WITH CUMULATIVE INDEX

Rudolf F. Graf
&
William Sheets

Encyclopedia of ELECTRONIC CIRCUITS

Volume 7

TAB
The Electronics Authority

Volume 7 ; Partition #1
CH 1; Active Antenna Circuits to CH 10 ; Antenna Circuits

To Scott
With much love from Popsi

Patent notice

Encyclopedia of

ELECTRONIC CIRCUITS

Volume 7

Rudolf F. Graf
and
William Sheets

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Contents

Preface

This latest volume of *The Encyclopedia of Electronic Circuits* contains approximately 1000 new electronic circuits that are arranged alphabetically into more than 100 basic circuit categories, ranging from "Active Antenna Circuits" to "Weather-Related Circuits." When taken together with the contents of the previously published six volumes, we provide instant access to more than 7000 circuits that are meticulously indexed and cross referenced. This represents, by far, the largest treasure trove of easy-to-find, practical electronic circuits available anywhere.

We wish to express our sincere gratitude and appreciation to the industry sources and publishers who graciously allowed us to use some of their material. Their names are shown with each entry and further details are given at the end of the book under "Sources."

Our thanks also go out to Ms. Tara Troxler, whose skill at the word processor and dedication to this project made it possible for us to deliver the manuscript to the publisher in a timely fashion.

Rudolf F. Graf and William Sheets
January 1998

1

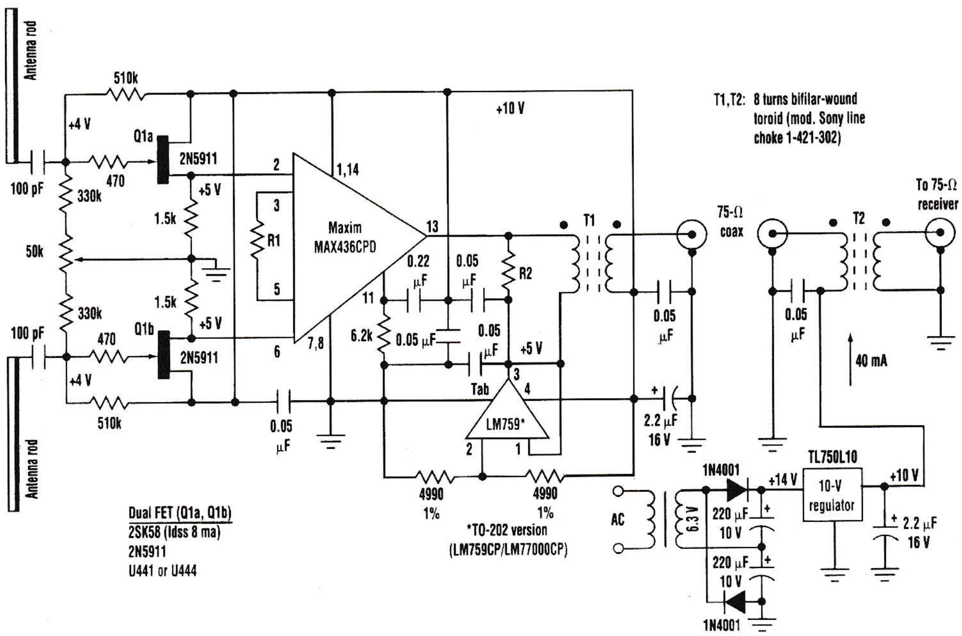
Active Antenna Circuits

The sources of the following circuits are contained in the Sources section, which begins on page 1043. The figure number in the box of each circuit correlates to the entry in the Sources section.

ACTIVE DIPOLE ANTENNA

BANDWIDTH, GAIN, AND SIGNAL LEVELS

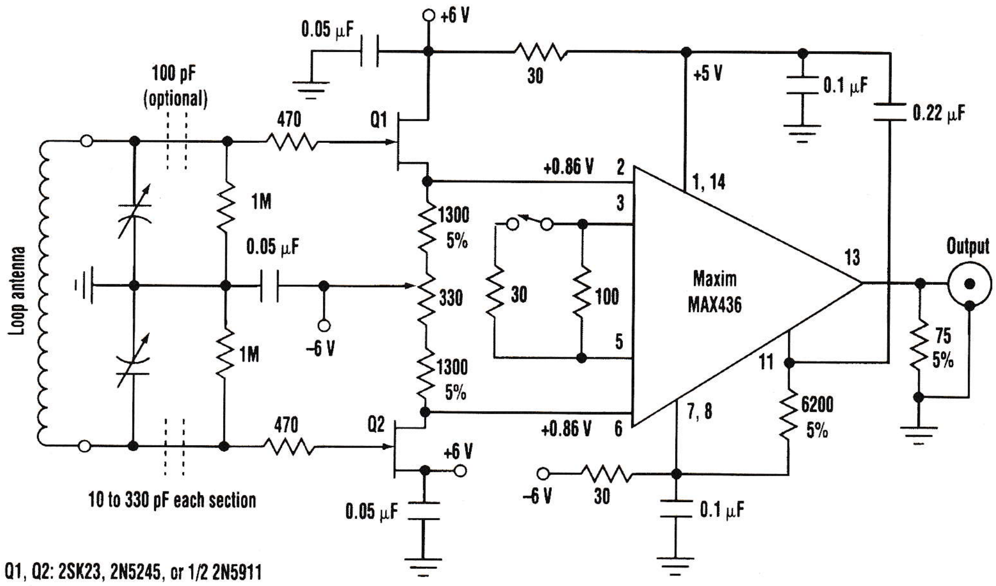
		-3 dB BW		Diff.	Max.	Max.
R1	R2	Low	High	V_G	In	Out
(Ω)		(kHz)	(MHz)	(dB)	(mV rms)	
100	75	50	39	12.8	233	510
100	150	56	36	15.3	230	670
27	75	50	31	23.9	62	490
27	150	56	29	26.4	61	640



ELECTRONIC DESIGN *Fig. 1-1*

This active antenna acts as a dipole and consists of a dual FET source follower feeding a differential amplifier. The LM759 acts as a virtual ground, splitting the 10-V supply. R1 is a gain set resistor (see table). Dc is fed in via coax cable. The frequency range is 100 kHz to 40 MHz.

HIGH-FREQUENCY LOOP ANTENNA

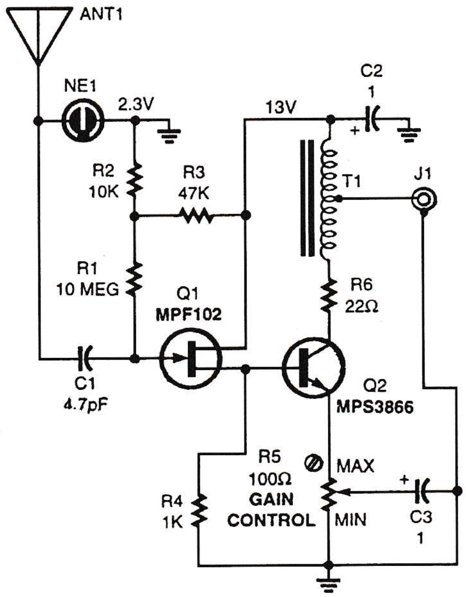


ELECTRONIC DESIGN

Fig. 1-2

Good performance in the 5- to 30-MHz range requires an amplifier with extremely high input impedance and low noise that can drive 75-Ω loads at high signal levels at frequencies over 30 MHz. Combining dual FET source followers and the new Maxim 436 wideband transconductance amplifier can produce just such an amplifier. A balanced configuration is used for the tuned loop to preserve the symmetry of the figure-eight polar antenna pattern. As a result of using FET source followers on the amplifier's front end, only the 1-MΩ gate resistors load the tuned circuit, so tuning is very sharp and resistance to off-frequency interference is very high. The FETs drive the differential inputs of the MAX436, which amplifies the balanced signal and converts it to a single-ended output. Voltage gain for this amplifier is switch selectable at either 8 dB or 20 dB into a 75-Ω load. Since the amplifier is designed to work into a 75-Ω load, the device can be connected to the receiver with a length of RG-59U cable. Maximum undistorted output is 1500 mV into 75 Ω, so overloading is unlikely even at the high-gain setting.

ACTIVE ANTENNA, 100 kHz TO 30 MHz



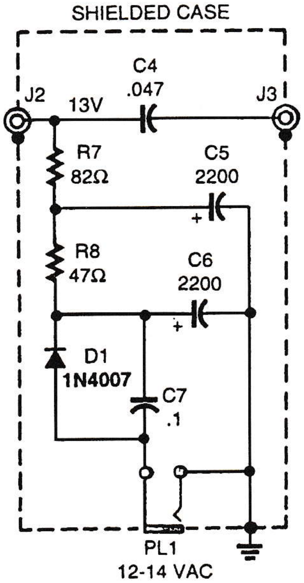
This circuit uses a FET and bipolar transistor combination to achieve high performance with a short pickup antenna (24 in. or 70 cm). R5 is a gain control and should be set for the minimum gain necessary for good results. T1 is 24 turns of #32 trifilar wire on a Ferroxcube P/N 768T188-3E2A core. J1 is used for dc feed and RF output. A dc block unit can be used at the receiver end. Dc power is 12 V at 30 mA. The pickup wire and preamp should be enclosed in a weatherproof assembly so that the antenna can be mounted outdoors in an electrically quiet area.

A complete kit of parts, including the PC board, is available from North Country Radio, P.O. Box 53, Wykagyl Station, New Rochelle, NY 10804-0053A.

POPULAR ELECTRONICS

Fig. 1-3

DC BLOCK FOR ACTIVE ANTENNA AND DOWNCONVERTERS

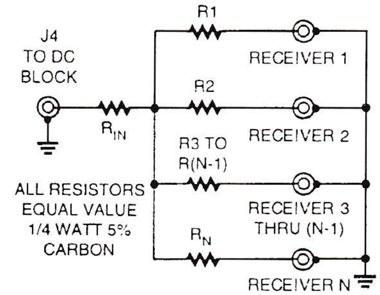


A suitable dc block and power source for active antennas and downconverters can be made from a few components as shown. This circuit is suitable for frequencies from 50 kHz up to VHF. A shielded case should be employed to prevent stray signal pickup. Dc power supplied to the active antenna or downconverter, via the coaxial signal cable, is 12 V at 30 mA.

POPULAR ELECTRONICS

Fig. 1-4

SPLITTER CIRCUIT FOR ACTIVE ANTENNA TO ENABLE MULTIPLE SHORTWAVE RECEIVER USAGE



NUMBER OF RECEIVERS	50Ω CABLE	75Ω CABLE
2	16Ω	24Ω
3	24Ω	36Ω
4	30Ω	43 OR 47Ω
5	33Ω	51Ω
N	$50\left(\frac{N-1}{N+1}\right)\Omega$	$75\left(\frac{N-1}{N+1}\right)\Omega$

RESISTOR VALUES
(NEAREST 5% TOLERANCE)

Identical-resistor-value star networks can be used to connect multiple receivers to a single active antenna. Although the loss is higher with this method than with conventional ferrite transformer splitters, the frequency response goes down to dc, and the extra loss is not usually a problem at LF, MF, and HF, as active antennas have plenty of gain and the received signal levels are limited by atmospheric and ambient noise signal strengths. The splitter should be mounted in a shielded box with suitable connectors to minimize stray signal pickup.

POPULAR ELECTRONICS

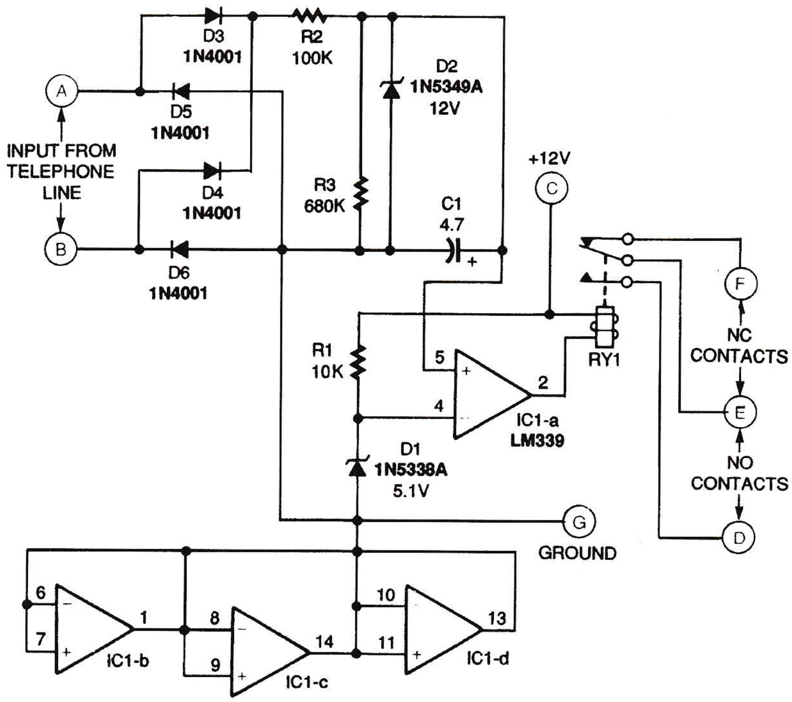
Fig. 1-5

2

Alarm and Security Circuits

The sources of the following circuits are contained in the Sources section, which begins on page 1043. The figure number in the box of each circuit correlates to the entry in the Sources section.

CUT PHONE LINE ALARM

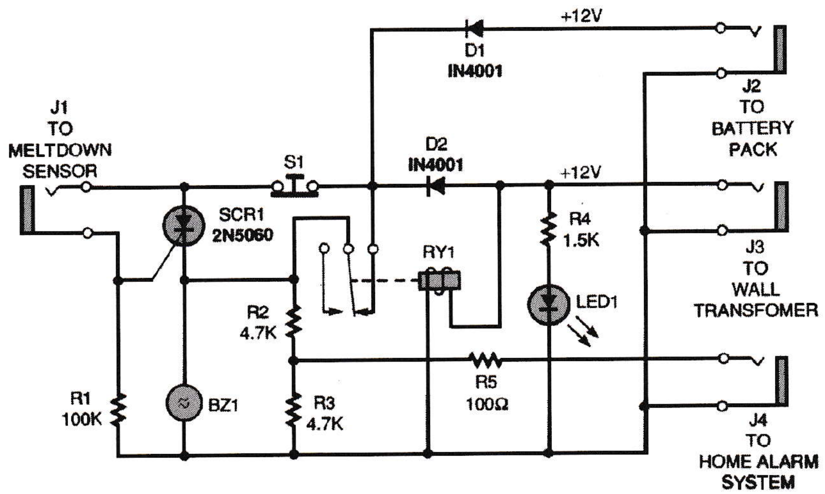


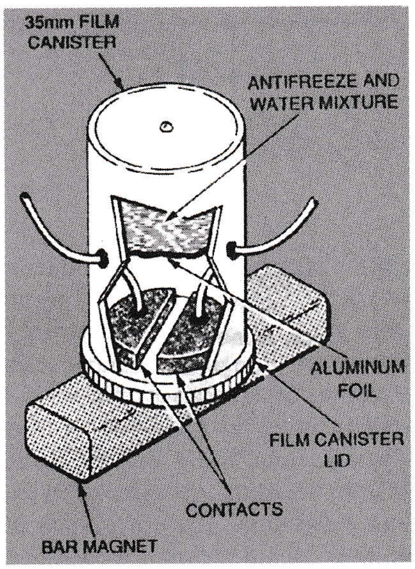
ELECTRONICS NOW

Fig. 2-1

The figure shows the schematic diagram of the phone line monitor. Note that 12-Vdc power is connected to the unit via solder pads C (positive) and G (ground) on the PC board. This power should be supplied from your home security system, since it will have battery backup, and this will be as reliable as your base security system. The input from the telephone line is fed to pads A and B. Polarity is not important to the monitor because the input is rectified by the full-wave bridge rectifier formed by diodes D3 to D6. Connecting the phone line to the phone line monitor in no way diminishes phone service, and its presence on the line will be unnoticed by you and those who call you. The rectified or polarized voltage from the bridge rectifier is fed to a long-time-constant filter formed by R2 and C1. This filter includes a zener diode (D2) that limits the voltage maximum charge on C1 to 12 V during normal operation. Resistor R3 provides a high-resistance shorting path to drain the charge from C1 when there is no input voltage. This resistor sets the time delay for activating the alarm. The trigger voltage for comparator IC1-a is generated by R1 and D1. Diode D1 is a 5.1-V zener whose output is fed to the inverting input (pin 4) of IC1-a. With the inverting input at 5.1 V, any voltage above 5.1 V on the noninverting input (pin 5) will cause the output of the comparator to go high. Since the output of IC1 is tied to the relay coil of RY1 and the other end of the relay is tied to +12 Vdc, the relay coil is not energized. When the voltage from the input filter drops below 5.1 V, the output of IC1-a goes low and energizes the relay. The contacts of RY1 (either the normally open set or the normally closed set) could also be used to trigger the home's security system.

FREEZER SENTRY



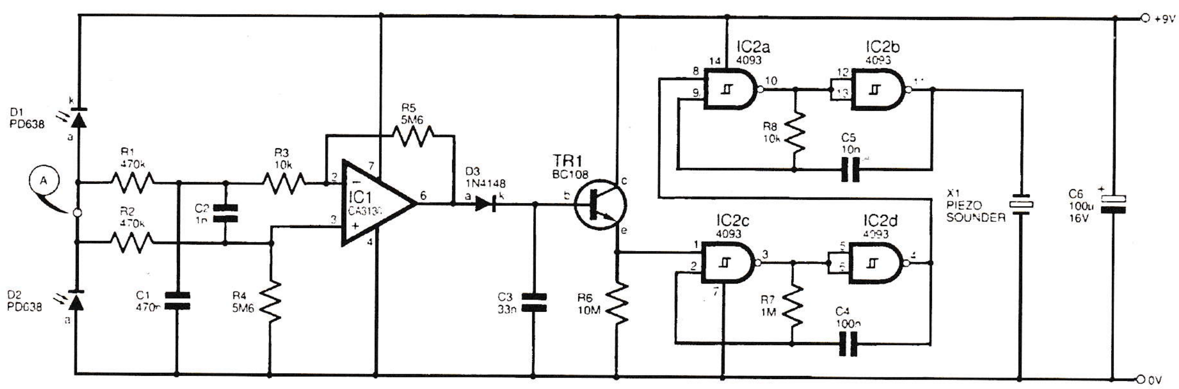


The meltdown sensor contains a liquid that melts at about 15° F. When the liquid starts to melt, it falls down to the bottom of the canister, pushing an aluminum foil disc against the electrical contacts.

FREEZER SENTRY *(Cont.)*

The heart of the circuit is SCR1, a silicon-controlled rectifier. Trigger voltage is supplied through J1 by the meltdown sensor when its contacts close. Resistor R1 is included to prevent any false triggering of SCR1 as a result of voltage fluctuations or noise from the power supply. Once SCR1 is triggered, it latches on, sounding the alarm buzzer until the reset switch (S1) is pressed. The reset switch interrupts current flow through the SCR, letting it turn off. Power for the circuit is supplied by a 12-Vdc wall-mounted transformer, which is connected to J3. As long as the wall-mounted power supply is working, relay RY1 will be activated, opening its normally closed contact. Normal power will also be indicated by LED1, with R4 limiting the current flow through the light-emitting diode. If the ac power fails, LED1 will go out and RY1 will deenergize, closing the relay's normally closed contacts. The relay contacts bypass SCR1, sounding the alarm. Backup power for that situation is supplied by a 12-V battery pack, which is connected to the circuit through J2 and D1. Diode D1 prevents the ac-derived power supply from attempting to charge the batteries, and D2 prevents the batteries from lighting the LED or energizing RY1 in the event of ac power failure. An additional feature of the circuit is that since the relay bypasses SCR1 during a loss of ac power, the reset button will not silence the alarm. Regardless of which type of failure caused the alarm to sound, R2 and R3 form a voltage divider that provides a 5-V signal to J4.

INTRUDER ALARM



EVERYDAY PRACTICAL ELECTRONICS ***Fig. 2-3***

The circuit triggers a pulsed-tone alarm when anyone passes by, and several of these units can be scattered around the premises to give burglars the impression that they are being monitored! It is guaranteed to drive any burglar bananas. Two photodiodes, D1 and D2, are used as shown to ensure sensitivity over a very wide range of lightning conditions, though the circuit will be less effective in diffuse light. IC1 is connected as a differential amplifier. As the voltage at point *A* swings high, the response at pin 2 of IC1 is slowed by capacitor C1, and the voltage swings high at the output (pin 6). Capacitor C3 charges up and transistor TR1 level-shifts the signal to enable the oscillator section formed from IC2, a quad NAND Schmitt. The piezo disk X1 will pulse accordingly. C3 determines the duration of the pulsed tone and resistor R8 determines the pitch. Photodiodes D1 and D2 should be mounted a small distance apart for best effect. The circuit draws a mere 0.5 mA.

BURGLAR ALARM

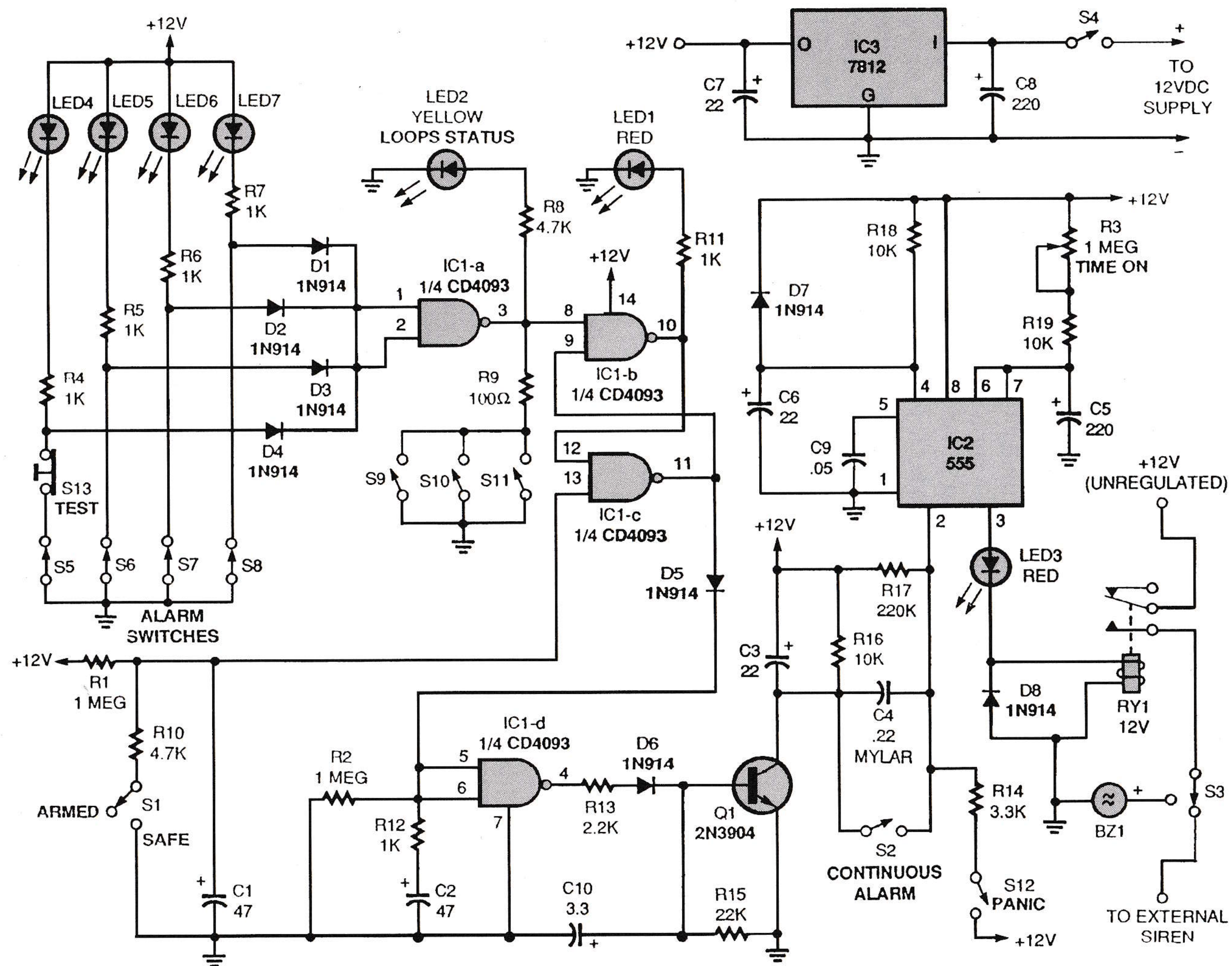
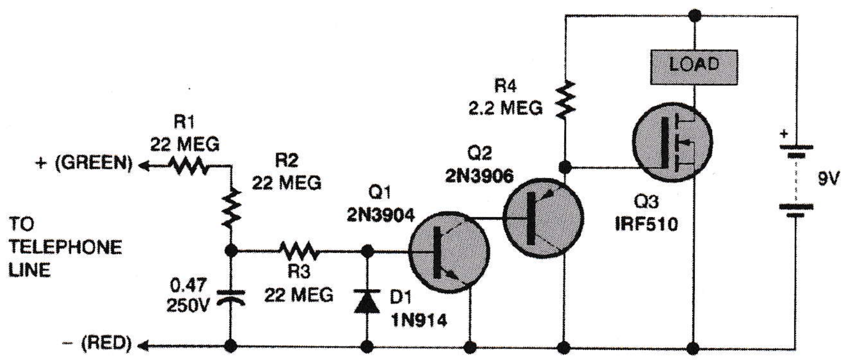


Fig. 2-4

This burglar alarm uses either normally closed (S5 to S8) or normally open (S9 to S11) switches or a combination thereof. Activation sets latches IC1-b and IC1-c. S1 is used to disarm the circuit. IC1-d and related components drive switch Q1, which triggers timer IC2. IC2 generates a pulse, determined by R3 and C5, that energizes alarm relay RY1. S2 allows for a continuous alarm and S12 is a panic switch to sound the alarm immediately. Either a built-in buzzer (BZ1) or an external siren can be used as an annunciator.

CUT PHONE LINE ALARM

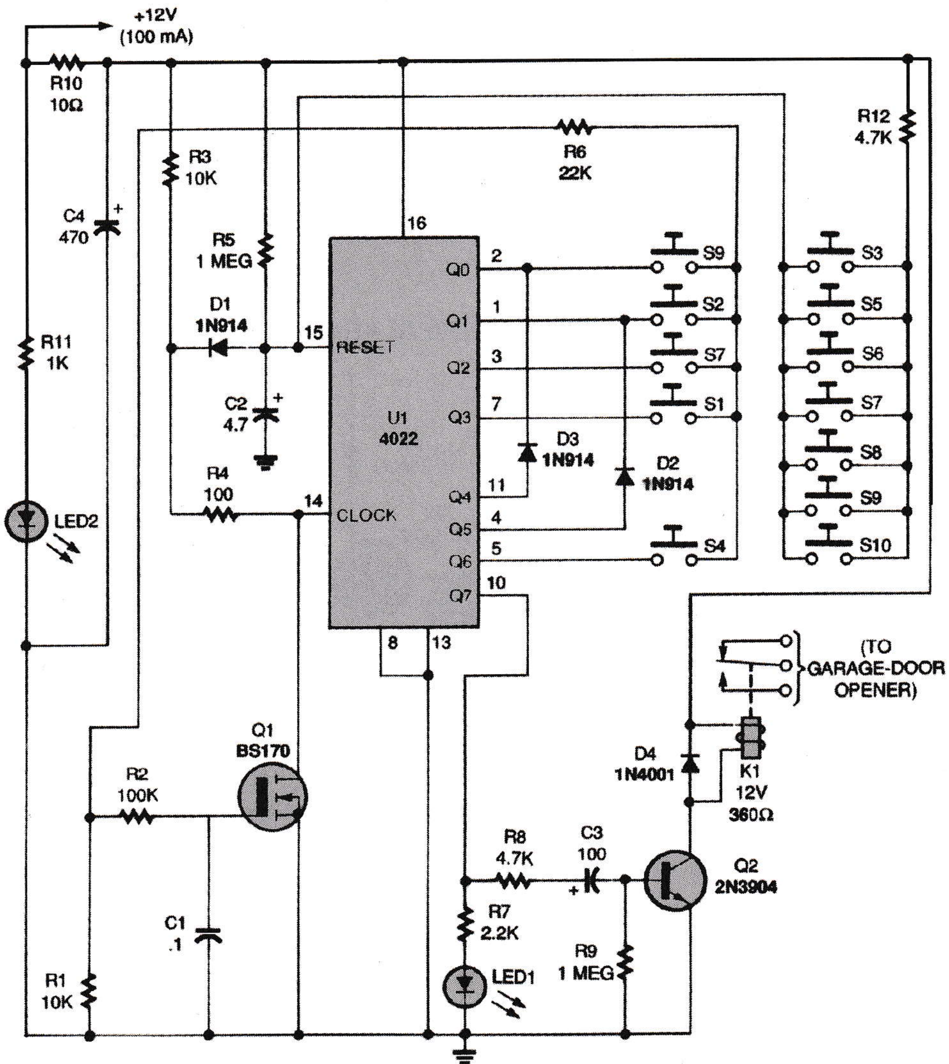


ELECTRONICS NOW *Fig. 2-5*

Detecting a cut phone line can be an important function of an electronic security system. Unfortunately, detecting a cut phone line isn't easy because the voltages on a normal phone line vary so much. The voltage is typically 48 Vdc when the telephone is on the hook, 2 to 15 Vdc during a conversation, 90 Vac during ringing, and 200 Vdc when the telephone company is testing the line. Brief moments of 0 V are common; what you really want to detect is a voltage that goes to zero and stays there. A second restriction is that the cut phone line detector cannot draw any appreciable current. Its impedance has to be higher than 50 MΩ or the telephone company will think it's a leaky cable. Components R1, R2, R3, and C1 smooth out momentary variations in voltage so that the alarm doesn't trigger every time the telephone rings. If the voltage stays at zero for 30 s or more, the alarm should trigger. The load can be a piezo buzzer, an optocoupler, or a small relay.

Because of the tiny currents it must detect, this circuit should be powered by its own 9-V battery, with no direct connection to the rest of the burglar alarm. Otherwise, a slight difference in ground potentials might cause the circuit to perform somewhat erratically.

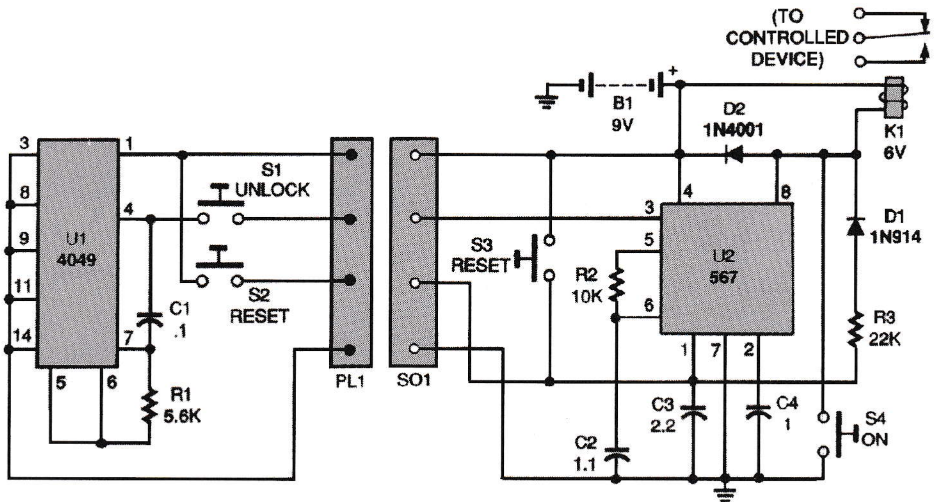
DIGITAL LOCK CIRCUIT



POPULAR ELECTRONICS *Fig. 2-6*

This circuit depends on the entry of a correct sequence code. An incorrect number that is not part of the code causes the circuit to reset. When the correct code is entered, Q2 operates relay K1 for a short time, depending on C3.

ANALOG ELECTRONIC LOCK

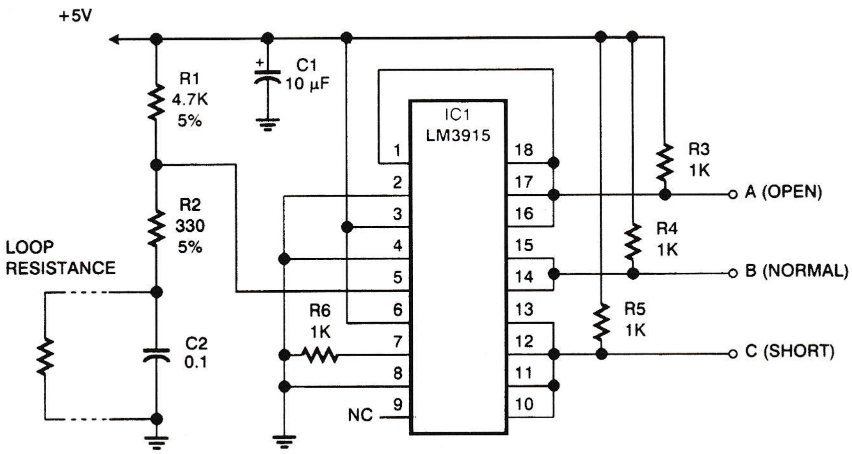


POPULAR ELECTRONICS

Fig. 2-7

The system is formed of two separate circuits—a key and a keyhole. The key engages the keyhole by means of a mating pair of connectors. The key is a tone-generator circuit consisting of a 4049 hex inverter CMOS IC (U1), switches (S1 and S2), a resistor (R1), and a capacitor (C1). The value of the tone generated by that circuit, in hertz, is determined by $1/(1.4 \times R_1 C_1)$. The keyhole is a 567 tone-decoder circuit that can be configured to detect any frequency from 0.01 Hz to 500 kHz. The frequency it detects (f_o) is set by resistor R2 and capacitor C2, according to $f_o = 1.1/(R_2 C_2)$. When the key is inserted into the lock and switch S1 is pressed, a tone is supplied to the input of the keyhole circuit. If the tone frequency is close enough to f_o, the 567 IC turns on the relay (K1), which should be connected to the electronic locking device. Components R3 and D1 are used to latch the circuit, so that the output stays on even after the input tone is removed. When S2 is pressed, the system is reset. Switch S3 resets the circuit from inside. *Note:* The accuracy with which the keyhole circuit detects f_o can be set by changing the values of three components. First, R2 should be between 2000 and 20,000 Ω. Second, the value in microfarads of capacitor C4 should be n/f_o, where n is a value between 1300 and 0000 (which gives a detection accuracy of up to 14 percent of f_o). Finally, capacitor C3 should have about twice the capacitance of capacitor C4. Battery B1 supplies both circuits.

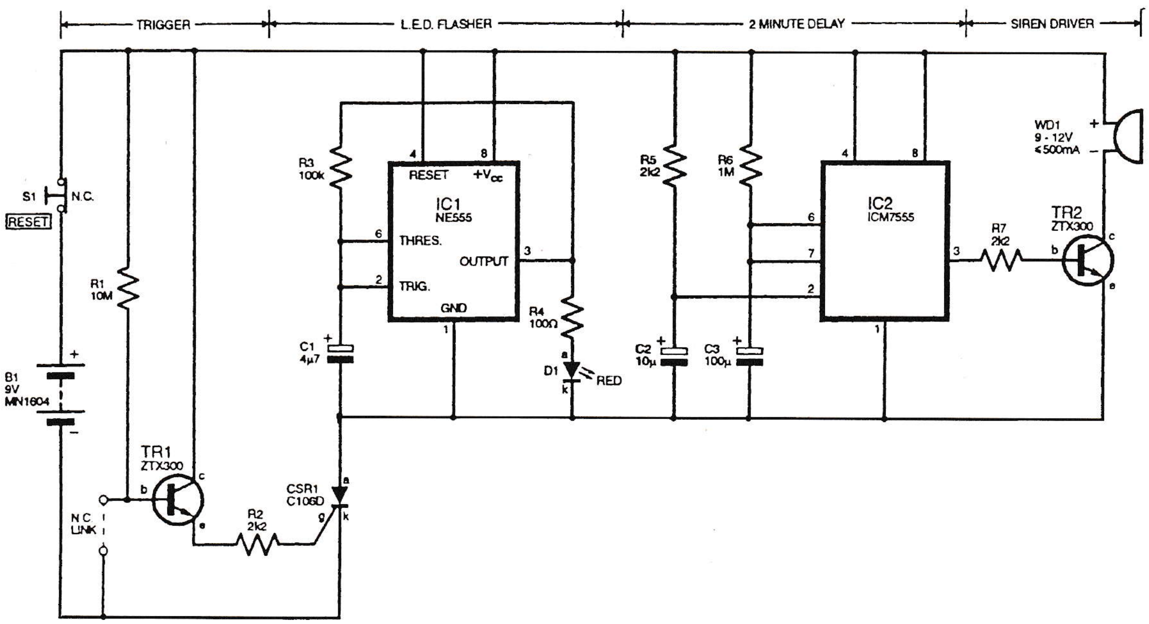
SAFER SECURITY SYSTEM



ELECTRONICS NOW *Fig. 2-8*

Many security systems use a closed loop of wires and switches, arranged so that whenever a door or window is opened, the loop will be broken and the alarm will sound. An obvious problem is that someone can tamper with the system, short out the loop, and later on come back and burglarize the premises without sounding the alarm. Hiding a known resistance in the loop is a very good idea. That way, the alarm can distinguish a short circuit from a correctly functioning closed loop. The figure shows a circuit that does the job. It is a somewhat unusual application for a National Semiconductor LM3915 IC, normally used to drive LED bar-graph displays. That chip happens to contain the right combination of comparators and logic circuits to do what you need. Step 1 is to translate the loop resistance into a voltage. That is done by putting a voltage divider with resistors R1 and R2. Capacitor C2 protects the circuit against electromagnetic noise—important because burglar alarms use long wires, often running near heavy electrical equipment. Step 2 is to translate the voltage into a logic signal indicating whether it's in the correct range. Normally, the LM3915 would drive 10 LEDs, one for each of the small ranges of voltage. To obtain logic-level outputs, we have it driving 1-kΩ resistors instead of LEDs. Since we need to distinguish only three situations, we tie some of the outputs together. The LM3915 has open-collector outputs that can be paralleled in that way. Note that they use negative logic (0 V for "yes," +5 V for "no"), the opposite of ordinary logic circuits. You can use inverters, such as the 74HC04, to produce positive logic signals, if that's what you need. Finally, note that the circuit will actually work with any supply voltage from 3 to 25 V.

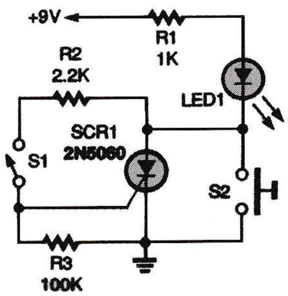
PROPERTY ALARM CIRCUIT



EVERYDAY PRACTICAL ELECTRONICS *Fig. 2-9*

The circuit is designed to protect by means of a wire loop or mercury switch. TR1 and associated components form a switch that is biased off by the normally closed (N.C.) link. When the link is broken, TR1 conducts and triggers the thyristor (CSR1) into conduction. Consequently, the LED flasher centered around the 555 astable of IC1 causes D1 to blink. Additionally, IC2 is a monostable timer that triggers through R5/C2 and drives an audible warning device via TR2 for a period of approximately 2 min before resetting. When the audio alarm has timed out, the LED will continue to flash, and this can be cancelled by opening S1, which resets the thyristor. The quiescent current of the circuit is very low because of the high value of resistor R1. A mercury switch can be used in place of the wire link to act as an antitamper alarm, in which case care must be taken to avoid accidental contact with the mercury bead itself because it is highly toxic.

TAMPER ALARM

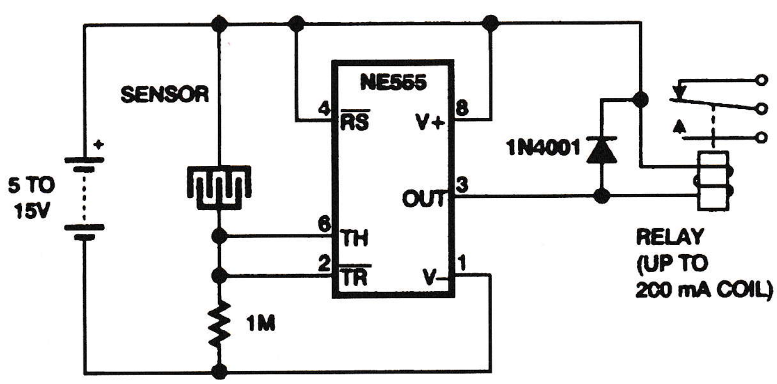


The silicon-controlled rectifier (SCR1) operates as a memory device to indicate a security breach in a room, desk drawer, safe, etc. Switch S1 can be a mechanical or magnetic switch. Position S1 in an object that you want to keep protected, making sure that the switch will close when the object is tampered with. When S1 closes, SCR1 turns on, lighting LED1. Pressing S2 resets the circuit.

POPULAR ELECTRONICS

Fig. 2-10

RAIN ALARM



ELECTRONICS NOW

Fig. 2-11

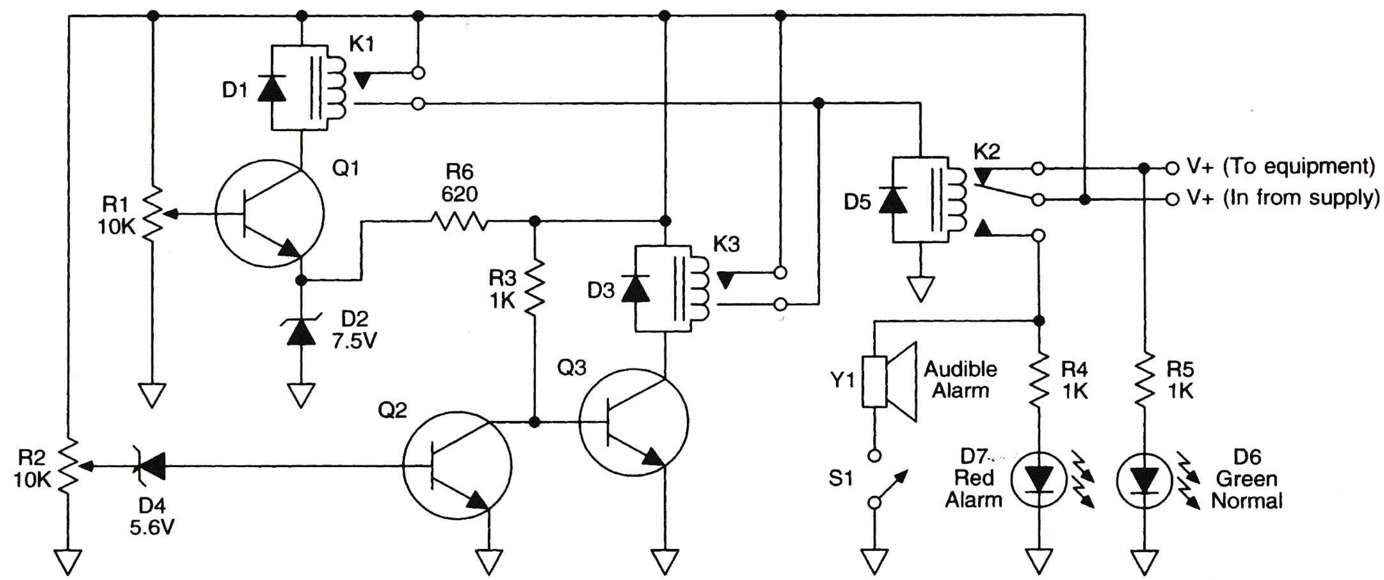
This rain-detector circuit closes the relay when water bridges the gap between the metal electrodes.

3

Amateur Radio Circuits

The sources of the following circuits are contained in the Sources section, which begins on page 1043. The figure number in the box of each circuit correlates to the entry in the Sources section.

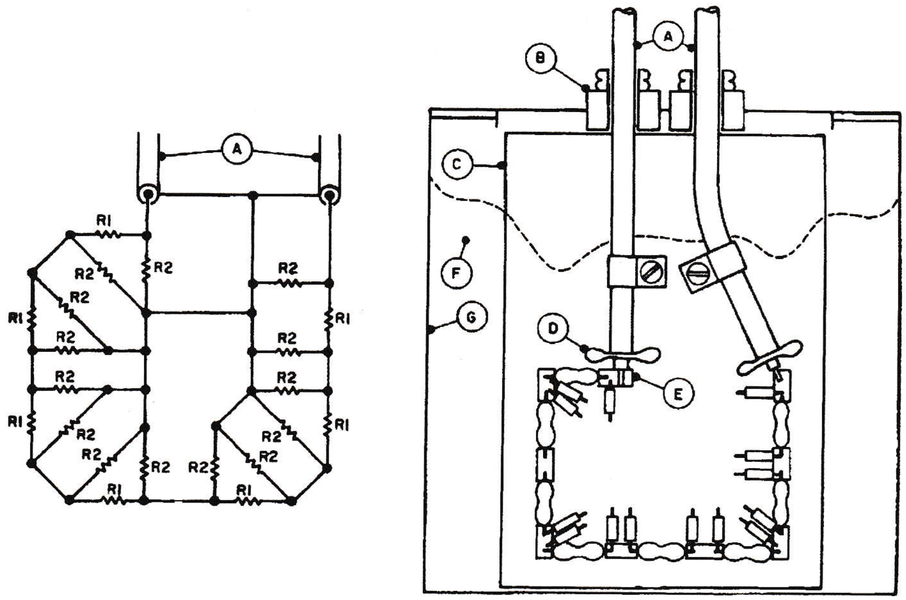
AUTOMATIC VOLTAGE CONTROLLER



73 AMATEUR RADIO TODAY *Fig. 3-1*

Station dc voltage, a nominal 113.8 Vdc, is fed through the normally closed contacts of relay K2. This voltage also provides power for the protective circuit illustrated. The voltage appears across R1 and R2, 10-kΩ trimpots, the wipers of which are set to exactly midrange, measuring a nominal 16.9 V dc. As the station dc varies between 111.2 and 115 V, the voltage at the wipers will vary from 5.6 to 7.5 Vdc. Zener diode D2 controls the high-voltage limit of 115 Vdc. R5 and zener diode D4 control the low-voltage limit of 111.2 Vdc. A voltage is fed from the wiper of R1 directly to the base of Q1, relay K1 is not energized, and its normally open contacts prevent relay K2 from being energized, allowing station dc to flow through K2's normally closed contacts. Above 115 V, the voltage at the base of Q1 also rises to or above 17.5 V, energizing K1, whose normally open contacts close, energizing K2, whose normally closed contacts open, removing the voltage from the station equipment. Should the voltage fall to or below 111.2 Vdc, zener diode D4 ceases to conduct, cutting off Q2, which causes Q3 to conduct, energizing K3. K3 applies operation voltage through its contacts to the coil of relay K2, opening its normally closed contacts, removing voltage from D6, the station equipment, and applying power to LED D7 and the audible alert.

10-dB 50-W ATTENUATOR



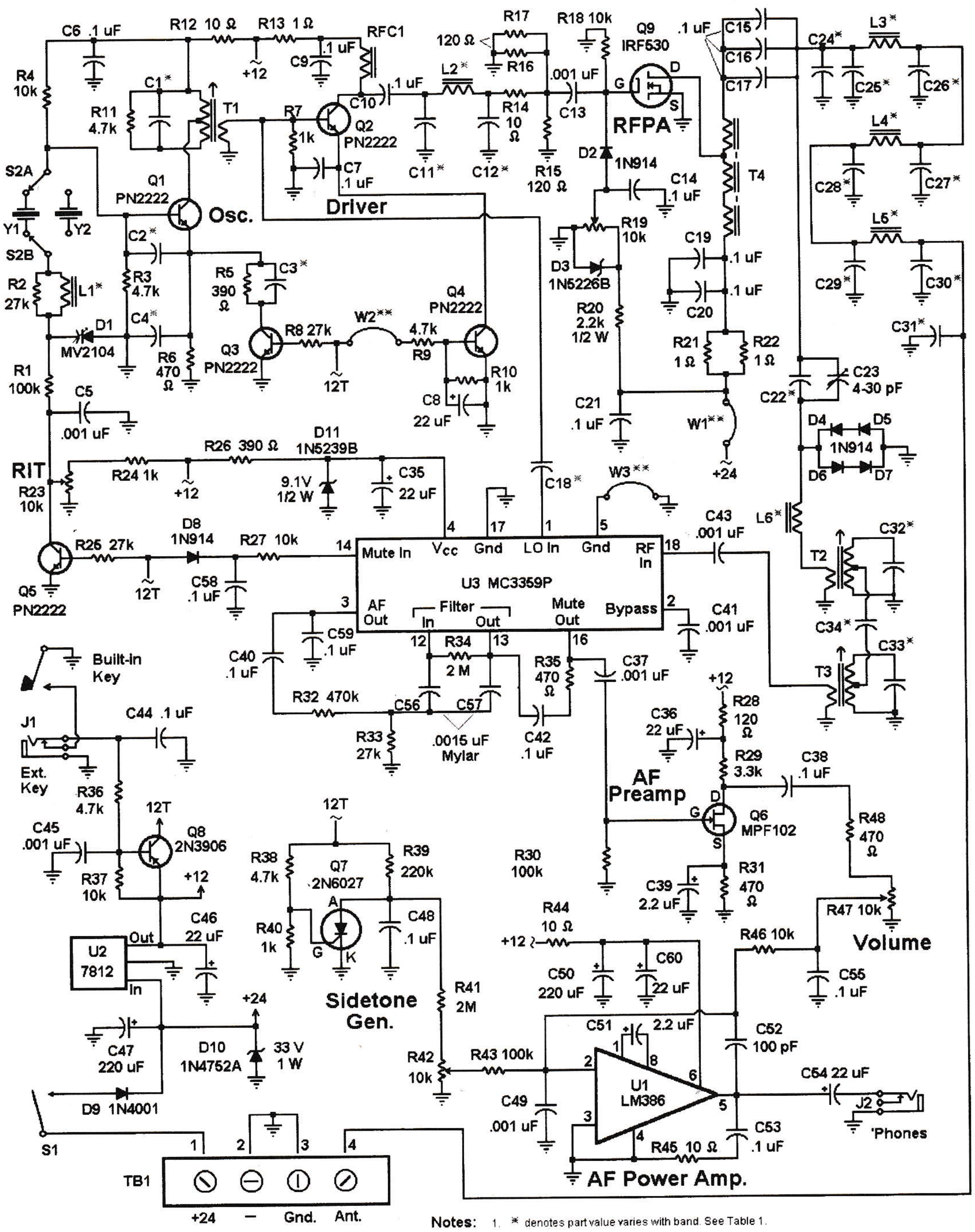
73 AMATEUR RADIO TODAY

Fig. 3-2

The 10-dB attenuator has an attenuation of 10 dB at lower frequencies at 2 m and 70 cm; circuit losses increase to 10.8 dB and 12.0 dB, including interconnecting RG-58/U cable losses of 0.4 dB and 0.6 dB, respectively. Establishing an SWR of less than 1.1:1 at 70 cm was the most crucial design consideration. Changes occur with different coolants. If the assembly is tailored for minimum SWR in air, its SWR increases to about 1.3:1 when you put it in vegetable oil. The SWR changes are caused by increased circuit capacitance due to the dielectric. This condition was improved by using household wax, paraffin, instead of oil. *Caution: Paraffin has a relatively low flash temperature; it can be used to make candles.* Next, to decrease the circuit distributed capacitance, increase the distance of the components from the circuit board by stacking two layers of PC boards at the tie-down pads. This raises the parts of connecting positions to about 0.120 in. The completed assembly has an SWR of less than 1.1:1 at both 70 cm and 2 m.

Schematic and layout of the 10-dB attenuator: R1, 10-Ω 1/2-W (7); R2, 1-kΩ 1/4 W (14). **A.** Input/output, 3 ft RG-58/U. **B.** Cable bushing, $\frac{1}{4}$ in. clearance hole. **C.** Component mounting board, $3\frac{1}{2}$ in $\times 2\frac{7}{8}$ in $\times \frac{1}{16}$ in PCB. **D.** Fan out end cable braid, twist into two segments, and solder to PCB with minimum lead lengths. **E.** Component tie-down pads (9), double thickness glass-epoxy PCB, $\frac{1}{4}$ in $\times \frac{1}{8}$ in $\times \frac{1}{8}$ in pieces cemented together and into position with clear household cement (Elmer's). **F.** Coolant, household wax (paraffin). Fill container with melted wax to $\frac{1}{4}$ in from the top. To melt wax, insert the container in hot water (about 200°F). **G.** Container, one-pint can.

10-W CW TRANSCEIVER



Notes:
1. * denotes part value varies with band. See Table 1.
2. ** W1-3 represent bare wire jumpers needed with the accompanying pcb layout.
3. Both Q9 and U2 require a heatsink. See text and photographs for details.
4. Component ratings: Unless specified, resistors are 1/4 W, electrolytic capacitors are 35 V and ceramic disk capacitors are 100 V.

Table 1 Band Data

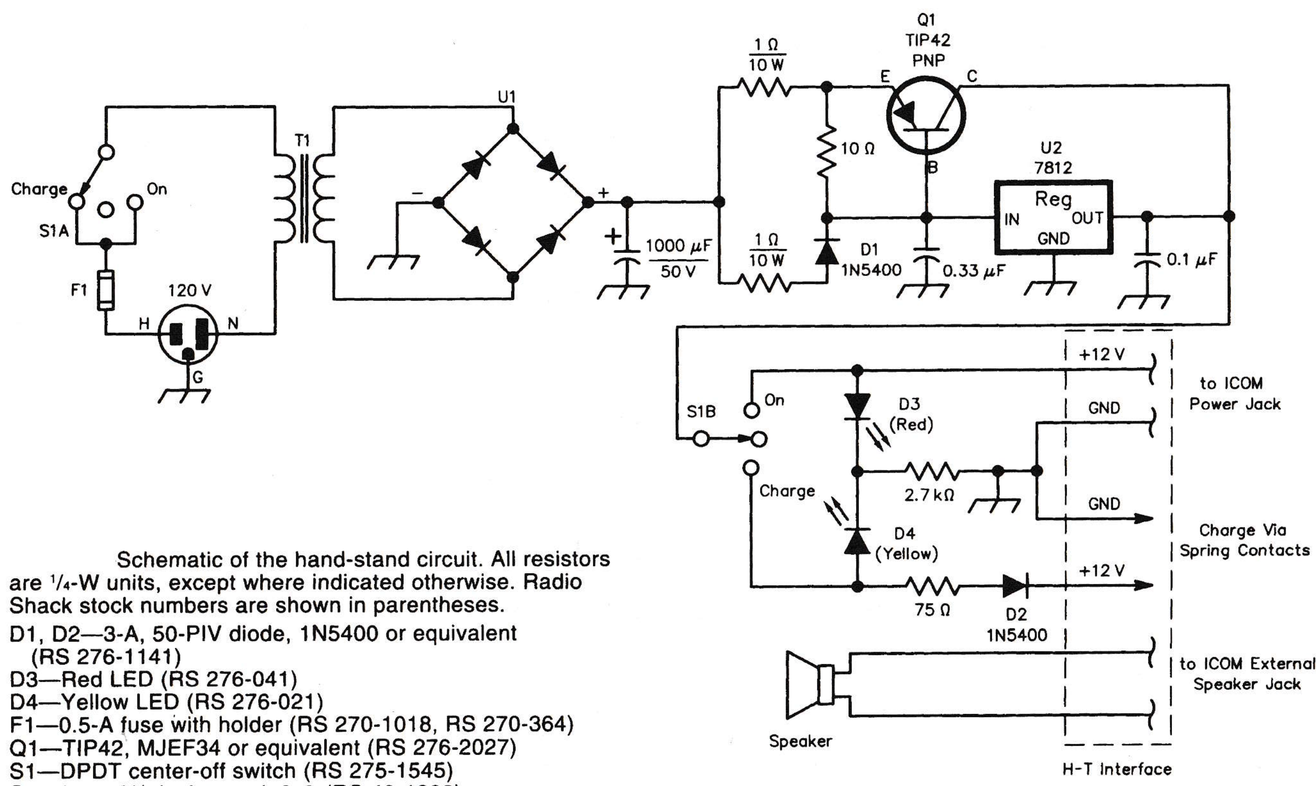
Component	80-M	40-M	30-M
C1	390 pF	68 pF	Not used
C2	18 pF	5 pF	Not used
C3	680 pF	270 pF	Not used
C4	820 pF	680 pF	390 pF
C11, C12	820 pF	390 pF	270 pF
C18, C34	39 pF	18 pF	10 pF
C22	18 pF	Not used	Not used
C25, C31	390 pF	270 pF	180 pF
C26, C28	390 pF	Not used	390 pF
C27, C29	820 pF	680 pF	68 pF
C30	68 pF	Not used	Not used
C32, C33	390 pF	68 pF	Not used
L1 (FT37-61)	40T #30	23T #28	17T #28
L2 (T50-2)	22T #24	14T #24	12T #24
L3, L5 (T50-2)	22T #24	17T #24	14T #24
L4 (T50-2)	25T #24	19T #24	16T #24
L6 (FT-37-61)	30T #28	25T #28	15T #28

Capacitors are 100v ceramic disk type. For inductors, wind turns using the enamel wire gauge given on the toroid core specified.

73 AMATEUR RADIO TODAY *Fig. 3-3*

This transceiver can be operated on the 80-, 40-, or 30-m CW ham bands. A crystal oscillator drives a driver and RF PA delivering about 10 W output. The receiver uses an MC3359 IC and is fed LO from the crystal oscillator used for transmitting, and a varactor diode is used for incremental tuning (RIT) of the receiver. The unit also has a CW sidetone generator for ease of monitoring the transmitted CW signal. The power supply is 18 to 28 Vdc at 1 A.

2-m HT BASE STATION ADAPTER



Schematic of the hand-stand circuit. All resistors are ¼-W units, except where indicated otherwise. Radio Shack stock numbers are shown in parentheses.

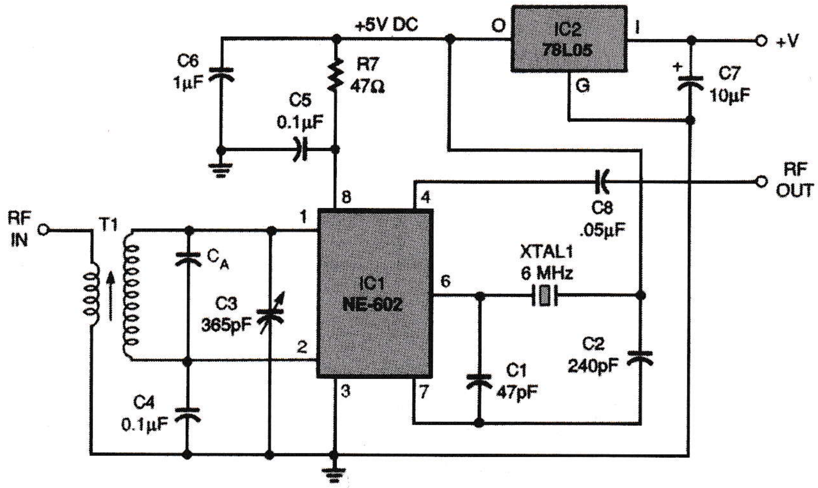
D1, D2—3-A, 50-PIV diode, 1N5400 or equivalent (RS 276-1141)
D3—Red LED (RS 276-041)
D4—Yellow LED (RS 276-021)
F1—0.5-A fuse with holder (RS 270-1018, RS 270-364)
Q1—TIP42, MJEF34 or equivalent (RS 276-2027)
S1—DPDT center-off switch (RS 275-1545)
Speaker—3½-inch round, 8-Ω (RS 40-1333)
T1—Transformer 120-V primary; 18-V, 2-A secondary (RSU 105 243 239)
U1—4-A, 100-PIV bridge rectifier (RS 276-1171)
U2—7812 voltage regulator (TO-220 package, RS 276-1771)

QST

Fig. 3-4

This device mates with a small handie-talkie (HT) and provides power and speaker interface as well as charging capability. It was designed for an Icom 02-AT, but can be adapted for other HTs as well.

WWV TO 75-m BAND CONVERTER

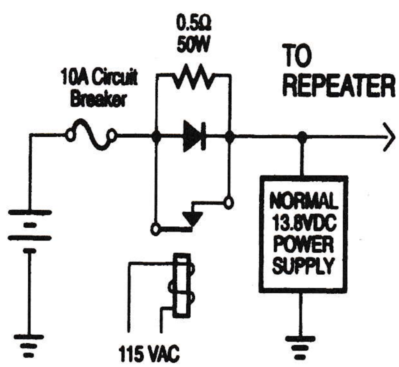


POPULAR ELECTRONICS

Fig. 3-5

This circuit for an HF-band converter will convert the 10-MHz WWV signal to a frequency in the 75-m ham band. The local oscillator section of NE-602 is available on pins 6 (base) and 7 (emitter). In this circuit, a 6.00-MHz crystal oscillator is provided by the NE-602. Capacitors C1 and C2 form the feedback network. The junction of C2 and XTAL1 can be connected to either the 15-Vdc line or ground (the former is shown here). The difference frequency between WWV's 10 MHz and the 6.00-MHz crystal frequency is 4.00 MHz, which is located at the top end of the 75-m ham band. Crystals with other frequencies will produce other output sum or difference frequencies, so tune the receiver appropriately if something other than 6.00 MHz is used.

REPEATER EMERGENCY POWER SUPPLY

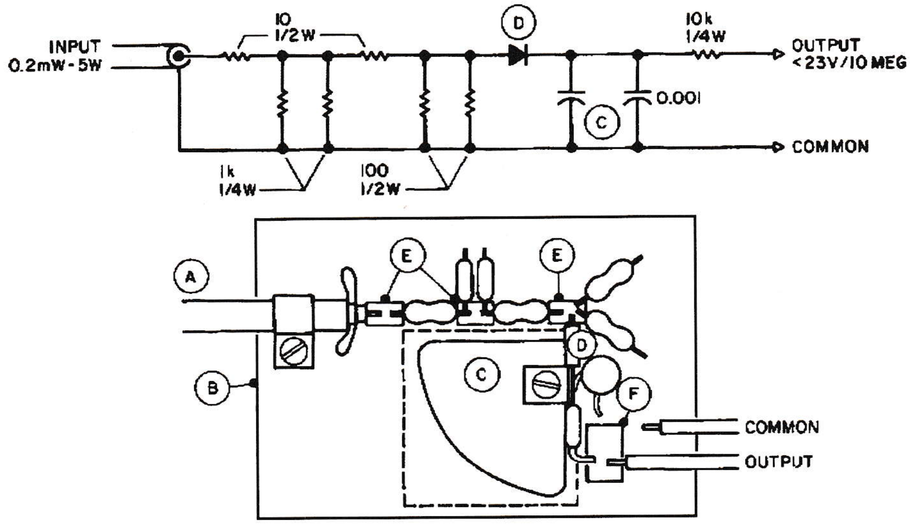


NUTS AND VOLTS MAGAZINE

Fig. 3-6

If your repeater needs emergency power, this circuit might do. Connect a 12-V storage battery, a relay, and a 0.5-Ω 50-W resistor as shown. Normally, the battery charges at a low rate (less than 1 A) through the 0.5-Ω resistor. When power fails, current can flow from the battery through the diode for a few milliseconds, until the relay drops out and closes the contacts, completely eliminating any voltage drop. If your repeater doesn't use a 13.8-V power supply, you could purchase a 2-A battery charger and connect a 0.5- to 1-Ω resistor (50 W) in series with the battery. This will charge at approximately $\frac{1}{2}$ A and maintain the battery.

DUMMY LOAD AND DETECTOR

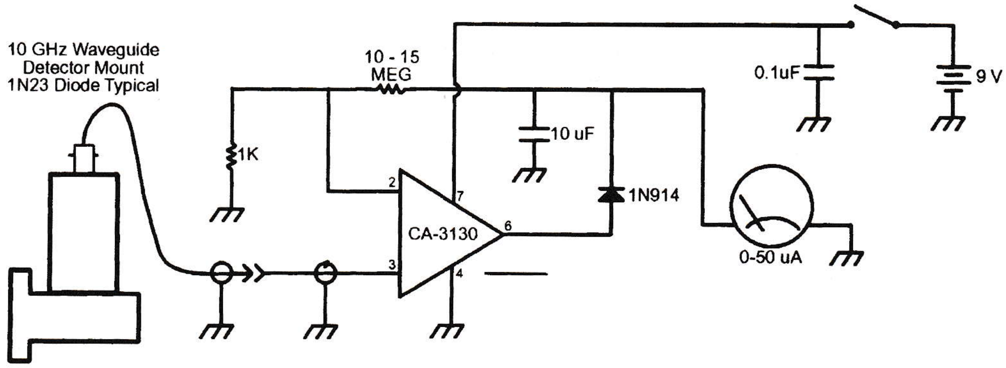


73 AMATEUR RADIO TODAY *Fig. 3-7*

Two 100-Ω, $\frac{1}{2}$-W resistors in parallel connected across a 50-Ω cable with near-zero lead lengths will be very close to a 50-Ω termination with the SWR less than 1.1:1. However, adding the diode introduces capacitor loading that results in an SWR of 1.5:1 or more. In the circuit, the components on the 2-dB resistor pad preceding the diode/load compensate for this, as they are tailored to reduce the SWR to less than 1.1:1. Although the power capability of this assembly is 5 W, forced-air cooling is required at the higher power levels, depending on the measurement period.

Schematic and layout of the dummy-load/detector assembly: **A.** Input, 1 ft RG-58/U. Fan out braid on connecting end, twist in two segments, and solder to PC board with minimum lead lengths. **B.** Base, 3 in×2 in×$\frac{1}{16}$ in PCB. **C.** Capacitor—90° circular sector, 1 in radius, 0.21-in-thick Reynolds sheet aluminum. Surface polish with 220-grit sandpaper to remove burrs. Dielectric, 2.7-mil polyethylene (Ziploc heavy-duty freezer bag). Feed through 2-56 screw with a plastic insulator on the back side. Hole is reamed on both sides with a large drill to prevent shorting to the foil. **D.** Peak readout diode, 1N34A selected to have a reserve resistance of less than 5 MΩ (RS 276-1123). **E.** Component tie-down pads, $\frac{1}{4}$ in×$\frac{1}{8}$ in×$\frac{1}{16}$ in glass-epoxy PC board. Cemented to base with clear household cement (Elmer's). **F.** Output tie-down pad, $\frac{3}{8}$ in×$\frac{1}{4}$ in×$\frac{1}{16}$ in PC board.

10-GHz WAVEMETER AMPLIFIER



73 AMATEUR RADIO TODAY ***Fig. 3-8***

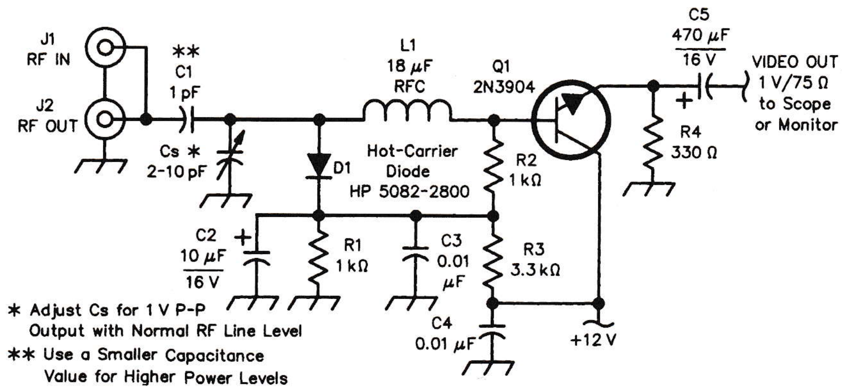
This wavemeter amplifier is connected to the microwave waveguide detector. This circuit operates from a single 9-V transistor radio battery for simplicity.

4

Amateur Television (ATV) Circuits

The sources of the following circuits are contained in the Sources section, which begins on page 1043. The figure number in the box of each circuit correlates to the entry in the Sources section.

ATV LINE SAMPLER



QST

Fig. 4-1

This device can be used to recover demodulated video from the output of an ATV transmitter. A small sample of the signal on the antenna feeder is tapped off and detected, and the resultant video is fed to an emitter follower. C1 is chosen for 1 V p-p under normal transmit conditions. This circuit was intended for 440-MHz AM TV signals. It will not work for FM or for 900-MHz or 1300-MHz signals. A striplike directional coupler can be used to sample the RF line without introducing an impedance bump.

UHF ATV DOWNCONVERTER FOR 900 AND 1300 MHz

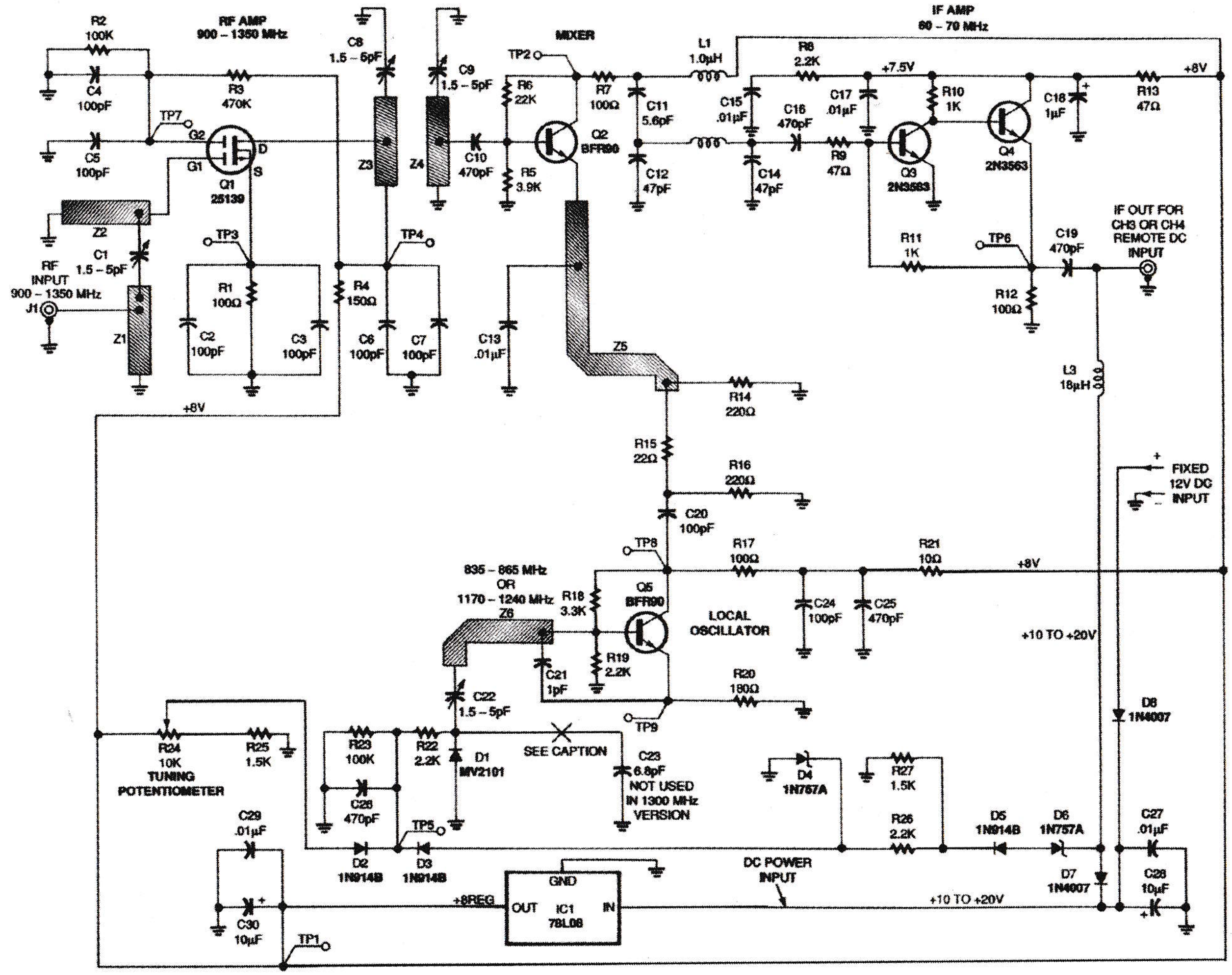


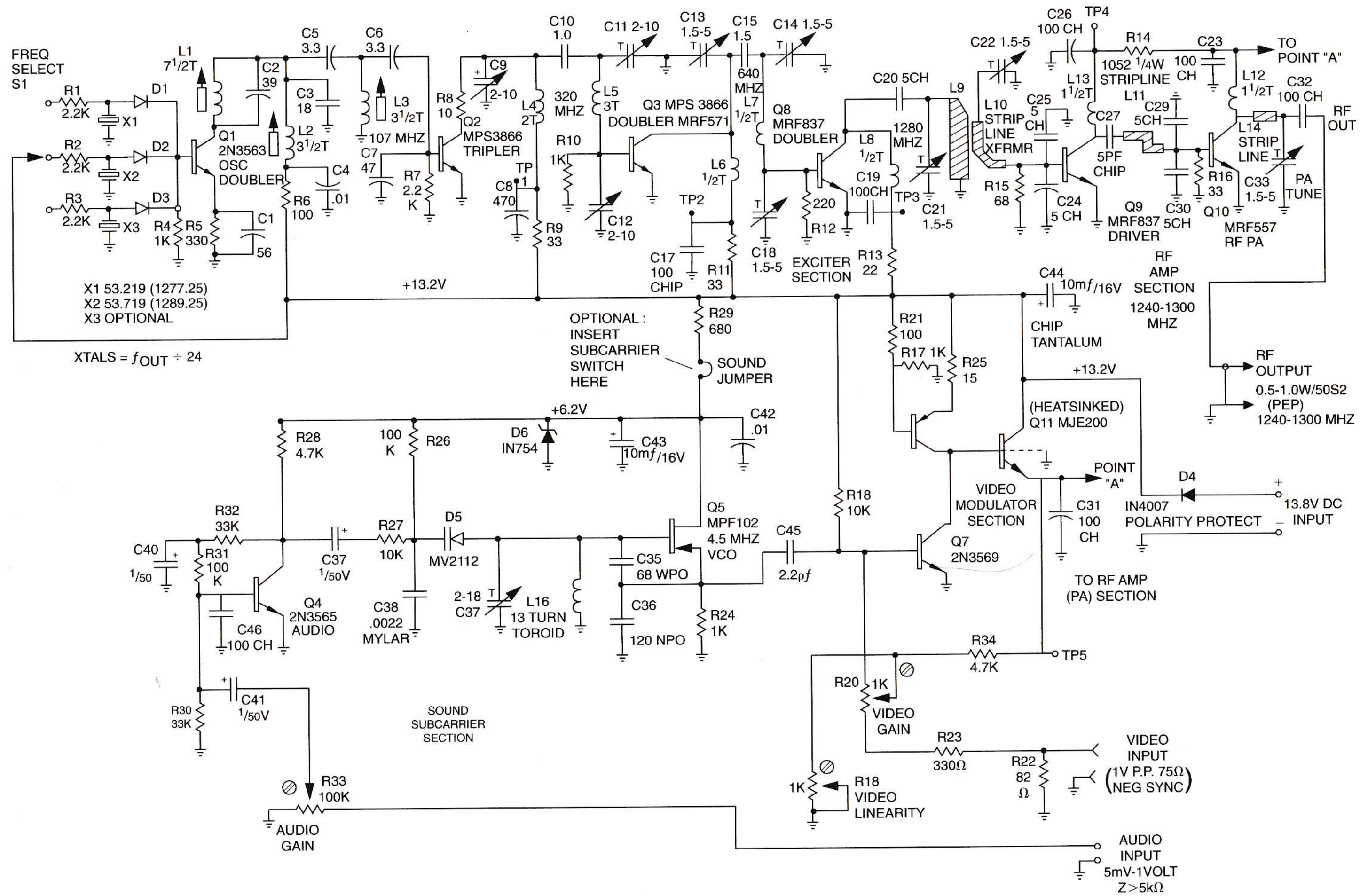
Fig. 4-2

UHF ATV DOWNCONVERTER FOR 900 AND 1300 MHz *(Cont.)*

This downconverter is tunable and can cover either 902 to 928 MHz or 1240 to 1300 MHz for receiving amateur television transmissions or other wideband signals. An NEC 25139 low-noise RF amplifier feeds a BFR90 mixer driven by a BFR tunable LO operating 61 or 67 MHz below the received frequency. A pair of 2N3563 transistors are used as a post-IF amplifier. Overall gain is 37 to 40 dB with around 1.5-dB noise figure. AGC control voltage can be used on gate 2 of the RF stage to reduce RF gain on strong signals; about −3 V is needed to reduce RF gain by >30 dB. Either on-board tuning via pot R24 or remote tuning via 10- to 20-V variable dc supply on the IF coaxial cable can be used. Note that striplines are different for 900 and 1300 MHz, and this requires separate models for each band, although the physical layout and circuit diagrams are identical.

A complete kit of parts, including PC board, is available from North Country Radio, P.O. Box 53, Wykagyl Station, New Rochelle, NY 10804-0053A.

1.3-GHz ATV TRANSMITTER



WILLIAM SHEETS

Fig. 4-3

This TV transmitter operates from a +12-Vdc source and produces about 1 W peak power on sync tips. Output frequency is 1240 to 1300 MHz, but operation is possible to 1325 MHz (for U.K. band). Video interface is 1 V p-p/75 Ω negative sync; audio is 5 mV to 1 V @ *Z*55 kΩ. For PAL operation, reduce the number of turns on L16 to 11 for 5.5-MHz sound.

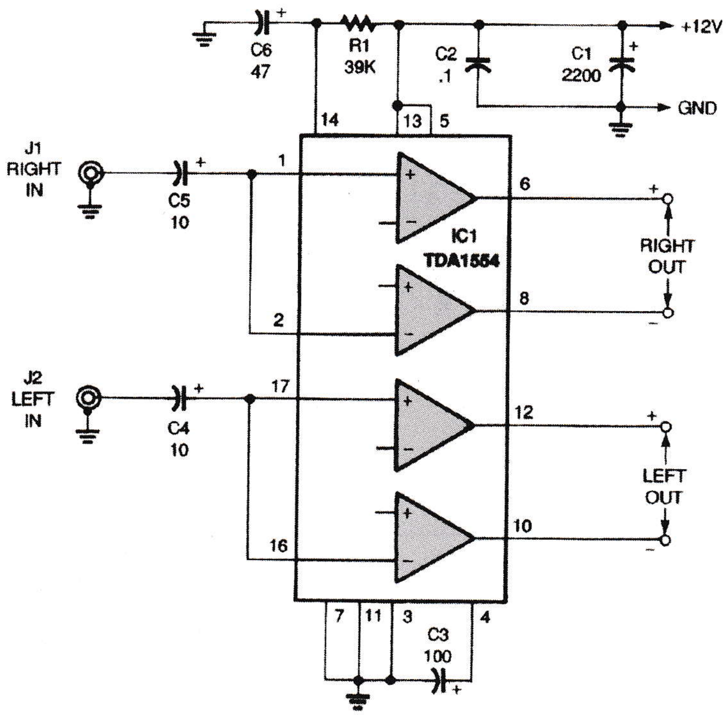
A kit of parts for this transmitter is available from North Country Radio, P.O. Box 53, Wykagyl Station, New Rochelle, NY 10804-0053A.

5

Amplifier Circuits—Audio

The sources of the following circuits are contained in the Sources section, which begins on page 1043. The figure number in the box of each circuit correlates to the entry in the Sources section.

22-W AMPLIFIER FOR 12-V SYSTEMS



POPULAR ELECTRONICS

Fig. 5-1

Power for the circuit (+12 V) is provided by a connection to the host vehicle's battery. A connection is also provided for the vehicle/s ground. Capacitors C1 and C2 provide decoupling of any signal riding on the supply voltage, while capacitor C3, working in conjunction with IC1, provides ripple rejection. The incoming audio signal is coupled to IC1 by capacitors C4 and C5. Those 10-μF capacitors are used to avoid rolling off of the low audio frequencies. Resistor R1 and capacitor C6 feed the mute switch circuit (included in IC1), providing the delay that eliminates turn-on pop. Their *R/C* time constant is about 1.4 s. None of the component values external to IC1 are crucial, but major value substitutions should not be made. Pin 14 (the mute switch) of IC1 must have at least 8.5 V for the amplifier to be ON, or be held below 3.3 V to ensure that the chip stays in the mute condition. Current requirements at this pin are on the order of 40 μA in the ON condition, and 100 μA for standby. The R1/C6 combination used here (47μF and 39,000 Ω) provides enough delay to eliminate turn-on pop without having an excessive wait for normal operation. In addition to this slight delay, pin 14 gradually comes up above the 8.5-V threshold as C6 charges up, rather than coming on instantly, as it would if a simple switch were used. Values for C6 and R1 are not crucial, but R1 should be no larger than 100,000 Ω, and the R1/C6 time constant should be on the order of a second or two. Too short a time constant may not eliminate the turn-on pop; too long a time constant does not harm, except causing an irritating delay.

60-W SWITCHING AMPLIFIER

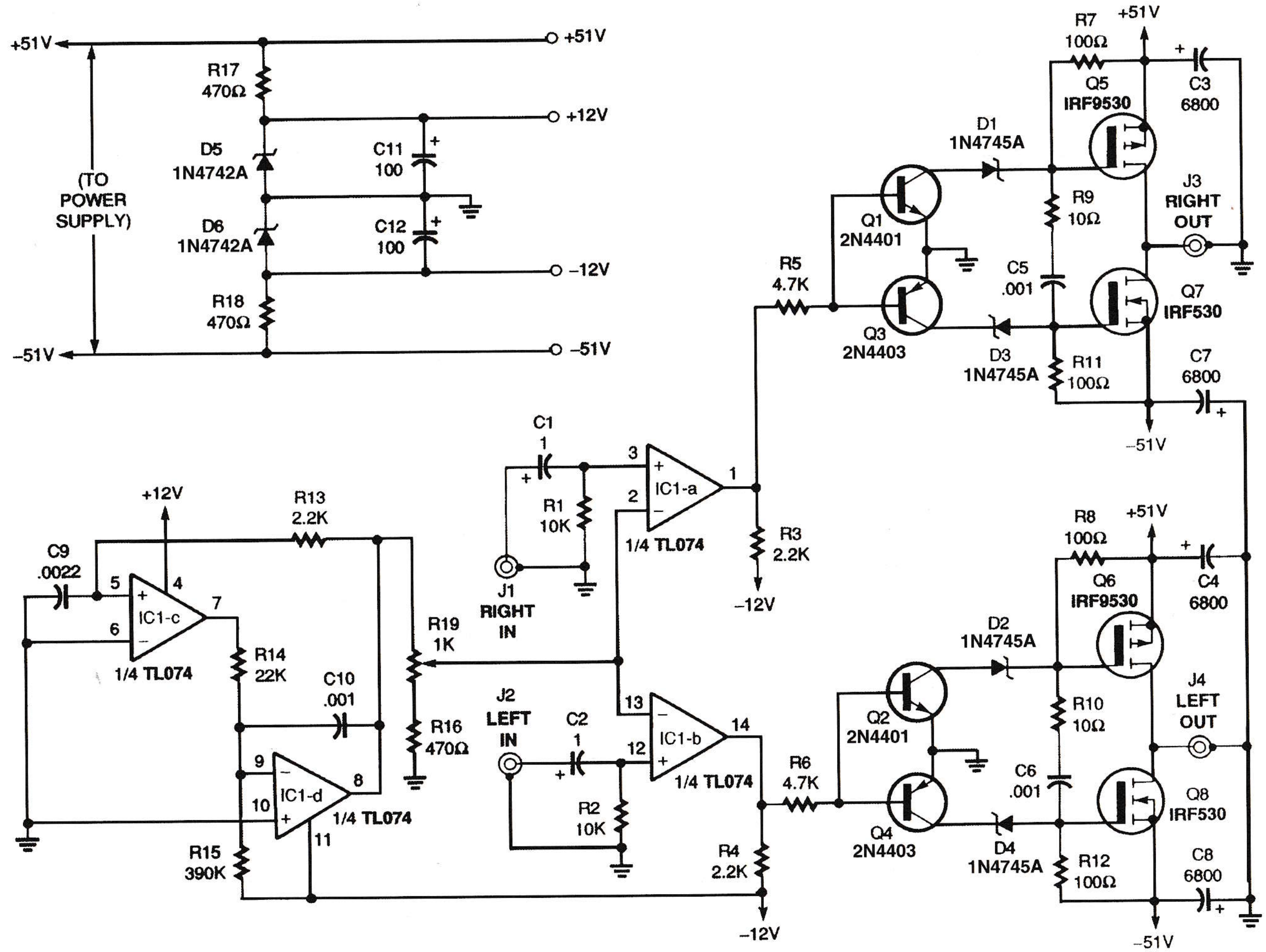
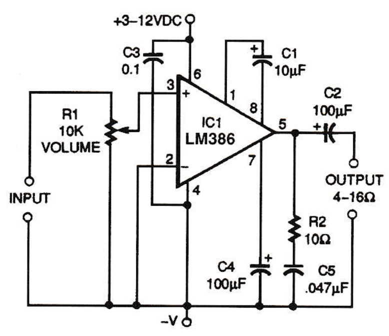


Fig. 5-2

The schematic for the switching amplifier is shown. A separate 51-Vdc source is required to power the amplifier circuit. The 51-Vdc source is fed to a pair of zener diodes, D5 and D6, and is filtered by capacitors C11 and C12 to provide a 12-Vdc source for part of the circuit. Also, part of the 51-Vdc source bypasses the zeners to power the sections of the circuit that require a high voltage. The right and left signals are input to the amplifier through jacks J1 and J2, respectively. Two sections of a TL074 op amp, IC1-c and IC1-d, generate a 4-V p-p, 50-kHz triangular reference waveform. The generated waveform is then fed to potentiometer R19. That enables the amplifier to use input signals with amplitudes ranging from 1 V p-p to 4 V p-p. The other two op-amp sections, IC1-a and IC1-b, function as comparators to produce the pulse-width-modulating output for the left and right channels of the amplifier. In the right channel of the amplifier, the output of the voltage comparator is coupled to the bipolar translating circuit through a current-limiting resistor, R5. The translating circuit has a positive and a negative "leg;" Q1, D1, and R7 make up the positive leg, and Q3, D3, and R11 make up the negative leg. Both legs are tied to ground through the emitters of Q1 and Q3, providing a reference point for the translator. The translator arrangement results in 17 V being present across Q1, Q3, and zener diodes D1 and D3. Sufficient current is then present to overcome the power MOSFET gate capacitance; that rapidly switches on and off the power MOSFET complementary push-pull output stage, composed of Q5 and Q7. Resistor R3 keeps the output swing centered at the midpoint of the supply voltage. Without R3, the square-wave output drifts down toward the negative rail. The *RC* network, composed of R9 and C5, which connects to both N- and P-channel gates, minimizes switching noise and sharpens the square-wave output. Note that both channels contain power-supply elements to split the incoming single-polarity voltage in half. Capacitors C3, C4, C7, and C8 make up a series-parallel circuit that converts the 51-Vdc supply to 25.5 Vdc. The output can feed full-range 60-W rms speakers, which demodulate the signal and produce an amplified audio output. (At peak output power, the current draw for an 8-Ω dynamic load is approximately 1.2 A at 51 Vdc.)

STABLE LM386 AUDIO AMPLIFIER CIRCUIT

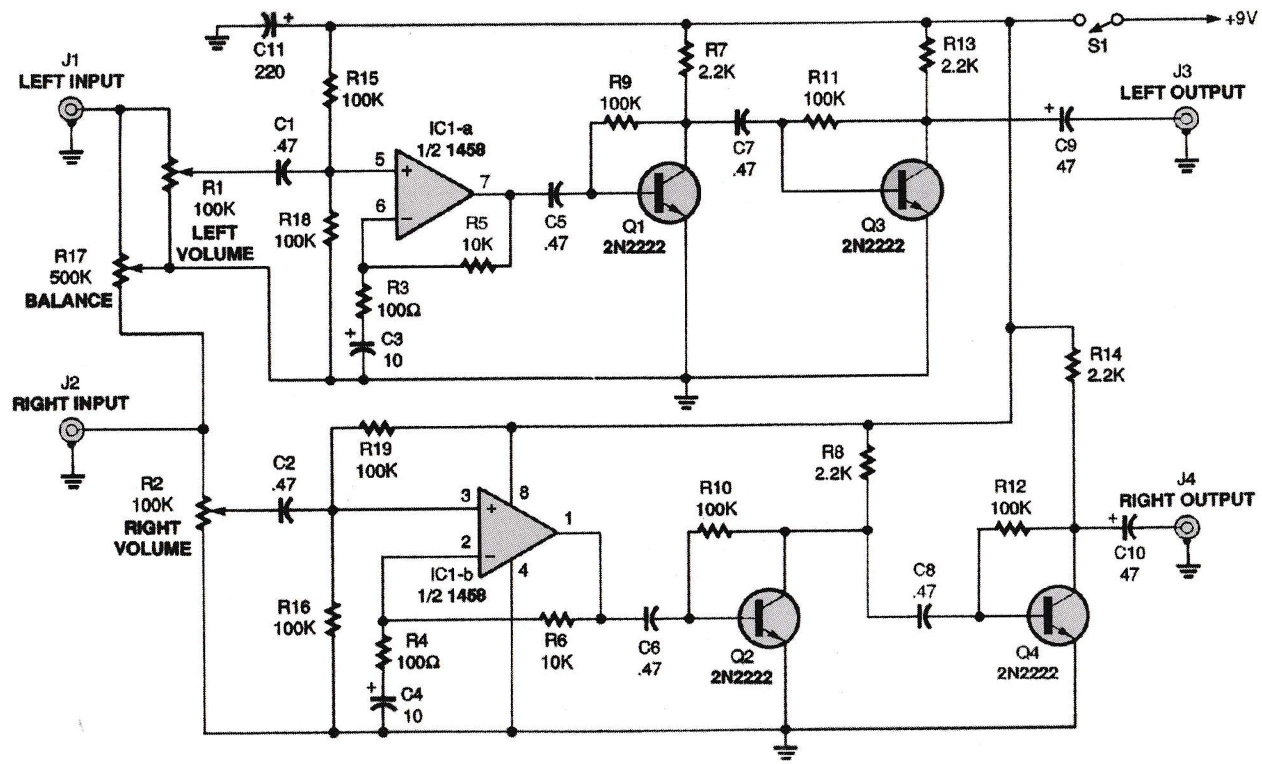


The circuit shown has components installed to improve the stability of the LM386 circuit. R2, C3, C4, and C5 are sometimes omitted, leading to instability with certain layouts. These components should be used to ensure stability. Output is up to 1 W, depending on supply voltage and load impedance.

ELECTRONICS NOW

Fig. 5-3

STEREO PREAMP

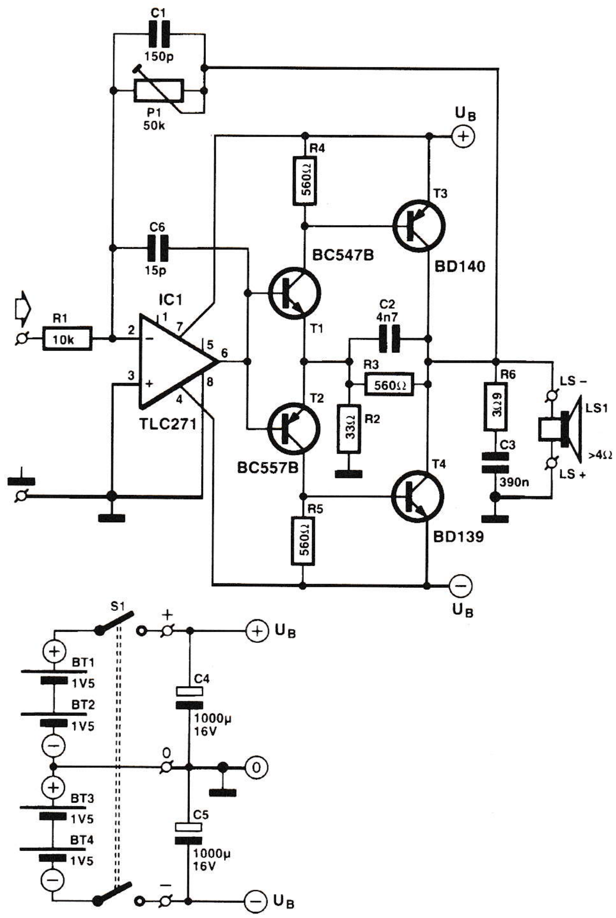


POPULAR ELECTRONICS

Fig. 5-4

The output of the audio source is fed to the left and right inputs of the circuit (J1 and J2). Potentiometers R1 and R2 control the volumes of the input signals, while potentiometer R17 is a balance control. The incoming signals are coupled through capacitors C1 and C2 to the noninverting inputs of op amps IC1-a and IC1-b. Because IC1 operates as a single-supply amplifier, its output signal fluctuates above and below half of the supply voltage. The output signals of the op amps are coupled to the bases of two 2N2222 transistors (Q1 and Q2), which further amplify the left and right signals. Then, the outputs of the transistors are coupled to the bases of two more 2N2222 transistors (Q3 and Q4), further boosting the left and right signals. The transistor pairs also act as buffers.

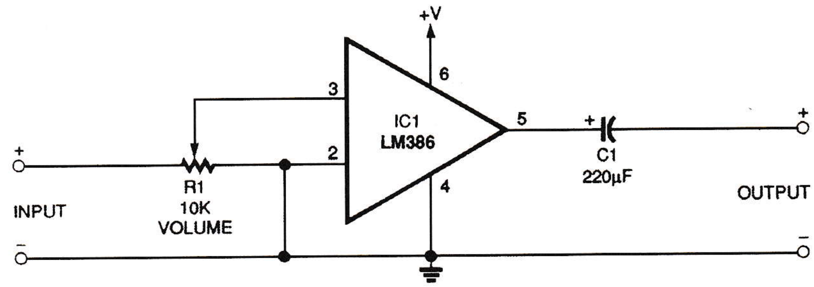
MINIATURE AUDIO POWER AMPLIFIER



ELEKTOR ELECTRONICS *Fig. 5-5*

A compact audio power amplifier with low current drain has many applications. These are the design basis for the mini amplifier. It continues working satisfactorily with a battery voltage down to 1.5 V. Its quiescent current drain is about 1 mA, and its efficiency is a worthwhile 70 percent. It provides an output power of 500 mW into 8 Ω (or 800 mW into 4 Ω), has a sensitivity of 400 mV, and its distortion is never higher than 1.2 percent. Because the output transistors have no emitter resistor, the voltage is determined solely by the knee voltage of T3 and T4. With a load of 4 to 8 Ω, these voltages are limited to 0.2 to 0.3 V so that the transistors can be driven virtually up to the supply voltage. The overall bandwidth of the amplifier is limited to not less than 21 kHz at the maximum amplification of ×5. With a 4-Ω load, the peak output current is 700 mA. A 315-mA fuse in series with the output is, therefore, a simple but effective short-circuit protection. At maximum drive with a music signal, the average current is only 50 mA. In operation the drive will never be continuously maximum, so the actual current drain will be much lower. A set of four penlight batteries should last about 200 hours.

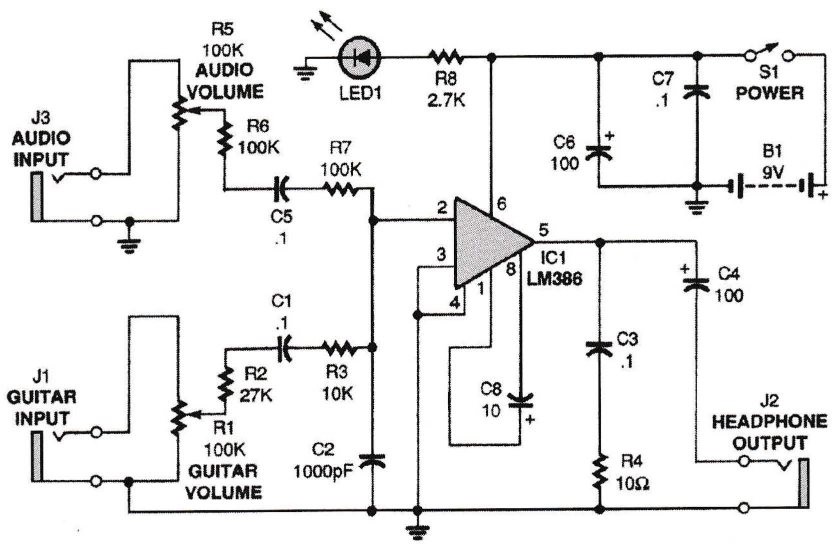
SIMPLE AUDIO OUTPUT AMPLIFIER



ELECTRONIC EXPERIMENTERS HANDBOOK *Fig. 5-6*

This audio amplifier circuit has a gain of about 20. A supply of 3 to 12 V can be used. Output is up to about 1 W, depending on load impedance and supply voltage.

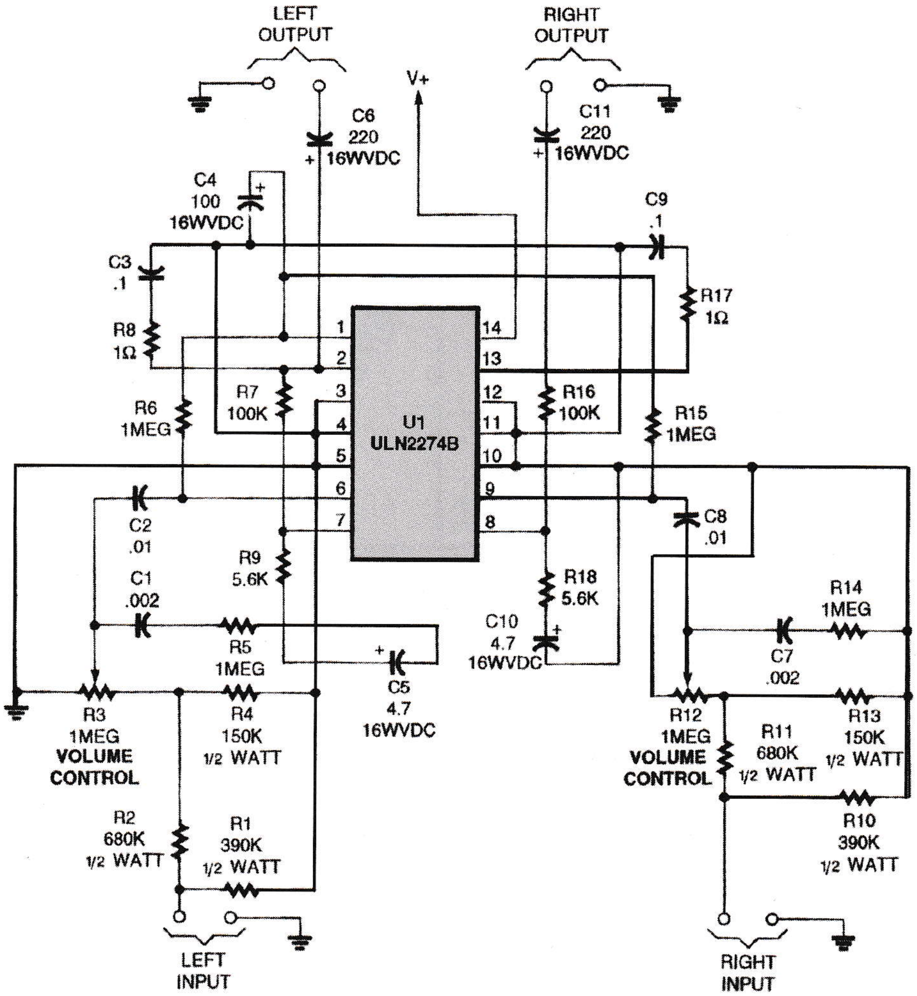
SIMPLE GUITAR AMPLIFIER WITH DUAL INPUTS



POPULAR ELECTRONICS *Fig. 5-7*

This amplifier uses an LM386 IC and has two inputs, an input for guitar and a separate audio input for a second guitar, a mike, etc. Power is supplied by a 9-V battery. While headphones are indicated, the amplifier will drive a small speaker. Output is around 300 to 500 mW, depending on load and battery voltage.

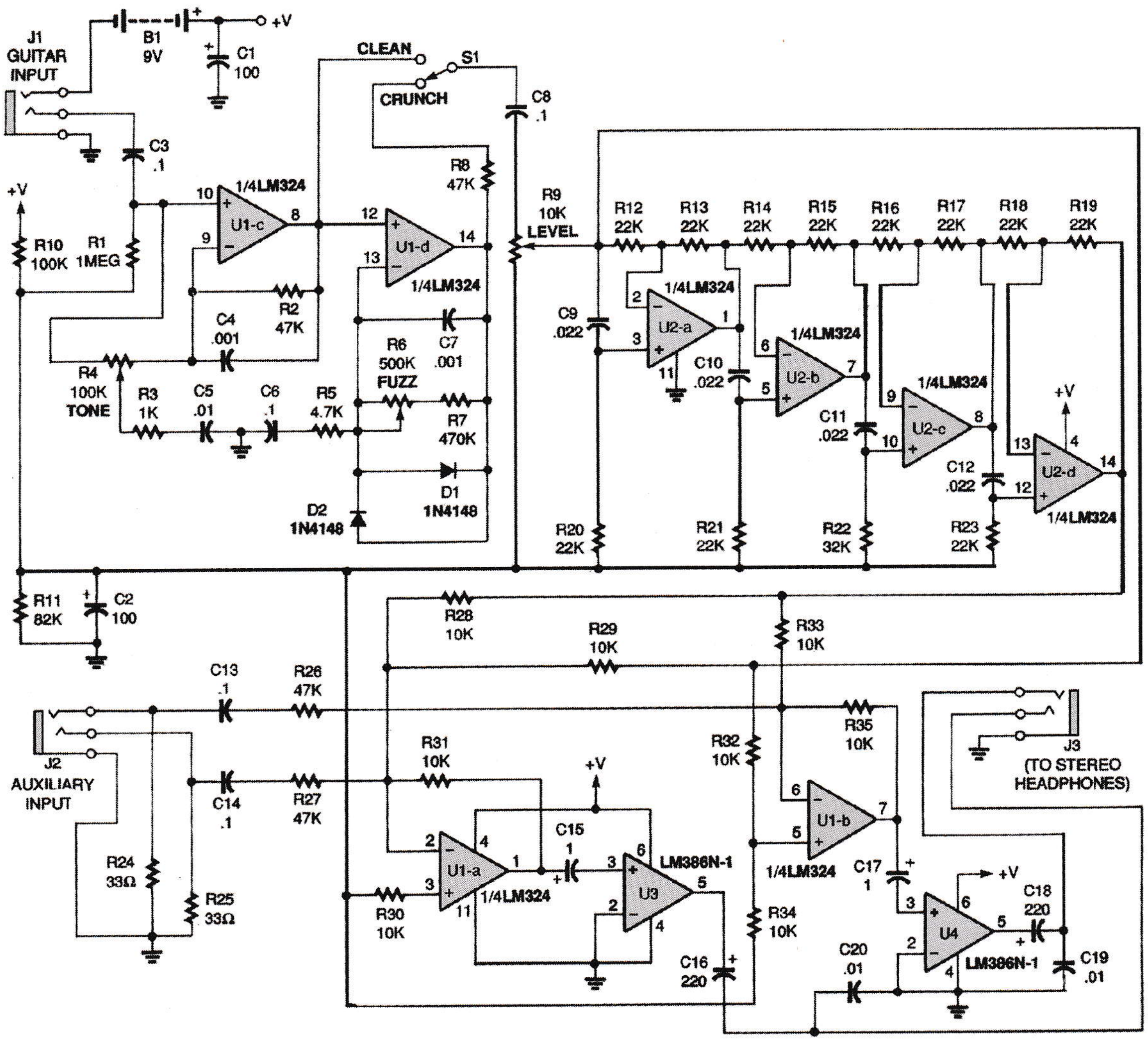
2-W STEREO AMPLIFIER



POPULAR ELECTRONICS ***Fig. 5-8***

The amplifier is built around a ULN2274B dual audio power amplifier and provides a maximum of 2 W of quality sound. Because the amplifier is composed of two identical subcircuits, only one subcircuit will be covered. Resistor R5 sets the tone and it can be replaced with a variable unit; lower values of that resistor produce more bass. The bias is set by R6 and C4, and R7, R9, and C5 are feedback elements. For a more realistic sound, R8 and C3 are used to roll off the high frequencies. Capacitor C6 is a dc-blocking capacitor. The circuit chip requires from 6 to 26 Vdc without distortion.

HEADPHONE AMPLIFIER FOR GUITARS

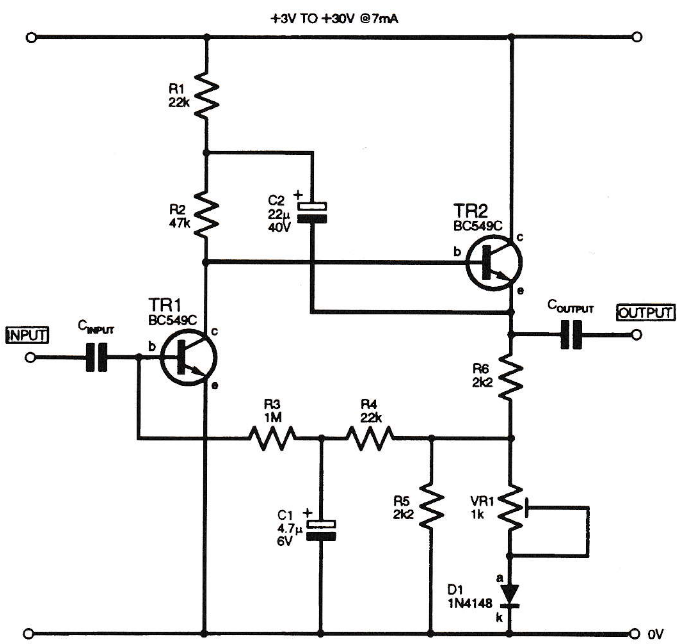


ELECTRONIC HOBBYISTS HANDBOOK *Fig. 5-9*

From the hard distortion provided by U1-d and D1 and D2 to the stereo imaging accomplished by U2, this is a guitarist's dream come true. Note that there is no power switch in the circuit; J1 turns on the unit whenever an instrument cable is plugged in.

The main components in the circuit are two LM324 quad op amp ICs (U1 and U2) and two LM386 power amp ICs (U3 and U4). The inputs to U1 and U2 are biased to a little less than half the power-supply voltage by resistors R10 and R11. Capacitors C1 and C2 filter the power-supply and bias voltages. J1 turns on the amplifier when the input plug is inserted. When an audio signal from an instrument is input through J1, the signal is fed through coupling capacitor C3 to the tone-control circuit composed of U1-c, R2, R4, and C4. Frequencies above 1 kHz are amplified or attenuated depending on the position of potentiometer R4, which is the tone control. Resistor R2 and capacitor C4 filter unwanted high frequencies. Audio level and overdrive are controlled by potentiometer R9; with that level control adjusted to full volume, the circuit's final amplifiers are overdriven to produce a soft distortion effect. To prevent any unwanted dc "swishing" noise, a coupling capacitor, C8, is used. Switch S1 toggles between the clean and distorted signals. When S1 is on the CRUNCH setting, diodes D1 and D2 and U1-d produce a distortion effect by clipping the amplified signal at 0.7 V. Frequencies below 160 Hz are attenuated by R5 and C6. The amount of gain or "fuzz" is controlled by R7 and potentiometer R6, and resistor R8 adjusts the distortion level to match the tone-control level.

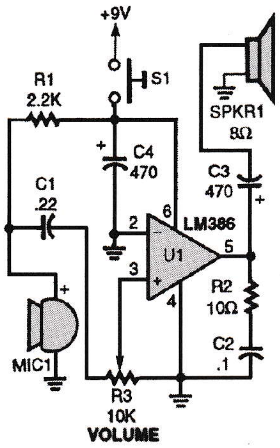
HIGH-GAIN AMPLIFIER



EVERYDAY PRACTICAL ELECTRONICS *Fig. 5-10*

This high-gain inverting amplifier stage was designed to operate with a rail of between 3 and 30 V. It includes a bootstrap network (R1, C2), which serves to increase the gain of the stage to approximately 3000, as well as offering a low-distortion output waveform at maximum amplitudes. The input impedance is approximately 80 kV at 200 Hz, the output level is 80 percent at 20 kHz, and noise at the output is 14 mV p-p. R5 and D1 were included to proportionately lower the bias to TR1 to compensate for any increases in the rail voltage; R5 can be omitted and D1 shorted out if the rail is constant. VR1 is adjusted to give symmetrical clipping of the maximum output signal.

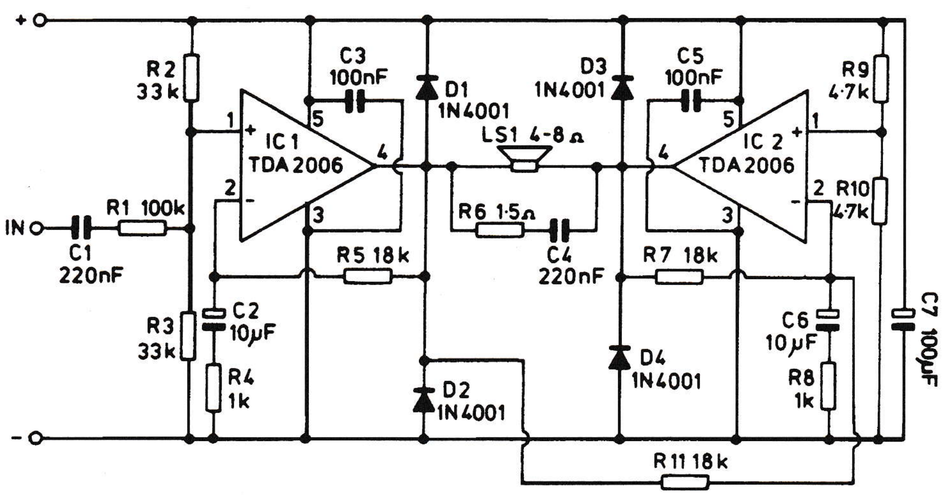
MINI MEGAPHONE



The mini megaphone is composed of an electret microphone (MIC1), an LM386 low-voltage audio-power amplifier (U1), a horn speaker (SPKR1), and a few other components.

POPULAR ELECTRONICS *Fig. 5-11*

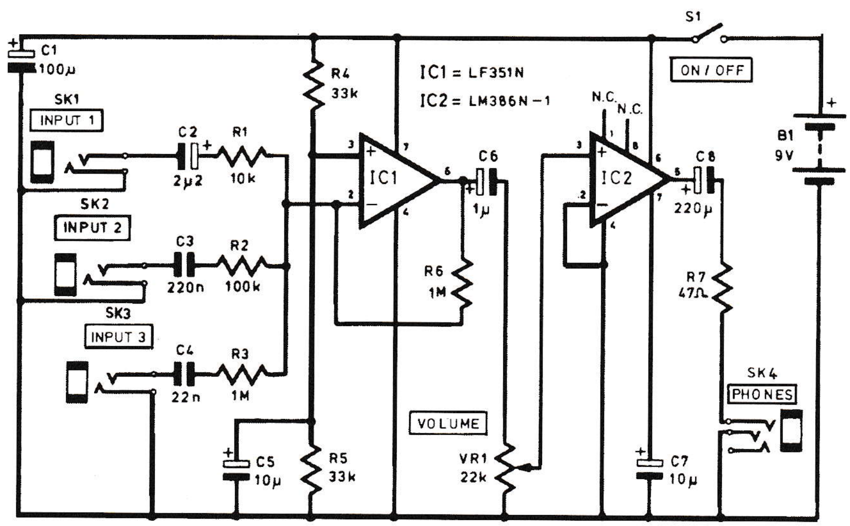
AUDIO POWER BOOSTER



ELECTRONIC EXPERIMENTERS HANDBOOK *Fig. 5-12*

The audio power booster is based on two TDA2006 audio IC power amplifiers. Power amplifier IC1 is used as what is virtually a noninverting amplifier, with the noninverting input of the device being biased to half the supply voltage by R2 and R3. R5 provides 100-percent negative feedback from the output to the inverting input of IC1 at dc so that the circuit has unity voltage gain and the output is biased to the required level of half the supply voltage. C2 and R4 remove some of the feedback at audio frequencies, and this gives a voltage gain of about 18 times at these frequencies. R1 is used at the input of the amplifier to reduce the sensitivity to a more suitable level, and C1 simply provides dc blocking at the input. IC2 is used in virtually the same configuration, but its noninverting input is not fed with an audio signal and it only receives the dc bias signal from R9 and R10. Resistor R11 couples the output signal of IC1 to the inverting input of IC2, and the value of R11 is chosen to give IC2 an effective voltage gain of unity. However, as the input signal is coupled to IC2's inverting input, there is a phase inversion through this section of the amplifier, giving the required antiphase relationship at the two outputs. Diodes D1 to D4 are protection diodes for the two ICs, while R6 plus C4 helps to prevent instability. Components C3, C5, and C7 are all supply decoupling capacitors.

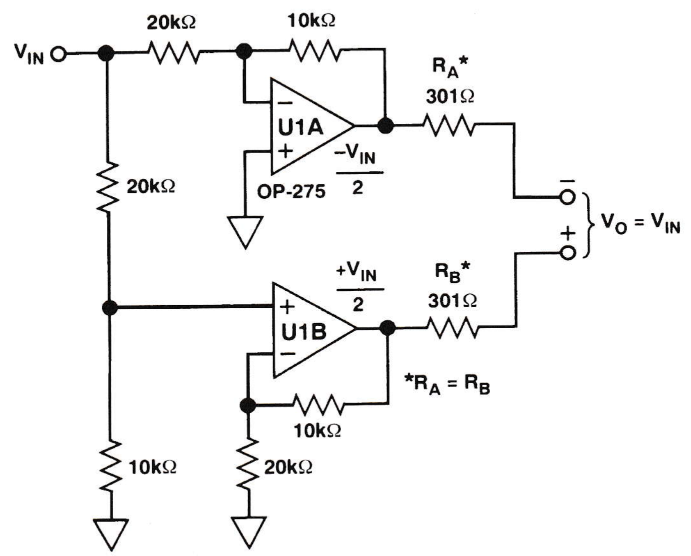
MULTIPURPOSE MINI AMPLIFIER



EVERYDAY PRACTICAL ELECTRONICS ***Fig. 5-13***

This circuit uses two audio IC amplifiers, one for a preamp and one for a power output stage. Three audio inputs are provided—low (1 mV), medium (10 mV), and high (100 mV) input—to drive a pair of headphones or a small speaker. The LM386 is good for 0.5 W or more output, and a small speaker can be connected directly to the junction of C8 and R7. A series combination of a 22-Ω resistor and a 0.1-mF capacitor should be connected between this point and ground to suppress possible high-frequency oscillations in this case.

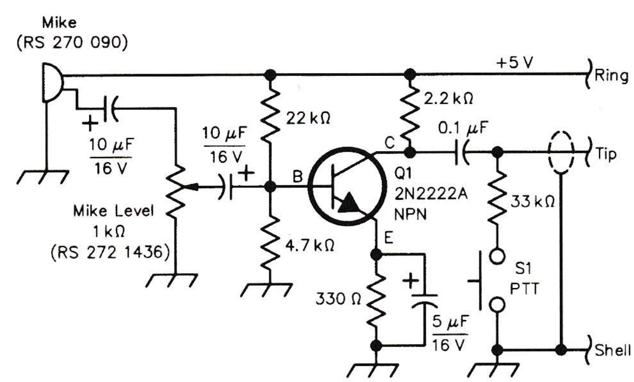
PUSH-PULL AUDIO LINE DRIVER



ANALOG DIALOGUE *Fig. 5-14*

A line driver for 600 Ω can be configured from two IC op amps. U1A and U1B are Analog Devices OP-275. These devices feature low power consumption, low THD, and high slew rate.

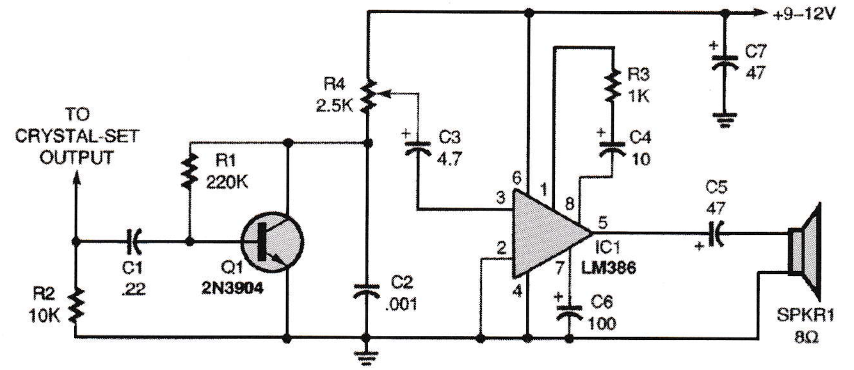
ELECTRET MIKE PREAMP WITH PTT CIRCUIT



QST *Fig. 5-15*

The schematic of electret mike element and amplifier circuit. All resistors are ¼-W units. The mike connector is an RS 274-284.

CRYSTAL RADIO AMPLIFIER



POPULAR ELECTRONICS

Fig. 5-16

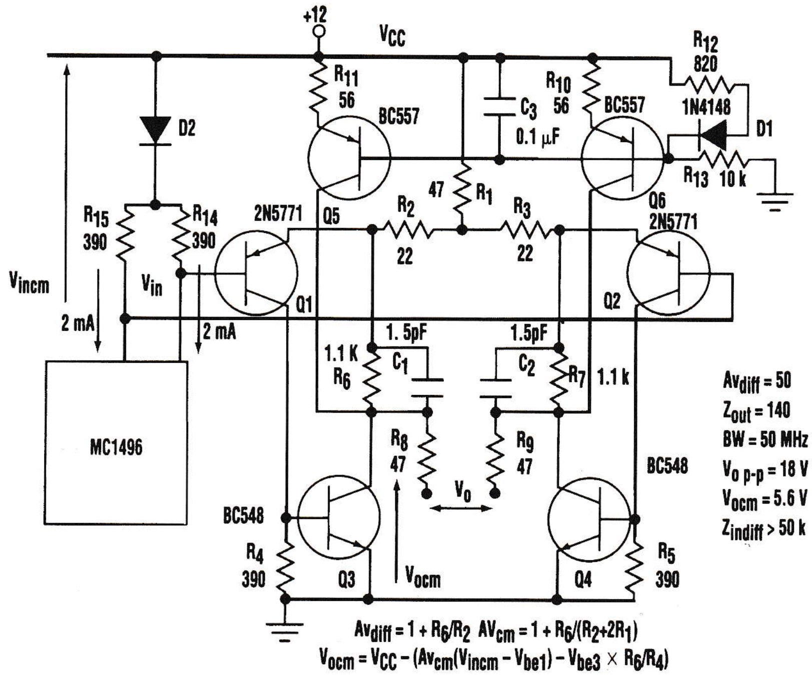
If you'd like to hear your crystal set at a comfortable, room-filling volume, hook it up to this amplifier.

6

Amplifier Circuits—Miscellaneous

The sources of the following circuits are contained in the Sources section, which begins on page 1043. The figure number in the box of each circuit correlates to the entry in the Sources section.

WIDEBAND CURRENT FEEDBACK AMPLIFIER



ELECTRONIC DESIGN

Fig. 6-1

When using multipliers such as the LM1496 or MC1495, low-value output resistors are necessary to obtain maximum bandwidth. This reduces the output swing available, which necessitates a differential high-gain, wideband amplifier. The amplifier has a differential gain ($A_{V\,\mathrm{diff}}$) of 50 and a bandwidth of about 50 MHz, giving it a total gain-bandwidth product of 2.5 GHz. It also provides an output swing of 18 V p-p from a 112-V supply. Transistors Q1 and Q2 form a differential pair that drives Q3 and Q4. Feedback is provided to the emitters of Q1 and Q2 by R6, C1 and R7, C2, which bootstraps the input impedance and sets the overall gain. Q5 and Q6 provide about 15 mA of current each, providing most of the sourcing current for the load. The basic design equations are provided to modify component values to suit different applications.

Simply envision the circuit is as a differential current-feedback amplifier, with the low-impedance port being the emitters of Q1 and Q2, and the current output as the collectors of Q3 and Q4. Because the output is a bridge circuit and the maximum positive current is set by R6, R7 and Q5, Q6, the output is short-circuit-protected between resistors R8 and R9. R1 can be replaced by a current source to reduce the common-mode gain. The main criterion is to balance the currents at the emitters of Q1 and Q2 to give a common-mode output voltage of $V_{CC}/2$. Some care should be taken when driving capacitive load because the circuit can oscillate under such conditions.

ACCURATE LOG AMPLIFIER

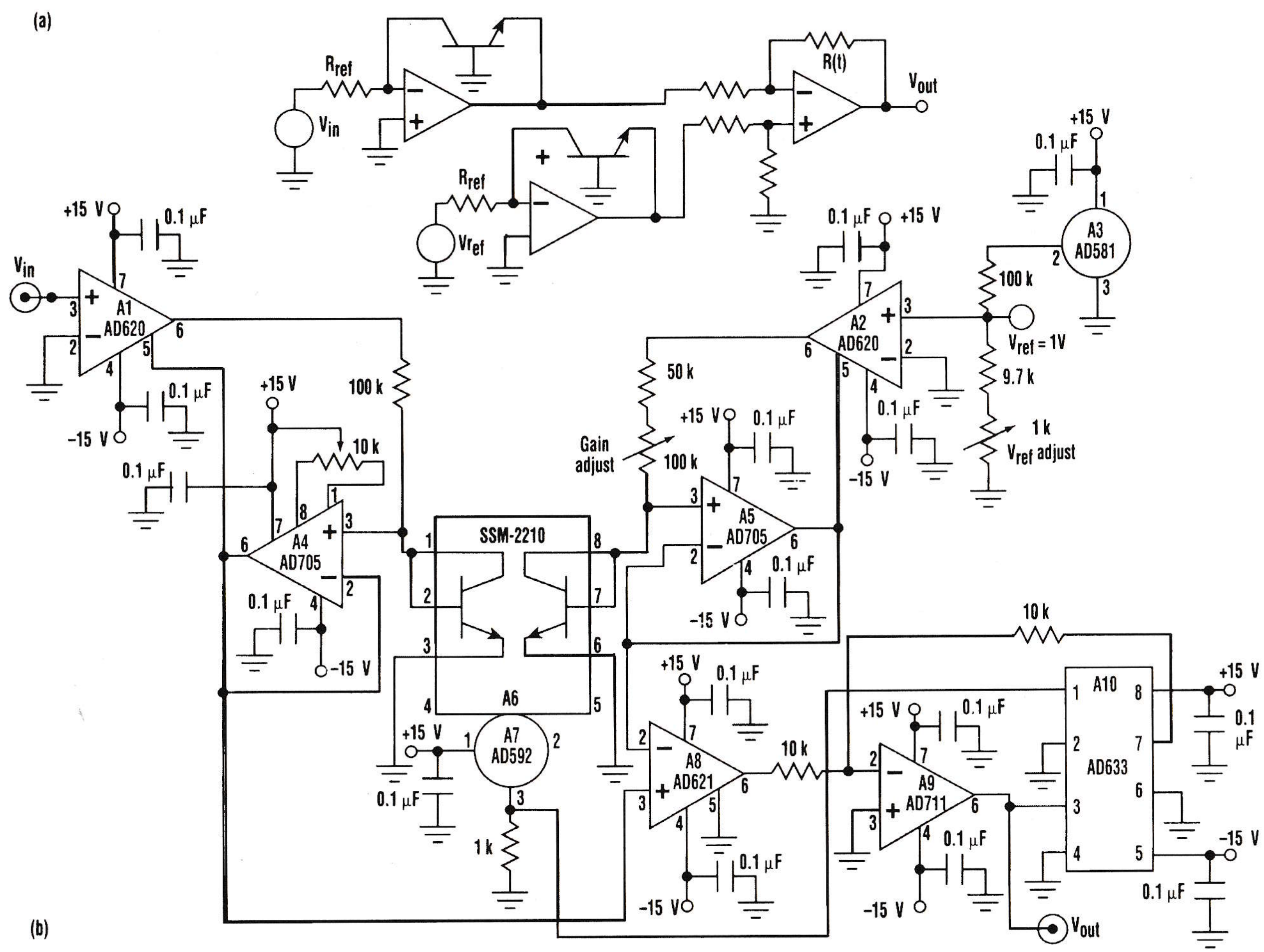


Fig. 6-2

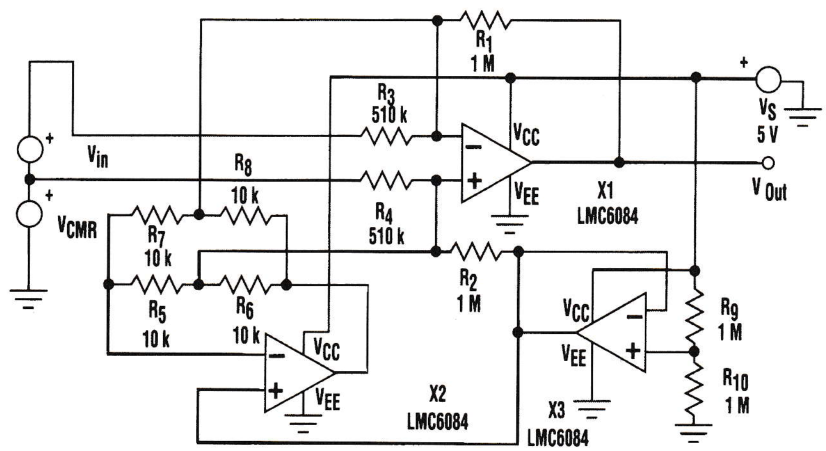
ACCURATE LOG AMPLIFIER *(Cont.)*

The log circuit consists of an instrumentation amp and an op amp together with a diode-connected transistor that produces a voltage proportional to the logarithm of the current. A circuit consisting of a voltage reference, an instrumentation amp, and an op amp, together with a diode-connected transistor, acts as a reference circuit. A thermometer IC, a fixed-gain instrumentation amp, and a divider circuit provide the necessary temperature compensation and scaling for a transfer function:

V_{out}51.985 $\log_{10}(V_{in}/1\ \text{V})$

V_{ref} must be set to 1.000 V and, with V_{in}5V_{ref}, the gain adjust has to be set so that V_o50 V. Calibration at low input voltage is done by changing buffer A4's offset voltage.

DIFFERENTIAL AMPLIFIER



ELECTRONIC DESIGN

Fig. 6-3

The differential amplifier shown handles common-mode voltages up to ±24 V on a 3.3-V supply, or up to ±40 V on a 5-V supply. It is handy when interfacing analog-to-digital converters (ADCs) or data-acquisition systems (DASs) in 3.3-V or 5-V single-supply systems to inputs with a wide common-mode range. Differential amplifier X1 is the actual differential amplifier, and R1, R2, R3, and R4 are the gain-setting resistors. X2 forces the common-mode voltage at X1's inputs to zero with respect to a quiescent biasing point provided by X3. The wide availability of dual and quad low-voltage op amps permits implementations with a single IC package. Biasing at one-half supply, or at some reference well within the supply rails, is necessary because positive-going common-mode inputs require X2's output to swing negative. R5, R6, R7, and R8 should have impedance at least an order of magnitude less than the gain-setting resistors of X1. The impedance relationship of R6 and R8 to gain-setting resistors limits the use of this circuit to high-impedance differential-amplifier circuits. Therefore, it is not well suited for wide-bandwidth circuits. The high impedances also favor the use of JFET or CMOS input op amps.

WIDER-BANDWIDTH PHOTODIODE AMPLIFIER

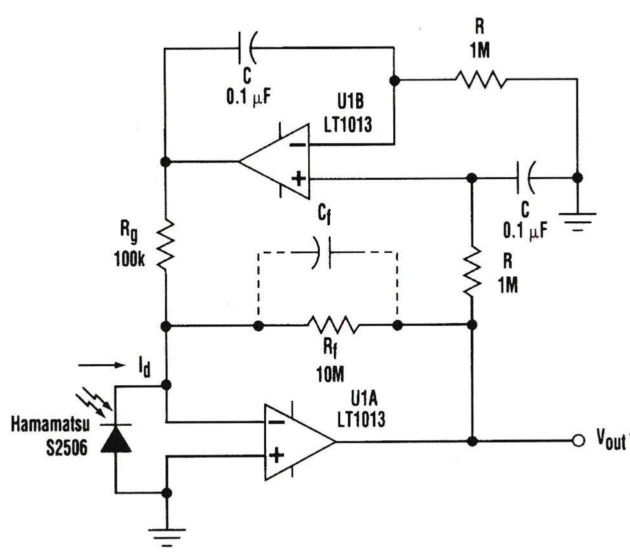


FIG.1

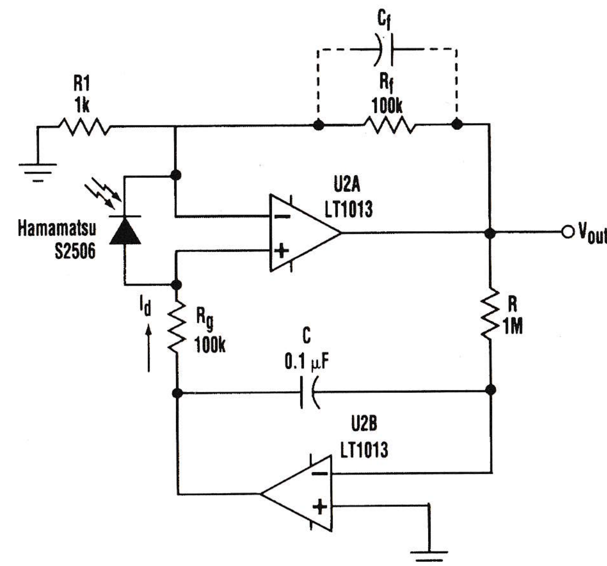


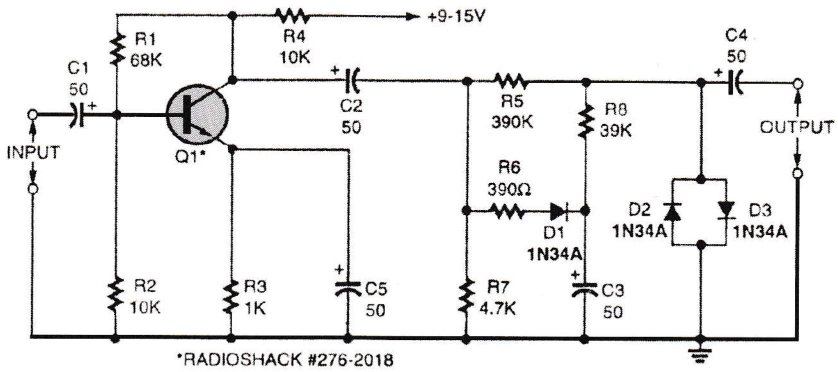
FIG.2

ELECTRONIC DESIGN

Fig. 6-4

Many photodiode applications require high gain and wide bandwidth. A dc-restored photodiode amplifier (Fig. 1) is useful in situations where a time-varying light signal of interest competes with unwanted ambient background light. To extend the amplifier's bandwidth, the design can be modified to provide current-to-voltage conversion with subsequent voltage gain (Fig. 2). Current from the low-capacitance photodiode flows through R_g and establishes a voltage at the noninverting terminal. This voltage then receives a gain equal to $11R_f/R1$. With the values shown in Fig. 2, the equivalent transimpedance $R_g(11R_f/R1)$ is equal to 10 Ω. The design uses an invertingintegrator to drive a restoration current through R_g. This low-frequency current cancels current from the photodiode at frequencies below the low-frequency cutoff pole. The low-frequency pole in Fig. 2 is given by $f_{-3dB}5(1/2\pi RC)(11R_f/R1)$. For the values shown, this is equal to 159 Hz. R_g helps determine the equivalent transimpedance and provides the path for the low-frequency restoration current. The measured high-frequency cutoff for the circuit in Fig. 1 is 4.9 kHz, with a total in-band noise of 370 μV rms. In Fig. 2, the high-frequency cutoff is extended to 11.7 kHz, with a total in-band noise of 589 μV rms.

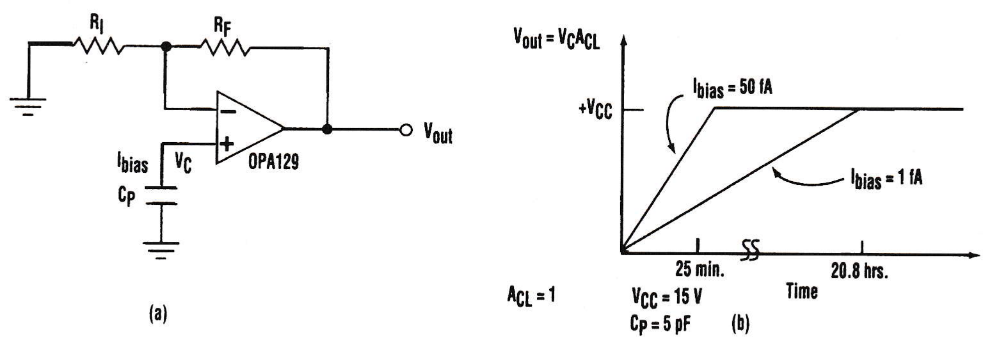
COMPRESSION AMPLIFIER



POPULAR ELECTRONICS *Fig. 6-5*

Here's a compression-type amplifier that can be used to keep the volume level of an organ constant. Unlike compressors used for public-address-system applications, the organ leveler can respond to the entire range of frequencies generated by the organ without coloring the voice. It can handle large fluctuations in input signal without clipping. It also works well as a microphone leveler.

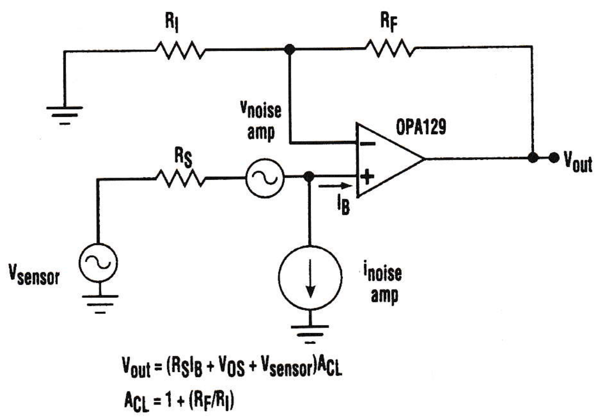
OP-AMP BIAS-PRECAUTION CIRCUIT



ELECTRONIC DESIGN ANALOG APPLICATIONS *Fig. 6-6*

All amplifiers must have a dc path for input-bias current to return to ground (a). Without this path, an amplifier will eventually drift to the output rail (b).

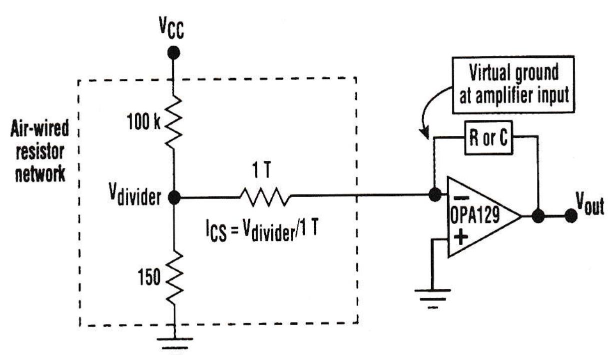
OP-AMP ERROR-SOURCE CIRCUIT



ELECTRONIC DESIGN ANALOG APPLICATIONS *Fig. 6-7*

The basic error sources for an op amp are shown referenced to the output. In high-source-impedance applications, the input bias current terms can become quite dominant.

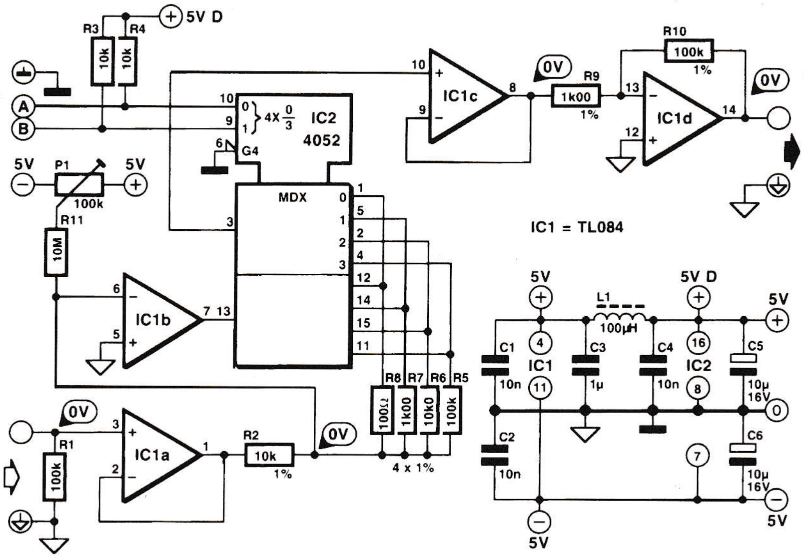
OP-AMP ERROR-CURRENT MEASUREMENT CIRCUIT



ELECTRONIC DESIGN ANALOG APPLICATIONS *Fig. 6-8*

Using an air-wired resistor-divider network, designers can make a precision femtoampere source that can inject a known error current into the amplifier to check the circuit's accuracy.

PROGRAMMABLE AMPLIFIER



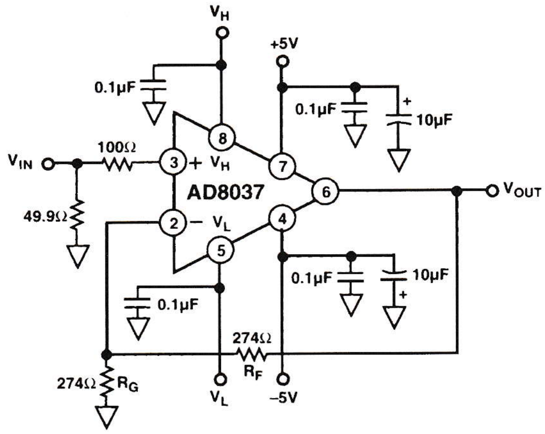
A	B	Amplification	
0	0	1	$(R_8/R_2) \cdot (R_9/R_{10})$
0	1	10	$(R_7/R_2) \cdot (R_9/R_{10})$
1	0	100	$(R_6/R_2) \cdot (R_9/R_{10})$
1	1	1000	$(R_5/R_2) \cdot (R_9/R_{10})$

ELEKTOR ELECTRONICS

Fig. 6-9

The programmable gain amplifier (PGA) is ideal for applications, such as data loggers and automatic measuring instruments. The amplification can be set anywhere between unity and ×1000. The bandwidth at any amplification is >30 kHz. The current drain does not exceed 7 mA. The input signal is buffered by IC1a and then applied to amplifier IC1b. The amplification of this stage depends on how feedback resistors R5 to R8 are switched into the circuit by IC2. How the resistors are intercoupled depends on the logic levels at inputs A and B. The interrelation among the resistors, the total amplification, and the logic levels is shown in the table. After the output signal of IC1b has passed through the multiplexer, it is applied at ×100 amplifier IC1d via buffer IC1c. The overall amplification is set with logic levels at inputs A and B as shown in the table. The amplification of the first stage has been kept low purposely to ensure that the value of the feedback resistor does not have to be high, which makes the effect of the leakage current of the multiplexer negligible.

CLAMP AMPLIFIER

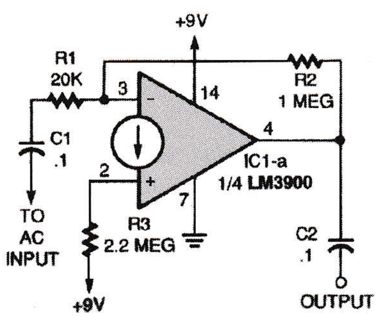


ANALOG DIALOGUE

Fig. 6-10

A clamp amplifier is a limiting or bounding circuit. For input voltages between two levels, V_H and V_L, the output is proportional to the input. For inputs greater than V_H or less than V_L (V_H or V_L × the amplifier gain, A_v), irrespective of the input. The threshold voltages, V_H and V_L, can be fixed or variable. If the amplifier can handle positive and negative input/output voltages, V_H and V_L can have any positive or negative value within the specified range, as long as $V_H > V_L$.

LM3900 AC AMPLIFIER



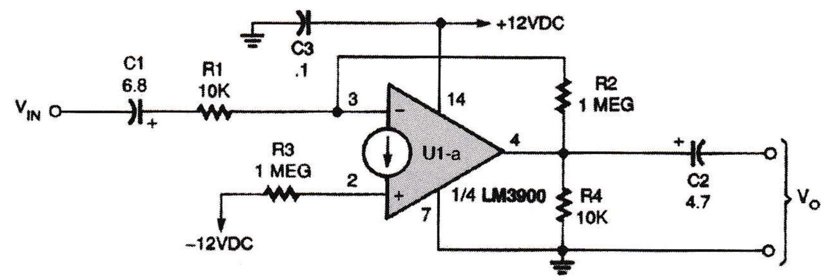
Although the LM3900 current difference amplifier (IC1) used in this ac amplifier really isn't a true op amp, it does simulate one in its performance; however, the IC requires only a one-polarity power source.

Gain is R2/R1, and R3 is 2×R2.

POPULAR ELECTRONICS

Fig. 6-11

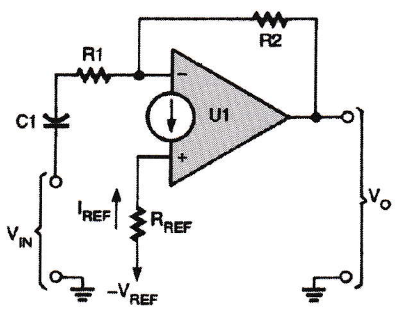
CURRENT DIFFERENCE AMPLIFIER



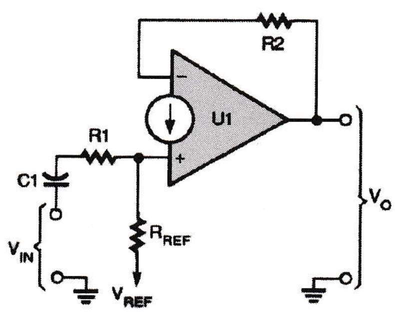
POPULAR ELECTRONICS *Fig. 6-12*

This practical 20-dB gain ac amplifier uses the LM3900 CDA.

CURRENT DIFFERENCE AMPLIFIER USAGE CIRCUITS



Here a current difference amplifier is used much like an op amp in an inverting follower circuit.



Here is a noninverting follower built around a current difference amplifier.

POPULAR ELECTRONICS *Fig. 6-13*

POWERED SUBWOOFER

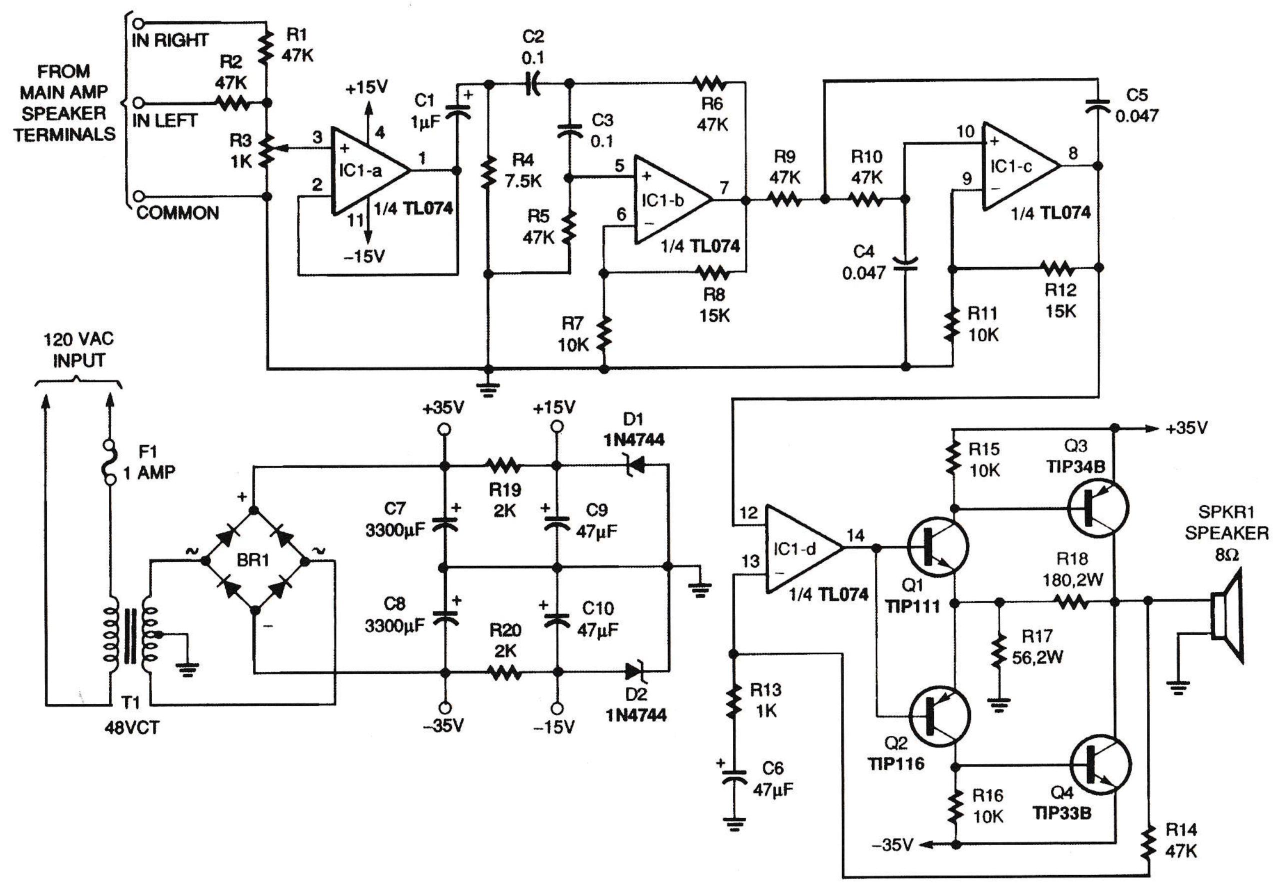
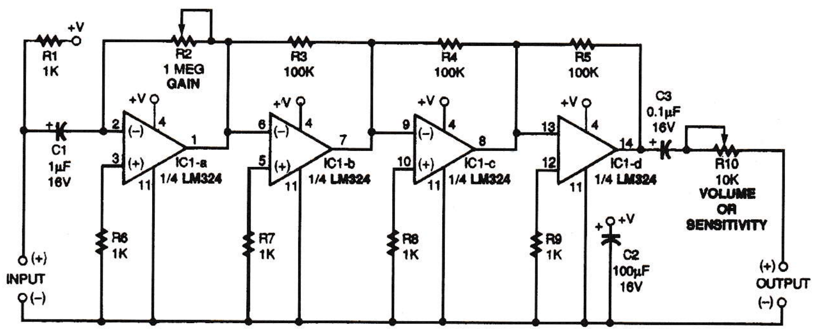


Fig. 6-14

The power supply consists of a center-tapped 48-V transformer, a bridge rectifier, and filter capacitors. The rectified and filtered output is about ±35 V. The power supply for op amp IC1 is regulated to ±15 V by zener diodes D1 and D2 and resistors R19 and R20. The input circuit consists of a mixer and voltage divider formed by resistors R1 and R2, potentiometer R3, and unity-gain buffer IC1-a. Potentiometer R3 is provided to adjust the output of the subwoofer to the desired level. Op amp IC1-b provides a 12-dB-per-octave high-pass filter with capacitors C2 and C3 and resistors R5 and R6. The cutoff frequency for this filter is $1/2\pi RC$, or about 34 Hz with the values shown. Resistors R8 and R7 set the gain and Q of the filter. Capacitor C1 and resistor R4 form an additional 6-dB-per-octave high-pass filter at about 20 Hz. A 12-dB-per-octave low-pass filter is formed by IC1-c, C4 and C5, and R9 and R10. The values shown set the low-pass cutoff at 72 Hz. The gain and Q of this stage are set by R11 and R12. These two filters, connected back-to-back, form a bandpass filter. When operated with ±15-V supplies, the output of op amp IC1-d can swing about 10 V peak to drive transistors Q1 and Q2. Resistors R17 and R18 provide negative feedback, and set the gain of the output stage at about 3. Hence, the output can swing to about 30 V peak. As long as the transistors are the high-beta types specified, the peak power output into an 8-Ω load is (30×30/8)/2556 W rms. The overall gain of the amplifier is set by resistor R13 and feedback resistor R14.

HIGH-GAIN AMPLIFIER FOR PHOTODETECTORS

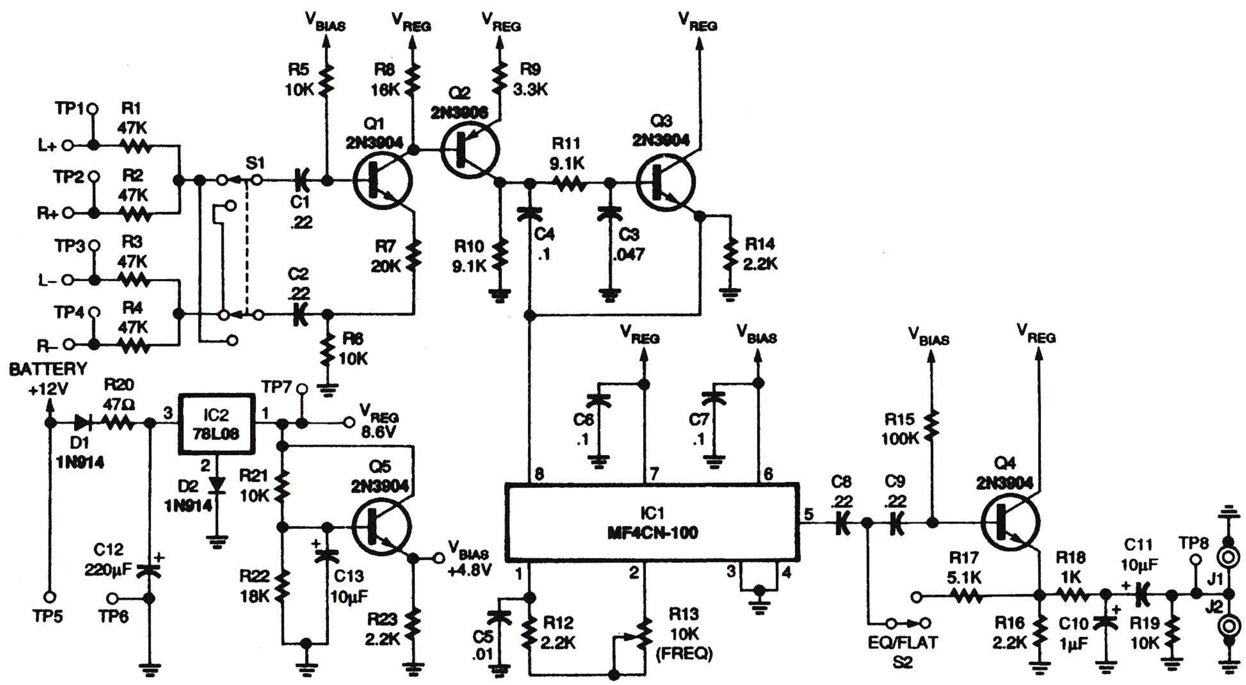


ELECTRONICS NOW

Fig. 6-15

Suitable for photodetectors, laser experiments, or general use, this four-stage amplifier uses a single LM324 quad op amp. A 9-V supply is recommended.

CAR STEREO SUBWOOFER CROSSOVER

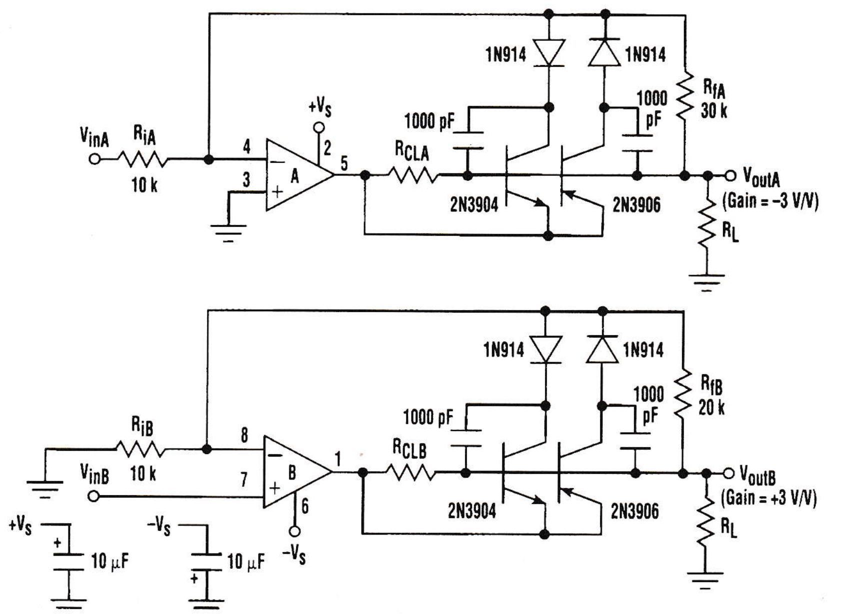


ELECTRONICS NOW

Fig. 6-16

This figure is the schematic for the subwoofer crossover. The inputs through Q1 form a differential summing amplifier, with switch S1 functioning as a polarity inverter. A 24-dB-per-octave switched capacitor filter (IC1) is the heart of the continuously variable filter. Potentiometer R13 controls the cutoff frequency of IC1 by controlling its sampling frequency. Because of the inherent sampling action of switched capacitor filters, an antialiasing filter is required at the input of IC1. Transistors Q2 and Q3, along with the surrounding components, form this second-order low-pass antialiasing filter. The subsonic filter with a boost stage follows the output of IC1 at 5. When switch S2 is closed, the boost is added. Additional subsonic filtering action is provided by C1 and C2 at the inputs of the crossover circuit. A "reconstruction filter" that eliminates sampling artifacts is formed by R18 and C10 at the output of IC1. The power-supply circuit, based on the 78L08 voltage regulator (IC2), provides both an 8.6-V main supply and a 4.8-V bias supply. Diode D1 protects against negative voltage spikes and incorrect hookup. Diode D2 biases the 78L08 regulator reference pin at 0.6 V to provide an output of 8.6 V, rather than 8 V.

CURRENT LIMITERS

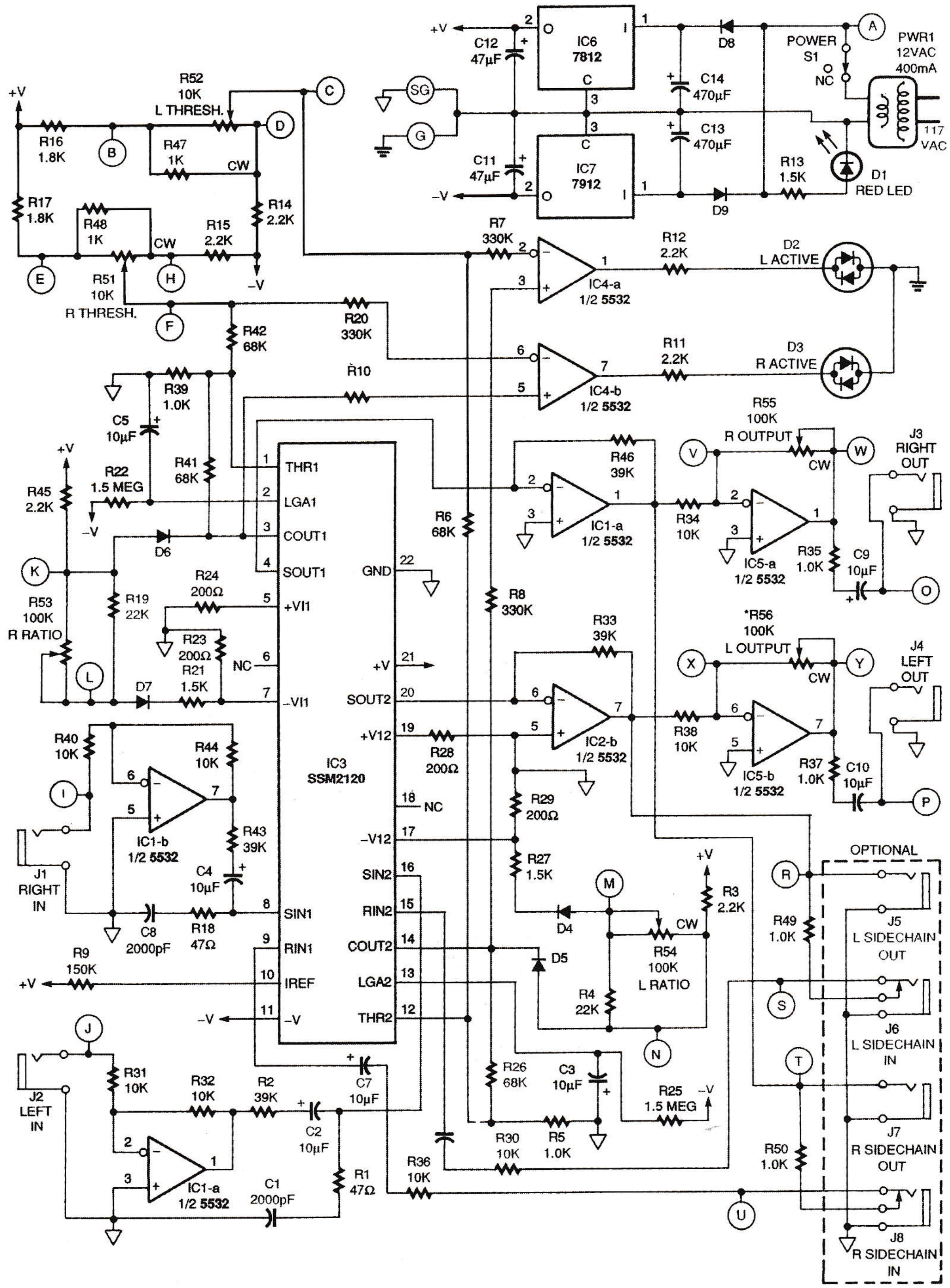


ELECTRONIC DESIGN ANALOG APPLICATIONS

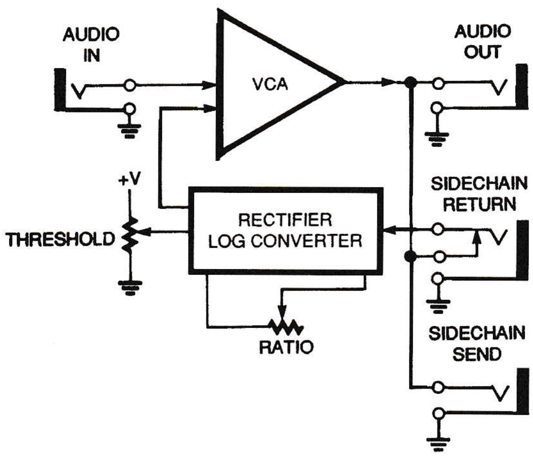
Fig. 6-17

A user-controlled internal current limit on power op amps isn't always provided by manufacturers. However, the current limit can be set externally by using the technique shown, in which the output current is sensed with a single resistor. The resistor activates a complementary transistor switch that reduces inverting gain, limiting output current. The technique is demonstrated with 8-pin OPA2541 or OPA2544 dual-power op amps that are lacking an internal user-controlled current limit. The external components add an adjustable current limit to these amplifiers. The PNP transistor controls the positive current limit, and the NPN transistor controls the negative current limit. Both transistors are OFF until the voltage drop across R_{CL} reaches the current-limit set point. At the current-limit set point, current from the controlling transistor will sum with the input current (through R_i) at the op amp's inverting input summing junction. This will limit the output. The diodes in series with the collectors of both transistors prevent forward base-collector bias. High-frequency oscillation during current limit is damped out with the 1000-pF capacitors. These capacitors only nominally affect the configuration's closed-loop bandwidth because the diodes, which are normally off, isolate them.

STEREO AUDIO COMPRESSOR



STEREO AUDIO COMPRESSOR *(Cont.)*



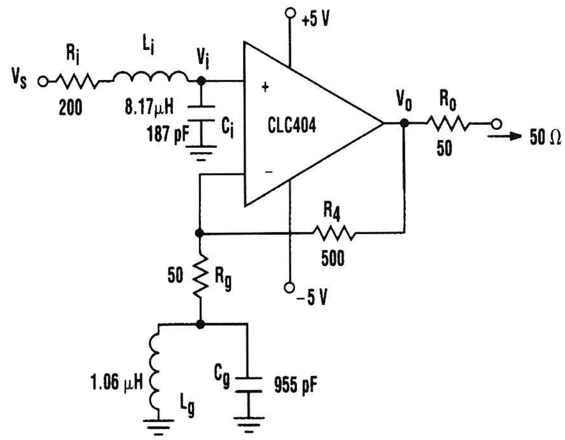
FUNCTIONAL BLOCK DIAGRAM of the Stereo Compressor. Sidechain portions of the diagram may be omitted from the unit's construction.

ELECTRONICS NOW

Fig. 6-18

The block diagram of the stereo compressor is shown. The input signal is fed to a voltage-controlled amplifier (VCA) that has a nominal gain of unity. Some of the output signal is fed to a precision rectifier followed by a logarithmic converter circuit. The output of this block is a dc voltage proportional to the log of the average level of the input signal. By sending some of this dc control voltage to the VCA, the gain of the VCA is automatically reduced when the input signal exceeds a user-determined threshold level. It is important to note that the signal level is determined after the VCA and not before. This allows the output level to increase and sound normal, but not increase as much as the input signal does. By varying the amount of feedback, the compression ratio is adjusted, which, in conjunction with the THRESHOLD control, determines the operating characteristics of the compressor. The optional sidechain jacks permit external processing of the audio signal or substitution of a completely different audio signal as the control signal. This add-on circuitry lets the user experiment and achieve some useful audio effects.

OP-AMP RESPONSE NULL CIRCUIT



ELECTRONIC DESIGN ANALOG APPLICATIONS

Fig. 6-19

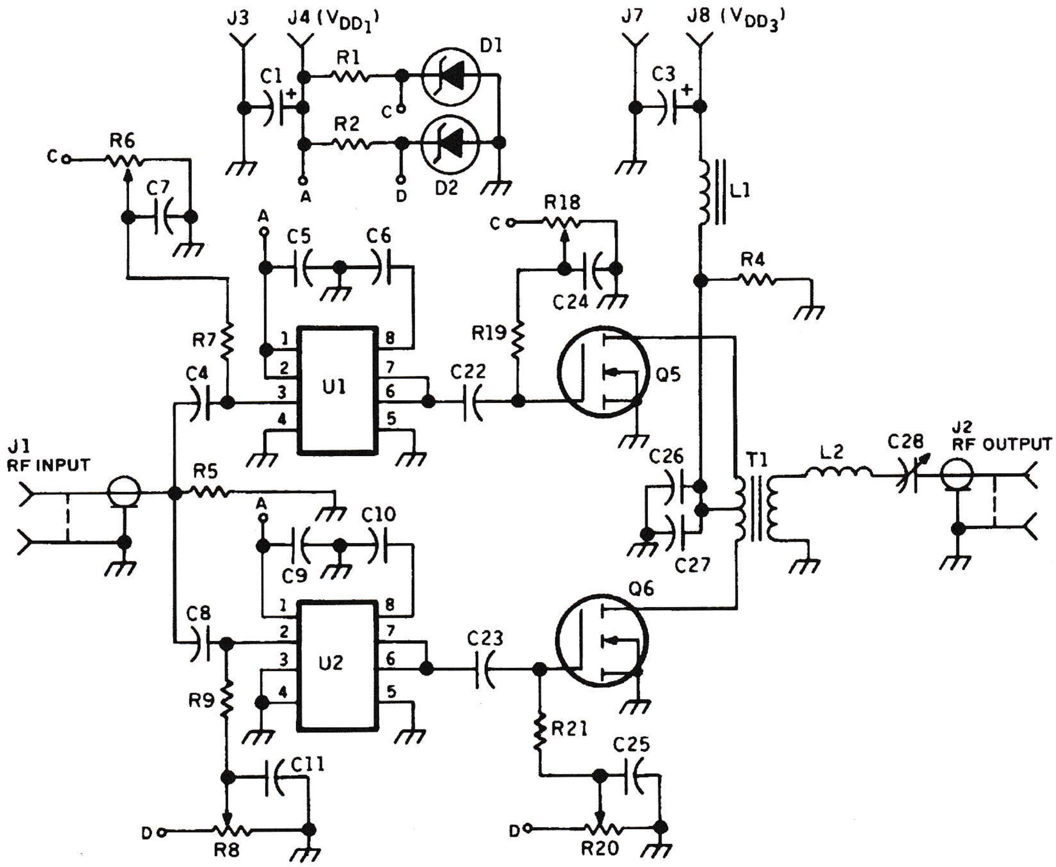
A sharp null can be achieved in a current feedback op amp's frequency response by adding a sharp cutoff filter. The response is modified by adding a resonant circuit in series with the gain-setting resistor R_g.

7

Amplifier Circuits—RF

The sources of the following circuits are contained in the Sources section, which begins on page 1043. The figure number in the box of each circuit correlates to the entry in the Sources section.

1.8- to 7.2-MHz POWER AMPLIFIER



COMMUNICATIONS QUARTERLY

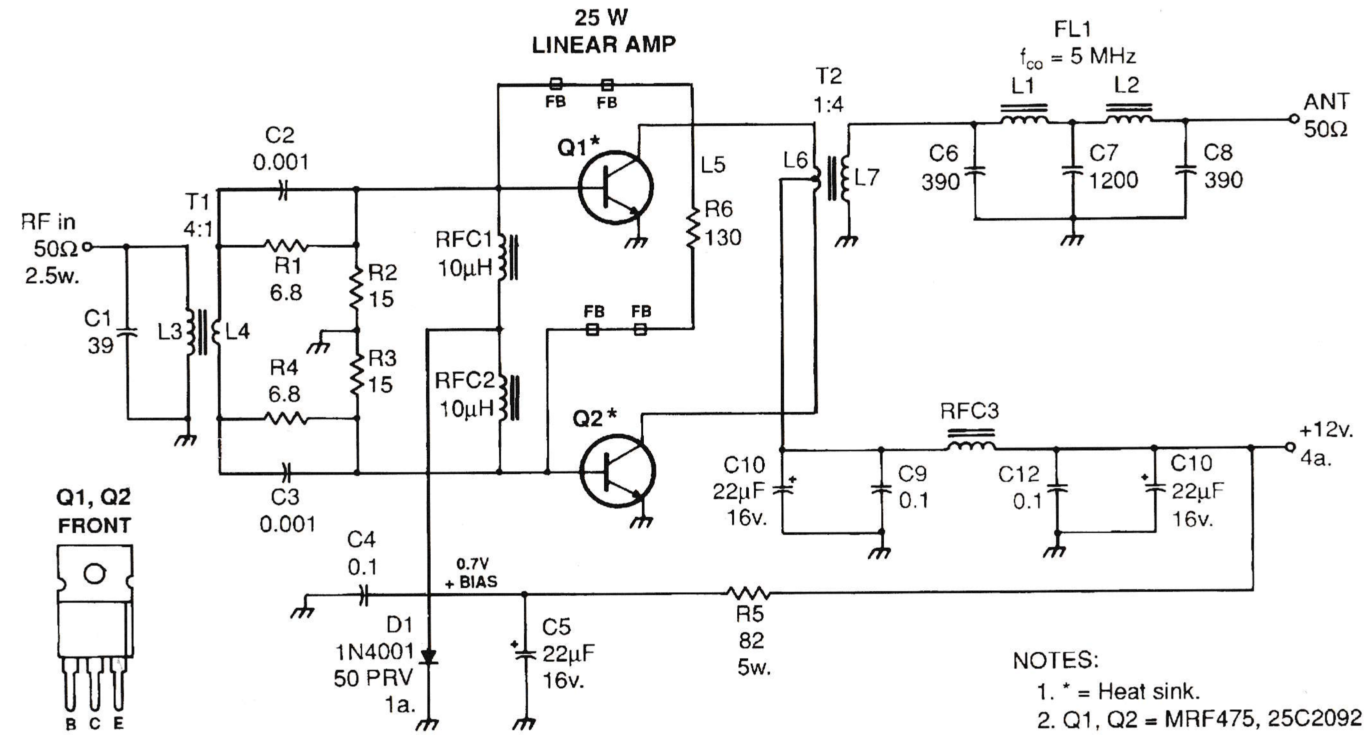
Fig. 7-1

A novel approach to a 250-W power amplifier (PA) is shown. The driver uses a pair of low-cost ICs, rather than the conventional RF transformer to provide out-of-phase driving signals for the two final MOSFETs. It also provides hard limiting (sine-wave–to–square-wave conversion) of the input signal. The Elantec EL7144C is intended for use as a gate driver. The internal Schmidt trigger allows it to serve as a hard limiter, and the presence of both inverting and noninverting inputs allows a pair to serve as a phase splitter. The RF input is ac-coupled to the noninverting input of U1 and the inverting input of U2. Adjustment of the biases via R6 and R8 allows the transition points to be selected to produce the desired duty ratio (50:50). The phase error between the two EL7144s is about 0.5 ns. (If an oscilloscope is not available, use a voltmeter with a 1-kΩ series resistor and set

Reference Designator	Part Description
C1	33-µF, 50-V electrolytic, Mallory
SKR33OM1HE11V	
C3	20-µF, 250-V electrolytic, Mallory TT25OM20A
C4-C27	0. 1-µF, 50-WV chip, ATC 200B 104NP50X
C28	
DI, D2	5.1-V, 0.25-W Zener, 1N751A
J1, J2	BNC female bulkhead
	Recommended: Amphenol 31-5538
	Used: RF Industries RFB-1116S/U
J3, J4, J7, J8	European-style binding post, Johnson 111-0104
Ll	3.5-µH, 7 tums #24 enameled wire on Ferroxcube
L2	768XT188 4C4 toroid.
Q5	*n*-channel MOSFET, APT ARF440
Q6	*n*-channel MOSFET, APT ARF441
Rl, R2	330-Ω RC07
R4	1O-kΩ RC07
R5	51-kΩ RC07
R6, R8, RI8, R20	1-kΩ trimpot, Bournes 3299X-1-102
R7, R9, R19, R21	4.7-kΩ RC07
T1	One Ceramic Magnetics 3000-4-CMD5005 block of CMD5005 ferrite
U1, U2	Schmidt trigger/limiter, Elantec EL7144C
Heatsink for DIP IC	Aavid 5802 clip-on
Heatsink for Q5 and Q6	Aavid 61475, 6.5-in wide by 4-in long
IC socket, 8-pin DIP (4)	Augat 208-AG 190C
PC board	Approximately 6.5-in wide by 8-in long
Plastic bracket for L2	Cut from plastic L
Plastic bracket for C28	Cut from plastic L
Feet (6)	Aluminum threaded spacer, 4-40 × 2 in (Keystone 2205)

the average output voltage to 6 V.) The EL7144s have high input impedances, so R5 provides a 50-V input impedance for the signal source. Input signals in the range of 10 to 100 mW are satisfactory, allowing this PA to be driven directly from a laboratory signal generator or oscillator with buffer. The best switching speed is obtained with VDD1=12 V. Output transistors are ARF440 and ARF441. See parts list.

25-W SOLID-STATE LINEAR AMPLIFIER

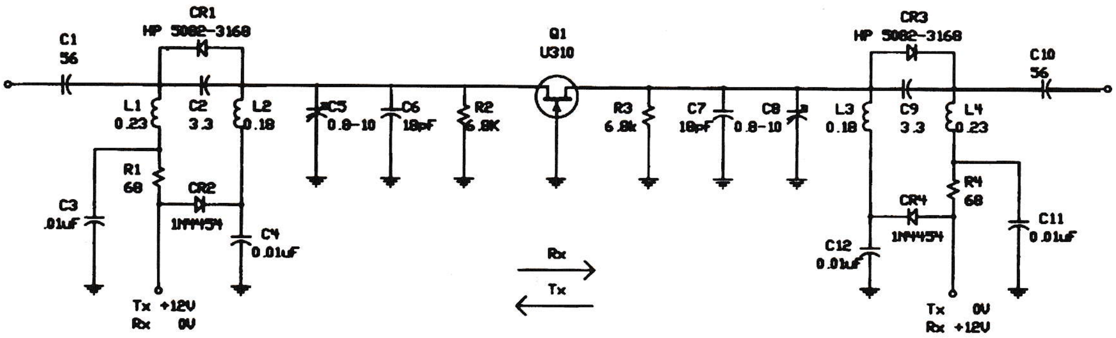


CQ MAGAZINE

Fig. 7-2

This shows a schematic diagram of the 25-W linear amplifier. Decimal-value capacitors are in microfarads; others are in picofarads. Polarized capacitors are electrolytic or tantalum, 16 V or greater. Resistors other than R5 are 1/4-W carbon-composition or carbon-film units.

BIDIRECTIONAL RF AMPLIFIER

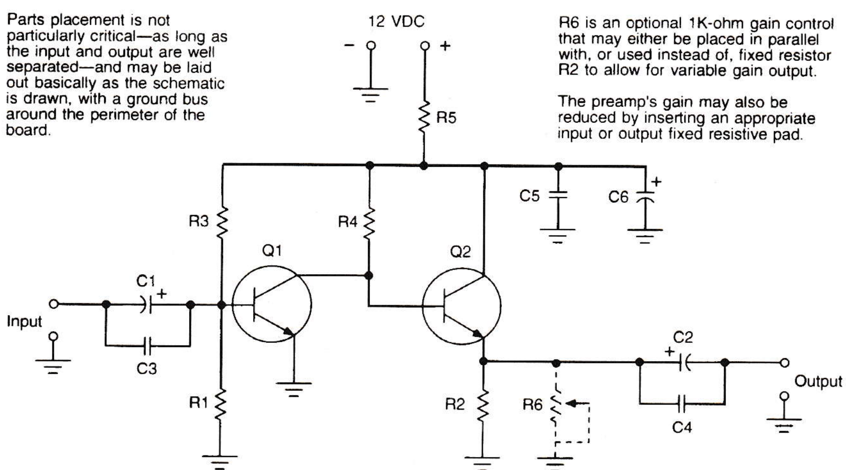


RF DESIGN

Fig. 7-3

JFETS can often be used with the source and drain interchanged. This interesting circuit makes use of this fact as a bidirectional RF amplifier at 70.0455 MHz. It is useful for transceiver applications.

GENERAL-PURPOSE WIDEBAND PREAMP



73 AMATEUR RADIO TODAY

Fig. 7-4

This preamp has a gain of 35 dB at 100 kHz, 30 dB at 10 MHz, and 17 dB at 100 MHz and draws 15 mA at 12 V.

LOW-NOISE 9-MHz AGC-CONTROLLED AMPLIFIER

	16 dB gain	13 dB gain
Noise figure	0.6 dB	.6 dB
Input impedance	50 ohms	50 ohms
Output impedance	50 ohms	50 ohms
Third order intercept		
Vs = +12V (max gain)	23 dBm	26 dBm
Vs = +20V (max AGC)	28 dBm	30 dBm
Input for 1 dB compression		
Vs = +12V (max gain)	0 dBm	+3 dBm
(max AGC)	7 dBm	+11 dBm
Vs = +20V (max gain)	+5 dBm	+8 dBm
(max AGC)	+11 dBm	+14 dBm

Amplifier input and output impedances are 50 ohms regardless of AGC-controlled gain. Gain range 45 dB.

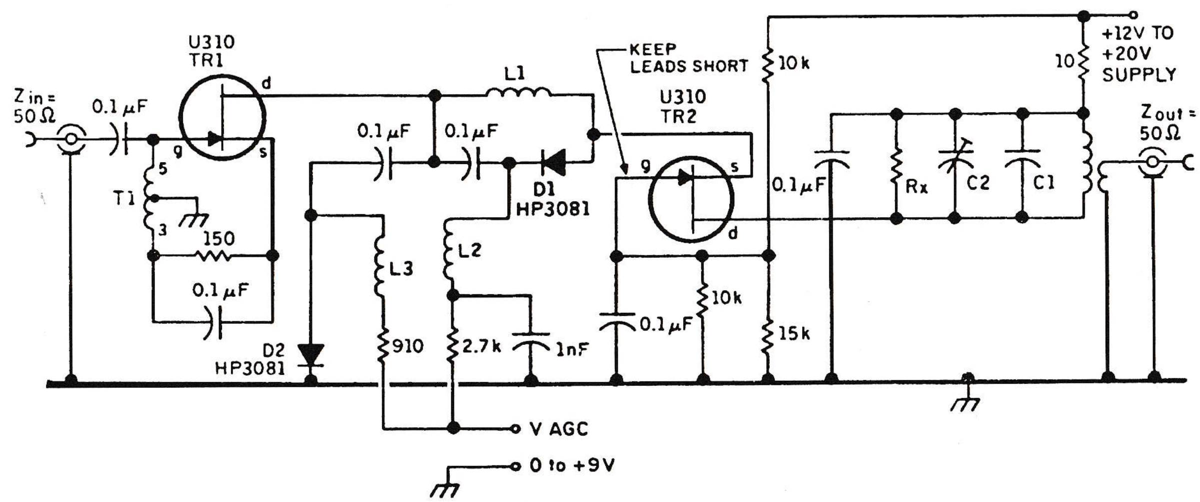
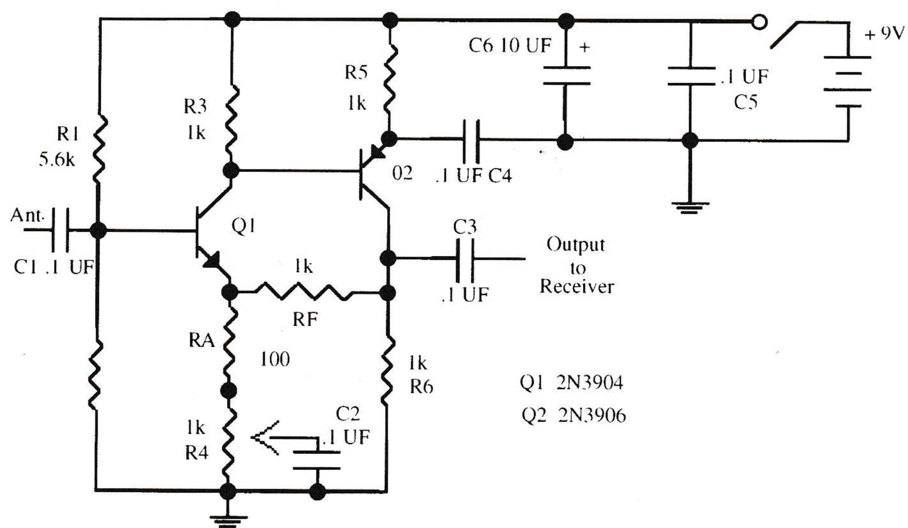


Fig. 7-5

The circuit diagram of the 9-MHz amplifier is given. Note that the AGC amplifier must be capable of sinking the current through D1 at 0 V (i.e., maximum gain). The warning to keep leads short in the drain circuit of the second U310 FET arises from experience in which the initial IP3 measurements proved to be poor because of this stage's oscillating around 400 MHz.

Component notes: The two U310s are Siliconix low-noise JFETs. C1 is an 82-pF ceramic, C2 is a 60-pF ceramic trimmer (Cirkit), and all other capacitors are monolithic ceramic (RS components). Resistors are 1/8 W metal film (RS components). D1 and D2 are HP3081 PIN diodes (Farnell). T1 is 1513 turns of 0.224-mm diameter Bicelflux enamel on Fairite Balun core 28-43002402 (Cirkit). T2 (primary) is 2.81 μH, 31 turns of 0.314-mm Bicelflux enamel on Micrometals toroid T37-6 (Cirkit). T2 (secondary) is (1) for 16-dB gain, 3 turns, Rx 6k2; (2) for 13-dB gain, 4 turns, Rx 3k9. Note that (1) and (2) could be relay switched for use with an SSB or CW filter (loss 10 dB or 3 dB). L1, L2, and L3 have 7 turns of 9.314-mm enamel on balun core 28-43002402 (Cirkit).

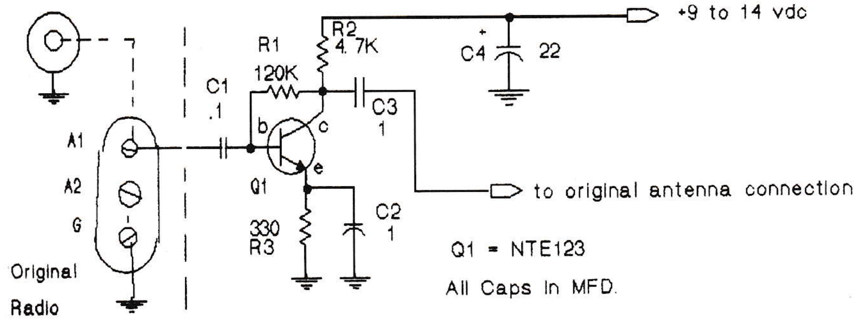
RECEIVER PREAMPLIFIER



73 AMATEUR RADIO TODAY **_Fig. 7-6_**

This preamplifier lets you use a short antenna over the range from 100 kHz to well over 55 MHz, with excellent sensitivity, using a vertical 30-in piece of #12 wire or a few feet of wire laying on the floor. Transistor Q1 (NPN) is directly coupled to PNP transistor Q2. Feedback from the collector of Q2 to the emitter of Q1 is accomplished by resistors RF and RA. Because of the high open-loop gain of the amplifier, the gain of the amplifier is R_F/R_A, or 20 dB maximum. A 1-kΩ potentiometer changes the effective value of R_A, resulting in a minimum gain of near unity.

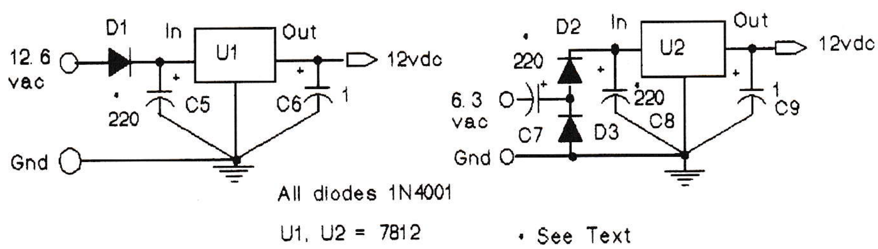
RECEIVER RF PREAMP



73 AMATEUR RADIO TODAY *Fig. 7-7*

The RF broadband preamplifier uses an NPN VHF transistor as an untuned broadband (0.5 to 30 MHz) RF amplifier. Input impedance is 50 Ω, allowing usage for all receiver inputs, and the unit has a 600-Ω output to match virtually all RF input circuits. The preamp delivers 30 dB of gain at 10 MHz, with a noise factor below 1 dB. Power for the preamp can be obtained from a variety of sources. The assembly requires from 9 to 14 Vdc and draws 8 mA of current. This makes it ideal for use in battery-operated portable equipment.

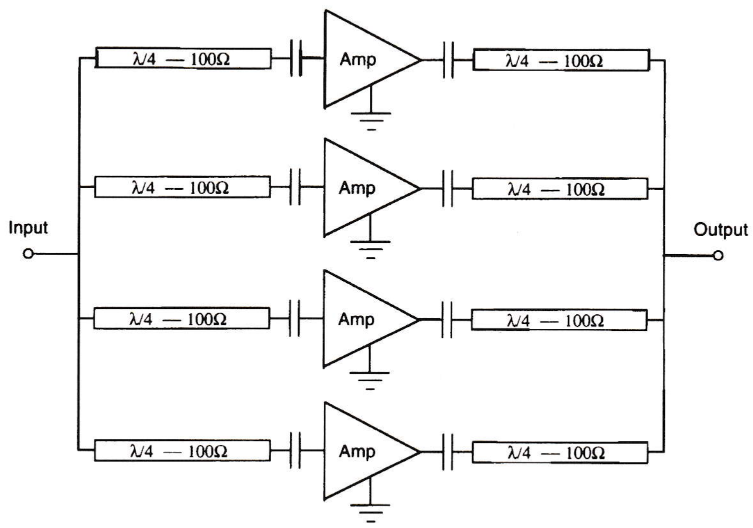
RF PREAMP SUPPLY



73 AMATEUR RADIO TODAY *Fig. 7-8*

Early tube-type receivers used filament voltages of 6.3 and 12.6 Vac, but had no low-voltage dc power supplies. The figures show how to "borrow" a little of the filament voltage, which is rectified and regulated to provide 12 Vdc for the preamp. In the 6.3-Vac version, diodes D2 and D3 act as a simple voltage doubler to step the input voltage up to approximately 15 Vdc. While the 220-μF capacitors used for the voltage doubler are sufficient for the load presented by the preamp, they will not provide the 115 V dc to the input of the regulator at more than about a 25-mA load. If other circuits will be used with these dc power sources, then the 220-μF capacitors should be increased accordingly (2200 μF will provide about 65 mA regulated output).

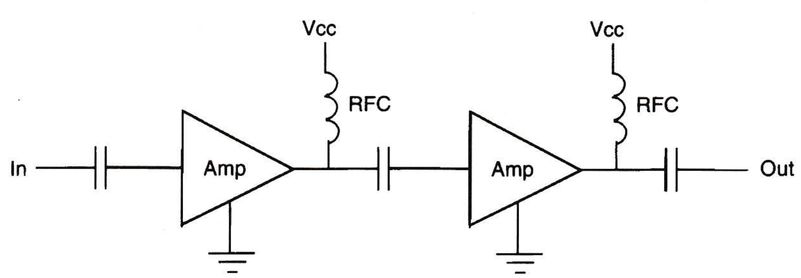
COMBINED MMIC AMPLIFIERS



RF DESIGN ***Fig. 7-9***

Quadrature combining, practical in microstrip, can be used to obtain a medium power output from several MMIC amplifiers.

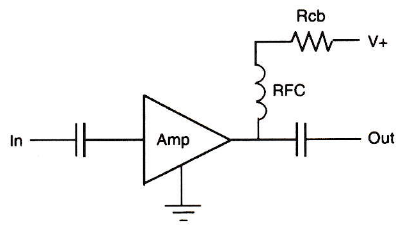
CASCADED MMIC AMPLIFIER CIRCUIT



RF DESIGN ***Fig. 7-10***

Most MMIC amplifliers can be cascaded, with dc blocking as the only interstage connection requirement.

MMIC AMPLIFIER CIRCUIT

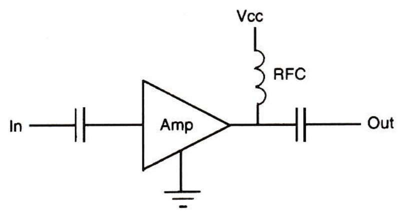


The addition of a series dropping resistor allows operation at higher supply voltages.

RF DESIGN

Fig. 7-11

SIMPLE MMIC AMPLIFIER CIRCUIT



This is the simplest implementation of an MMIC amplifier.

RF DESIGN

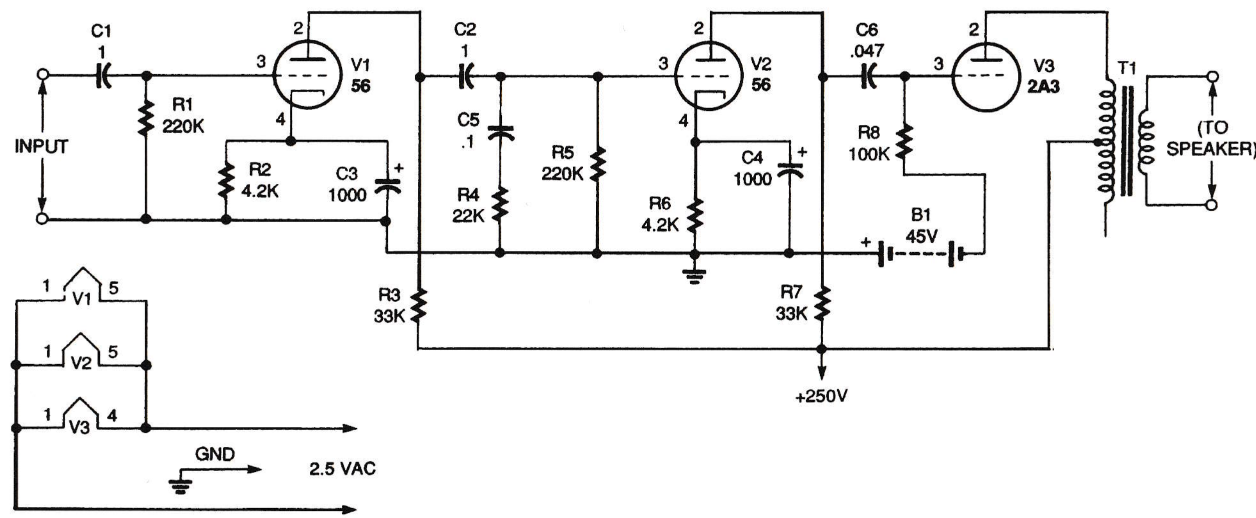
Fig. 7-12

8

Amplifier Circuits—Vacuum Tube

The sources of the following circuits are contained in the Sources section, which begins on page 1043. The figure number in the box of each circuit correlates to the entry in the Sources section.

SINGLE-ENDED HI-FI AMPLIFIER

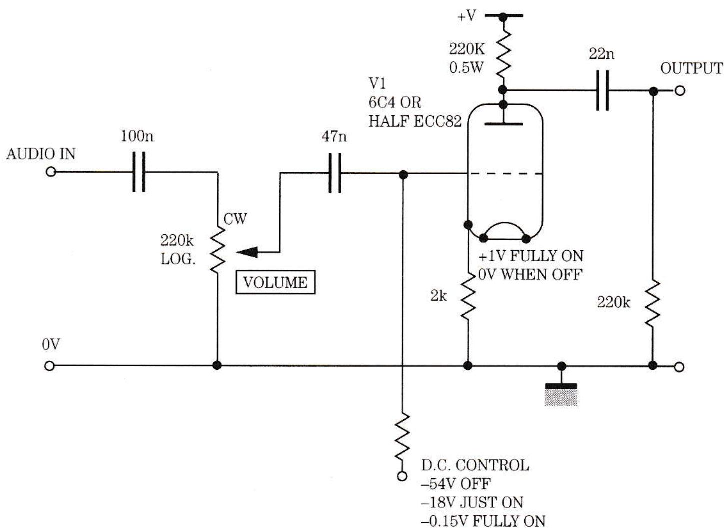


POPULAR ELECTRONICS

Fig. 8-1

The circuit as shown will handle up to about 0.5 V; above that, distortion will be present. The input stage amplifies the signal voltage about seven times, and the second stage amplifies the voltage about 10 times. Both stages use type 56 triodes (V1 and V2). The output stage uses a type 2A3 tube, V3. Two 22.5-V batteries wired in series (B1) were used to provide 45 V on the grid of V3. In this circuit (and other single-ended amplifiers), direct current flows in the primary of the output transformer (T1) to use the circuit modification shown in Fig. 2. That change keeps dc out of the primary at some sacrifice in power. With the modification, the amplifier will be flat (within 1 dB) from 20 to 20,000 Hz. (The modified circuit requires that a high-voltage transformer be used in the power-supply circuit.) Note that transformer T1 is shown connected from one end of the primary to the center tap. That was done because it is assumed that the transformer used will have a primary impedance of about 8000 Ω. The recommended load for a 2A3 tube (V3) is 2500 Ω for maximum output, but increasing the impedance lowers the distortion while only slightly lowering the power.

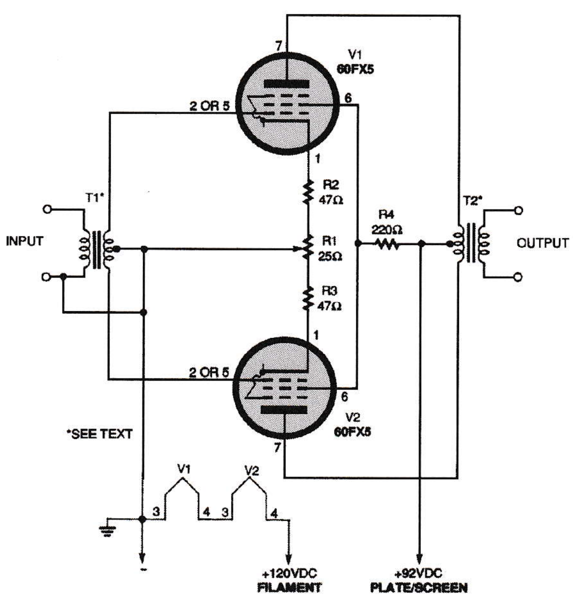
VOLTAGE-CONTROLLED AMPLIFIER STAGE



Gain is controlled by a variable negative grid bias in this amplifier stage.

EVERYDAY PRACTICAL ELECTRONICS ***Fig. 8-2***

AUDIO AMPLIFIER



Some hobbyists still prefer to use older vacuum tube technology. A push-pull audio amplifier using a pair of 60FX5 tubes is shown in the figure. T1 is a 1:3 audio interstage, while T2 is a universal output transformer of about 5000 Ω to voice coil (4 or 8 Ω) impedance.

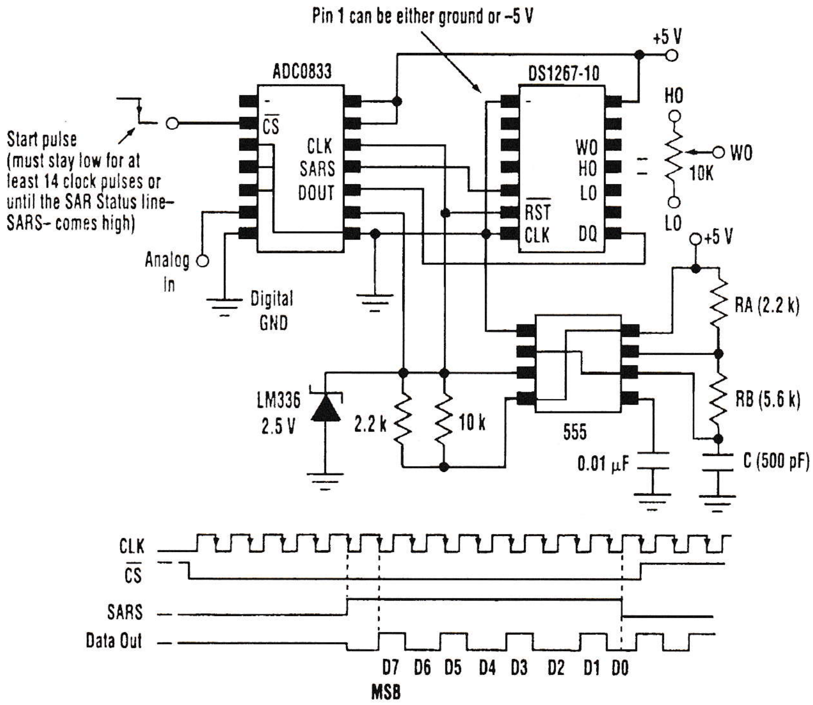
ELECTRONIC HOBBYISTS HANDBOOK ***Fig. 8-3***

9

Analog-to-Digital Converter Circuits

The sources of the following circuits are contained in the Sources section, which begins on page 1043. The figure number in the box of each circuit correlates to the entry in the Sources section.

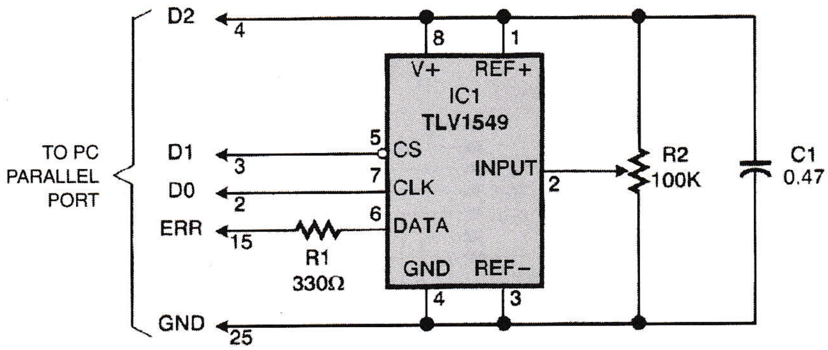
ADC CONTROLLING DIGITAL POTENTIOMETER



ELECTRONIC DESIGN *Fig. 9-1*

This design was created to control a DS1267 digital potentiometer with an analog signal. The DS1267 is a dual-pot chip, but this design will enable control of only one section. Here, the analog-to-digital converter (ADC) used is an ADC0833 8-bit serial I/O converter with a four-channel multiplexer. The analog input to channel 3 of the ADC is employed. The timing diagram illustrates the operation of the circuit. A negative start pulse on the chip select of the ADC starts the sequence (the pulse must stay low for at least 14 clock pulses or until the ADC's SAR Status line comes high). The next five clock pulses perform various housekeeping in the ADC. The Data Out line comes out of tristate on the negative edge of the fifth pulse, and the SAR Status line comes high to signal a conversion in progress. The first bit on the Data Out line is a leading zero for one clock period. Data is clocked into the DS1267 on the positive edge of the clock pulse. The input format for the DS1267 requires that the first bit determine the stack select (used in the DS1267 when the two pots are combined) and the following 8 bits provide data. Following transmission of these 9 bits, the SAR Status line goes high, disabling further input to the DS1267 (the ADC0833's output format continues transmission of 8 more bits of the conversion in reverse order, but the DS1267 ignores these). Input range for the ADC is 0 to 5 V. Pin 1 of the DS1267 is shown tied to ground (for pot connections referenced to ground; however, −5 V can be used to provide a range of 15 to −5 V on the pot).

ANALOG-TO-DIGITAL CONVERTER CIRCUIT



ELECTRONICS NOW *Fig. 9-2*

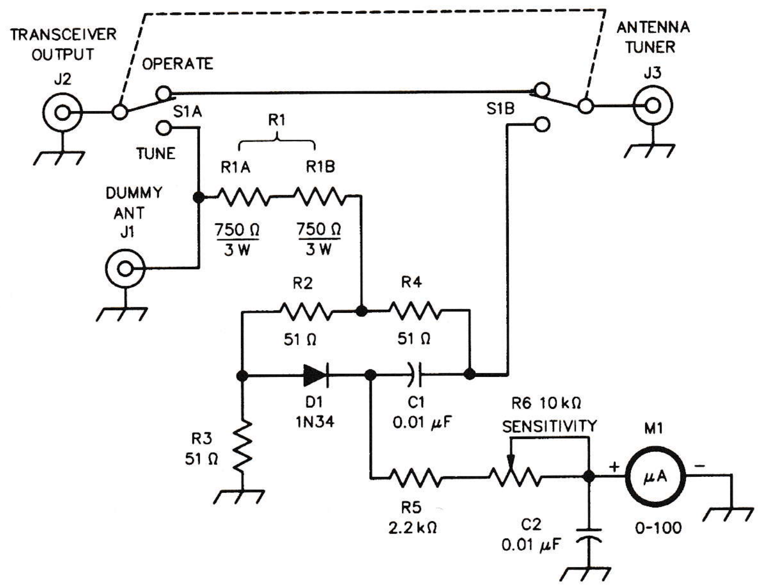
A working circuit that uses a PC parallel port to receive data from a 10-bit analog-to-digital converter (ADC) (Texas Instruments TLV1549) is shown. A fourth wire for reset can be powered from a logic-level signal. In fact, if your printer port produces 5 V (not all do), you can use the more-common TLC1549. Resistor R1 reduces transmission errors by isolating the ADC from the cable capacitance; it might be unnecessary if the cable is short.

10

Antenna Circuits

The sources of the following circuits are contained in the Sources section, which begins on page 1043. The figure number in the box of each circuit correlates to the entry in the Sources section.

ANTENNA TUNING INDICATOR

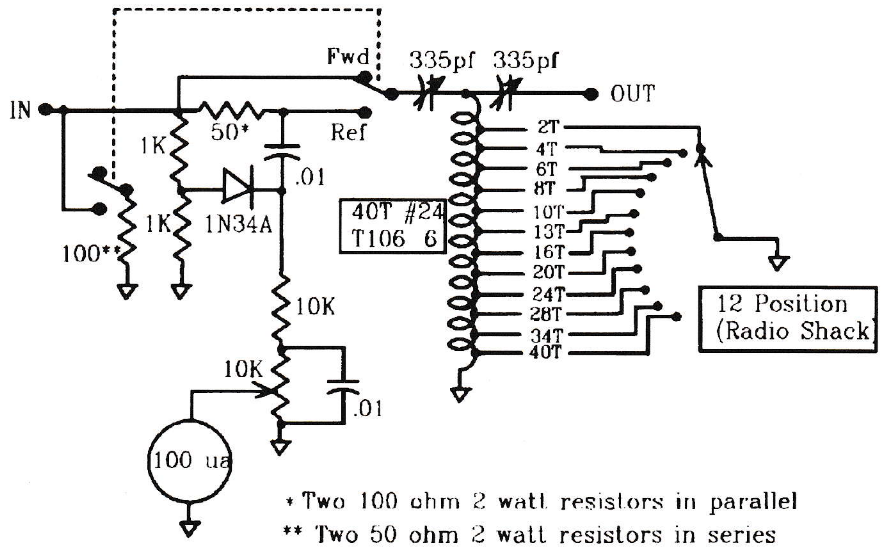


C1, C2—0.01-μF general-purpose ceramic capacitor
D1—Germanium diode (1N34, 1N60, 1N270 or equivalent)
J1-J3—Coaxial jacks
M1—0-50 or 0-100 μA dc meter
R1A, R1B—750-Ω, 3-W, 5%-tolerance metal-oxide film resistor
R2-R4—51-Ω, ½-W, 5%-tolerance carbon-film resistor
R5—2.2-kΩ, ½-W, 5%-tolerance carbon-film resistor
R6—10-kΩ, linear taper potentiometer
S1A—Double-throw, double-pole (DPDT) toggle switch (I used one rated for 120-V service)

QST MAGAZINE ***Fig. 10-1***

The stealth antenna tuning indicator consists of a sensitive reflected-power bridge and indicator (R2 to R6 and associated components) and a switch (S1) that lets you route your transceiver's power into a dummy antenna (TUNE) or your antenna system (OPERATE). One more component, R1 (a resistance consisting of two separate 3-W resistors, R1A and R1B), leaks just enough of your transmitter's power to the bridge and your antenna system to allow low-interference tune-up when S1 is set to TUNE.

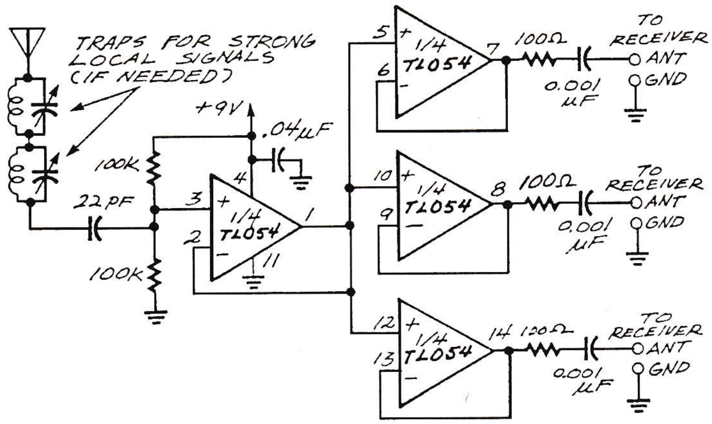
LOW-POWER ANTENNA TUNER AND SWR METER



73 AMATEUR RADIO TODAY *Fig. 10-2*

The SWR meter is a variation of a resistive bridge. This circuit has the advantage of providing high sensitivity at low power inputs. Its disadvantage is that the maximum power that can be applied to the circuit is limited by the power dissipation of the 50-Ω bridge resistors because 75 percent of the transmit power is absorbed by these resistors under perfectly matched conditions. In this circuit, a DPDT switch adds in a 100-Ω resistor only for SWR readings, allowing the circuit to provide a reasonable SWR for your transmitter even during severe tune-up conditions. Additionally, you have minimum insertion loss in the FORWARD position because the 1-kΩ bridge resistors permit you to always indicate forward relative power and calibrate the full-scale reading for SWR measurements. The antenna tuner itself is a standard T-type tuner utilizing a pair of 335-pF miniature transistor radio variable capacitors and a toroidal inductor, tapped as shown in the figure. To actually make the taps, simply wind the toroid with 40 turns of #24 wire, and then scrape the outer surface of each appropriate turn with a hobby knife to clean off the enamel insulation. Then tin each wire turn, and tack-solder tap wires to them.

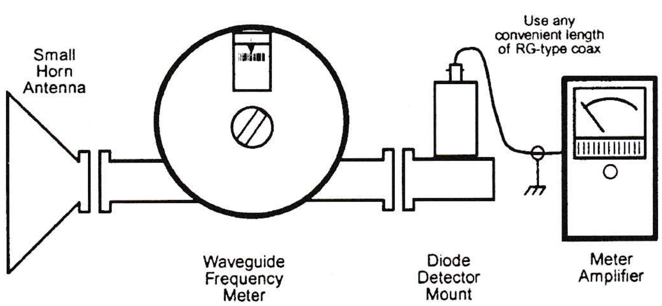
OP-AMP ANTENNA AMPLIFIER



ELECTRONICS NOW ***Fig. 10-3***

The impedance of a random-wire antenna at broadcast-band frequencies will be several kilohms, a poor match for the 50-Ω input of a receiver. Also, the inputs of multiple receivers can't be connected directly to a single antenna, or they'll detune each other. The circuit solves both problems. The first op amp overcomes the impedance mismatch, strengthening the signal greatly even though it has no voltage gain. The rest of the op amps feed the signals to the separate receivers. No low-pass filter is needed because the gain of these op amps drops off sharply above 2 or 3 MHz.

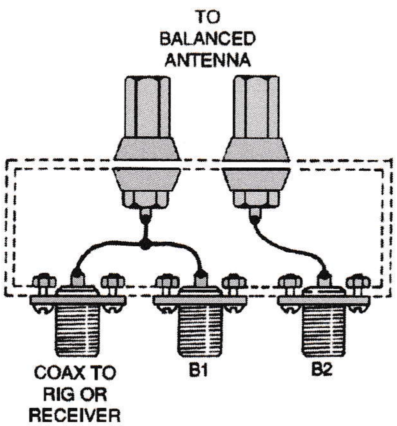
10-GHz WAVEGUIDE TEST ANTENNA SETUP



73 AMATEUR RADIO TODAY ***Fig. 10-4***

This waveguide test antenna, wavemeter, and meter amplifier setup uses a small horn antenna and a variable commercial waveguide frequency meter to determine RF frequency. RF is sampled with a detector and displayed on an amplified meter for sensitive meter indications.

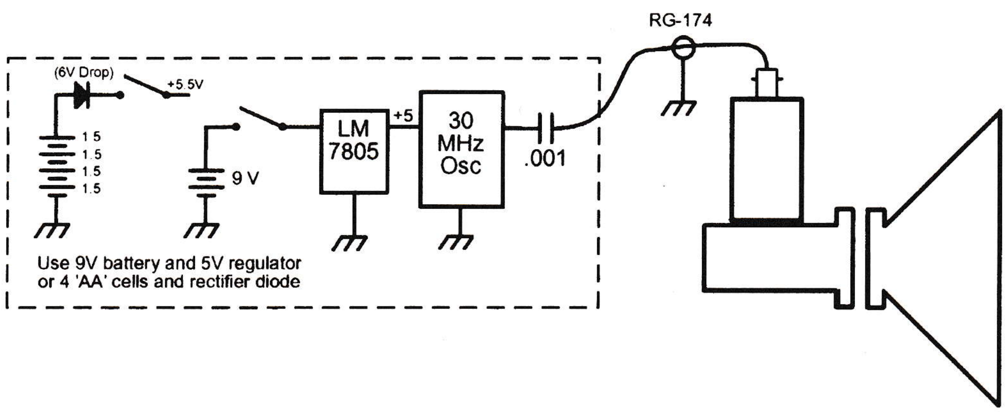
BALUN BOX



Here's the connection box for making a 4:1 coaxial balun. It is intended for mounting on the antenna center isolator.

POPULAR ELECTRONICS ***Fig. 10-5***

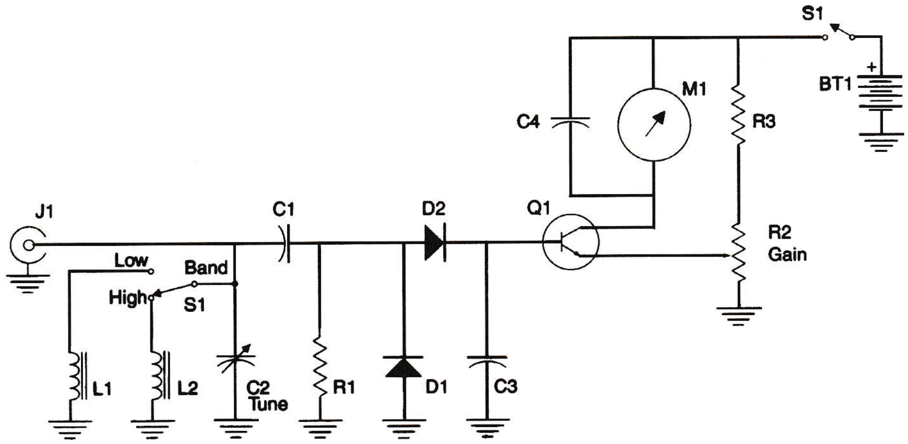
MICROWAVE REFLECTION ANTENNA



73 AMATEUR RADIO TODAY ***Fig. 10-6***

Originally used for 10-GHz microwave transmitter testing, this antenna modulates a received signal with 30 MHz and reflects it, producing a signal component 30 MHz offset from the incident signal for reception and dish-aiming tests.

ANTENNA NOISE BRIDGE DETECTOR



Parts List

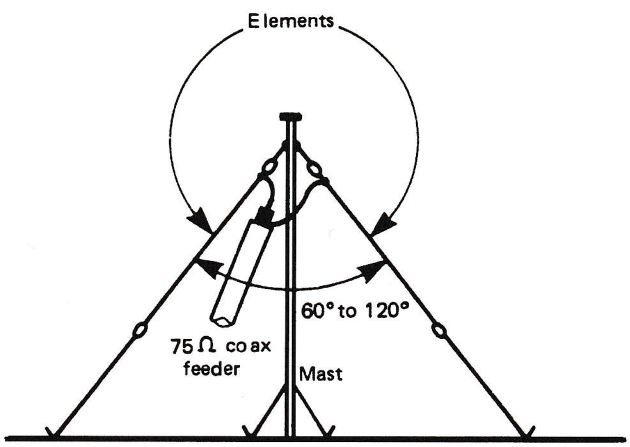
BT1	9-Volt alkaline battery
C1	100 pF mica or poly capacitor
C2	140-150 pF variable capacitor
C3	0.1 µF disc capacitor
C4	0.01 µF disc capacitor
D1,D2	Germanium diode: 1N34, 1N60, 1N90, 1N270, etc.
J1	SO-239 UHF female connector (or builder's choice)
L1	33 turns #26 enam. wire on T50-2 toroid (40-30 meters)
L2	11 turns #26 enam. wire on T50-2 toroid (20 through 10 meters)
M1	100 or 200 µA meter (see text)
Q1	NPN small signal transistor: 2N2222, 2N3904, 2N4124, etc.
R1,R3	10k 5% 1/4 Watt resistor
R2	1000 Ohm linear taper poten tiometer, with switch S2
S1	SPDT toggle or slide switch (Bandswitch)

Fig. 10-7

ANTENNA NOISE BRIDGE DETECTOR *(Cont.)*

The circuit is illustrated in the figure. The noise output from your antenna noise bridge is applied though a coax jumper cable to J1, an SO-239. This noise, which usually will peak slightly below 1.0 V, is broadband white noise and is fed though C1, a 100-pF capacitor, to a pair of small-signal diodes connected as a rectifier/voltage doubler. The rectified dc voltage, filtered by C3, an 0.1-μF disk capacitor, is then applied to the base of a small-signal NPN transistor (Q1), which serves as a meter amplifier. Meter M1 is a 200-μA meter. It monitors collector current through Q1. On/off switch S2 is mounted on the GAIN control, which, in series with R3, forms a voltage divider across battery BT1, a 9-V battery, which powers this instrument. The GAIN control is wired so that the wiper travels from the end of R3 to ground as the knob is rotated clockwise. This sets the emitter bias and the point at which Q1 will go into conduction as rectified noise voltage is applied to the base of Q1. The current drain from the battery is approximately 8 μA with no input, increasing to slightly over 200 μA with the meter at full scale. With such low current drain, an alkaline battery should last for years, even if you forget to turn the instrument off! This instrument covers the range from below 40 m to above 10 m in two bands: 40 and 30 m, and 20–17–15–12–10 m. Bandswitch S1, an SPDT toggle or slide switch, selects the frequency range. The tuning capacitor C2 is a small 150-pF air variable.

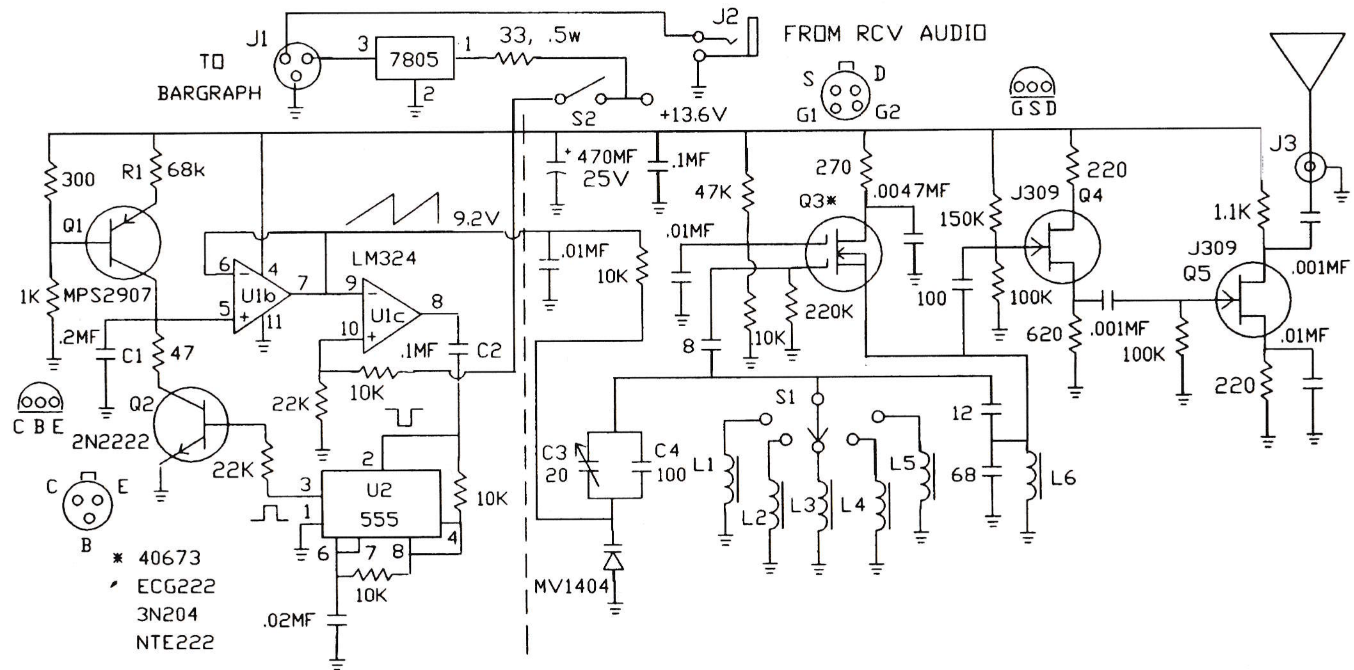
INVERTED VEE ANTENNA



ELECTRONIC EXPERIMENTERS HANDBOOK *Fig. 10-8*

The inverted vee antenna is widely used by SWLs and radio amateurs. It has the advantage of needing only one support and can be fit into somewhat smaller spaces in some instances. A balun having a 1:1 impedance designed for 50 Ω can be installed at the feed point for improved performance, if desired.

SWEPT OSCILLATOR FOR HAM-BAND ANTENNA TUNING

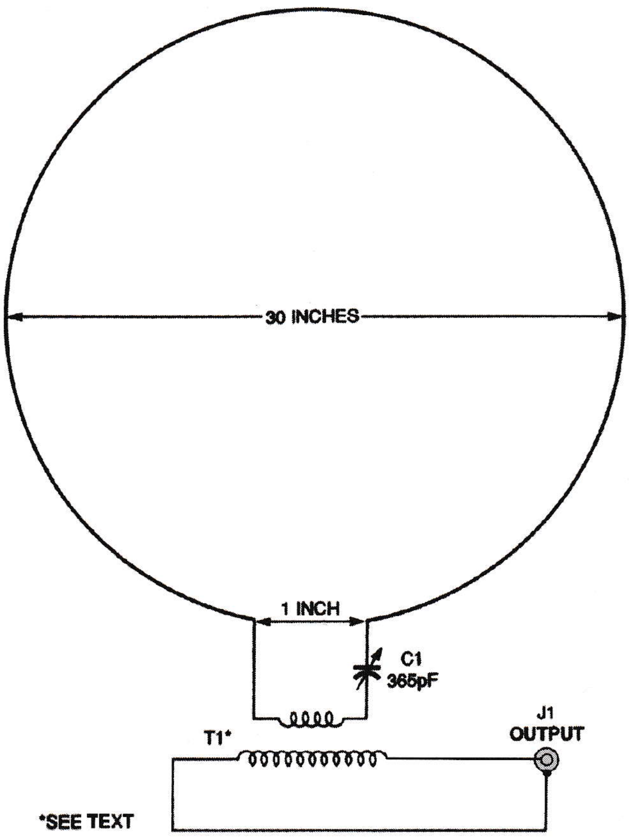


73 AMATEUR RADIO TODAY

Fig. 10-9

Transistor Q1 acts as a constant-current generator, charging capacitor C1 at a rate determined by the value of R1. The high input impedance of U1b ensures that the constant-current generator is not excessively loaded and forwards the voltage level of C1 to U1c. U1c is configured as a comparator, and output pin 8 goes low when pin 9 rises above 9 V. This switching action applies a trigger pulse via capacitor C2 to activate the monostable multivibrator, U2. The resulting high pulse from pin 3 of U2 provides a discharge path for capacitor C1 through turned-on transistor Q2. A continuous sweep ramp with reset is produced at pin 7 of U1b at a rate determined by R1C1 (approximately 75 Hz). The swept oscillator section consistsof a dual-gate MOSFET transistor in a Colpitts configuration, followed by a buffer amplifier that provides the RF from the selected frequency range to an output amplifier and short antenna. As the output sawtooth waveform from U2, pin 7, is applied to the varactor, the capacitance of the tank circuit decreases from approximately 62 pF at the low end of the ramp to a very low value at the maximum sweep level of about 9.2 V. The on-off switching action of the sweep waveform modulates the generated RF to produce an obnoxious buzz, which is easy to differentiate from other low-level signals at the selected receiver frequency when adjusting the tuner or antenna.

40-m LOOP ANTENNA

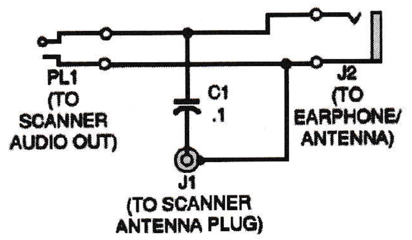


POPULAR ELECTRONICS

Fig. 10-10

A cliff-dweller's dream, this 40-m loop can get apartment-based hams on the air. It also makes a great receiving antenna. The matching transformer, T1, is wound on T50-2 toroid core. The primary consists of 4 turns of 18-gauge enameled copper wire, and the secondary consists of 12 turns of 20-gauge enameled copper wire. Close-wind the secondary and the primary, and make sure that the two windings do not overlap.

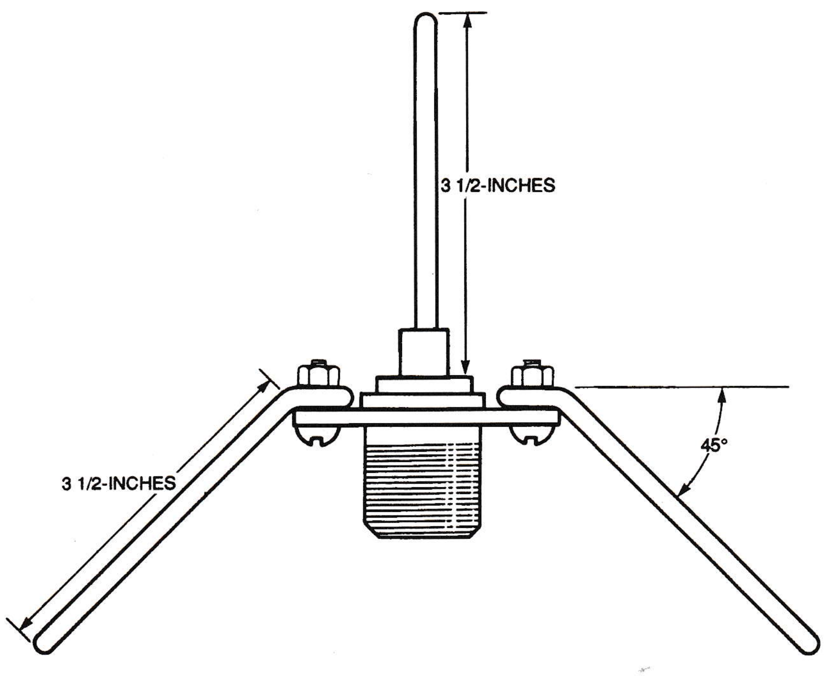
UNDERCOVER SCANNER ANTENNA



POPULAR ELECTRONICS *Fig. 10-11*

The figure shows the schematic for the antenna circuit. Because the circuit is passive, no power supply is needed. Plug PL1 connects to the audio output or earphone jack of a scanner. The audio signal is then fed to J2, the earphone/antenna jack of the circuit. A 0.1-μF capacitor, C1, connects the center ("hot") terminal of J2 to a BNC jack, J1. When an earphone is plugged into J2, C1 feeds RF from the earphone wire to the front end of the scanner, through J1, without directly connecting the audio circuit to the receiver. An earphone connected to J2 will therefore both provide audio and act as an antenna.

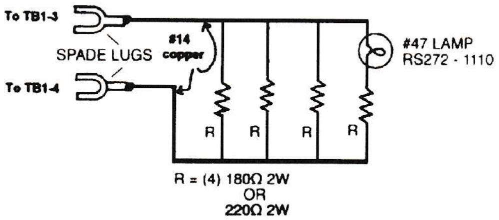
800-MHz ANTENNA



POPULAR ELECTRONICS *Fig. 10-12*

This simple quarter-wave antenna can improve performance on the 800-MHz band and can be built in just a couple of hours.

10-W DUMMY LOAD

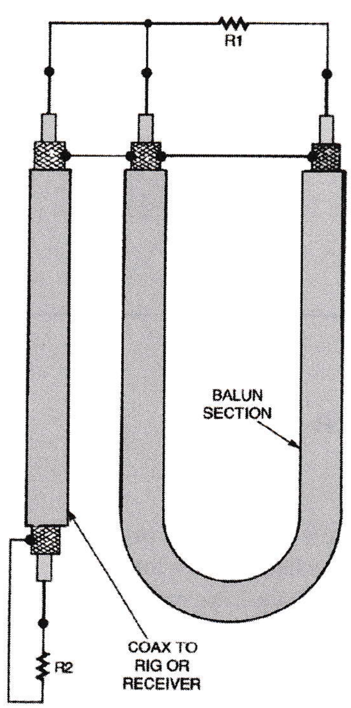


This dummy load was intended for tune-up of a 10-W CW ham rig. It should be useful for general-purpose applications in the HF range. The spade lugs shown can be replaced with a UHF connector for more versatility. The lamp acts as a relative power indicator.

73 AMATEUR RADIO TODAY

Fig. 10-13

COAXIAL LINE BALUN



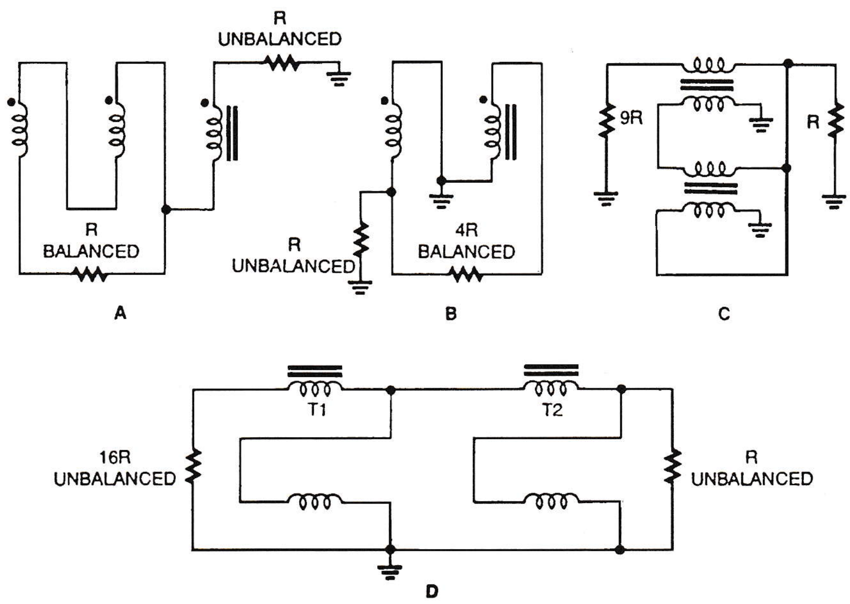
A coaxial cable 4:1 balun transformer can be made from 75-Ω coax cable.

Remember that the electrical length of the balun section is a half wavelength at the operating frequency. This is about equal to the physical length times the velocity factor of the cable, plus any effect the connections might have on these lengths.

POPULAR ELECTRONICS

Fig. 10-14

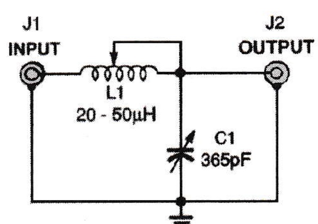
TOROIDAL TRANSFORMER



POPULAR ELECTRONICS *Fig. 10-15*

The several types of impedance-matching transformers are: 1:1 balun (A), 4:1 balun (B), 9:1 un-un (C), and 16:1 un-un (D).

SIMPLE ANTENNA TUNER



This simple tuner can properly match anything from a bedspring to a long-wire antenna. Be sure to use a voltage-transmitting-type unit for C1 if more than 5 W of output power is to be used.

POPULAR ELECTRONICS *Fig. 10-16*