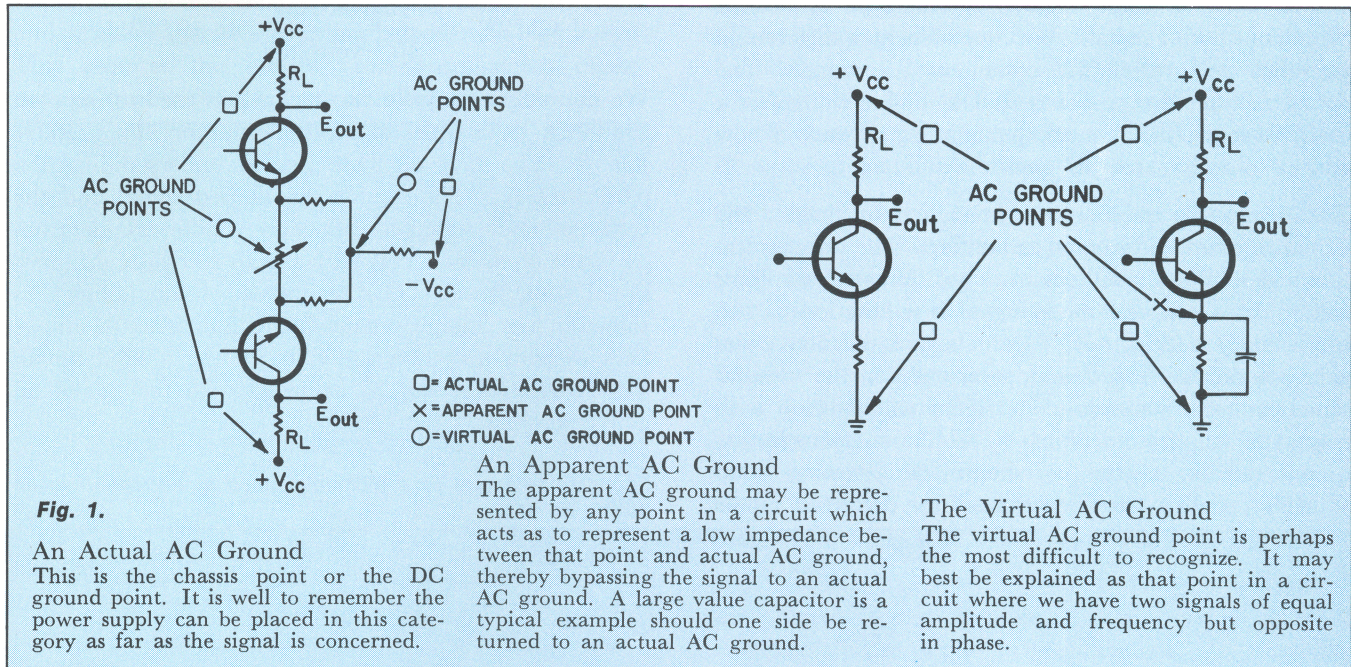


our attention to the push-pull type and use this form to describe a differential amplifier. However, the paraphase amplifier is the basic form of the differential comparator, a technique in differential measurement described later on in this series.

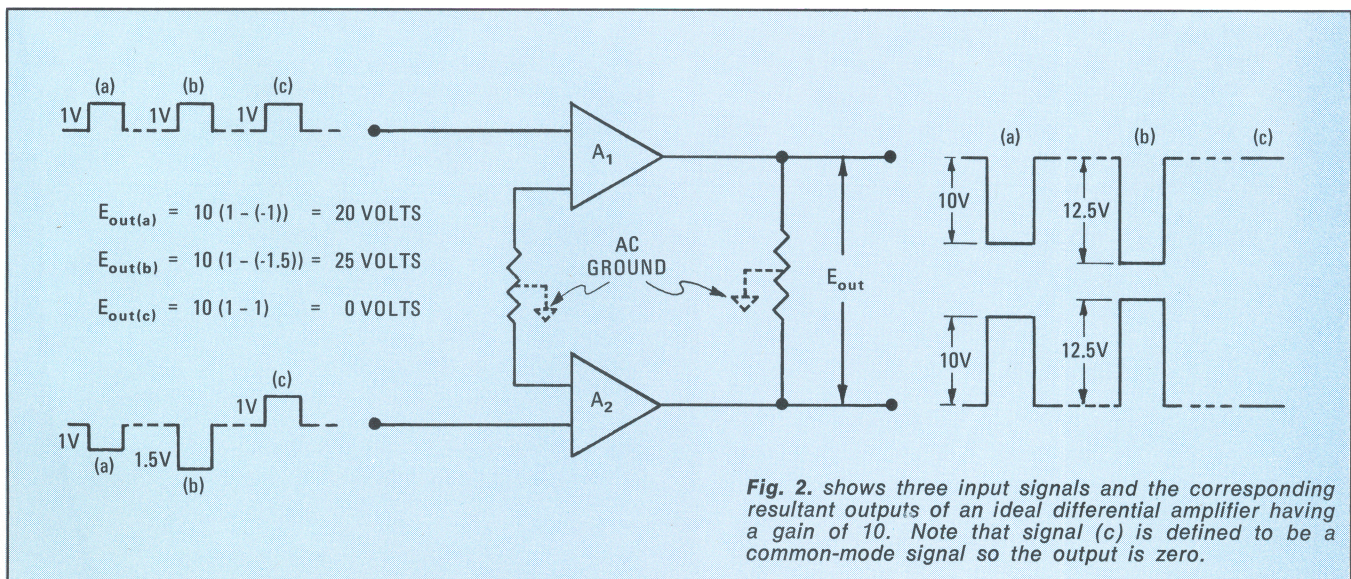
Let us reflect for a moment and see if the differential amplifier family meets our basic definition of any linear

amplifier. We may think of a differential amplifier as two single-ended amplifiers placed back to back. We need to recognize the existence of AC ground points and remember that the input and output voltages will develop across impedances connected to those AC ground points. We normally encounter three types of AC ground, (Fig. 1).



There are some interesting facts we should note about Figure 2. Let us assume that the gain of A_1 and A_2 is, say, 10. Remember this gain is fixed. We normally refer to a gain in the differential configurations as being from side to side or measured from the output of A_1 to the output of A_2 . The voltage we would expect to measure side to side will be "gain times the difference between the input terminals".

The phrase, "difference between the input terminals" implies both amplitude and phase, since this difference is the graphical addition of the two signals appearing at the input terminals of A_1 and A_2 . Looking at signal (a) we see two equal input voltages of opposite polarity which result in an output voltage 10 times their difference. With signal (b) we have two input voltages of opposite polarity but unequal in amplitude. The output



Vertical Amplifier

The vertical circuitry is relatively easy to troubleshoot using the standard technique of starting at the output and working back to the source of the problem. One difference you will note is that lifting the collector leads of output transistors Q530 and Q580 doesn't center the trace as you would expect. Instead, the vertical plates rise to +115 V and attract the CRT beam current. This is due to no post deflection anodes. You will also notice that if one vertical lead to the CRT is open, varying the voltage on the other plate does not drive the trace off-screen; it stays pretty close to the center.

The most common problem experienced in the vertical is U210 or U310 failing. If either IC fails, the trace is deflected off-screen.

Trigger, Sweep, Horizontal

Troubleshooting the trigger is pretty much a matter of signal tracing and voltage measurements. No persistent problems have been experienced in this area.

The sweep circuit is best analyzed by checking for proper voltages and waveforms. The instruction manual contains some twenty-three waveforms for the sweep circuit. The best point to start is to check the voltage at TP678 to see if tunnel diode CR678 is in the high or low state. If it is in the high state the sweep should be running. It is fairly easy to signal trace from that point to determine where a malfunction is occurring.

The horizontal section is also straightforward and should not be difficult to troubleshoot. Linearity problems are usually diode related. Gain problems can usually be traced to resistor changes with a cam switch contact occasionally causing problems.

Summary

The 432 and 434 are relatively trouble free and easy to service, the most difficult areas being the high-efficiency power supply and Z-axis circuitry. We hope this article makes these areas easier to service.

INSTRUMENTS FOR SALE

453, like new, \$1800. Marvin E. Wilson, AR Industries, Inc., Beech St. & Railroad Ave., Cincinnati, Ohio 45217. (513) 242-0272.

661/5T1A/4S3. Ven Lee, Leewood Arms Apt. A12, Wappingers Falls, N.Y. 12590. (914) 897-7823 (work) or 297-0975 (home).

535A/CA, \$800. M. G. Stroud, 2501 Buena Vista, Arlington, Tx 76010.

561A/3A1/3B3, like new. Make offer. John Burton, Washington Univ., Behavior Research Lab. (314) 621-4211.

535 w/new CRT, \$750. Pat Gee, Mobilscope, Inc., 17734½ Sherman Way, Rededa, Ca. 91335. (213) 342-5111.

545 w/cart, \$650. Good cond. E. Silverman, Oak Park Tool & Die, 8726 Northend Ave., Oak Park, Mich. 48237. (313) 547-4688.

535, 53/54C, 53/54D, Q. All in fair cond. Penti Arento, De Laval Turbine, Inc., P. O. Box 251, Trenton, N.J. 08602. (609) 587-5000.

310A. Mr. Mathey, H. J. Theriler, 22 Ashmont Ave., Whitensville, Ma. 01588. (617) 234-7405.

513D, Best offer. R. Mendelson, 27 Somerset Pl., Murray Hill, N.J. 07974. (201) 464-5244.

422, Exc. cond., \$1000. T4002/4802/4901/Joy Stick, 6 mos. old, \$3500 or ? Elektek Enterprises, 2109 Crompond Rd., Peekskill, N.Y. 10566. R. Briordy, (914) 739-2625.

Telequipment D54A. Frank Mann, (312) 296-2608.

INSTRUMENTS FOR SALE

513D, \$150, Exc. cond. Charles Mannino, 85-36 54th Ave., Elmhurst, N.Y. 11373. (212) NE 9-2524.

531/500A. Realemon Foods, 1200 W. 37th St., Chicago, Il. 60609.

531, RM35A, 2-551's, CA's, K's. R. H. Williams, 8521 Middlebrook Pike, Knoxville, Tn. 37921. (615) 584-7739.

3A72, \$200. Good cond. John Piso, (617) 877-1424.

422 slightly used. Make offer. Reichardt Co., 1345 Monroe Ave., N.W., Grand Rapids, MI. 49505. (616) 459-5800.

564B Mod 08/3A6/3B4, \$1350 complete. Dan Miller, (714) 540-8270 or 535-8829.

1A6, like new, make offer. Dr. Robt. Fitzgerald, Univ. of Oregon Medical School, 3181 S.W. Sam Jackson Park Rd., Portland, Ore. 97201. (503) 228-9181, Ext. 749.

7A16, \$375. John Newby, Union Prescription Shop, 136 Bus Terminal Rd., Oak Ridge, Tn. 37830. (615) 483-8429.

84 Test Plug-In, \$75; 81 Plug-In Adapter, \$50 or best offer. Robert Lindbery, Electro-Pacific Co., 5780 Thornwood Dr., Goleta, Ca. 93017. (805) 964-4879.

310, \$450. Wayne Davis, 2999 Whispering Hills Ct., Chamblee, Ga. 30341. (404) 458-3178.

647/10A1/11B2, \$2400; R116, \$1350; 531A, \$575; 545A, \$950; CA, \$225. All in like new cond. Bill Bartlett, Certified Calibration Labs, Inc., 2710 Park Ave., Phila, Pa. 19132. (215) 229-7557.

INSTRUMENTS WANTED

Dual trace scope; 530-540 Series OK. Victor C. Barton, 214 Coleen St., Livermore, Ca. (415) 443-0309.

Portable Tektronix scope, prefer dual trace. Joe Gaspard, 16717 S. Jeanette Ave., Cerritos, Ca. 90701. (213) 926-5903.

507. Don Hudson, Joslyn Manufacturing & Supply Co., Lima, N.Y. (716) 624-1110.

519, George Busch, University of Colorado, Chemistry Dept., Boulder, Colo. 80302.

Q or 3C66, cash or trade. R. M. Wilson, Barrow Neurological Institute, 350 W. Thomas Rd., Phoenix, Az. (602) 277-6611, Ext. 3145.

130 LC Meter, working or not, lowest price. C. E. Spitz, 1420 S. Randolph St., Arlington, VA 22204.

530/540/w CA, or 516. R. Mendelson, 27 Somerset Pl., Murray Hill, N.J. 07974. (201) 464-5244.

453 or 454. Reas, or trade (531, RM35A, 2-551's, CA's, K's). R. H. Williams, 8521 Middlebrook Pike, Knoxville, Tn. 37921. (615) 584-7739.

Telequipment D54 or port. 10 MHz Tektronix dual-trace. Bob Laub, 1281 Sanford St., Vermilion, Ohio 44089. (216) 967-7363.