IEEE
spectrum

Energy in Europe: tilting toward fusion

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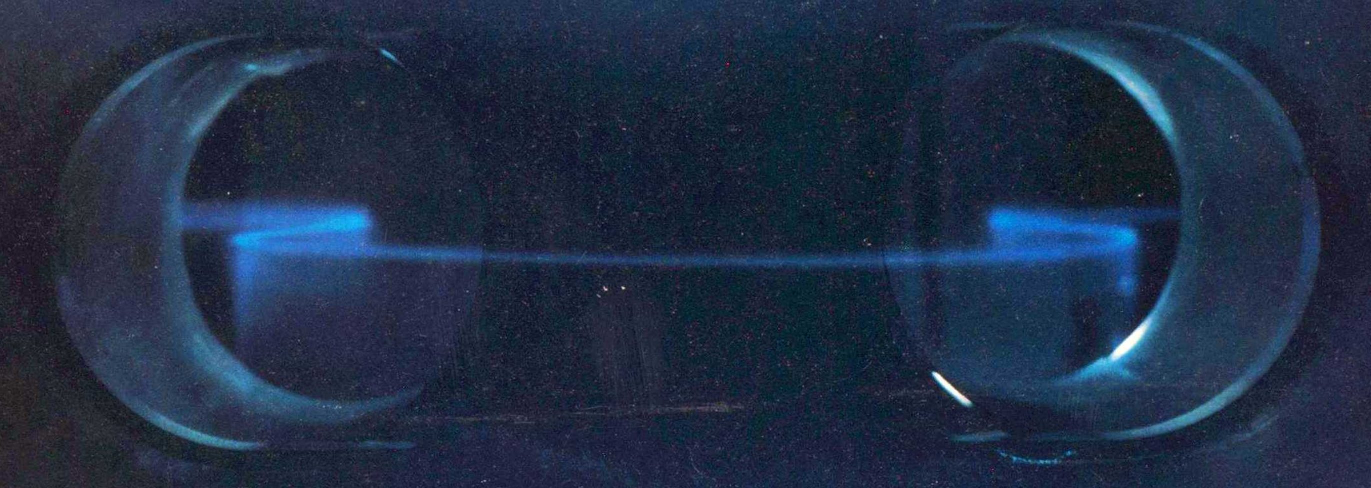

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IEEE spectrum

the cover

"Blue eyes" is really an arrangement of two small magnetic coils used to divert plasma impurities from inside a Tokamak vacuum chamber experiment on controlled nuclear fusion (article: p. 36). The bluish electron beam traces the path of the diverted particles. Photo: U.K. Atomic Energy Authority

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Consumer electronics

Electronic gamesmanship

It's man vs. microcircuit as video games entertain by challenging human skill (now) and intellect (soon)

Spawned by the fantastic success of Atari's quarter-gulping "Pong" game (now standard equipment at taverns and shopping mall arcades), home video games are essentially an add-on feature that consumers buy and connect to their television set's antenna terminals. The heart of all such games is low-cost logic and memory. Some are built with hard-wired circuit boards and standard ICs, while others use microelectronics specifically designed for generating video game action, sound, and scoring. This latter field is presently dominated by the General Instrument Corp., but Fairchild, National Semiconductor, RCA, Rockwell International, and Texas Instruments have all announced product and/or development efforts regarding video games and game chips. And dozens of small assemblers have bought parts, designed games/packaging, and now await Federal Communications Commission (FCC) approval. Meanwhile, "second generation" video games containing microprocessors and featuring ROM or tape cassette programming are under rapid development, with one product announced (to date) and several others imminent.

The game-makers get going

First to market a video game consumers could buy and take home was Magnavox, in 1972. However, their original Odyssey® game was not an immediate sensation, perhaps because it had no automatic score-keeping feature, lacked sound, and required a plastic overlay on the TV screen to simulate the net, goals, and boundaries of a playing field (static electricity held the overlay in place). Since then, Odyssey has evolved through four model changes and is now offered with automatic serve, digital scoring, and sound for $89.95. Also, all stationary playing-court features are electronically generated. Magnavox's game circuits are produced by Texas Instruments and the General Instrument Corp.

The second major milestone in the evolution of home video games was established just over a year ago when Atari and Sears teamed up to produce and market Hockey Pong® for the 1975 Christmas season. The product had many of the important features associated with Atari's successful line of coin games and sold briskly.

Don Mennie Associate Editor

Introduced in time for the holiday season, the Fairchild Video Entertainment System incorporating the F8 microprocessor uses replaceable ROM cartridges to provide unlimited format selection (left). Not to be easily outdone, dedicated-logic designs—like the "tank battle" chip now being readied by the General Instrument Corp.—will provide a limited selection of advanced games while retaining a low price.

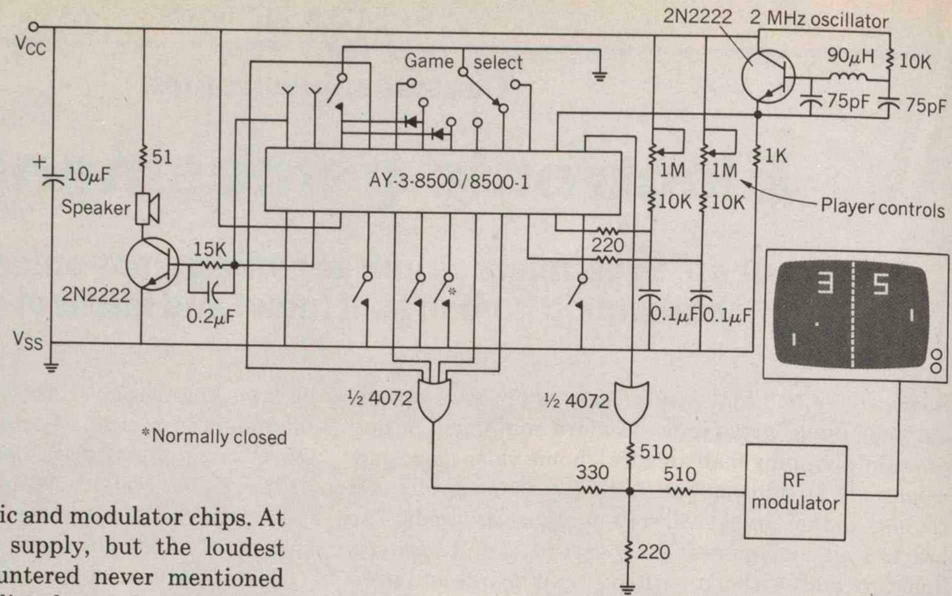
By working closely with one of its integrated circuit suppliers (American Microsystems, Inc.), Atari was assured a supply of dedicated, proprietary game chips. These chips greatly reduced the parts count, and costs, associated with Atari's original coin-game products that were constructed with hundreds of standard logic circuits. The coin games normally sell for $1000–$3000 each—but consumer acceptance of the add-on TV version was expected to peak somewhere under $100 retail.

Meanwhile, with Odyssey more streamlined and the Atari/Sears venture a proven success, the lucrative aspects of consumer TV games became obvious to other entrepreneurs. For many, the first opportunity to enter the market came in March 1976 when the General Instrument Corp. (GI), Hicksville, N.Y., announced production of its AY-3-8500 TV-game integrated circuits. Product acceptance was swift and favorable. New companies anxious for an early shot at the home video game sweepstakes quickly snapped up GI's projected 1976 production capacity of game chips.

With dedicated logic available, constructing a TV game is reduced to assembling a few inexpensive components—ICs, RF modulator, potentiometers, switches, subcarrier oscillator, and power supply or batteries—in an attractive master control package (Fig. 1). And typical of novelty or gift items, a preholiday advertising blitz is being employed to recruit customers. A curious aspect of this routine involves the different game models (and corresponding prices) that certain manufacturers offer. Since virtually all the new game-makers that have developed products in time for the 1976 Christmas season use the GI chip (it can produce a half-dozen externally selectable games), the abundance of options is remarkable. Apparently the cheaper games have only three- or four-position selector switches, whereas the "top end" product includes a full six-position switch. Price spreads of $10–$30 hinge on a few cents' worth of contacts!

Games features that are genuinely more expensive to implement include color (subcarrier generators required) and certain special sound effects that accompany the action and scoring during play. Realistic-sounding motorcycles, explosions, and power dives require audio circuits that do more than just amplify the digital noise that is readily available from the video logic.

Consumer electronics is perhaps the most competitive arena for new technology, so it's not surprising that GI's game chip soon had company. Though GI enjoyed several months as the sole source (excluding custom ICs), several other major IC manufacturers promptly announced products, held applications seminars, and had samples out to potential volume customers. Texas Instruments announced six video-game ICs this past August; and earlier in the summer, National Semiconductor an-



[1] Intended to use battery power and a minimum of external components, General Instruments' AY 3-8500 video-game chip delivers six externally selectable games. An interesting subtlety involves the "bat" used for tennis operation. It is divided logically into four equal, adjacent sections. When a "hit" is detected by the logic, the section of the bat that made the hit determines the new angle of the ball's return path.

nounced both video-game logic and modulator chips. At this time, demand exceeds supply, but the loudest grumblings *Spectrum* encountered never mentioned parts shortages or poor quality, but rather the type-approval testing sequence required for finished games by the Federal Communications Commission. Because they contain a low-level RF source for direct interfacing with television sets, home video games fall under the definition of Class I television devices in the FCC rules, and as such must pass a stringent examination for stray radiation before being offered for sale.

Scaling Chapter I, section 15

No one suggests that the FCC is unfair or capricious in conducting the tests. All submitted games are given the same careful scrutiny at the FCC's field laboratory in Laurel, Md. Debate centers on the formal requirements themselves (section 15.4 and subpart H of Chapter I of Title 47 of the Code of Federal Regulations). These were developed about five years ago, prior to the emergence of video games. It was (then) expected that most of the products submitted under this section would be consumer-grade video tape or video disk equipment.

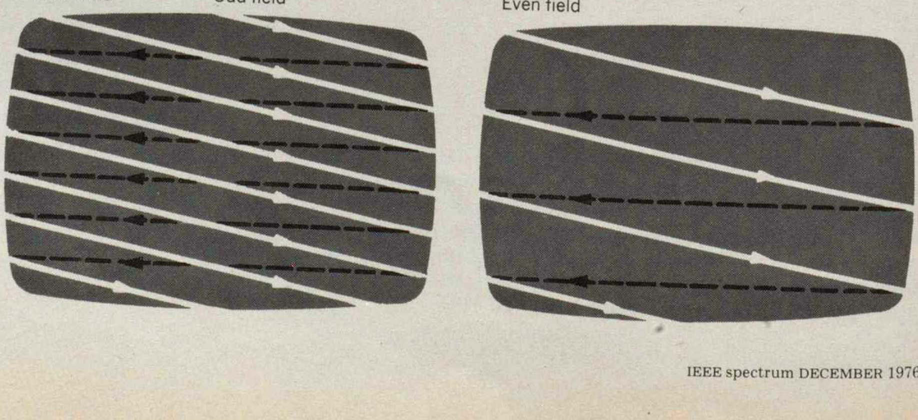
The basic radiated emission limit all Class I devices are held to is 15 μV/m at $\lambda/2\pi$ or one meter, whichever is larger. This applies to all stray radiation—be it digital noise, video signal harmonics, or leakage from an RF modulator. The cabling used between video games and TV receivers is often a source of problems if a high VSWR is present. Standing waves produced by poor impedance matching or cable defects can easily generate RF fields above the prescribed limits. The FCC testing looks for worst-case conditions, so if coiling, bending, or twisting adversely affects cable VSWR (and thereby emissions), excessive radiation may result.

Also under close FCC inspection is the dual-input transfer switch used to select "antenna" or "game" by the TV viewer. This device must exhibit 60-dB isolation (minimum) between its two inputs on all channels used by the video game's RF modulator. Unbalanced Balun coils and closely spaced contacts allowing RF leakage across the open switch position have produced many isolation-test failures.

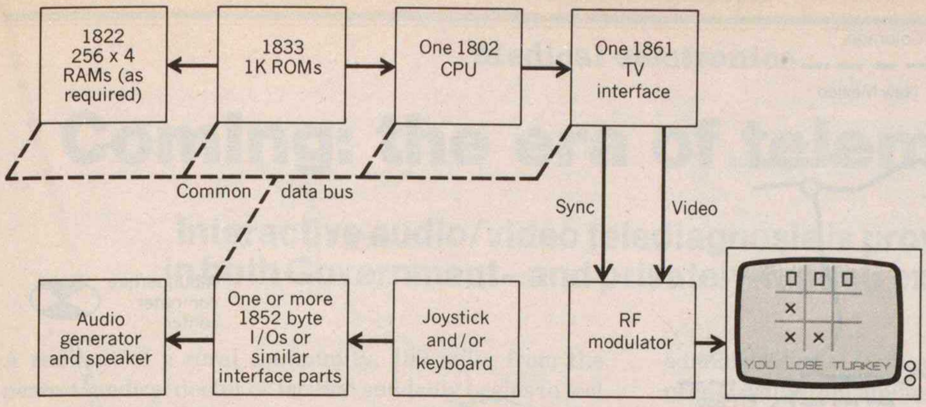
Perhaps the widest rift between the FCC and the video-game industry involves the Commission's requirement that FCC control extend over the whole product, not just the RF circuits. This means that each new game offered for sale must first go through the FCC's entire field-testing sequence, even if it is nearly identical to other models already approved. Since a $1500 filing fee is charged for each video game submitted, and turnaround time is currently about 60 days, industry concern is understandable. But as John Robinson of the FCC Laboratory Division explains, there is no way the Commission can assure compliance without requiring a full test sequence. FCC bulletin OCE 33 is available to anyone needing details on the actual test procedures.

Scanning short cuts save memory

The information delivered to a home TV receiver from a video game consists of low-level modulated RF switchable between channels 3 and 4. Channel choice, made when the game is first installed, depends on the interference potential from local broadcasts. Physical separation of adjacent-channel TV transmitters, long mandated by the FCC, insures that where local signals are strong (as in most metropolitan areas) either channel 3 or 4 will be vacant.



[2] Noninterlaced CRT scanning produced by video-game circuits causes the same field to be swept twice per frame, producing a 262-line image (right). Maintaining the standard 525-line odd–even interlacing (left) would require much more memory and add little noticeable picture quality during play.



[3] One possible microprocessor-based video game built largely with circuits from the RCA Solid State Division operates with user-selectable ROM cassettes that determine the game(s) immediately available (they contain permanent instructions for the playing-field layout, shape of players, etc.). When a new game is initiated, information is transferred from the ROM to the RAM, where it is held and then updated as play progresses.

While the game-generated TV signal matches the frequency of commercial broadcasts, the video modulation has been somewhat modified to simplify the game circuits' complexity. Rather than faithfully adhering to the standard 525-line 60-field interlaced-scan NTSC format, game circuits produce a 262-line 60-field picture. With this scheme, odd–even interlacing is abandoned, and every field scans the same portion of the TV's CRT screen (Fig. 2). The modified vertical sync pulses (no equalizing pulses or serrations) produced by the game circuit insure that the TV set does not interlace.

The 262-line noninterlaced format greatly reduces the logic memory capacity otherwise needed to keep track of moving balls and players during the course of a game. Each line scanned on the CRT is divided into discrete segments (GI chose 64), whose status must be continually monitored and updated. And horizontal, vertical, or diagonal motion should flow between segments, simulating natural movement, rather than jump in a noticeably discontinuous manner—which also adds complexity.

Because of small errors in TV receiver alignment, tracking, focus, and picture stability, some scanning overlap is always present (on a field-to-field basis), making the 262-line game picture quality no coarser than a 525-line broadcast picture. In fact, GI engineers told *Spectrum* that the 262-line image enjoys improved contrast over standard interlacing, and is particularly well-suited to presenting tennis- and handball-type games.

Sound runs a close second to video in determining the success of a given TV game package. Audio feedback has proved essential for maintaining interest and excitement during play. Some manufacturers provide all the necessary amplifiers and speakers within their game control console, while others modulate a separate FM audio carrier, making use of the TV set's available sound system. As IC game circuits are adaptable to either method, it's strictly a question of cost that determines the route taken. So far, placing an amplifier and speaker in the game console has proved the favored option.

Make room for the microprocessor

The big enemy of all new games—electronic or otherwise—is boredom. Just how many rounds of TV tennis is the average consumer good for? As long as the answer is finite, serious marketing problems are certain to arise, so manufacturers have developed second-generation programmable video games based on the microprocessor. This makes much more complex games available, and allows new games to be introduced at low cost.

First to market with this type of product was Fairchild Consumer Products Division, Palo Alto, Calif., with its Video Entertainment System, model FVE100 at $150. After gaining approval by the FCC late in October, the new Fairchild game was on its way to retail outlets and consumers by early November.

Game selection is made through the FVE100's keyboard console with action directed by two hand controls. Tennis and hockey are "resident" with the system; the first add-on ROM cartridge costs $20 and contains tic-tac-toe, shooting gallery, and two tracing games.

A second microprocessor game, to be introduced on a regional basis starting in January 1977, comes from RCA Distributor and Special Products Division, Deptford, N.J. It too will feature keyboard entry and ROM cassette programming. The product utilizes a COSMAC microprocessor, which is being supplied by the RCA Solid State Division (Fig. 3). Pricing, according to RCA spokesmen, will be "similar to Fairchild."

Meanwhile, at this year's WESCON show in Los Angeles, Calif., General Instrument demonstrated a blackjack-playing TV game built around its CP 1600 microprocessor. Others said to be actively developing marketable microprocessor games include National Semiconductor and Texas Instruments.

The future of video games is open-ended, but it's a good bet that this "fun" product marks the initial mass entry of computer capability into the home environment. With ROM or tape programming, much more can be expected than simple gamesmanship. For example, a video display, computer, keyboard, and cassette program have been teamed to form a user–interactive blend of technologies by Rockwell International's Admiral Group.

Demonstrated as a concept rather than a product, Videospond was shown to be a versatile teaching machine and advanced video game during invited sessions at the June 1976 Summer Consumer Electronics Show in Chicago. William H. Slavik, then director of advanced research for Rockwell, put the hardware through its paces. First, a cassette-recorded alphabet lesson was played featuring positive reinforcement (a correct answer from the "child" audience moved the program ahead). Next, a game was presented where eight different colored boxes (six of each type) were randomly distributed in a 48-square grid. For a brief time, all the colors and positions were visible, then the grid went black. Each correct matching pair that was correctly remembered from the full-color display scored one point.

Though Videospond is no longer under active development, Mr. Slavik and several of his key associates from Rockwell have started their own consulting firm, Novatec, in Rosemont, Ill. They are presently active in many kinds of microprocessor applictions, including video games. ◆