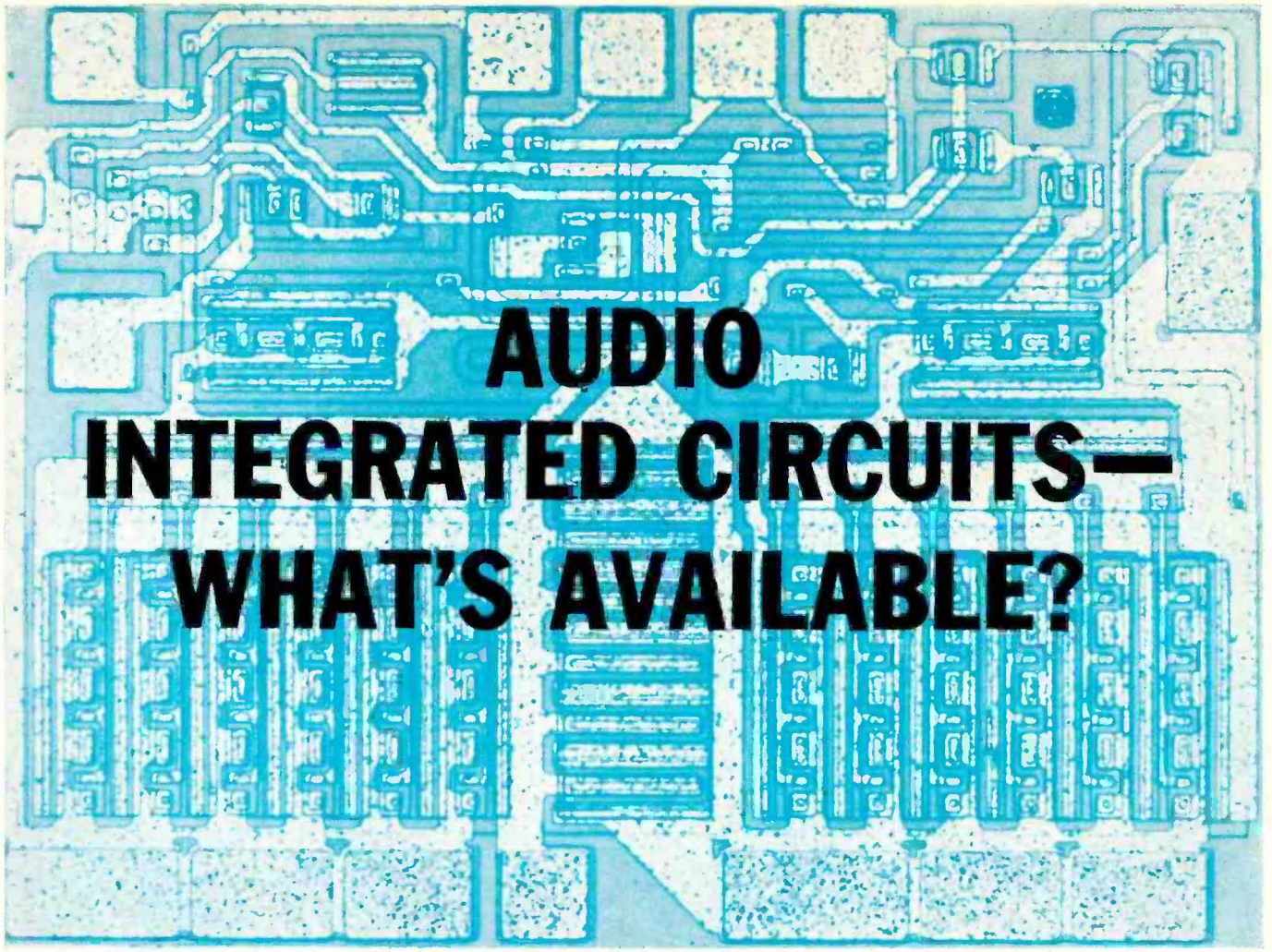


AUDIO INTEGRATED CIRCUITS— WHAT'S AVAILABLE?

Photomicrograph of circuitry used in Motorola MC1554G is fairly typical of the complexity found in the other IC's.

By DONALD E. LANCASTER

A wide range of low-cost IC's is now readily obtainable for use in low-power audio circuits. Here is a rundown on what's available with new ones coming out almost daily.

WITH the recent introduction of a dozen new integrated circuits, the audio designer now has at his command a wide range of low-cost linear IC's. He can buy a half-watt audio amplifier for under $3; a one-watt unit for under $4; in single quantities. He can obtain a preamplifier IC with a gain and input impedance considerably higher than most vacuum tubes for about $2, and make use of other integrateds whose replacement would require three or more stages of complex conventional circuitry. He can also get broadcast-quality performance to the one-watt power level in two premium units priced in the $15 to $25 range. Also available are subminiature audio IC's and special circuits whose gain is easily controlled electronically. (*Prices for production quantities of any of these items is, of course, substantially lower than the single-unit prices given above, and further price cuts are imminent.—Editor*)

Let's take a closer look at some of the audio integrated circuits that are available and see who makes them and just how they might be put to use. All those we'll talk about are available from distributor stock and the prices mentioned are the approximate single-quantity ones. Complete data and a list of distributors are available; see Table 1.

Amperex is one of the latest entries in the field of linear IC manufacturing. They have recently introduced five very moderately priced, high-performance, low-level audio IC's specifically aimed at consumer audio and hi-fi markets.

Their "Bifet," the TAA320 ($2.25), is most interesting. This IC consists of a MOS transistor followed by a bipolar transistor emitter-follower and a biasing resistor, all packaged in a three-lead TO-18 can. The device combines an input impedance of 10^{12} ohms or so, a transconductance of 40,000 micromhos minimum, and a voltage gain of 40 to 100 under typical bias conditions. With external circuit impedances at the megohm level, response approaches d.c. to 1 MHz.

This is the first major low-cost integrated circuit with an input impedance comparable to or better than most vacuum tubes. Total audio noise voltage is on the order of 25 microvolts, meaning that even fractional millivolt signals may be readily amplified with no noise problems.

The obvious use of the Bifet is as a high-gain, high-input-impedance microphone and phonograph preamplifier. The high circuit impedance levels allow very small input coupling capacitors, even at subaudio frequencies. Another important application is in phase-shift and Wien-bridge oscillators. The extremely high input impedance is also useful in timer

and delay circuitry, and other such types of applications.

A second unit, the TAA310 ($4.90), is a conventional monolithic IC in a ten-lead TO-5 can. The TAA310 is a general-purpose, low-noise, low-level preamplifier ideally suited as a tape record/playback preamplifier. A 4-dB noise figure is combined with a 90-dB (× 32,000) voltage gain and an uncompensated upper frequency limit of 15 kHz. The IC contains five transistors, four diodes, and five resistors. A 7-volt single-ended supply is needed. In a tape-preamp circuit (Fig. 1), the TAA310 provides 64 dB of tape-compensated gain, a 75-dB volume-control range, and 0.5% distortion at a 0.5-V r.m.s. output level.

This IC is useful for any low-level preamplification or tone-compensation circuit where input impedances of 50,000 ohms or less are acceptable or desirable.

Controllable-Gain Amplifier

Although not called an "audio" IC, the *RCA* CA3023 ($2.95) wide-band amplifier will find a wide range of audio applications owing to its electronic gain capability. The device has a 53-dB power gain and a 16-MHz bandwidth, all combined with a 10,000 to 40,000-ohm input impedance. A single supply (4.5 to 12 volts) powers this 12-lead TO-5 style IC.

The gain may be electronically varied over a 33-dB a.g.c. range, making this IC ideal for speech compressors, blast limiters, squelch circuits, automatic level monitors, and any other applications where it might be desirable to control the circuit gain with a d.c. control voltage.

Subminiature Audio Unit

Where size and cost are of utmost importance, the *Amperex* TAA103 ($2.55) low-level amplifier may be put to good use. This four-lead epoxy-cased IC measures only 100-mils square by 50-mils high, yet has a 60-dB gain and can put out 8 milliwatts with less than 5% distortion. Total noise figure is 12 dB. A 6-volt, 11-mA supply is required. Optimum load impedance is 150 ohms.

Hearing aids, headphone booster amplifiers, and other subminiature audio applications are top candidates for this particular IC. Input source impedance should be 1000 ohms or less. This monolithic IC contains three transistors and two resistors.

A very similar unit, the TAA236 ($2.10) is available in a conventional TO-18 can for use where ease of handling offsets the requirements for very small size.

Low Voltage, High Gain

The *Westinghouse* WC183 ($7.00) is a low-level audio amplifier that has some unique features. This 12-lead, TO-5 style IC may be powered from a single 1.5-volt cell, producing a gain of 60 dB, a power output of 5 milliwatts, and an efficiency of 55%. Higher supply voltages may be

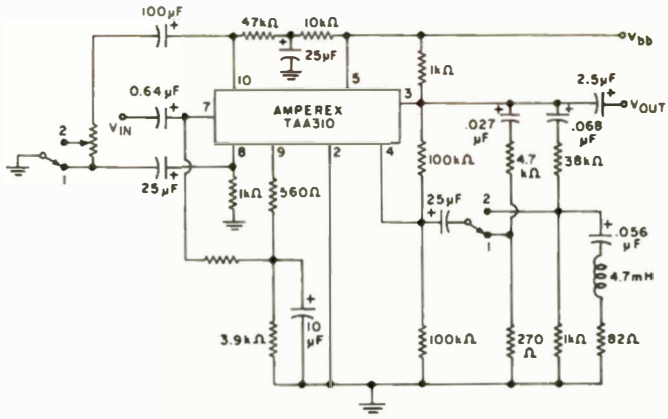
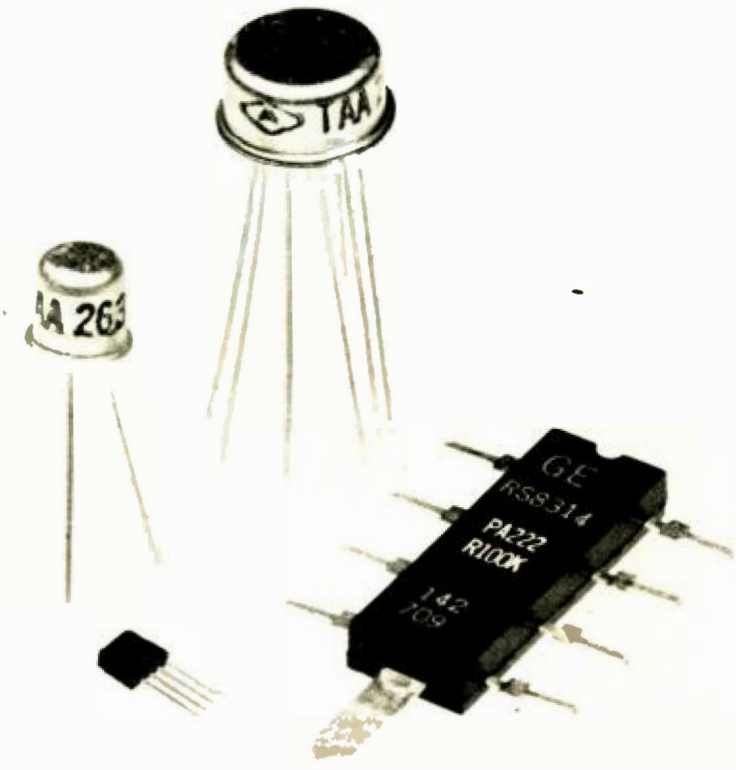


Fig. 1. Tape-recorder preamp with switch in playback position. Values for unlabeled resistors are chosen for optimum results.



The audio IC's described here come in a variety of packages. The units shown above are about two times their actual size.

TABLE 1. LISTING OF MANUFACTURERS OF AUDIO INTEGRATED CIRCUITS

Amperex Electronics Corporation
Semiconductor Division
Providence Pike
Slatersville, R.I. 02876

Fairchild Semiconductor
313 Fairchild Drive
Mountain View, California 94040

General Electric Company
Semiconductor Products Dept.
Electronics Park
Syracuse, New York 13201

Motorola Semiconductor Products
Box 955
Phoenix, Arizona 85001

Radio Corporation of America
Electronic Components and Devices
Harrison, New Jersey 07029

Westinghouse Electric Corp.
Box 7737
Elkridge, Maryland 21227

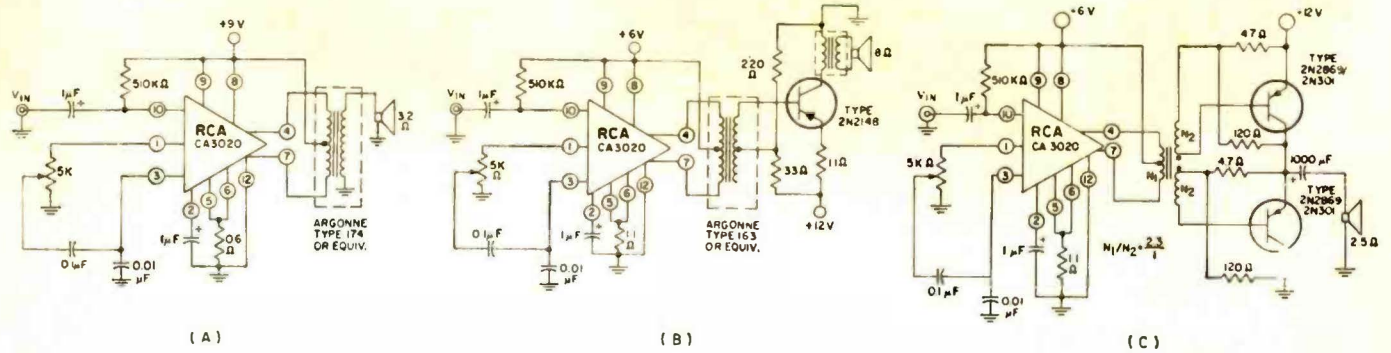


Fig. 2. Circuits using IC's in (A) half-watt audio amplifier, (B) 4-watt class-A amplifier, (C) 7-watt class-B amplifier.

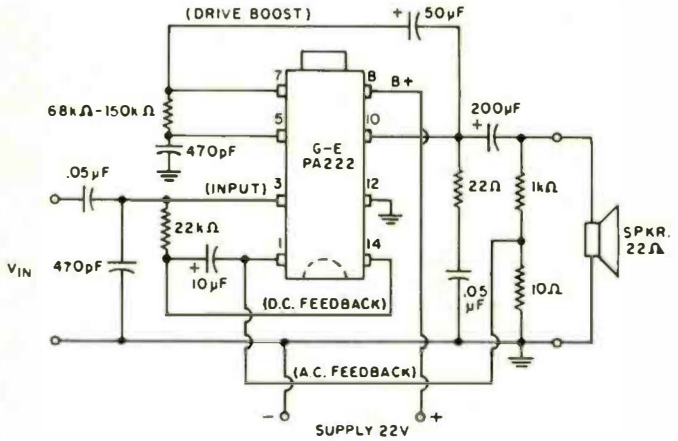


Fig. 3. Circuit diagram of the one-watt audio amplifier.

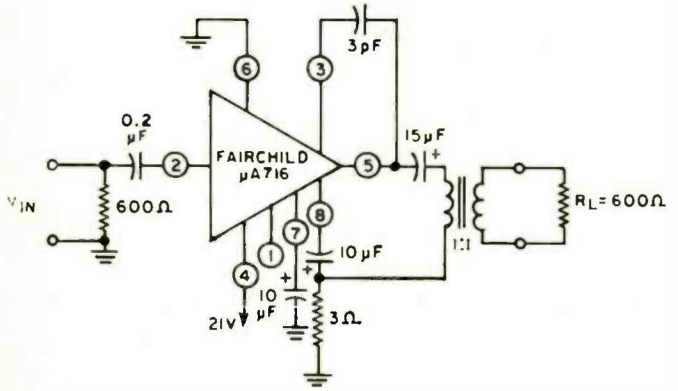


Fig. 4. Telephone system channel amplifier using an IC.

used to achieve 100-milliwatt power levels and gains as high as 94 dB. The high efficiency is obtained with class-B operation, producing distortion figures which range from 2 to 15 percent.

The WC183 is well suited to any application that requires efficient operation off a minimum supply voltage or extreme voltage gain in a compact package.

Higher-Power Audio Amplifiers

Certainly two big bargains in IC's today are the *RCA* and *G-E* integrated-circuit power amplifiers, both of which will directly drive speakers to 0.5 to 1-watt power levels.

The *RCA* CA3020 ($2.80) combines a 58-dB typical power gain with a 40,000 ohm input impedance and a 550-milliwatt typical output level in a 12-lead, TO-5 style package. Harmonic distortion is 1% at the 150-milliwatt level when high-quality coupling components are used. In the absence of compensation, the frequency response extends from several hertz to 6 MHz. Nine volts at 100 milliamperes are required to handle the half-watt peak output level.

The CA3020 will directly drive a special center-tapped speaker, or else an ordinary loudspeaker and output transformer, such as shown in Fig. 2A, may be used. The same IC readily serves as a driver for higher power audio amplifiers. A typical 4-watt class-A version and a 7-watt class-B single-ended amplifier circuits are shown in Figs. 2B and 2C.

The *G-E* amplifier offers higher power at a higher price tag. The PA222 ($3.70) comes in an epoxy in-line type package with an extended heatsink tab, and will deliver 1 to 2 watts of audio power into a 22-ohm load at 10% distortion. Frequency response extends from 55 to 15,000 Hz at the 1-watt level; 75 millivolts of drive into a 40,000-ohm input are needed for this output power. A single 20-25 volt supply is employed.

This IC is susceptible to high-frequency oscillation and considerable additional circuitry is required to prevent r.f. parasitic oscillation, as the recommended amplifier circuit of Fig. 3 indicates. For high-power operation, the heatsink tab must be held at 25° C or less, through external heatsinking.

There are numerous uses for either of these two amplifiers, particularly in speaker applications where fidelity or high volume are not of prime importance. Intercoms, recorder monitors, AM radios, portable phonographs, and signal tracers are but a few of the many possible applications of these two exciting new devices. As speaker efficiency will markedly affect volume in the 0.5 to 1-watt range, high-efficiency speakers should be used wherever practical.

High-Fidelity IC's

Motorola and *Fairchild* both have entered the broadcast-quality audio market with two power IC's with excellent distortion figures and performance capabilities.

The *Fairchild* entry is the μA716 ($15.00), which is capable of 150-milliwatts output power at 0.2% distortion over a d.c. to 10-MHz bandwidth. Gain taps are available to select one of four different values of fixed gain. Input impedance is 10,000 ohms while the output impedance is 1 ohm. The standby current is 1.5 mA, obtained from a single-ended 22-volt supply.

A typical application is the telephone-channel amplifier shown in Fig. 4. This circuit provides 40 dB of gain over a 50-Hz to 100-kHz bandwidth with less than 0.1% distortion and an output noise level of —75 dBm over any 4-kHz bandwidth. Gain stability over a wide temperature range is within 0.1 dB.

Motorola's candidate is the MC1554G ($22.50), which will deliver 1 watt of output power from d.c. to 300 kHz. Distortion at the one-watt level is only 0.4%. Output impedance is 0.2 ohm, while the voltage gain is controllable from 10 to 36, with best distortion figures obtained at low gains and high load impedances. The wide bandwidth creates r.f. instability problems which may be overcome by careful circuit layout and the use of a compensating network. The circuit may be directly coupled to a speaker if split power supplies are used, or capacitor coupling may be employed if a single 16-volt single-ended supply is used. The output noise voltage is 0.3 millivolt, and the standby current drain is 11 milliamperes. This IC requires no heatsink and comes in a 10-lead TO-5 style package. ▲