form a small company which, among other things, manufactures a board for mounting the DIP's. You push the IC into the board from one side and solder to pads on the other side. There are two extra pads (also with holes) for interconnection to each pin. I use small telephone wire for interconnection, and find that a wire may easily be soldered and unsoldered many times without lifting a pad. A whole IC may be unsoldered by wicking the pads and prying it out, although I have found this not often necessary."

For a spec sheet on these IC breadboards, write:

Advanced Digital Design
P.O. Box 4409
Huntsville, Alabama 35802

The boards hold 32 of the 14-pin DIL ICs, cost $8 each.

Don continues: "In reference to Newsletter Number 7 (November 1967), page 5, SHIFT REGISTERS (by National Semiconductor), I wish to warn members that these shift registers are of the dynamic type, which require a continuous two-phase clock at a minimum of 10 Kc. This means that if the register is used to store data for future use, one must keep track of where it is in the continuous loop by an associated counter. I have done this, and have found that it loses no data if the power supply is adequately filtered. National also makes a dual 100-bit (200-bit) dynamic shift register which sells for $36 in single quantities; part number MM506."

Incidentally, Ungar now has an IC desoldering tip, No. 859, designed to "remove ICs rapidly without causing delamination." The desolderer melts all 16 solder pads at the terminals simultaneously. The device is designed for use with the Ungar 47½-watt heat unit, No. 4045, which fits the 777 or 776 handle. The Lafayette Radio price for the desoldering tip is $1.65; for the heat unit, $2.97.

WIRE-WRAP AND TERMI-POINT

For more information on tool-applied terminations, such as the wire-wrap discussed by Fred Sias earlier in this issue, see the February 1968 EEE article, "Packaging/Interconnections, Part 1: Tool-Applied Terminations," pages 66 through 74.

BOOKS AND ARTICLES

"How to Build a Working Digital Computer," by Alcosser, Phillips and Wolk, Hayden Book Co., N.Y., 175 pages, $3.75.

The blurb on the back cover notes that the book "shows the reader how to construct a working model of a digital computer, using simple, inexpensive components." The six basic units are "encoder,

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 eight weeks or so.

arithmetic unit, control panel, drum memory, core memory, and decoder."

The blurb is misleading, but the computer, although manually operated, is quite ingenious. The core memory is really a read-only memory made of paper clips, bent to form switches. The drum is also read-only, made of a large juice can and 29 paper clips that make contact with the drum through holes cut in graph paper wrapped around the can. The drum contains the program steps, using 26-bit instruction words.

The arithmetic unit consists of 39 DPDT switches and 5 SPST ones; the Appendix shows how you can build your own switches with paper clips and dowels.

This book may be of interest if you're working with a grade-school group or perhaps even a high-school bunch that's low on funds.

SQUARE ROOT

IC's Generate Instant Square Root, (EDN, March 1968, pp 26, 27), by Graham of Fairchild, gives a nice circuit for square root: To the 10's complement of the number is added 1, 3, 5, 7 ......, until the most significant bit changes to 0, at which point the total number of additions to the complement is the square root.

UNUSED LEADS

Q&A from the "Test Your IC IQ" page in Electronic Design (page 198, March 14, 1968):

Is there a rule of thumb to help us decide what to do with "extra" leads on digital ICs?

What is done with unused leads often depends on the particular circuit application. In general, it is safe to leave unused output leads open. Unused input leads, on the other hand, should be tied to ground or some other potential point to prevent parasitic transistor action or leakage under any possible signal combination. The best potential point to use will depend upon the circuit geometry, and in most cases will be apparent from the circuit schematic, which can be obtained from the manufacturer.

IC SOCKETS

An EEE survey on "Sockets for Integrated Circuits" appears in the July 1968 issue (pp 56, 58, 60, 61), and discusses packaging sockets, test sockets, contact problems and dielectric materials.

APPLICATION NOTES

The latest Application Note Catalog from Motorola, dated April 1968, lists 43 on digital circuits. Some are of little amateur interest, such as on IC reliability, but most give worthwhile design info, such as "Designing Integrated Serial Counters," or are about particular Motorola digital ICs.

ACS NEWSLETTER

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LAST ISSUE OF THIS SERIES

IT'S SUBSCRIPTION RENEWAL TIME

The money has finally run out, and so this is the last issue in this series of ACS Newsletters. For a new subscription, please send in \$3.00 (\$3.50 if you live in Italy, Japan or Switzerland).

If your name is Fronek, Gantner, Gruner, Hanson, Harrold, Haynes, Pfeiffer, Sundstrom, Van Ornum, Young or Zuccaro, you don't need to send any more money now, as you're already paid up, by virtue of previous contributions.

As of this issue, there are 91 ACS members, in 27 states and 5 countries. I hope most of you will continue to be members, because the more of you there are, the more issues there will be in the new series of Newsletters.

Along with your renewal checks, please send me a few words about what you intend to do with your computer when it's finished.

One of the first Newsletters in the new series will be a roundup of the basic circuits used in ACS computers. So, if you buy ICs, please let me know in your renewal letter what make and types you use for lamp drivers, memory drivers, flip-flops and gates. If you build your own, please send schematics of these circuits.

IBM SMS CARDS

According to IBM Industrial Products, there are about 3800 different SMS circuit cards. Some of the cards are used in several pre-360 machines; others are in families of cards used in only one computer or group of computers, such as the 1400 series.

There is no list of code numbers and corresponding circuit types for these cards, according to IBM. The tabs are broken off because they are gold-plated, and Federal law requires that the gold be recovered, even though there is only a few cents' worth on each board.

SAVE THE MOSFETS

Walk across a rug, touch an unmounted MOSFET, and it's shot. Even less electrostatic potential than that is enough to destroy a MOS field-effect transistor. To get around this problem, some vendors ship MOSFETs with the leads soldered together, or shorted with a piece of metal foil.

That's fine until you're ready to mount the transistor in a circuit. But when you separate the leads for assembly, you can wreck the transistor by building up static charges.

Page 66 of the Dec. EEE shows how some NASA engineers use a loop of flexible nickel wire, attached to a music-wire spring, which is slipped over the transistor case and then around all the transistor leads, shorting them together and allowing them to be handled without damage to the transistor. The device is removed after the transistor is soldered into a circuit. If there's enough space, it can be removed and used again, but the wire can be cut and replaced if necessary.

AN XS3 COMPUTER

Don Tarbell, who was last mentioned in the August 1968 Newsletter (page 5) writes that his computer uses the excess-3 code, and its 4 registers are each 5 digits by 4 bits. Clock speed is 10 Kc at this time, but will probably be speeded up to 100 Kc or 1 Mc later on. He is using mainly the Motorola MC700P line of ICs.

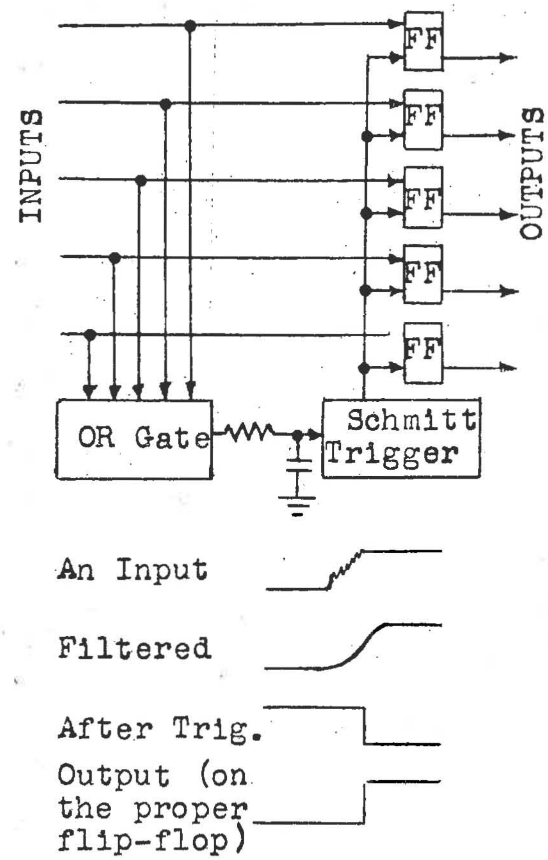
Don's computer at this time consists of the processor, a Teletype tape reader, TTY tape punch/printer, Western Union page printer, and two code-conversion boxes. It has add, subtract and hardware multiply, and will soon have a hardware divide. He can run programs from the paper-tape reader or from a magnetic-tape recorder. A 4K memory will soon be added to the system.

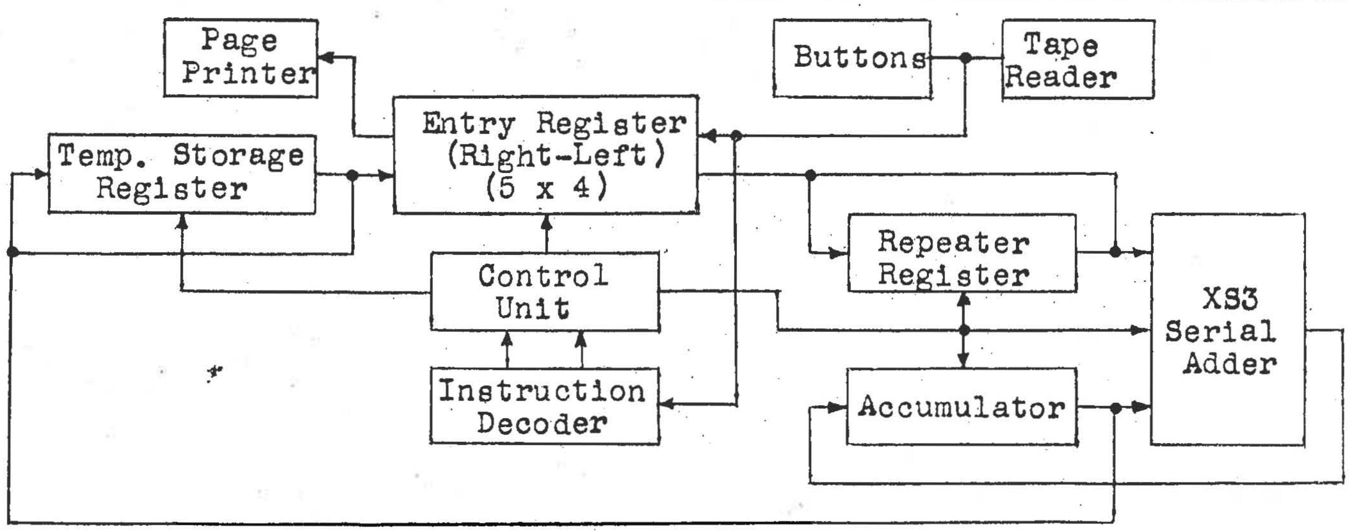
His sources of hardware are Allied Radio, Airwork Gulf, Lafayette Radio, Ampex Computer Products, Western Union, and friends. All the schematics came from his own design, or from fragmentary sources.

Here is a block diagram of Don's computer; most of the lines are actually several wires, and most of the junction points are 4-line digital switches:

The instruction set at this time is: 0,1,2,3,4,5,6,7,8,9, ADD, SUBTRACT, ENT MULT, MULT, STORE, RECALL, SHIFT, STOP, SHIFT IF POSITIVE, RESUME, COPY INPUT, RUN, PRINT OUTPUT.

Following is a solution Don had for the problem of filtering five inputs that were full of contact bounce from buttons or tape reader.





Don says his present problems are:
(1) Find suitable drivers and sense amplifiers for a memory that requires 190-ma drive current and has min. 30 mv output to 200 ohms.
(2) Understand how present-day computer compilers and assemblers perform translation functions.
(3) Find equal and plus signs for his printer.

P-S AND S-P CONVERTERS FOR TTY

Back in the May 1968 ACS Newsletter, a member noted that someone should design parallel-serial and vice-versa converters for TTY from ICs, and which he believes a "good numer of ACS members could use."

Jim Haynes writes that there are two such items in existence. One is a set of boards for 5-level TTY intended for amateur radio use for selective calling, and produced by Harold Quinn of St. Louis. But Jim didn't have Quinn's address at the time. The other item is a Teletype send-receive converter that uses ICs. Another ACS member, who is with Teletype, says the only card that seems to be applicable is one used as the sending distributor on the Model 37. However, "it would be difficult to get these cards, since production at present is needed for sets being built." The card uses 21 ICs, three of which are Motorola MC853P dual JK flip-flops, or equivalents made by ITT or Fairchild.

SCRAP IBM EQUIPMENT

According to a special section on "Computer Trends" in the Dec. 9 issue (pages 44-45) of Electronic News, IBM now has a policy which says that, as of July 16, 1968, no scrap will be sold whose source of origin is IBM. The policy is said to be that such parts will be junked and melted down for salvage. The new policy came about because of a junk dealer in Boulder, Colorado, to whom IBM was selling worn-out tape drives. The first models sold were old tube models "not worth much to anyone." Newer models, such as the 727 and 2400, began appearing, and salvage hunters had a field day, at 25 to 30 cents a pound. Competition soon sent the prices up to 35 or 50 cents. But then some people began using the surplus parts in supposedly new equipment, even selling some of it back to IBM. IBM doesn't want old parts sold to the public; they carry its label and "might compromise IBM's image."

Whether the new policy is countrywide, or applies only to tape drives, is not known at this moment.

CRT NUMERIC CHARACTER GENERATOR

For those interested in CRT display, Fairchild Semiconductor has a seven-segment numeric character generator that is a MOS/LSI circuit with 150 gates on a chip.

The 3250 DIP accepts four-bit binary-coded words, and generates four deflection pulses synchronized with a serial train of video pulses that subsequently control the CRT beam. About 550 characters (the 10 numerals and a few special symbols) can be displayed at a 60-cycle refresher rate.

The 3250 DIP sells for $60 each in quantities of 1-24, operating at -55°C to +85°C. A limited-range unit (0°C to +70°C) sells for $42, in quantities of 1-24.

NEW FREE BOOK FROM DEC

A new 425-page book, "Introduction to Programming," is available free from DEC as the latest in their Small Computer Handbook Series. It is oriented toward the PDP-8 family of computers, of which over 3500 are in operation.

Single copies may be obtained free by writing Dept. P, Digital Equipment Corp., 146 Main St., Maynard, Mass. 01754.

S-P CONVERSION FOR TTY

Don Tarbell, noting that someone was looking for circuits to convert from Teletype to their computer, enclosed a circuit he uses for serial-to-parallel conversion from his Teletype tape reader. The capacitors in the schematic opposite may need to be adjusted somewhat, depending on the transistors used and the frequency desired. His unit runs at 60 words a minute.

Don says the best IC sense amplifier he's seen yet is Texas Instruments' SN7525N. This dual in-line package has <u>two</u> sense amplifiers in it, and costs about $13 in single quantities. He has tested some samples, and they work OK.

When he gets his memory hooked into the computer, Don intends to work on three software packages:

(1) A simple version of Fortran.
(2) A compiler for solving special math problems such as higher order equations, differential equations, and many simultaneous equations.
(3) An English conversational program to solve logical questions depending on previous input statements.

PRINTED CIRCUIT KIT

Kit #500 contains PC boards and all chemicals and supplied needed to manufacture printed circuits. Each kit contains two PC boards, 4-3/4 by 3-3/4 inches; a resist-ink pen; one 6-oz bottle of resist-ink solvent; and one 1/16-inch drill bit. The kit is packed in an acrylic box which serves as a developing tray. Costs $5.95 from Injectorall Electronics Corp., 4 North Road., Great Neck, NY 11024

ONE REASON FOR BUILDING A COMPUTER

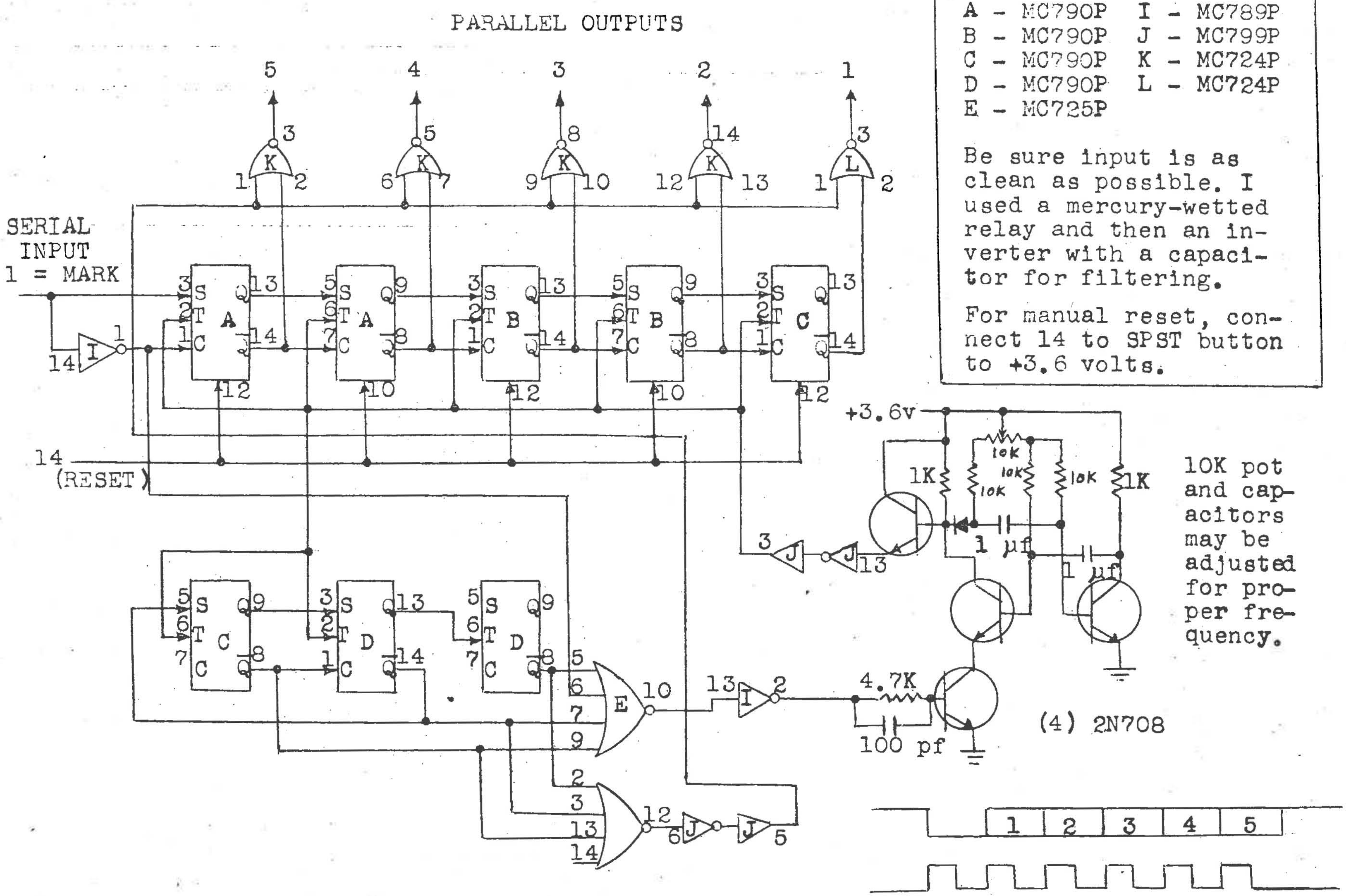
One of the newest ACS members has an unusual reason for wanting to build a computer. Some years ago he had cerebral meningitis. Among other things, the accompanying fever damaged his memory considerably, both in the ability to remember things, and the memories that were already in it, back to when he was 11. As he puts it;

"Since I had never previously had much difficulty remembering things, it took quite a while for the new condition to be recognized. The trouble masked itself, as it were, since I couldn't keep in mind the <u>fact</u> that I couldn't remember things. Eventually I simply learned it."

"The first solution was to keep a journal of my activities and copies of everything I wrote (letters, orders, etc.). This worked for a while (10 years), but now I'm being driven out of the house by the mountains of accumulated paperwork. I am similarly obliged to keep all bills, recepts, canceled checks, etc., for years back. Simply <u>finding</u> the stuff is becoming a problem."

"So the second solution is to put it all on mag tape and let a computer keep track of it. Obviously, such a computer will be more business-type than scientific. (Of course, if it can do math problems as well, so much the better.)

"My real problem, of course, is the computer's enormous complexity, with many different things going on simultaneously. A poor memory is



NOTES

A - MC790P	I - MC789P
B - MC790P	J - MC799P
C - MC790P	K - MC724P
D - MC790P	L - MC724P
E - MC725P	

Be sure input is as clean as possible. I used a mercury-wetted relay and then an inverter with a capacitor for filtering.

For manual reset, connect 14 to SPST button to +3.6 volts.

obviously a great handicap here. While I concentrate on what's going on in one area, the activity elsewhere escapes from me. For this reason, I am obliged, much more than most people, to depend on circuit diagrams. The diagram serves as a memory and I can switch my attention back and forth without any part getting away."

"But all the computers I have had anything to do with, have been far too big to get onto one circuit diagram, or even several, and I still get lost in the pages and pages of circuitry. However, it seems possible that the type of limited-scope, single-purpose computer I have in mind might be encompassed in only a few drawings that I could eventually comprehend.

"Some of the computer's functions might be of some use once it is built (such as listing), but there might also be things I could do right now that haven't occured to me. I will appreciate anything anyone can do."

Any suggestions? He has 30 reels of one-inch instrumentation tape, two 120Kb core memories from the IBM 1620, a 32Kb core memory, and some 4Kb frames.

THREE LOGIC PROBES

Within several weeks of each other, three logic probes were put on the market. Because ACS members may be interested in debugging digital circuits without having to use a scope, details of the three probes are given here. Is there an ACS member who will design us a probe using the best features of all 3?

A hand-held probe for detecting the presence and polarity of digital pulses as fast as 25 nsec is available at $89 from Pulse Monitors, Inc., 351 New Albany Road, Moorestown, N.J. 08057.

The Digi-Probe model 1210 uses ICs, operates from a 5-volt 75-ma source, and has red and green indicator lights "to allow non-technical personnel to perform most digital circuit production-line checks with the probe, in lieu of a scope."

A second such probe is marketed by Automated Control Technology, 3452 Kenneth Dr., Palo Alto, Cal. 94303. A lamp at the end of the probe will light for logic 1 (+2.0 to +6.0 V), and remain off for logic 0 (zero to 0.8 V). High input impedance prevents upsetting flip-flops and one-shots.

Hewlett-Packard has a logic probe with a lamp at the tip that flashes for 0.1 second for a positive pulse, goes out for momentarily for a negative pulse, turns on low for a pulse train, burns brightly for a high logic state, and turns off for a low logic state.

Overload protection is from -50 to +200 V continuous; 120 V AC for 10 sec. Input impedance is 10 kohms.

Pulses as short as 30 nsec will cause a flash. Price of the HP 10525A Logic Probe is $95.

The probes are all small: the Digi-Probe is 1" x 1¼" x 2¼", with the probe extending 1-3/4" beyond the case. Weight is 2½ ounces.

REMEMBER TO RENEW

If you'd like to subscribe to Volume II of the ACS Newsletter, please send a check or money order for $3.00 to:

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