COVER STORY

TV SETS WITH 1" SCREENS— OR, WHAT HATH THE IC WROUGHT?

By LESLIE SOLOMON
Technical Editor

YES, TV receivers are getting smaller . . . and smaller . . . and smaller. Way back in the post-World War II days of TV, the picture size of available sets was about 5 inches. If you wanted a larger picture, you simply bought a magnifying lens, stuck it in front of the screen, and sat back smugly satisfied. During the next few years, the size of the CRT started to grow and 5's became 7's, 9's became 15's, and 17's grew to 21's and 25's. At one point even a 27-incher was available, and, on top of that, large-screen projection TV came into being. Then, for a good many years, picture tubes stabilized at a nominal 21-inch plateau. However, there always were undercurrents in the set size area, with an occasional 9- or 11-incher (vacuum-tube powered) set breaking the surface—they weren't successful.

Then the transistor came to TV, the floodgates opened, and the size trend started to reverse. Solid-state circuitry meant portability, and portability necessitated reducing the size and weight of the picture tube. Suddenly, we were in the age of the small set and sizes rapidly dropped to 9", 7", and then down to 4" and 3". We were deluged with imported small-screen eye-strainers as recently as two years back. The circle was complete—but not to the 5" set where it all began. Sony (whose business philosophy has always been "think small") recently announced a 1" TV receiver—complete with magnifying lens!

Sony's Set. Shown on this month's cover, and on p. 31, Sony's 1-inch set is expected to go into production in a year or so and sell at a price estimated to be about $200, with this price hopefully dropping with demand.

The tiny TV weighs almost 2 pounds (with batteries) and has about half the volume of a cigarette carton. The set will operate a couple of hours from an internal nickel-cadmium battery that can be recharged when the set is operated from the power line. The one-inch picture is slightly enlarged by a lens incorporated in a combined retractable hood and on/off switch. Pulling the hood forward automatically turns the set on.

Two tuners, one for VHF and the other for UHF are incorporated. Tuning on VHF is continuous rather than by the usual detent, while a switch alongside the VHF tuning control enables choice of high-or-low-band VHF. A collapsible monopole antenna is used for all reception and a small loudspeaker is mounted below the CRT.

The company declines to divulge any technical information on the set but merely claims the use of an unknown quantity of integrated circuits, with conventional transistors used elsewhere.

Motorola's Set. Sony is not the only company with an eye towards extra small-screen (1-inch) TV sets. Last year, the Advanced Engineering Laboratory of Motorola Consumer Products Division demonstrated its version of a 1-inch TV set, shown in Fig. 1. Although Motorola has no intention of marketing this set, they state that the circuit design has been made available to interested manufacturers.

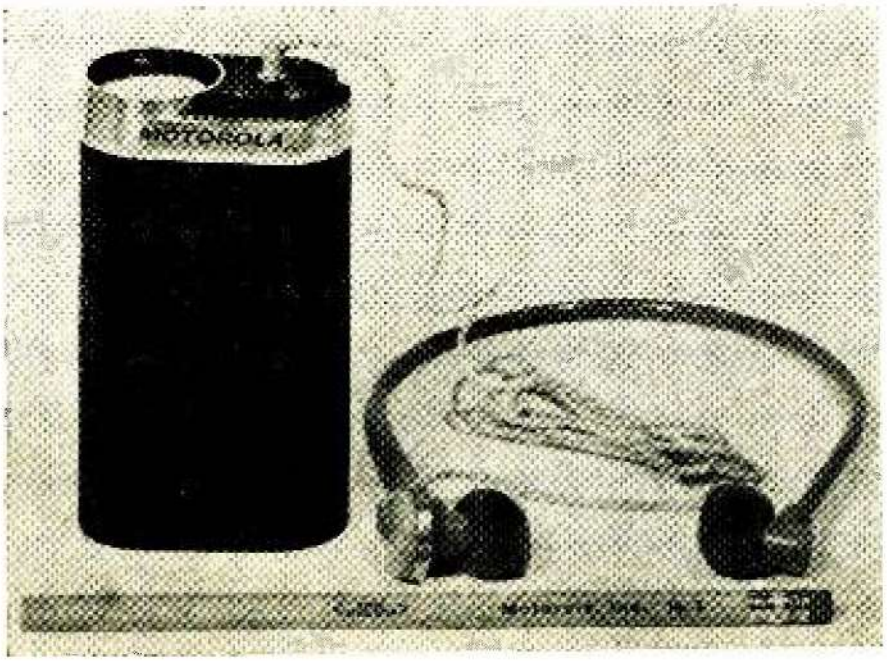
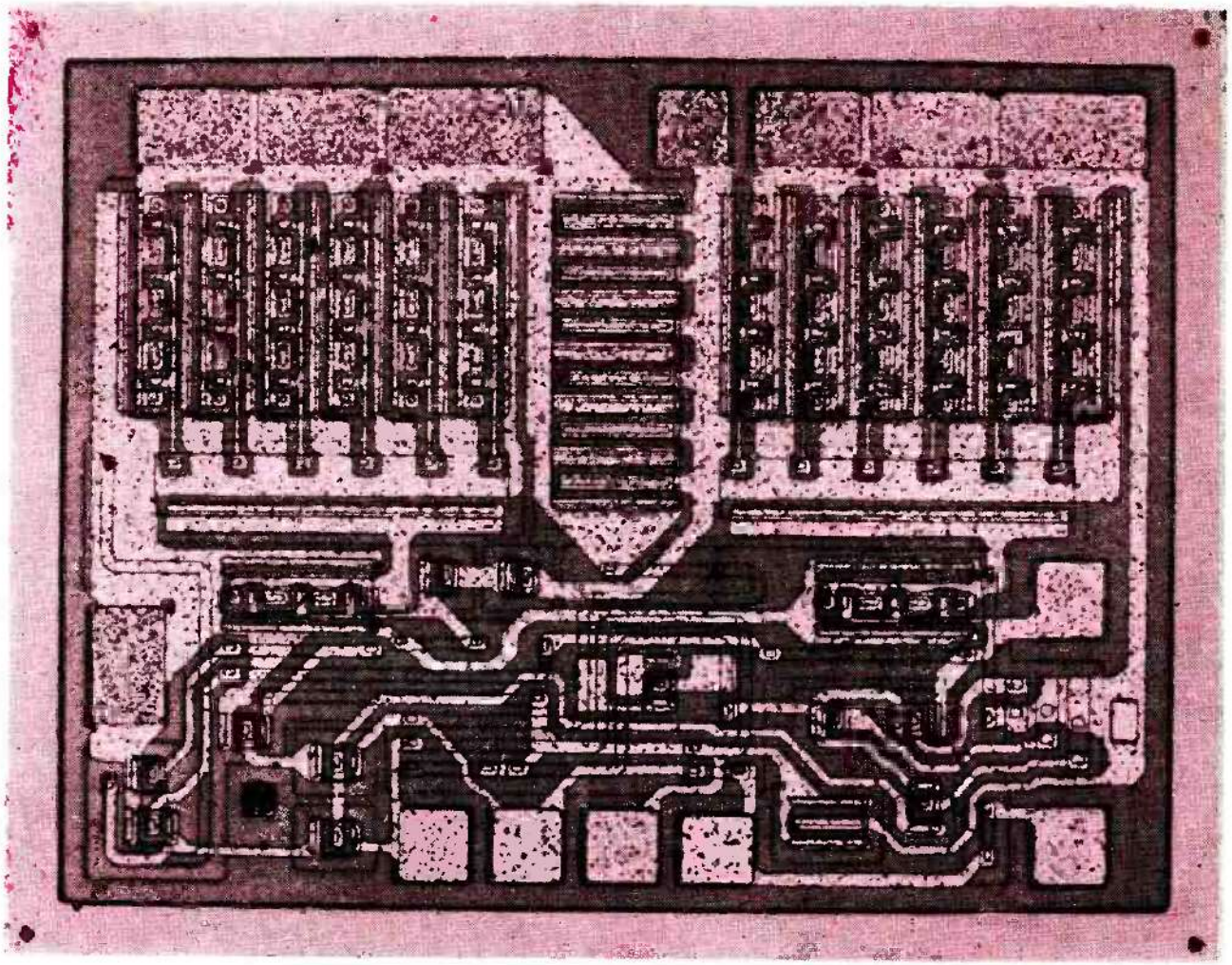


Fig. 1. The Motorola experimental 1" TV set does not use any IC's, yet isn't much larger than a pack of king-size cigarettes. The set has a 1"-diameter electrostatic CRT, and the actual receiver occupies only 1.2 cubic inches! Four penlight cells supply necessary power and the earphone lead also acts as the antenna. Don't wait for this set . . . it's not going into production.



Shown above is a greatly enlarged view of a Motorola MC 1554, 1-watt IC chip. Having 10 transistors, 6 diodes, and 14 resistors, this chip will deliver 1 watt of audio output at 0.4% distortion and is "flat" to 300 kHz. The rectangles at top right and left are the power output transistors. Oh, yes . . . this chip fits into a TO-5 can (0.3" diameter by 0.18" deep) with room to spare.

Because this 29-transistor, 14-diode receiver was designed and built in 1964, it does not use integrated circuits. It weighs only 12½ ounces and the entire unit occupies just 13 cubic inches of space.

The receiver circuits are mounted on a three-layer module occupying a total volume of 1.2 cubic inches. About half of the set's internal volume is taken up by the 1⅛-inch diameter, 4-inch long, electrostatically deflected CRT. One interesting feature of this set is that the earphone lead also doubles as the antenna.

Power for this tiny TV comes from four penlight cells driving a d.c.-d.c. converter that delivers the 11, 100, 275, 1200, and 3000 volts required for operation. To minimize any possible interference (caused by switching transients) between the voltage converter and the set's active circuits, the voltage converter switching frequency was made to be very close to the line scanning frequency (15,750 Hz).

These two units demonstrate the feasibility of the so-called "coat-pocket" TV receiver. Although the Motorola receiver is made up entirely of discrete solid-state components, the present state-of-the-art of IC's has improved to the point where miniature TV sets like these can incorporate IC's for the bulk of their circuitry. This broad use of IC's will not make the TV sets any smaller, but it will make them easier—and possibly cheaper—to manufacture.

Integrated Circuits for TV. If you examine the schematic of a typical transistor TV set, you will note that no circuits, with the exception of the video amplifier,

sweep output stages, and possibly the audio amplifier, are required to produce a large voltage or power output.

During the past year, many new and improved linear IC's have made their appearance. Performance-wise, linear IC's do not differ greatly from similar circuits using discrete solid-state components. The major difference is, of course, size—up to 12 transistors, their associated resistors, and sometimes a few diodes, complete with all their interconnections, can be mounted within an ordinary TO-5 transistor can, or in an in-line package about half the size of a postage stamp. If you don't know the size of a TO-5 can—it is about 0.3-inch in diameter and 0.18-inch high.

Because of the extremely small size of an IC, stray capacitance is greatly reduced, making most linear IC's capable of operation (relatively "flat") from d.c. to the MHz region. All that the designer must do is couple the frequency-selective external components to the IC.

As an example of this compact circuitry, the RCA CA3013/14 IC, as used by several receiver manufacturers in FM i.f. circuitry (radio and TV), incorporates 12 transistors, 9 diodes, 3 diode capacitors, and resistors—all in a TO-5 transistor can. As shown in Fig. 2, this IC contains a three-transistor i.f. amplifier, another three-transistor i.f. amplifier and limiter, a two-transistor limiter, a five-diode FM detector, and a two-transistor audio preamplifier—and the entire IC is powered from a two-transistor, six-diode voltage regulator. The specs are impressive. Using a 10-volt d.c. input, this IC produces a 4.5-MHz power gain of 75 dB, has an AM rejection of better than 50 dB, and develops about 0.2-volt of audio output.

Another IC manufacturer (Texas Instruments) has taken a different road to making a complete i.f. package. Instead of the monolithic IC system used by RCA and others, TI is making use of thick-film techniques to create its HC-1001 module. This ½-inch-square, 0.2-inch-high capsule contains the functional equivalent of 30 individual components and has an input sensitivity of 300 μV, and an AM rejection of 35 dB. As shown in Fig. 3, the module contains a four-transistor i.f. amplifier, a two-diode FM detector, and a two-transistor audio preamplifier.

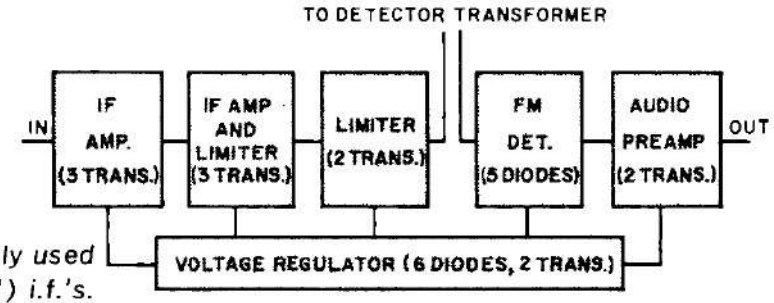


Fig. 2. This RCA IC is presently used in both FM and TV (sound) i.f.'s. It now becomes possible to have a complete i.f. in a TO-5 can (except for tuned circuits). In the not-too-distant future, it is likely that the entire FM set (and the bulk of the TV set), will be found in one tiny can!

Still other IC manufacturers are announcing their entry into the linear IC for broadband amplification field. The two latest are Motorola with the MC1550 IC for video amplification, and General Electric with the PA189 i.f./discriminator, useful for both 4.5 and 10.7 MHz.

IC's In Actual Use. Several radio and TV manufacturers have produced AM and FM radios using IC's, and some are incorporating IC's in their present line of monochrome and color TV sets. At present, these IC's are being employed only in low-voltage input and output i.f. amplifiers (both video and audio), sync separation, a.f.c. circuits, chroma demodulators, etc. This low signal voltage requirement has been imposed because getting power or high-voltage output from an IC has been difficult.

When it is considered that a present-

day electromagnetically-scanned CRT requires several watts of yoke power to sweep both the horizontal and vertical axes, and needs up to 30-40 volts of video to effectively modulate the electron beam, one realizes how limited present IC's are. If electrostatically swept CRT's are considered, IC's simply cannot produce the necessarily large voltage swing to fully deflect the electron beam across the screen.

It is only within the past year or so that several manufacturers have been able to produce linear IC's having a capability of up to one watt output. Typical of these is the Motorola MC 1554 module that includes ten transistors, six diodes, and fourteen resistors in a TO-5 can; the d.c. voltage requirement is only 18 volts. And General Electric has a PA237 that can deliver one watt with a 12-volt d.c. supply, and two watts when the voltage is raised to 24 volts.

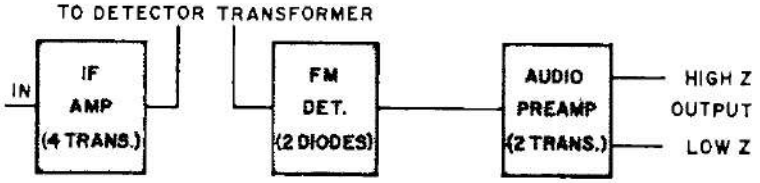


Fig. 3. The internal arrangement of Texas Instruments' thick-film, i.f. IC. It contains the functional equivalent of 30 discrete components in a package only ½" square by 0.2" thick! It also requires the use of external tuned circuits at the i.f. frequency.

Two Requirements. Obviously, the first requirement is the development of a CRT that uses very little heater power. (Remember that heater power is wasted power and may represent over half the set's total consumption.) The CRT also must operate on a low value of yoke current to scan the screen in both the vertical and horizontal directions—this also means a physically smaller yoke, thus saving weight and size while simultaneously reducing the power-handling capability of the IC that would be used as the sweep amplifier. And finally, the CRT must be capable of complete control of the electron beam with only a few volts (peak-to-peak) applied to the beam control element—cathode or control grid, thus reducing the output voltage requirements for an IC used as the video amplifier.

The high voltages needed by a CRT are currently available from d.c.-to-d.c. voltage converters that have been designed for other, non-TV purposes. Such voltage converters can presently be manufactured as small modules for easy insertion into a final cabinet. Although voltage needs may reach as high as 3 kV, current needs are modest (a few mA or so).

The second requirement is the development of small tuners, probably going away from the relatively bulky and complex mechanical detent switching in the larger sets to all-electronic tuning with some form of electronic variable capacitor (such as a varactor).

The Overall Picture. What will the price situation be? That depends on how well the tiny sets sell, plus the declining production cost of turning out the low-cost IC's. As hundreds of IC's are automatically made at a time on a 1-inch diameter slice of silicon, the total yield per slice must be high to keep costs down. At present, the yield leaves a lot to be desired.

The small CRT's must also be reasonably economical to manufacture. Today, most glass factories are producing the big-money items—color TV tubes—and may be loath to create expensive production lines to turn out small CRT's that will frankly be a gamble.

Looking at the overall picture of the super-miniature IC TV set, there seems no doubt that it is destined for the future. If the miniaturization of other components—speakers, batteries, CRT's, controls, and switches—keep pace with the electronics, then the only limit to smallness will be the knobs! -30-