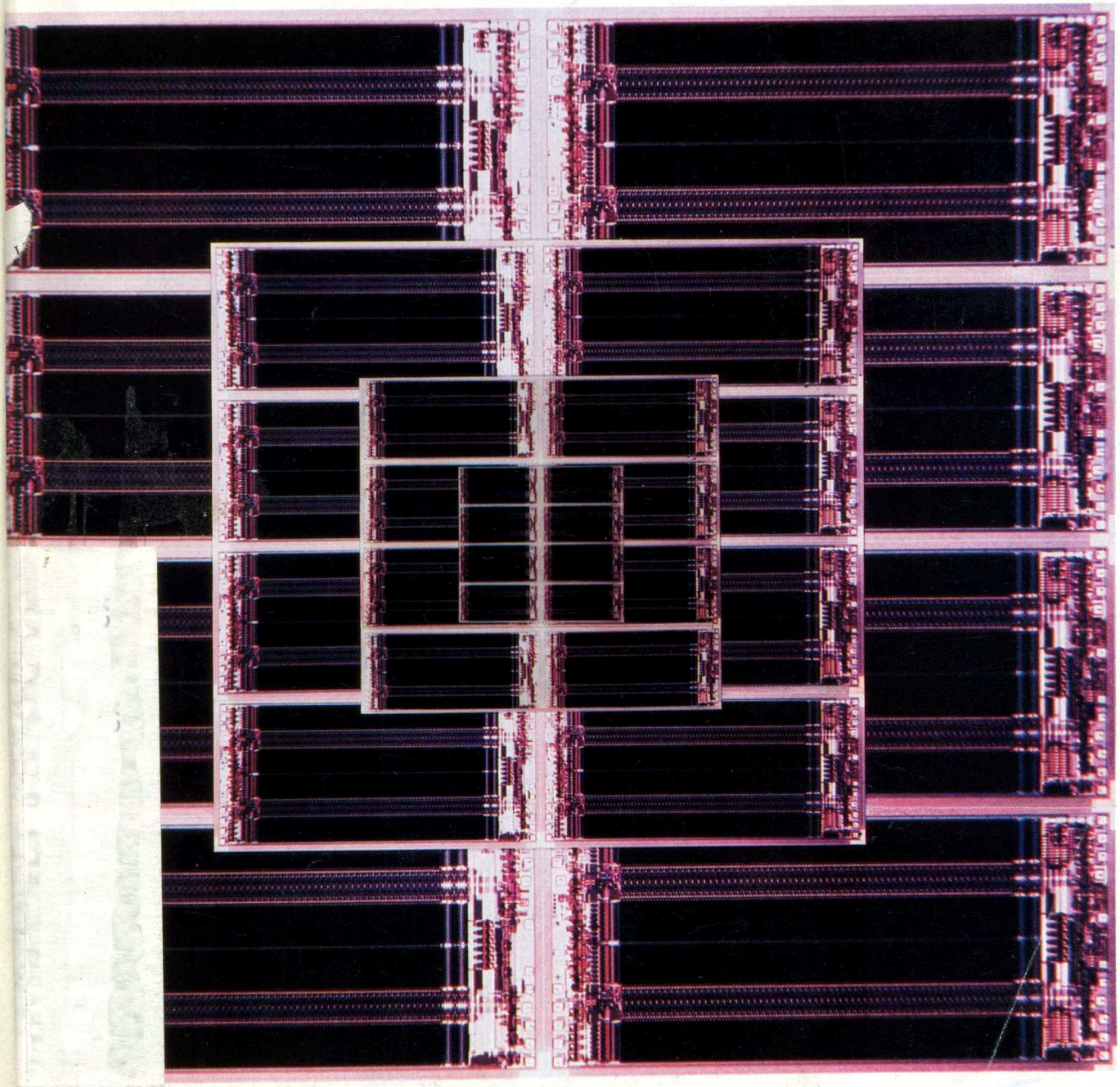
IEEE spectrum

An applications review:

TECHNOLOGY'80



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Articles

Applications review

The Institute

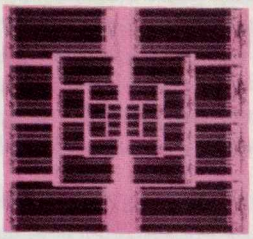
Departments

* Student news in student edition

the cover

VLSI is one major thread through this annual review of technology issue (articles begin on p. 30). Seen on the cover, successively reduced in size portending advances to come, is a Bell Laboratories 64 kb dynamic RAM. It is fabricated using double polysilicon NMOS technology.

TECHNOLOGY'80



Consumer electronics

Intelligent television receivers; personal computers proliferate; cable TV expands

Increasing design-effort continues to be invested in conversion of the television receiver to a home information center. The improvements being designed into the TV set range from processor-controlled tuners in the receiver to viewdata and teletext decoders for upcoming data-bank services.

Peripheral entertainment equipment for the TV receiver has also expanded in function and sophistication with the inclusion of longer-playing video tape recorders and personal computers that interface to the receiver.

The following developments in 1979 stand out:

- Companies such as RCA, Magnavox, Zenith, Sony, Toshiba, GE, and Hitachi began using microprocessors for the first time to control television tuner functions.
- The video disk, still a costly peripheral at $750 for the least expensive, received a boost on two counts: IBM and MCA Inc. set up a joint venture to sell optical video disk machines that MCA had pioneered, and RCA introduced its long-awaited Selectavision at $500. Selectavision uses simpler technology than most video disk machines.
- Video tape recorders expanded their capacities. The recording time of VHS-format machines rose to 6 h and that of Beta format machines to 5 h. BASF, Magnavox, and Toshiba planned to introduce 8-h machines using parallel track recording.
- The same technology that gave birth to video disk recording was being employed by Philips in the Netherlands to develop an audio disk system. It promises to give stiff competition to long-playing records when fully developed.
- Personal microcomputer systems with more data-processing capability were offered; they come close to matching lower-end minicomputers. Business-oriented microcomputer systems came from the Radio Shack Co. in Dallas, Texas, and Apple Inc. in Cupertino, Calif. Texas Instruments in Dallas introduced its 99/4 home computer and received a marketing assist from a ruling by the Federal Communications Commission. An FCC waiver recently issued allows the computer to be connected to the home TV receiver via an approved rf modulator, thereby eliminating the need for a separate video display terminal. Previously, home computers had to have rf modulators built into the system.
- While teletext and viewdata services are being test-marketed in Britain, France, Canada, and Japan, GTE of Waltham, Mass., set up a marketing organization called Viewdata to market the interactive British Prestel service in the U.S. The British and French teletext systems are being tested and evaluated by a television station in St. Louis, and the French system alone is being tried at a station in Salt Lake City. Differences in U.S. and European television signal standards are blocking early implementation of both systems (Fig. 1).
- Hand-held consumer electronics products were enhanced on three fronts: games became more plentiful and challenging, calculators moved up to the sophistication of personal computers, and language translators were introduced.

Nicolas Mokhoff Associate Editor

Smart TV sets abound

A number of solid-state improvements have been incorporated in the TV receiver to make the set an intelligent video terminal. RCA, among others, introduced its electronic tuning system, Channelock, in 1978, and a number of other manufacturers followed suit. Now, RCA is using Mostek's 3870 NMOS microprocessor to control a 19-inch TV set. A10-digit keyboard TV tuner with a digital display for date, time, and channels can be programmed up to seven days in advance. The built-in clock is programmed to turn the set on, change channels, and turn the set off at the times desired. With an electrical outlet on the back of the set, the home lights can be turned on and off or an electric coffee brewer started.

RCA has developed an even more modern system for the Finnish Salora Co. of Salo, Finland (Fig. 2). To accommodate the full VHF and UHF broadcast bands, a CDP 1802 microprocessor scans up to 99 frequency channels and processes real-time events in the three input/output modes of the central processing unit: program, interrupt, and direct memory access. Two keyboards, main and remote, accommodate up to 50 programming functions. A unique sidelight is the TV set's battery back-up system, which allows operation of the set for up to one week in the event of power failure. Beyond a week, the set would automatically shut off, but the program information would be retained for up to three months.

Although the Finnish television company has no immediate plans for incorporating the circuit commercially, it is an indication of where television technology is headed. Available today from the General Electric Co. is a precursor of that all-encompassing TV. The new GE model has the first 82-channel single-knob electronic tuner that covers both television bands in three revolutions. Other manufacturers that feature limited programming function in their sets include Sanyo, Hitachi, Zenith, Magnavox, Mitsubishi, and Toshiba. The Zenith and Magnavox units employ microprocessors that control adaptability to cable television. This eliminates set-top CATV converter circuits needed to accept cable programs.

As teletext services become more readily available around the world, receivers have to be produced that will incorporate the teletext decoders for accepting the signal on the unused vertical blanking lines. The Sony Corp. of Tokyo, is working on such a receiver (Fig. 3). Ten ICs will be used for the teletext decoder circuits to enable both manual and remote control of TV and teletext signals. Sony, among other manufacturers, is producing these sets for Britain, where teletext broadcasting has already begun.

Frequency synthesis tuning systems are indeed becoming a common sight. As the world becomes more interdependent, it becomes highly desirable to standardize on a global television tuning standard. Lacking a standard has prompted Plessey

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Semiconductors Ltd. of Swindon, England, to develop a multistandard frequency synthesis system. Since, in a tuning system, only the actual local oscillator frequency is of interest, Plessey engineers developed a system which can generate oscillator frequencies for different standards. This becomes useful in border areas between countries and for TV sets installed in ships traveling through various territories.

The system is divided into two functional blocks. A synthesizer block performs the basic synthesizer function common to all custom-designed systems. The other block is a custom circuit suited to individual customer's control and the different TV standards requirements. The custom design block comprises among other ICs, key chips for different TV standards. Each has a mask-programmable ROM which can be changed to meet different TV standards. Each of these can be connected in parallel and selected by addressing the corresponding code for each standard. Data for controlling both blocks is fed via an interface from a central microprocessor.

Two prototype systems have been developed for Europe and the United States. Processing technologies are mixed in both systems and range from emitter-coupled logic to NMOS and MNOS.

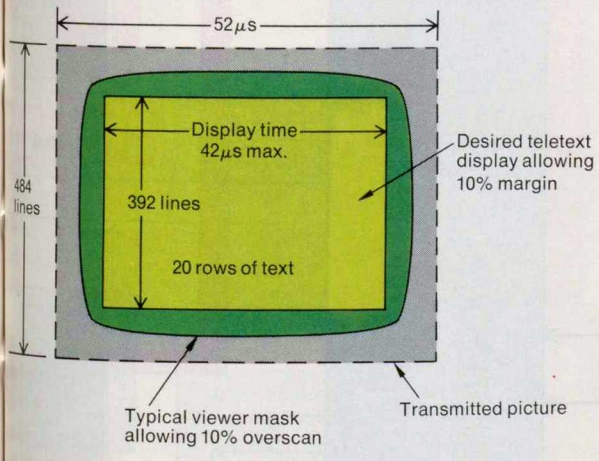
Cable TV expanding

With the recent deregulation of private satellite Earth stations, a new surge of cable television programming is expected from the more than 1700 cable stations in the U.S. Earth stations pick up the video signal from leased satellite transponders.

New technology for the cable-TV industry is also being implemented at all levels. The latest achievement is by Jerrold Electronics, a division of the General Instruments Corp. The company was able to expand the 300-MHz cable television bands to 400 MHz. This, in turn, increased cable channel capacity from 35 to 52 channels.

Meanwhile, Warner Cable of Houston, Texas, a division of Warner Communication, has bid along with other cable companies to build an advanced cable-television system in

[1] Two format strategies are proposed by Mullard Ltd. of Surrey, England, for using the British teletext system in the United States. One is for 40 characters per row and the other for 32. The 40-character format is preferable because the higher resolution gives a clearer television text. One method for adapting the higher-character format to U.S. television is to disassociate the incoming character signal from the video signal, allowing separate control.



No. of characters per row	Display time, μs	Display time per character, μs)	Display clock rate, MHz
40	40	1.0	6.0
	45	1.125	5.3
32	34	1.0	5.6
	40	1.25	4.8

Working toward U.S. teletext standards

The Broadcast Television Systems Committee, sponsored by the Electronics Industry Association, last year established a subcommittee to study teletext services with a goal of deriving a single set of technical standards for a teletext system in the United States. The report could form a basis for a Petition for Rule Making to the Federal Communications Commission for adopting such a system in the U.S. Representatives on the subcommittee include those of the principal industries involved: the networks, major television stations or groups, broadcast equipment manufacturers, receiver manufacturers, and IC manufacturers. Observers include representatives from the FCC, the National Telecommunication Information Agency, and professional societies.

To adopt a teletext format for the 525-line, 60-field U.S. television system, the subcommittee divided its tasks into three categories: transmission standards, format standards, and features and decoder options. The technical factors affecting transmission include data bit rate, type of coding, pulse amplitude and shape, and the available vertical blanking lines that may be used without causing interference to the video signal. Several formats are being evaluated in deriving standards for the number of characters per row and the number of rows per page. These include 32 or 40 characters per row and 20 or 40 rows per page. In the third category, more than a dozen features and decoder options are being contemplated: complexity of graphics, number of colors, mixed-mode and priority capability, double size letters, bulletins, etc.

The transmission standards are to be developed by field and laboratory tests, while standards for the other two categories may be derived through analysis by experts in the field. Three major teletext systems are being analyzed: the British Ceefax/Oracle, the French Antiope, and the Canadian Telidon systems. Field on-air experiments are proceeding at KSL-TV in Salt Lake City, Utah, with the Antiope and at KMOX-TV in St. Louis, Mo., with both the British and the French systems.

One critical study under way is analysis of the pulse shape. This involves computer analysis of various pulse shapes recorded from actual teletext signals, and how they are affected by noise, distortion, and multipath transmission. Multipath distortion causes "ghosts" in a television picture and can completely destroy a teletext presentation because the reflections cause bit errors, resulting in erroneous characters. Developing an IC known as an equalizer to eliminate the "ghosts" is simple in concept, but expensive to implement in a consumer product.

Underlying the subcommittee's work is a charter to make any proposed system capable of future expansion and improvement without making existing receivers obsolete. This is because teletext is a technology that involves not only television, but also digital data transmission and computer technology which are developing at an increasing pace. The Broadcast Television Systems Committee is considering presenting its subcommittee's recommendations in final form at the annual conference of the National Association of Broadcasters in April this year.

metropolitan New York City. More than 80 channels will be available to residents of three boroughs. The channels will carry all the cable networks and superstations like Ted Turner's 24-hour cable network from Atlanta, Ga. The system will also feature the interactive Qube option that is presently operating in Columbus, Ohio, and Houston, Texas. The Qube system allows two-way communication with viewers.

Cable television is also an attraction because it can deliver stereo sound to receivers equipped with the appropriate circuits. A number of color television sets have incorporated improved audio systems. Although not true stereo, the new systems simulate it. Standards for stereo TV are being developed by industry and Government agencies. An electronics Industries Association committee will make recommendations to the FCC by this summer. Meanwhile, RCA, Magnavox, Sylvania, and Zenith have all joined Quasar the innovator of "stereo-like sound."

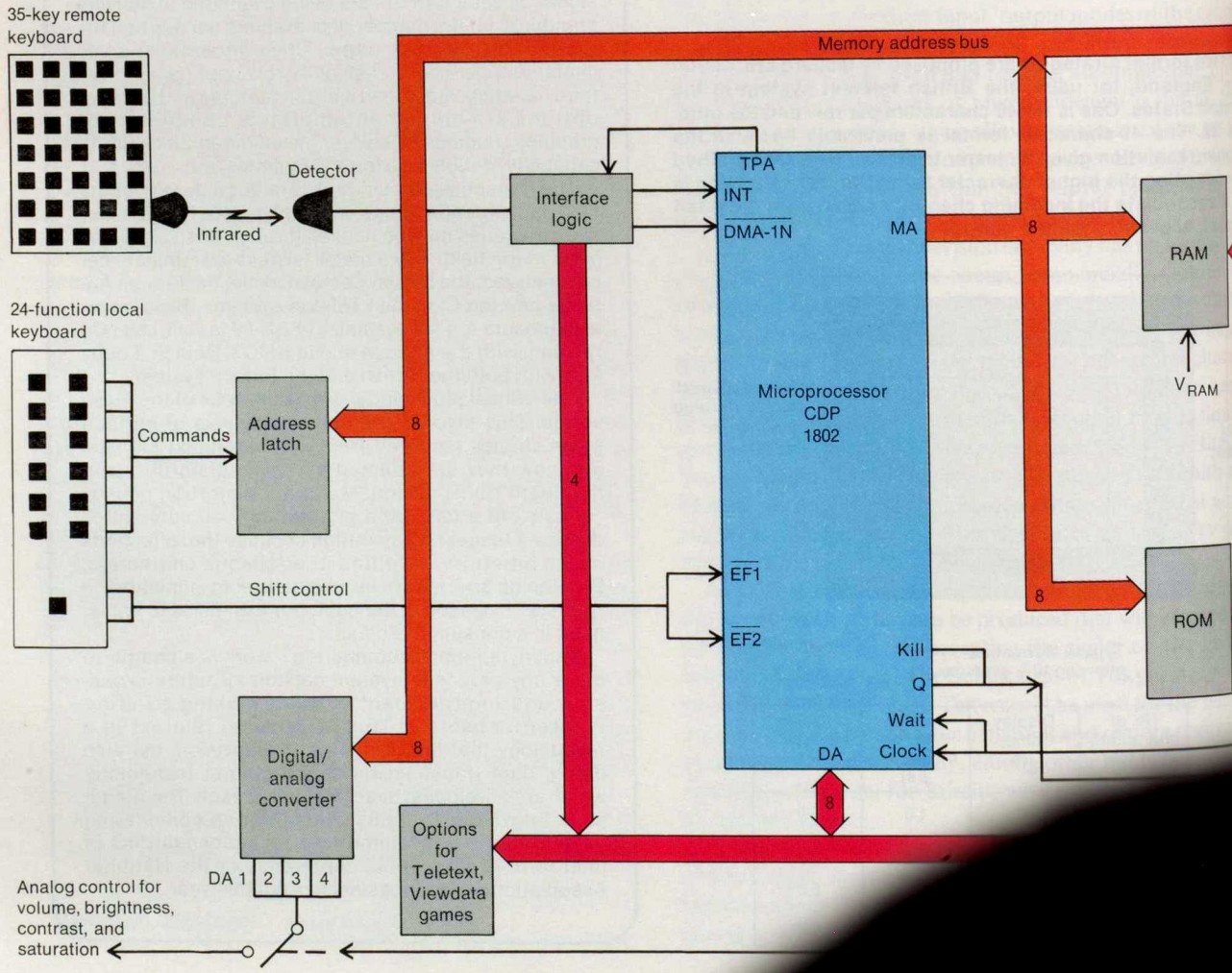
All of the systems for simulating stereo incorporate special audio processing circuitry and multiple speaker systems. The circuits consists of two separate audio amplifiers, tone controls, and improved speaker systems. Some companies even provide output jacks for use with separate hi-fi systems.

Sound improvement follows video gain

In hi-fi systems, a notable audio receiver is Radio Shack's STA-2200. According to the company's chief engineer, Alfred Zuckerman, the microprocessor-controlled tuner has some unique features. The receiver can precisely tune in to any desired frequency and preprogram up to 12 AM or FM stations. The CMOS computer controls a phase-locking loop synthesizer to recall the station from memory. The memory has a battery-powered back-up feature. Another novel feature is the FM front-end. It uses dual-gate MOS field-effect transistors, effectively eliminating any input overloading problems. At the output, MOSFET power transistors deliver 60 W of audio power per channel, with a total harmonic distortion of 0.02 percent. A Dolby decoder is built in, and the set has full taping capability. The receiver sells for $600.

The audio disk that Philips is developing is compact: 11.5 cm in diameter, 1.1 mm thick. The disk records music and text optically, using digital pulse-coded-modulation techniques (see "Higher fi by digits," *Spectrum*, December 1979, p. 28). It plays back 60 min of hi-fi stereo recording over a disk player the size of a typical cassette tape deck. High quality and reliability are ensured because of the digital recording and reproducing techniques, which use a laser diode as a contact

[2] The microprocessor-controlled color TV receiver can be preprogrammed with 16 different TV program listings, which are stored in the RAM. Also, up to 99 UHF-VHF channels can be accessed through local or remote control. The ROM is used to look up the proper channel allocation according to the depressed keys. Nickel-cadmium battery cells maintain operation of the clock up to one week, thereby saving program information during possible blackouts.



e pickup head. Philips contends that these compact disks l sell for $5 as soon as the technology becomes fully eloped.

In video tape recorders, Philips also is an innovator. The npany has introduced the first such system that has two cks on one side. This had doubled the playback time to ht hours. The VR 2020 incorporated a microprocessor that namically controls the self-correcting circuitry of the ording and playback heads. This allows a compact 7-mm-wide tape, 6.35 mm on each side, to record pro- ms from 26 TV stations.

me computers become business machines

Home computers continue to pop up, with the second- eration machines having architectures more like mini- nputers than microcomputers. The Apple and Radio Shack sions were outstanding.

The Apple II Plus used an upgraded software package that ends the scientific functions one can perform to include ex- nents, logarithms, square roots, absolute values, random mbers, and trigonometric and logic functions. It also has an omatic start-up ROM that places the computer in the Basic gramming mode, thereby eliminating a preliminary tine for getting the system ready—an advantage for vices.

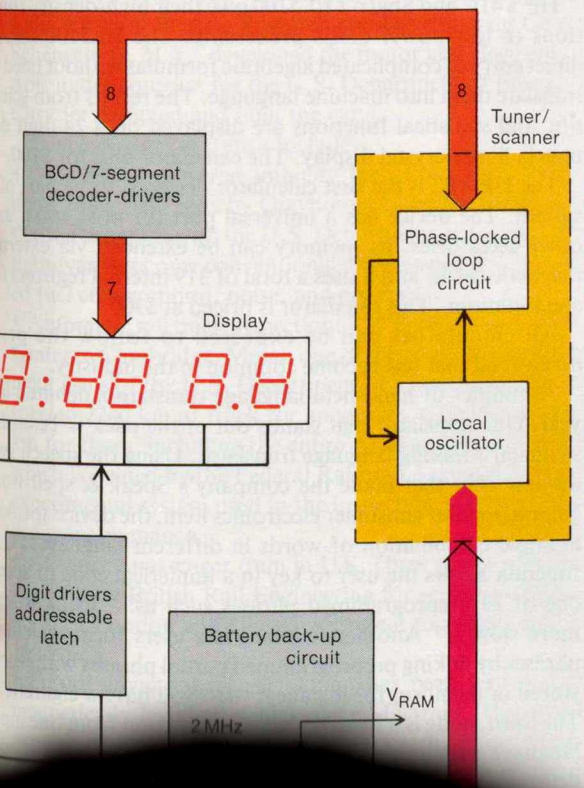
Radio Shack introduced in its TRS-80 II the capabilities of a l-sized minicomputer. The system stands alone and can be used as a general-purpose data-processing computer, an intelligent terminal, and a word processor. In addition to 32 kilobytes or 64 kilobytes of internal RAM, the system has a built-in 8-inch floppy disk that stores one-half million more bytes, expandable to 2 megabytes through expansion of three extra floppy disks. With software packages available or processing of general ledgers, accounts receivable, inventory control, mailing-list management, and payroll, this microcomputer-based system is definitely moving into small-business applications.

On the other hand, TI's entry into the home computer field could fill the marketing gap that Radio Shack will open. But TI's 99/4, introduced more than six months ago, ran into engineering problems, and the company had trouble supplying retailers in time for the holiday season. The 99/4 is based on TI's 9900 16-b microprocessor and is programmed in Basic. Software modules (ROMS) plug in for applications ranging from education to games. A full 16 kb of random-access memory can be used for calculations. A 13-inch CRT display is sold with the basic keyboard terminal, but it is unnecessary when the system is connected to the home TV receiver.

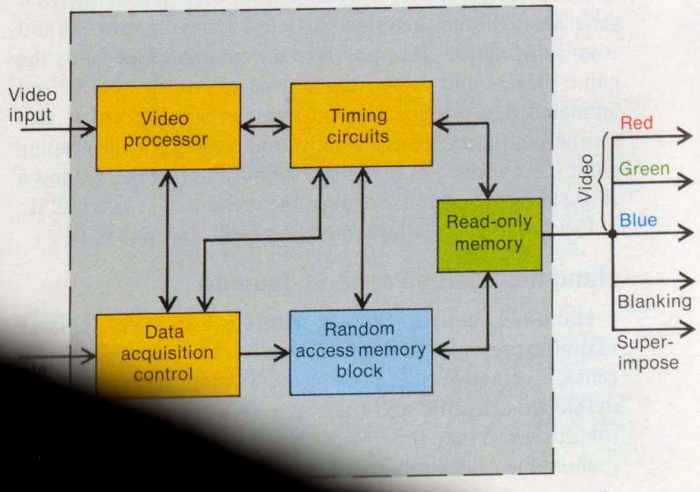
One of the more interesting options for the 99/4 is a speech synthesis accessory for $150. The unit contains the same ROMS as in the Speak & Spell game introduced by TI in 1978, but with a different vocabulary. Up to 250 prompts and messages are provided for the user. The basic home computer will sell for $1150.

Video games are played on cable TV

Of interest to prospective home-computer buyers is the Jerrold Electronics Playable system, which enables cable television operators to supply a wide variety of video games and information services to subscribers. By connecting a Mattel Electronics terminal called Intellivision to the television set, a viewer can choose between 20 games and information services a month. The terminal can be purchased for $250 from the cable companies, which include the Teleprompter Corp. The American Television and Communications Corp., Cox Cable Communications Inc., and the United Cable Television Corp.



[3] Teletext decoder from Sony Corp. is a 160 mm × 120 mm circuit board that contains four LSI chips and two 4-kb RAMs for storing a page of data. When the teletext decoder receives the control signals from the remote control decoder, it extracts the teletext data signal from the video detector output and obtains red, blue, and green data signals. These are synchronized with the TV picture so that, when accessed, a full page of color text appears in place of the video picture.



Comparing programmable calculator features

Manufacturer	Texas Instruments	Casio	Sharp	Hewlett-Packard
Model	TI-59	FX-502	EL-5100	HP-41C
Logic	Algebraic operating system	Algebraic notation	Algebraic notation	Reverse Polish notation
Introduction	July 1977	January 1979	March 1979	July 1979
Maximum program steps	960	256	80	2223
Maximum data registers	100	22	11	319
External mass memory	Magnetic cards	Standard audio tape recorder	none	magnetic cards
Plug-in ROM	5000 steps	none	none	4000 steps
Display type	LED	LCD	LCD	LCD
Display range	± 10/2	± 10/2	± 10/2	± 8/2
Alphanumeric display	No	No	Yes	Yes
Size, in	6½ × 3¼ × 1¾	5½ × 2¾ × ⅜	7 × 2¾ × 4	5⅝ × 3⅛ × 1¼
Weight, oz	12½	3½	4¼	7¼
Memory retention	No	Yes	Yes	Yes
Battery system	Secondary	Primary	Primary	Primary
Batteries	3 A size NiCd's	2 G12 $Ag0_3$	3 G13 $Ag0_3$	4 type N
Battery operating time	3 h	1300 h	unknown	9–12 months
Major accessories	PC-100C thermoprinter-plotter, ROM	Music/tape adapter	None	Plug-in thermoprinter-plotter, card reader, bar-code wand, ROM, RAM

Monthly subscription fees are projected at $10.

The basic receiving element in the cable adapter terminal is a narrowband varactor tuner controlled by a phase-locked loop circuit. At turn-on, the receiver is pretuned to the frequency that gives the directory of programs. Two players can select the program of their choice, which locks them to the radio frequency containing the information for the game. The data is demodulated in a standard detector and loaded into a RAM. When the RAM is fully loaded, it is functionally disconnected from the cable system and acts as a read-only memory for the length of that program. In this final stage, the cable adapter terminal appears to the player as if it had loaded the Mattel plug-in cartridge for that specific program. The cable adapter or the Mattel plug-in cartridge supplies the data that establishes the rules of the game, including the shape and color of the program background and the size, form and color of the objects and animated figures. Upon completion of the game, or at any time the players choose, another program may be selected by returning to the directory.

Another terminal, the Mattel Player, incorporates a microprocessor system called STIC II. It has been developed for Mattel by the Microelectronics Group of the General Instrument Corp. The STIC II consists of several LSI chips that generate all the required standard television synchronizing and color information. It responds to the commands given by the game players and directs the movement of all objects and animated figures appearing on the television screen. It also synthesizes data to generate background sounds while keeping game scores. Many of the programs, such as Checkers, allow a single player to compete against the computer—the STIC II.

Field trials of the Playcable system will start this year.

Hand-held games exceed demand

Hand-held microprocessor games are in such demand, manufacturers say, that not enough were available for the recent Christmas rush. However, an abundant supply of highly developed scientific and other specialty calculators were on the shelves to take their place. Notable entries included programmable calculators that are starting to resemble the first generation of personal computers. Products from Hewlett-Packard, Texas Instruments, Sharp, and Casio mark the second generation of calculators that can not only handle numbers, but also converse in words and alphanumeric symbols. The accompanying table compares key features of the most popular second-generation programmable calculators.

HP's 41C and Sharp's EL5100 owe their high-density functions to low-power CMOS processing. The EL5100 allows direct entry of complicated algebraic formulas without need to translate them into machine language. The results from scientific and statistical functions are displayed on a 24-digit dot matrix liquid-crystal display. The calculator sells for $100.

The HP 41C is the first calculator designed to be part of a system. The device has a universal port for ROM, RAM, and other accessories. Its memory can be extended via external magnetic cards, and it uses a total of 319 internal registers for computations. This calculator is priced at $300.

All calculators can be expected to follow the price downtrend that has become common in the industry.

A number of hand-held language translators debuted last year. One translator that stands out of the pack is Texas Instrument's talking language translator. Using the speech synthesizer chip that made the company's Speak & spell word game a popular consumer electronics item, the device speaks a multiple combination of words in different languages. One function allows the user to key in a numerical code to access one of 25 preprogrammed phrases such as: "Speak a little more slowly." Another function lets users form their own phrases by linking preprogrammed partial phrases with words stored in memory, for instance: "Do you have a cigarette?" The third mode is a straight translate function from one input language to another output language. Two learning modes drill users on pronunciation and translation of selected words.

Plug-in ROM modules are available for English, Spanish, French and German. Japanese and Chinese will follow suit this year. The voices used for the different languages reflect the most generally accepted accents. For instance, the French is pronounced in Parisienne. The price of the device is $300 and the plug-in modules cost $60.