

NDD

CIRCUIT COOK BOOK

eti
ELECTRONICS · TECHNOLOGY
INNOVATION

No. 6



AUDIO CIRCUITS • ALARMS • OSCILLATORS • CIRCUITS FOR CARS •
CIRCUITS FOR JUST ABOUT EVERYTHING • MORE THAN 140 IDEAS!

FOREWORD

Well, it's been a long time between drinks! Welcome to ETI's Circuits Cookbook #6 — source for inspiration, ideas and solutions in electronics, for enthusiasts, technicians and engineers, radio amateurs, CBers, students and hardware hackers.

As with the previous publications in this series, the circuits have been grouped into a number of categories — 11 in all here, *PLUS* a special feature section on 555 Circuits, detailing how to use this versatile, low-cost timer/oscillator IC and giving a number of different applications. Handily, it includes large design nomographs so you can quickly choose oscillator and timer resistor and capacitor component values.

Unlike the earlier Circuits Cookbooks, this is *not* a compilation of circuits out of the "Ideas For Experimenters" pages from *Electronics Today* magazine. This time, we gathered circuits from many ideas, experiments and prototypes kept on file, built up over many years. Some have been culled from semiconductor manufacturers' applications literature, some from friends and associates. Hence, a great number of circuits will no doubt be fresh to many of you.

As you will appreciate, it was not really possible to try out all the circuits for ourselves, and while a lot of care has been spent checking and preparing them for publication, we can't guarantee them or answer any queries or provide further details other than those published.

Another first for this Cookbook is the use of computer-aided draughting throughout, using AutoCAD software, a Houston roller plotter and a PC/AT compatible computer. All the symbols used were created as drawing blocks, a range being initially developed by ex-ETI draughtsman David Currie, with subsequent development of a wide range of blocks and draughting techniques to suit this application being carried out by, or under the guidance of, Jamye Harrison.

Enough! This is your "circuit ideas supermarket", so we'll let you get into it.

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Battery operated neon flasher
6V lamp flasher

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Log-scale S-meter
'True' stereo indicator
'Come in, spinner'
Fuse-blown indicator
Receiver S-meter
Battery monitor
Twin lamp flasher

THE MAINS AND POWER CONTROL

Mains voltage adjuster
Mains wiring locator
Soldering iron tip saver
Drill speed controller
Simplest motor speed controller

OSCILLATORS, SWITCHES AND TIMERS

Simple touch switch
Temperature touch switch
Touch-on, touch-off 'capacity' switch
Repeating timer No. 1
Repeating timer No. 2
Delay those 'chime blues'!
Touch-on, touch-off contact switch
Two-transistor Morse practice oscillator
'Bipolarising' electrolytics
Variable M-S ratio oscillator
Dark switch
Infra-red switch
Op-amp variable square-wave oscillator
Simple sine oscillator
One-second trigger

POWER SUPPLIES

Simple bench supply
'Reduce that ripple'
Odd tranny power supply
Negative rail generator
Using 5V circuits on a 3V battery
High voltage dc-dc converter
Crowbar protection for battery eliminator supplies
Regulator for battery powered circuits
Very low regulated voltage
Overvolt protector for 3-terminal regulators
Battery charger protector
Overvoltage crowbar for a power supply
'Twincap' power supply

RADIO FREQUENCY

Stable, wideband RF amp
Active AM band antenna
Linear scale RF wattmeter
Booster amp for TV or scanners
FET AM receiver

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TV/video splitters
Sensitive field strength meter
'Tunable' toroid inductance
Crystal oscillator with gate
455 kHz oscillator
TTL crystal oscillator
Wideband buffer
Wideband frequency doubler
Audible SWR meter
Broad range crystal oscillator
Off-air Morse monitor
I.F. Oscillator
Passive field strength meter
Novel RF wattmeter
RF 'snifter'

TEST INSTRUMENTS

Linear-scale capacitance meter
In-circuit transistor checker
Yes/no transistor checker
Mini signal injector
PNP/NPN transistor checker
Linear scale ohmmeter
Crystal checker that works over wide range
CMOS gate identifier
Centigrade electronic thermometer
RMS-to-DC converter
Signal injector/tracer
Another electronic thermometer
Very low current ammeter

UJT CIRCUITS

UJT Morse practice oscillator
UJT crystal checker
UJT audible continuity checker
UJT sinewave oscillator

MISCELLANEOUS

The mysterious 'chirrup'
Dog chaser
Polarity protector
Video buffer
'Adjusting' a zener
Digital quadrature phase generator
Sound trigger for photo-flash
Slave flash trigger

555 CIRCUITS

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555 monostable timer design
The 555 as an oscillator
A 555 VCO
Driving a relay with the 555
555 twin flasher
Driving a speaker from the 555
555 duty cycle variability

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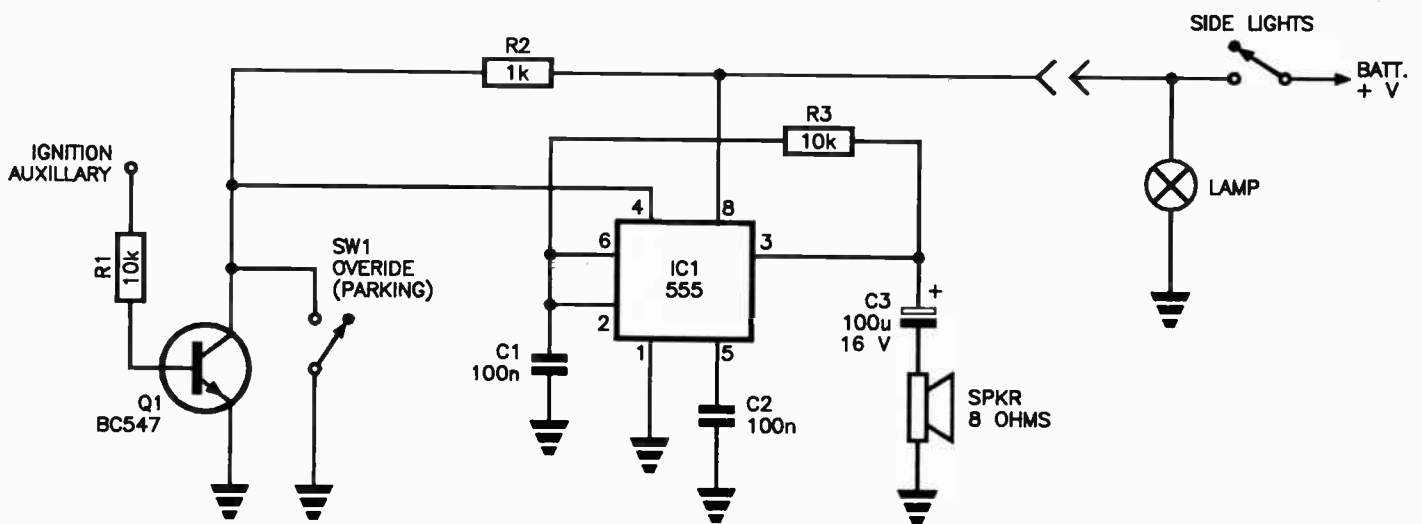
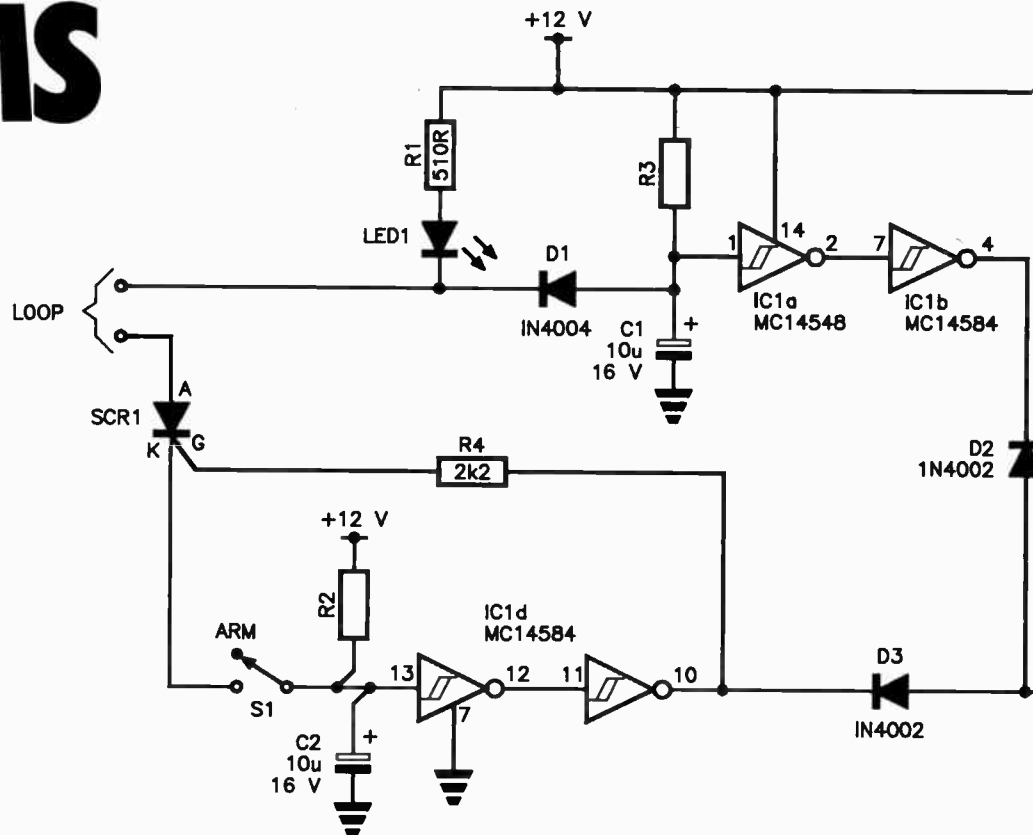
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Disclaimer

While every effort has been made to ensure all drawings and sketches prepared for this publication are accurate, no responsibility is accepted for the failure for any reason of any circuit or concept to operate effectively or at all, whether due to any fault in design or otherwise, or for its suitability for any purpose or application. Furthermore, no responsibility is accepted in respect of any injury or damage caused by any fault in the design, interpretation or application of any such circuits or concepts aforesaid.

ALARMS



Lights-on alarm for your car

A 555 is used here in a slightly unusual triggered oscillator circuit to indicate that you've left your lights on when leaving your car.

When you turn off your ignition, the auxiliary circuit on the ignition switch is activated with 12 V. This is used to bias on Q1 which pulls pin 4 of the 555 [the reset pin] low. If you've left your lights on, the side lights circuit will be powered up

and power will be applied to the circuit. The 555 immediately breaks into oscillation and the speaker alerts you to the fact your lights are on. If you leave only your side lights switched on, the result is the same.

The parking lights switch should be wired in parallel with the collector of Q1 for additional safety.

Simple burglar alarm

HERE'S a no-fuss burglar alarm circuit that's not prone to false alarms, yet provides the sophistication of separate entry and exit delays. It requires all sensors to be of the normally closed type which are connected in a loop (marked 'loop' on the circuit).

The circuit is based on a hex CMOS Schmitt buffer, the Motorola MC14584. When the Arm switch [S1] is open, the input of IC1d is high (C2 being charged via R2) and its output goes low. The input of IC1c is thus high and its output low; this turns on SCR1 by driving its gate high via R4.

As SCR1 is turned on, current flows through the loop via R1 and LED1, which lights, indicating the alarm is armed. The input of IC1a is held low via D1 and the loop. Thus, IC1b's input is high, its output low and D2 ensures the base of relay driver Q1 is held low via D2.

If the loop is opened by an intruder, D1 no longer holds the input of IC1a low and C1 will charge via R3. When the charge on C1 exceeds the Schmitt threshold of IC1a, taking some 20-odd seconds, its output goes low and the output of IC1b goes high. This allows base current to flow to Q1 via R5 and the relay turns on.

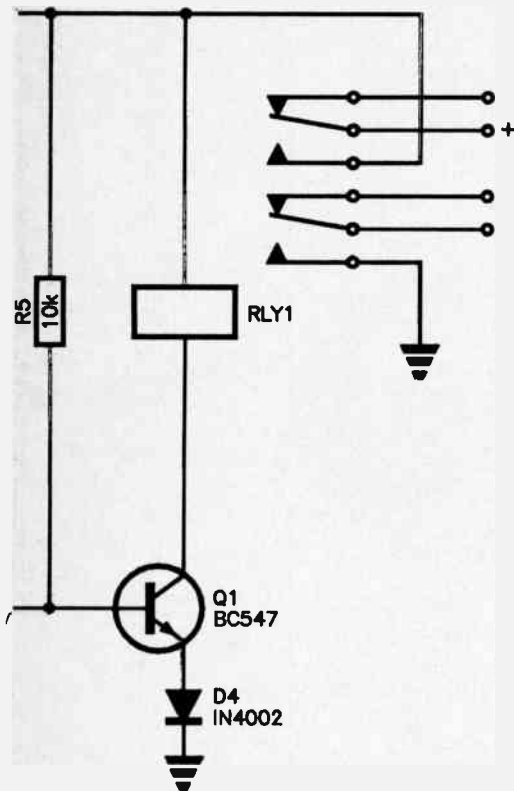
The relay contacts can trip any sort of alarm circuit as you have a number of options provided: normally closed contacts, changeover to ground or changeover to +12V.

Exit delay is provided by R2-C2. You can choose the value of R2 to provide you with some 20-50 seconds of delay, using a value between 1M Ω and 6M Ω . Entry delay is provided by R3-C1. You can choose R3 in the same range of values as for R2 to provide the required entry delay.

The relay back-emf will not affect Q1 because D4 will be reverse-biased by the back-emf of RLY1. Secondly, this diode provides some half a volt of bias-boost for Q1 so that D2 and D3 can starve its base of current when the outputs of IC1b and c are low, respectively.

A trickle-charged 12 V sealed battery should be used to power the alarm.

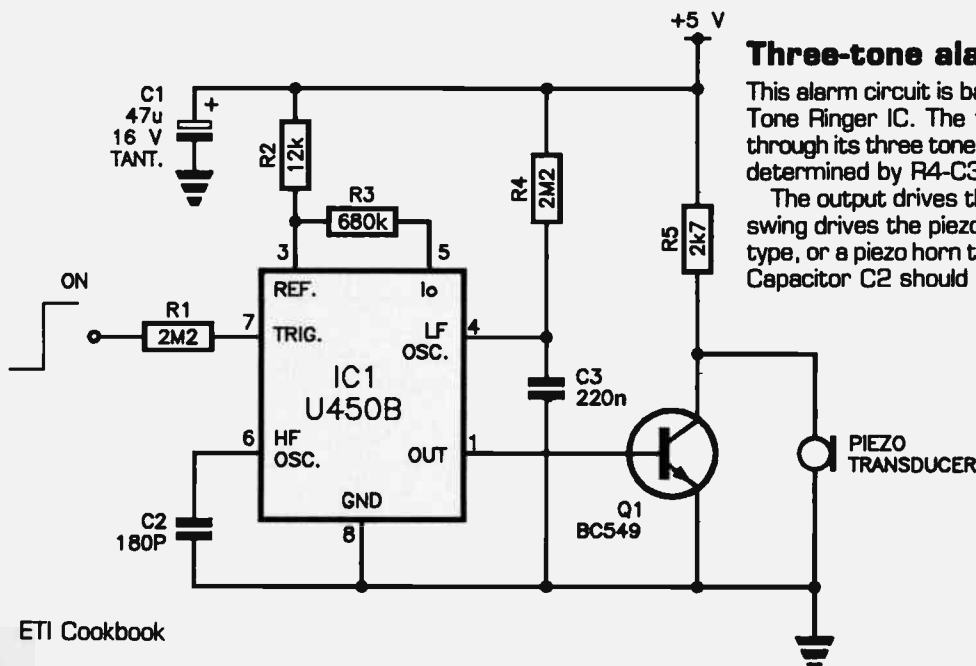
Switch S1 is closed to disarm the alarm. This puts the input of IC1d to ground, driving its output high, which in turn drives the output of IC1c low, pulling the base of Q1 low via D3. The gate of SCR1 is also pulled low. If the loop is opened (by opening your front door and its normally closed sensor), the SCR will turn off.



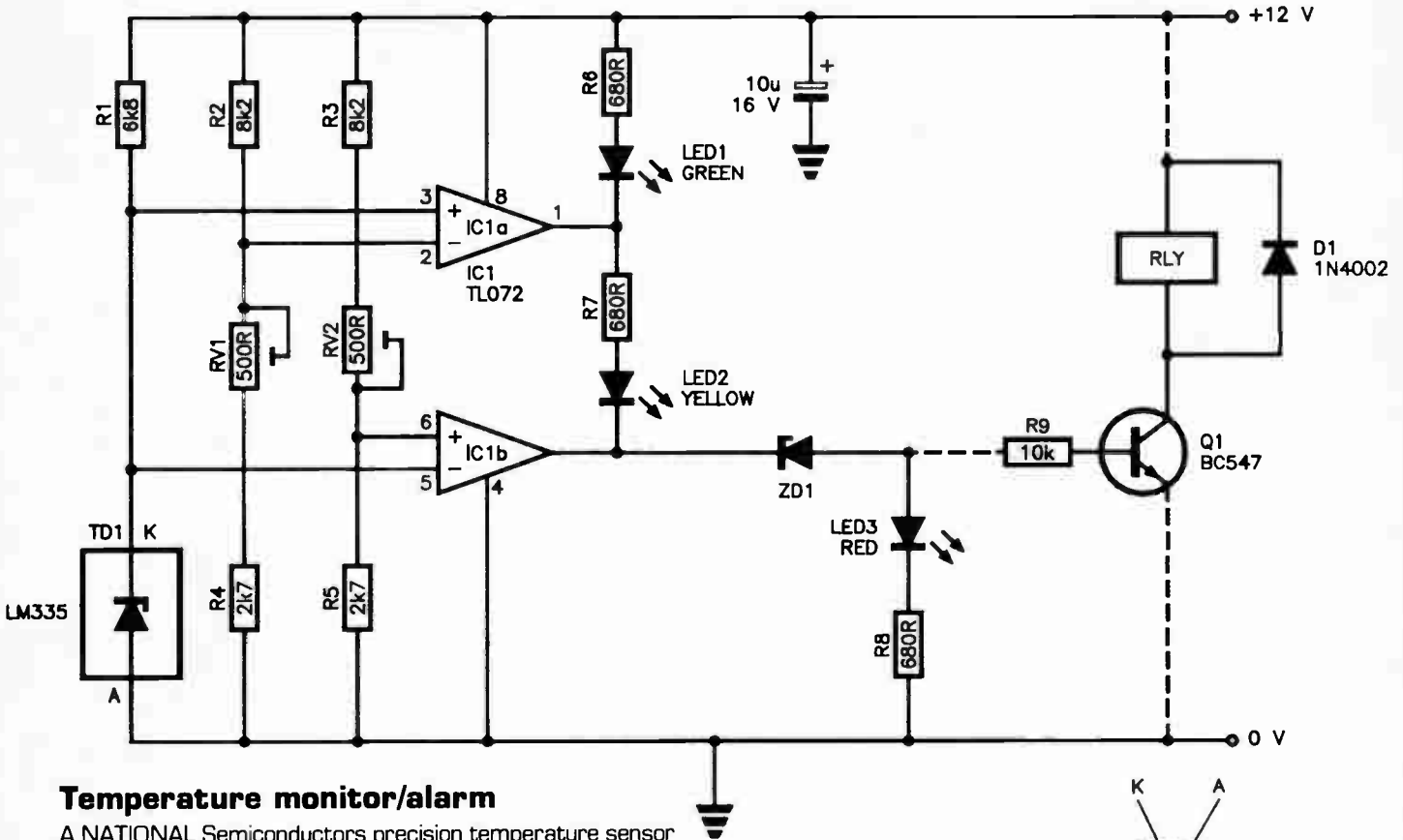
Three-tone alarm

This alarm circuit is based on the Telefunken U450B Three-Tone Ringer IC. The trigger requires a high. The IC cycles through its three tones of 800, 1067 and 1333 Hz at a rate determined by R4-C3.

The output drives the base of Q1 whose collector voltage swing drives the piezo transducer. This may be a small disc type, or a piezo horn tweeter (which gives quite loud output). Capacitor C2 should be a polystyrene type, not a ceramic.



ALARMS



Temperature monitor/alarm

A NATIONAL Semiconductors precision temperature sensor type LM335 is coupled with a window comparator circuit to provide a temperature monitoring function, indication being provided by red, yellow and green LEDs. A relay driver can be attached to provide an alarm or switching function. The unit is ideal for monitoring heatsink temperature in an audio power amplifier, for example.

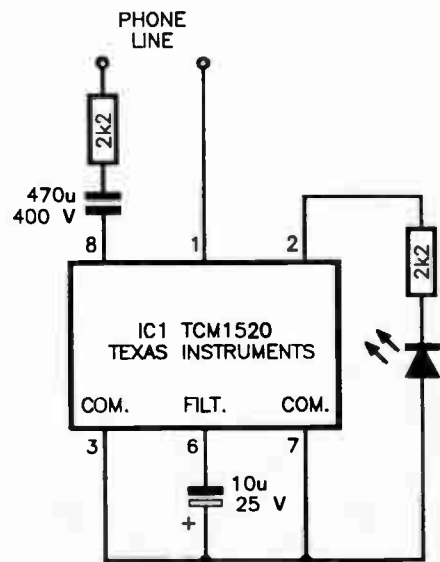
Trimpots RV1 and RV2 set the upper and lower temperature limits. The sensor, TD1, establishes a temperature-dependent reference voltage that varies at 10 mV per degree Celsius. The set points can be adjusted such that with the sensor below 50 degrees or so the green LED lights, up to about 80 degrees the yellow LED will light, while above that only the red LED will be lit. ZD1 is a 3V3 zener.

The relay driver can be added as shown by the dashed lines. The whole circuit is powered from a 12 V supply.

Visual phone ring indicator

FOR a visual indication of ring current present on a phone line — as an add-on to a modem or your phone — this little circuit would be hard to beat.

It uses a ring indicator IC produced by Texas Instruments, the TCM1520. When ringing tone pulses appear on the line, it flashes the LED in sympathy with the pulses, attracting your attention. A high brightness LED here will really attract your attention.



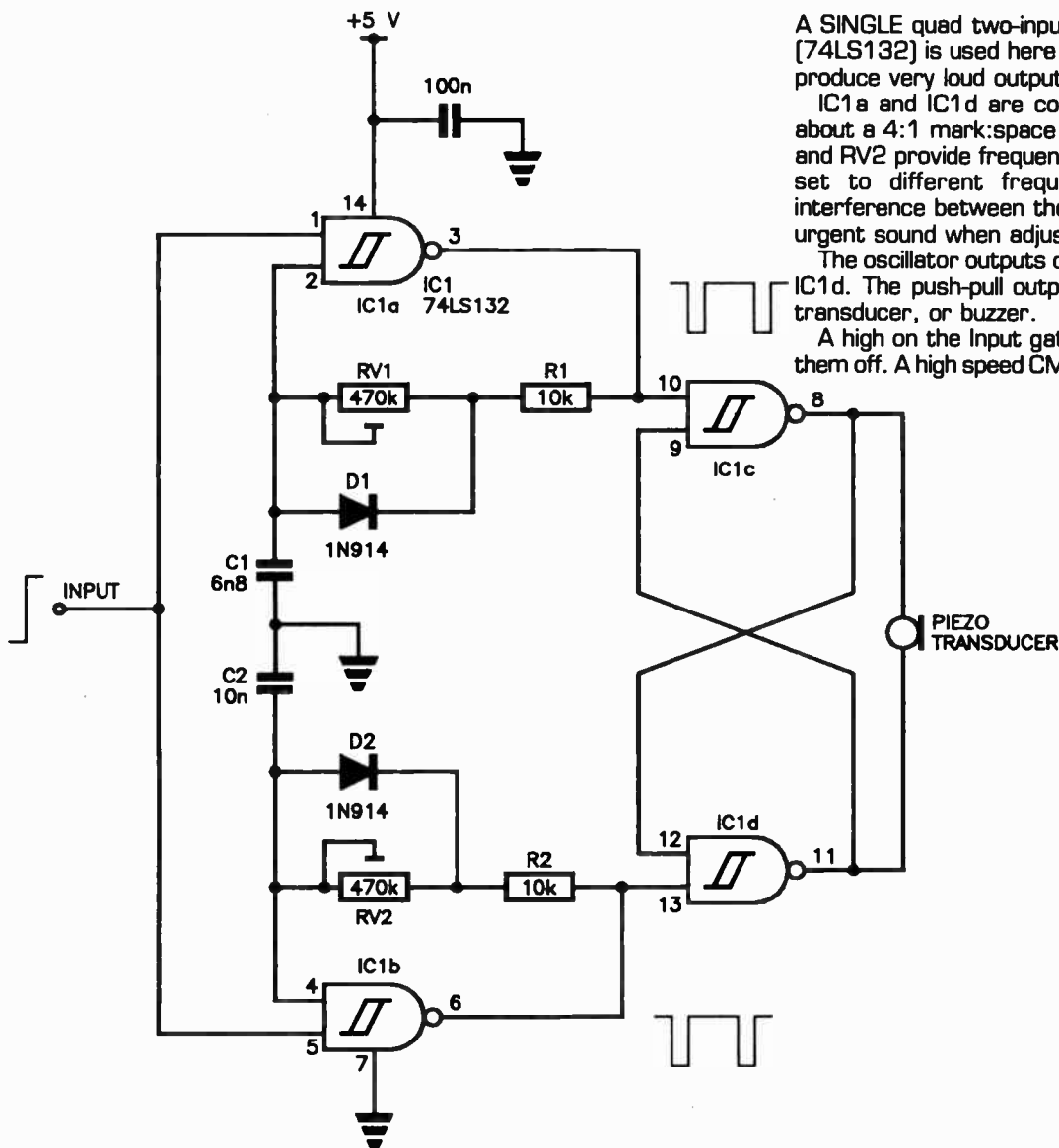
Piezo transducer alarm

A SINGLE quad two-input NAND Schmitt trigger package [74LS132] is used here to drive a piezo transducer. It will produce very loud output with a shrill, rippling note.

IC1a and IC1d are connected as gated oscillators with about a 4:1 mark:space ratio provided by the diodes. RV1 and RV2 provide frequency adjustment. The oscillators are set to different frequencies which provides complex interference between the two notes, giving rise to a really urgent sound when adjusted properly.

The oscillator outputs drive a flip-flop comprising IC1c and IC1d. The push-pull outputs of the flip-flop drive the piezo transducer, or buzzer.

A high on the Input gates the oscillators on, a low gates them off. A high speed CMOS device [HCT] may also be used

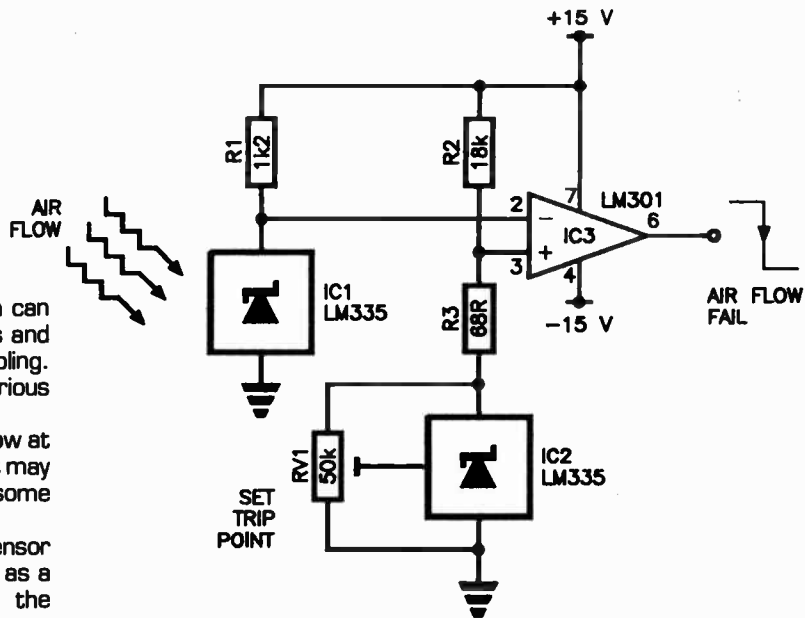


Fan fail alarm circuit

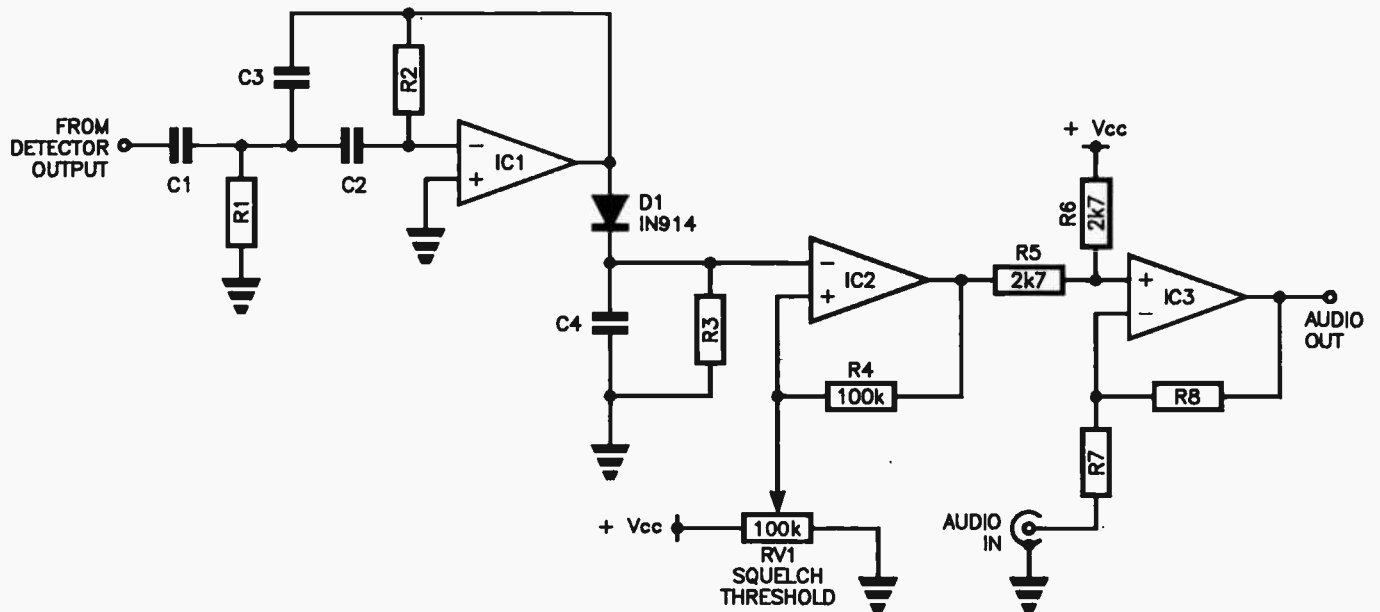
For any equipment that's fan-cooled, failure of the fan can have catastrophic results. Computers, power supplies and high powered amplifiers often use or require fan cooling. Blocking or restriction of the air flow can also have serious consequences.

This circuit detects the presence or absence of air flow at some suitable point, and provides a low-going output that may be used to turn on an indicator or trigger an alarm of some sort.

Two National Semiconductor LM335 temperature sensor ICs are used, one in the air flow [IC1], the other used as a reference [IC2]. Their outputs are compared at the differential inputs of an LM301 [IC3]. The bias of IC2 is set so that the LM301's output is normally high while the air flow is passing across IC1. When the air flow reduces or ceases, RV1 is set such that the LM301's output goes low.



AUDIO



Audio squelch circuit

A "squelch" circuit is a very handy facility for a receiver to suppress the noise during reception when a channel is unoccupied. You can add this circuit on to a receiver which does not have a squelch facility.

When the receiver is tuned to an unoccupied channel, high [audio] frequency noise is present at the output of the detector. In this circuit, a high pass filter [IC1] and a comparator [IC2] are used to determine whether a signal is present in the channel or not, by detecting the level high frequency noise. The comparator then turns off an op-amp [IC3] in series with the receiver's audio path.

Motorola's MC3405/MC3505 IC can provide all the active devices. IC1 is a high pass filter that amplifies the noise above the speech band [rolloff is around 3 kHz]. Its input comes direct from the receiver's detector output.

The output of IC1 is rectified by the 1N914, which charges C4. Resistor R3 provides a discharge time constant. The dc is applied to the inverting input of IC2, connected here as a comparator. The non-inverting input of IC2 has a variable dc voltage applied via RV1 to provide a squelch threshold adjustment.

The receiver's audio is passed through IC3, connected as an inverting amplifier. IC3's non-inverting output is connected to the output of the comparator, IC2. This swings between Vcc and ground.

With no signal present, the noise filtered out by the first stage will produce a peak rectified voltage across R3 that will exceed the threshold set by RV1. Thus the output of IC2 will cut off IC3, cutting off the audio.

To determine values, proceed as follows: Choose a gain for IC1, the high pass cutoff frequency and Q. You'll need a few volts at the output of the rectifier. Cutoff frequency might

be 3 kHz to 5 kHz; Q typically less than 10. Choose values for C1 and C2; typically 1n or less. Now, R2 may be calculated from:

$$R2 = \left[\frac{Q}{2 \pi f C} \right] [2A_o + 1]$$

Now calculate C3:

$$C3 = \frac{C}{A_o}$$

followed by R1:

$$R1 = \frac{A_o}{2 \pi Q f C [2A_o + 1]}$$

where A_o = gain of IC1

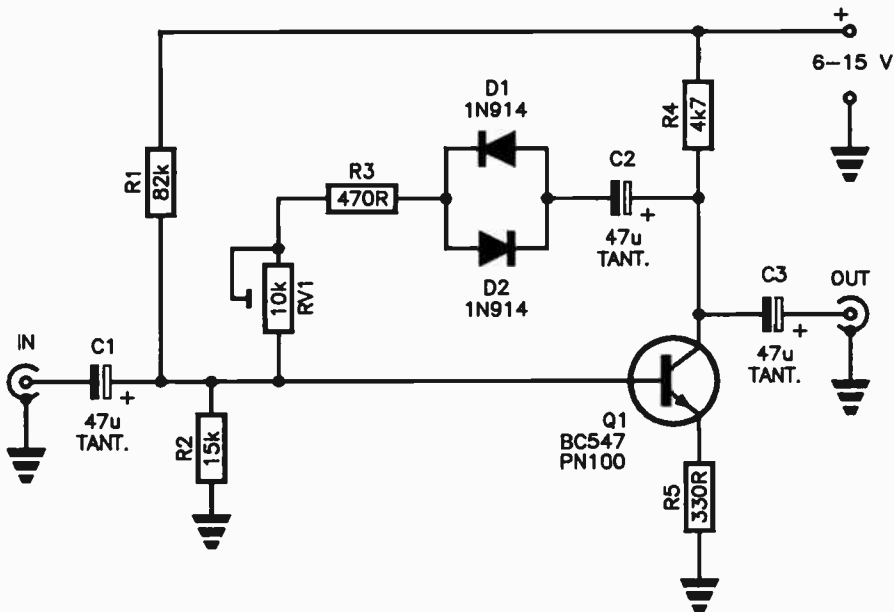
f = high pass cutoff frequency

C = value of C1 or C2 [which are equal]

The time constant of C4R3 must be greater than five times the typical period of variation of the input signal; half a second to a few seconds should prove adequate.

The gain of IC3 is set by the ratio of R8 to R7. This need only be a buffer stage with a gain of two, but it could have substantial gain if so desired. The input and output may need to be capacitively coupled.

The circuit is powered from a single supply rail of between 5 V and 15 V.



Audio soft-hard clipper

To compress the dynamic range of an audio signal — often effectively used for speech compression on PA systems and transmitters — a gain-controlled or gain-limited stage is employed.

A gain-controlled stage is inherently more complex than a gain-limited stage, or clipper. The simplest clippers just use a pair of back-to-back diodes to limit the signal voltage swing to the diode turn-on voltage of about 0.6 V. This provides fairly hard clipping, where the input signal waveform is truncated or clipped virtually straight across the top.

This circuit employs a pair of back-to-back diodes in the feedback path of a single-stage transistor amplifier, with a potentiometer control that allows some variation in the

clipping characteristics, from soft to hard. You get hard clipping when RV1's at minimum, soft clipping when it's at maximum.

Note that the stage gain can be varied by varying the ratio of R4 to R5. Resistor R5 provides a little degenerative feedback. The stage should be followed by a low pass filter to attenuate the harmonics generated by the clipping process. While tantalums have been specified for the capacitors, low-leakage types may be substituted here. Any common small signal transistor may be used for Q1.

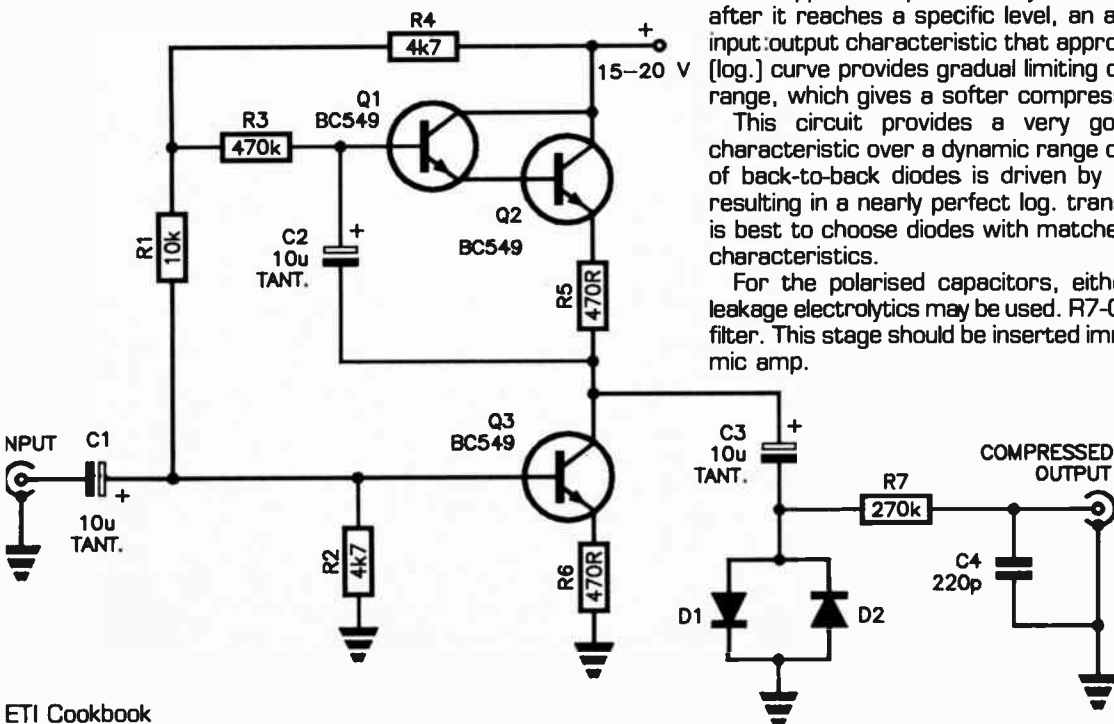
This circuit should be inserted straight after the mic input stage.

Log. compressor

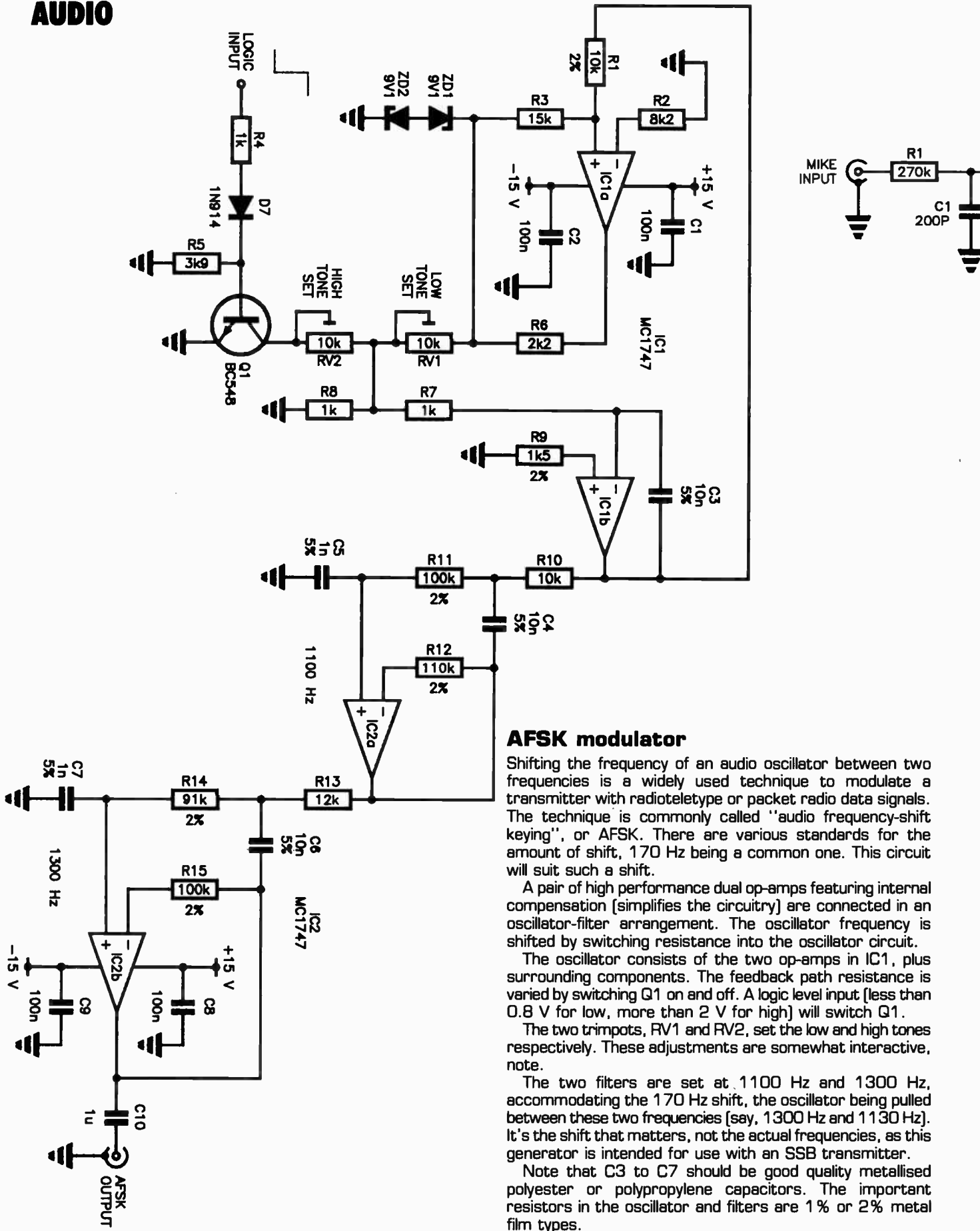
While clippers compress the dynamic range of an audio signal after it reaches a specific level, an amplifier which has an input:output characteristic that approximates a logarithmic [log.] curve provides gradual limiting of a signal over a wide range, which gives a softer compression characteristic.

This circuit provides a very good log. input:output characteristic over a dynamic range of some 60 dB. A pair of back-to-back diodes is driven by a current generator, resulting in a nearly perfect log. transfer characteristic.

For the polarised capacitors, either tantalums or low-leakage electrolytics may be used. R7-C4 provides a low-pass filter. This stage should be inserted immediately following the mic amp.



AUDIO



AFSK modulator

Shifting the frequency of an audio oscillator between two frequencies is a widely used technique to modulate a transmitter with radioteletype or packet radio data signals. The technique is commonly called "audio frequency-shift keying", or AFSK. There are various standards for the amount of shift, 170 Hz being a common one. This circuit will suit such a shift.

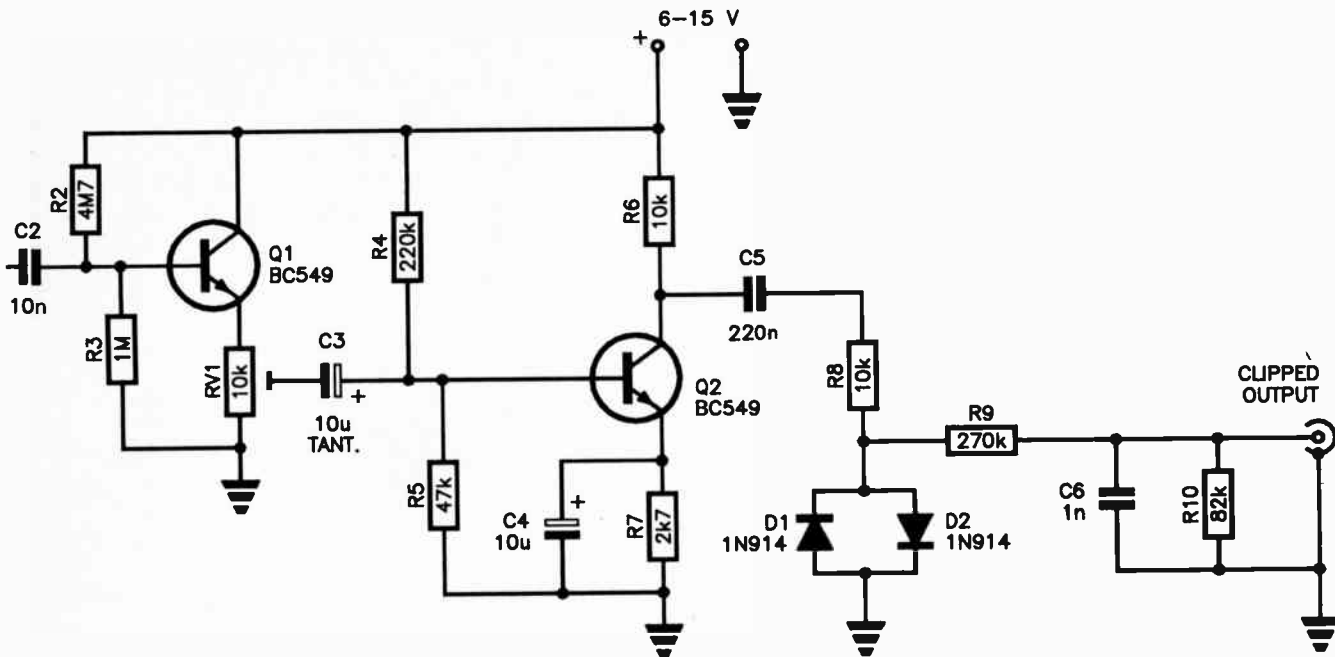
A pair of high performance dual op-amps featuring internal compensation [simplifies the circuitry] are connected in an oscillator-filter arrangement. The oscillator frequency is shifted by switching resistance into the oscillator circuit.

The oscillator consists of the two op-amps in IC1, plus surrounding components. The feedback path resistance is varied by switching Q1 on and off. A logic level input [less than 0.8 V for low, more than 2 V for high] will switch Q1.

The two trimpots, RV1 and RV2, set the low and high tones respectively. These adjustments are somewhat interactive, note.

The two filters are set at 1100 Hz and 1300 Hz, accommodating the 170 Hz shift, the oscillator being pulled between these two frequencies [say, 1300 Hz and 1130 Hz]. It's the shift that matters, not the actual frequencies, as this generator is intended for use with an SSB transmitter.

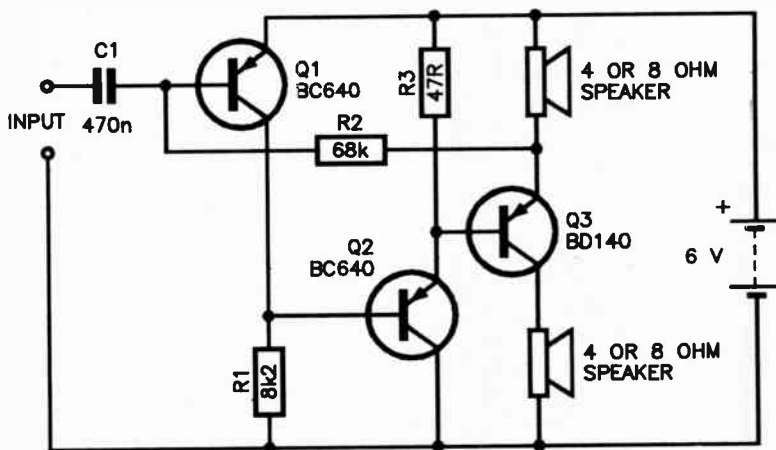
Note that C3 to C7 should be good quality metallised polyester or polypropylene capacitors. The important resistors in the oscillator and filters are 1% or 2% metal film types.



Audio clipper

Clippers are used to limit the maximum level in an audio system, for a tape recorder, in a transmitter or PA, for example. While it does introduce some distortion, it can improve speech intelligibility by reducing the dynamic range. It's remarkable how simple such a technique can be.

Two back-to-back diodes (D1 and D2) are used to clip the positive and negative signal waveform peaks. The clipper is preceded by a two-stage transistor preamp. RV1 sets the gain. The input has a low pass filter (R1-C1) to obviate RF interference. The output also has a low pass filter (R9-C6) to attenuate harmonics generated by the clipper.

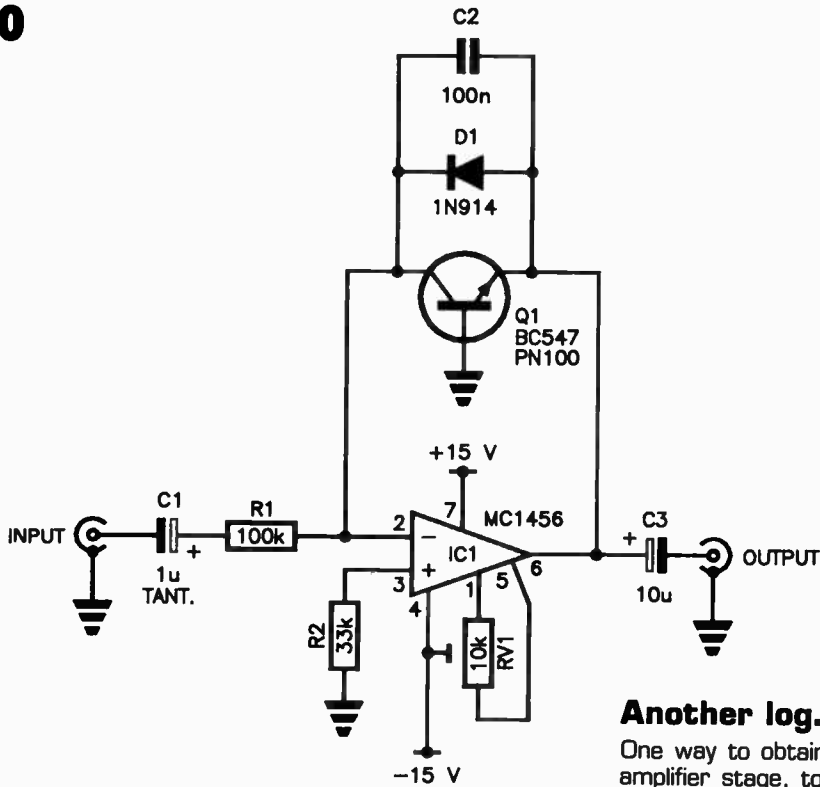


Really simple audio amp

This simple audio power amp delivers around one watt output from a 6 V supply. But you need two speakers. It's ideal for battery operated gear where small, 50 mm transistor radio type speakers can be used.

The 8D140 (Q3) should be mounted on a small heatsink. The value of R1 should be adjusted to obtain about a 1.5 V drop across each speaker. The full 1 W output is obtained with 4 Ohm speakers, half that with 8 Ohm types.

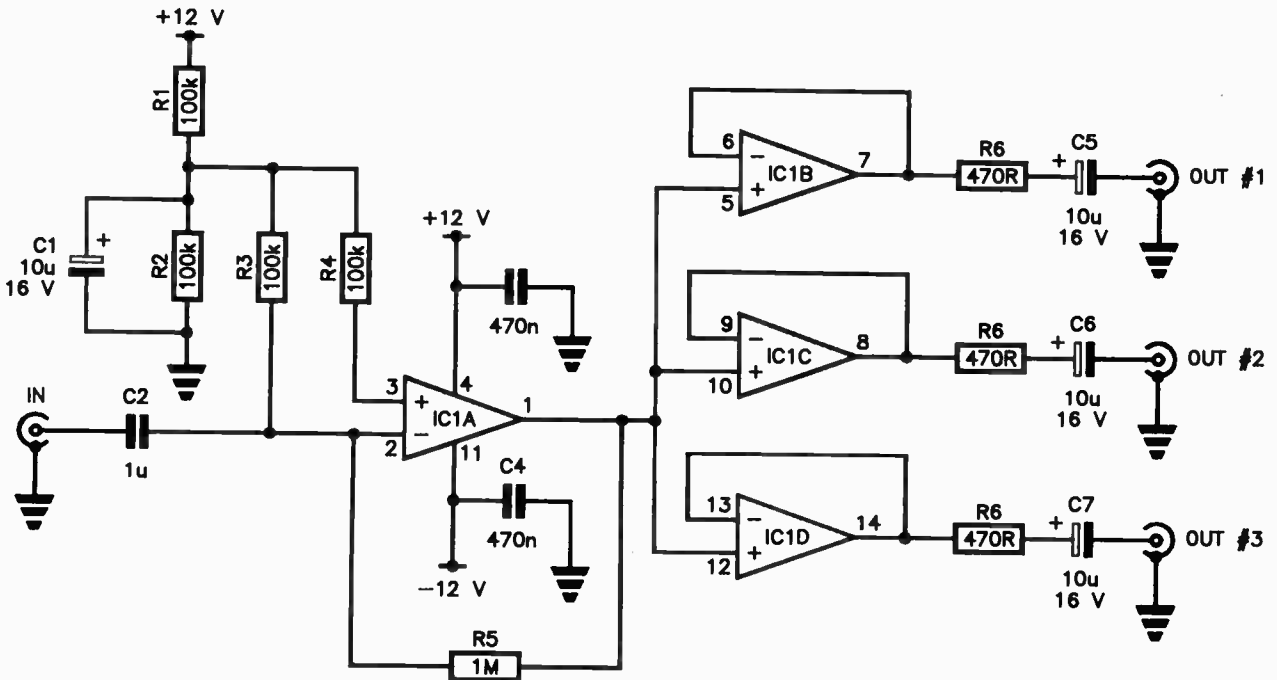
AUDIO



Another log. compressor

One way to obtain log. input:output characteristic for an amplifier stage, to be used as perhaps a compressor, is shown in this circuit. The base-emitter junction of a transistor is connected in the op-amp's feedback path. Most small-signal transistors may be used. Diode D1 limits output voltage swing. RV1 is adjusted to set the op-amp's output offset voltage to zero.

The transistor is connected in the op-amp's feedback path. Most small-signal transistors may be used. Diode D1 limits output voltage swing. RV1 is adjusted to set the op-amp's output offset voltage to zero.

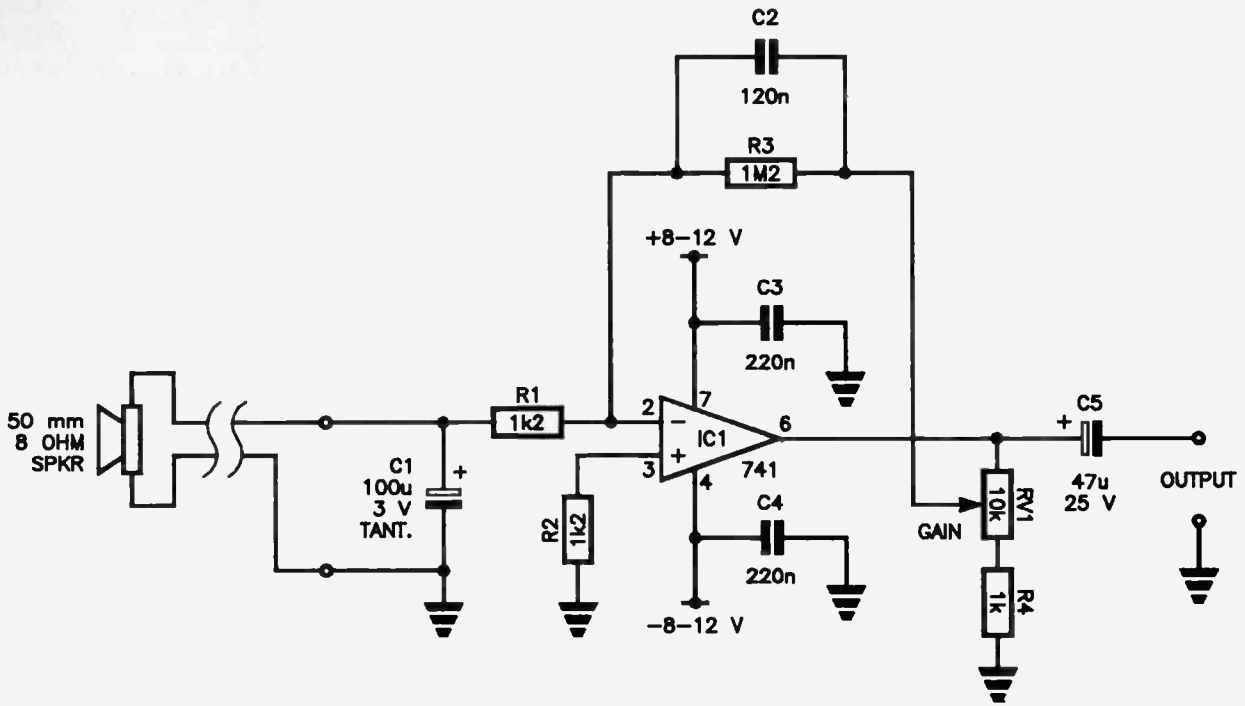


Audio slave driver

To slave a number of amps or other audio gear from a single source, you need to buffer the source and isolate the slaves from each other.

A FET-input quad op-amp is employed in this circuit to provide three outputs from a single input source. The popular

TL074 or LF347 is specified. One op-amp from the package provides the input buffer, the other three are connected as voltage followers. To protect these from shorted outputs R6, R7 and R8 are included.

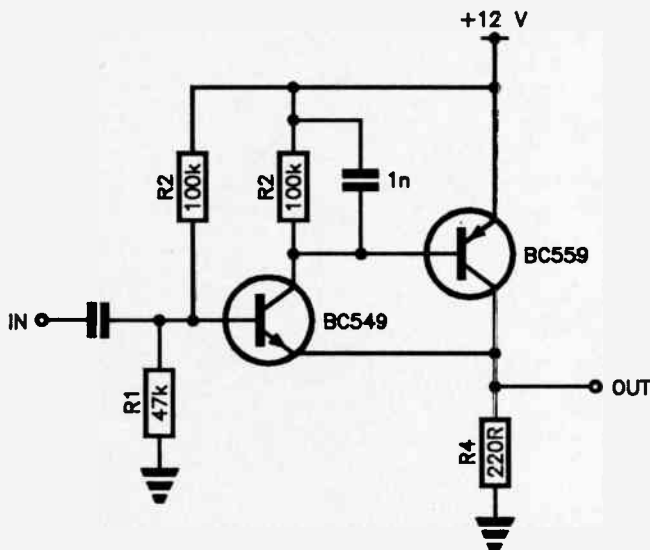


Stethoscope preamp

LISTEN to that boom-biddy-boom! Using a small 50 mm transistor radio-type loudspeaker as a microphone, and arranging high gain at the low frequencies involved and rolling off the high frequencies, this circuit provides a very effective stethoscope preamp to use ahead of an audio amp to amplify

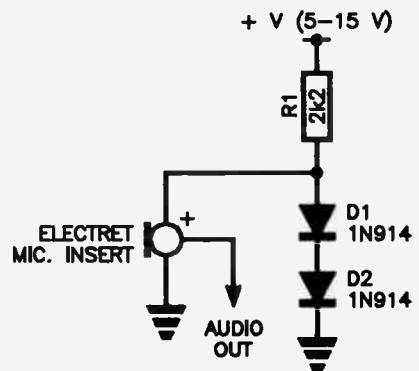
heart beats.

Potentiometer RV1 provides a gain control. C1 rolls off the high frequency response of the speaker mic. C2 rolls off the op-amp's high frequency gain. The output may be fed into the Tape or Aux input of any audio amp.



Low output impedance buffer

THIS simple buffer provides a medium-high input impedance and a very low output impedance. The NPN-PNP pair are direct-coupled common-emitter stages. This presents a high input impedance at the base of the BC549 and a very low output impedance across R4 by virtue of the common feedback path. The 1n capacitor improves the bandwidth. The input capacitor can be chosen to suit the application. It may range from 10n to 1u or so. Upper frequency response extends into the MHz region.

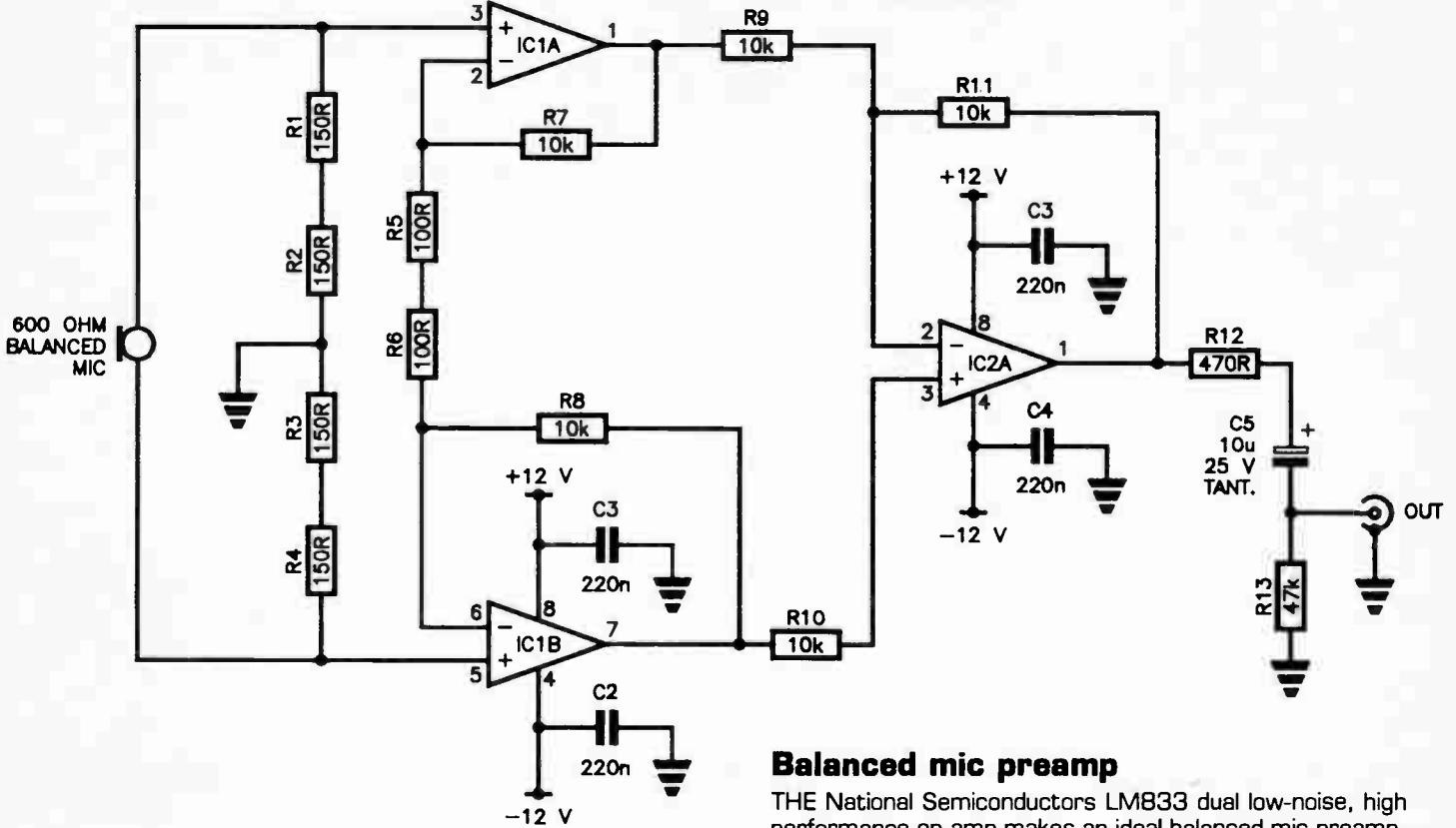


Bias for electret mic insert

A COUPLE of forward-biased diodes can be used to supply bias for an electret mic insert. These have three terminals. Identify them and hook up the bias circuit as shown. Audio output comes from the third terminal.

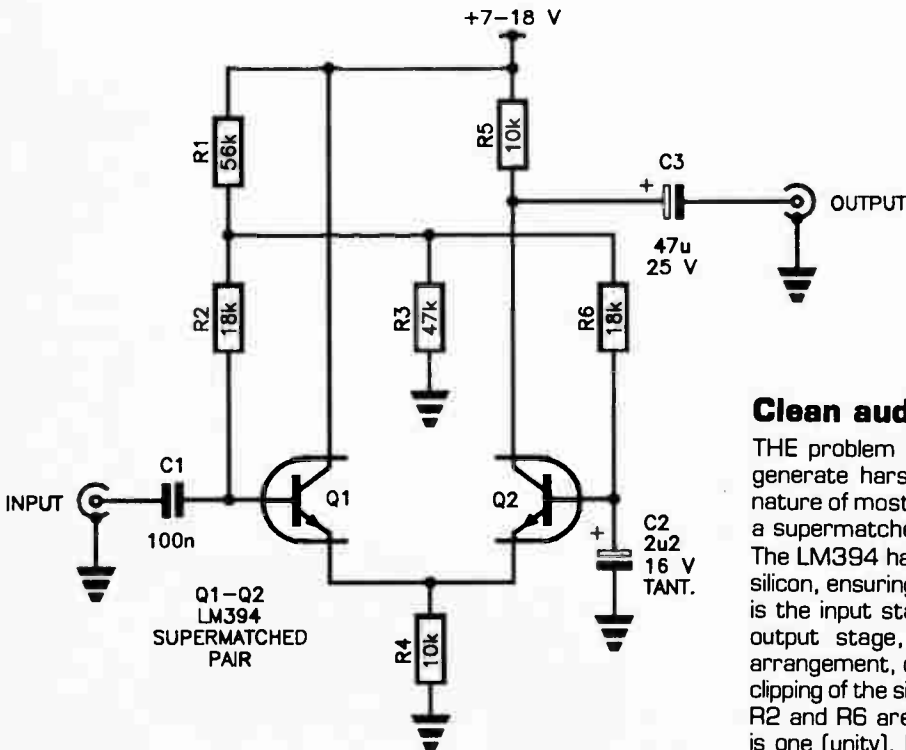
AUDIO

IC1 - LM833
IC2 - LM833



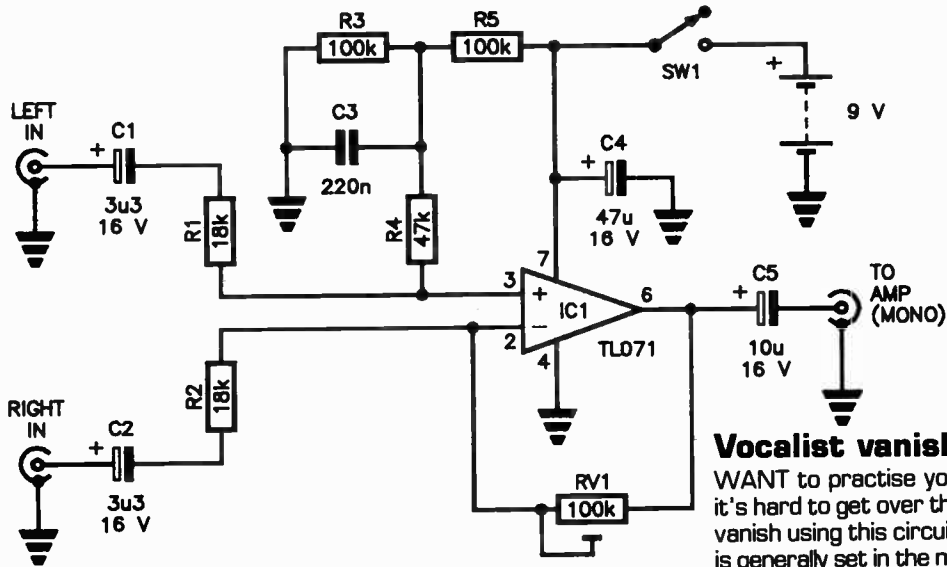
Balanced mic preamp

THE National Semiconductors LM833 dual low-noise, high performance op-amp makes an ideal balanced mic preamp. This circuit accommodates typical 600 Ohm balanced mics and provides a gain of around 40 dB. One op-amp from a second LM833 provides the output op-amp (IC2A). R12 protects IC2A from shorts on the output. Metal film resistors are recommended for lowest noise.



Clean audio clipper

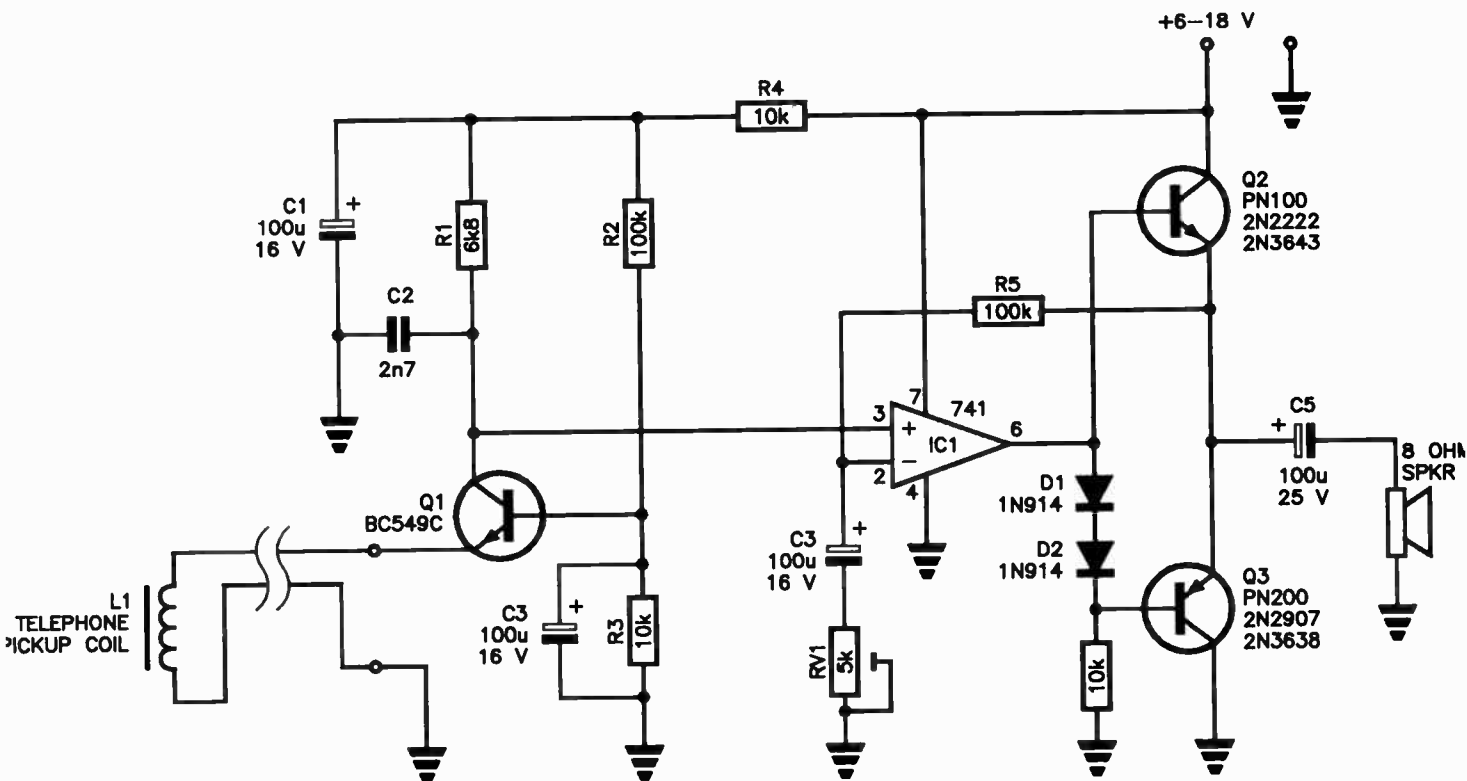
THE problem with most audio signal clippers is that they generate harsh harmonics owing to the non-symmetrical nature of most circuits. This circuit overcomes that by using a supermatched transistors pair, the LM394. The LM394 has two transistors etched on a single piece of silicon, ensuring close matching of characteristics. Here, Q1 is the input stage, operated in common-collector. Q2, the output stage, is operated in common-base. With this arrangement, overdriving at the input produces symmetrical clipping of the signal. R1 and R3 provide a bias divider network, R2 and R6 are base isolation resistors. Gain of the circuit is one (unity). Input impedance is quite high.



Vocalist vanisher

WANT to practise your singing to your favourite band, but it's hard to get over the vocalist? You can make that vocalist vanish using this circuit. It relies on the fact that the vocalist is generally set in the middle of a stereo recording, equal signal being fed to each channel. Feed each channel through this circuit, then back into your amp set to mono, and the vocalist vanishes!

To avoid the necessity of having split supply rails, the non-inverting input of IC1 is biased at half the supply rail by R3-R5. RV1 sets the feedback to provide maximum attenuation of the centre stereo signal. Power can be supplied by a 9 V transistor radio battery, or any 9 V dc supply.



Telephone loudspeaker add-on

THIS audio amplifier will provide loudspeaker level volume from your telephone and requires no actual connection to the phone.

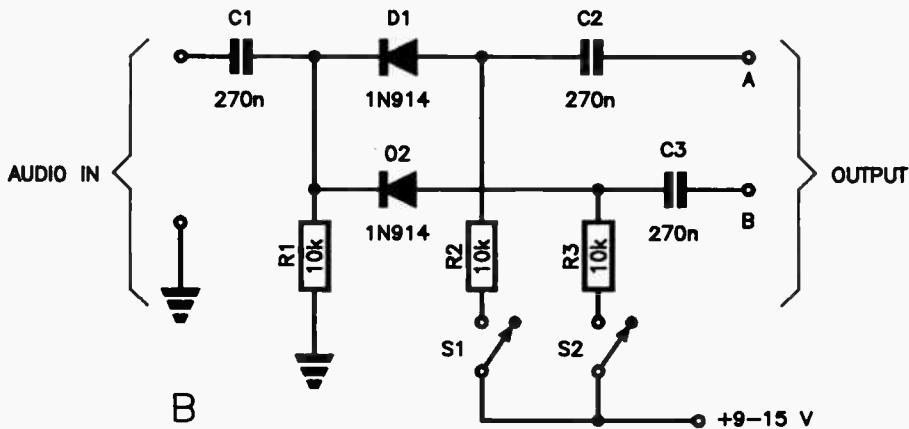
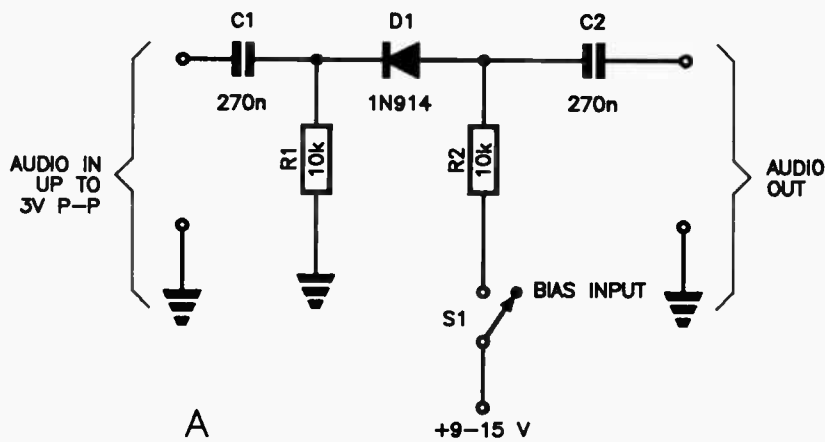
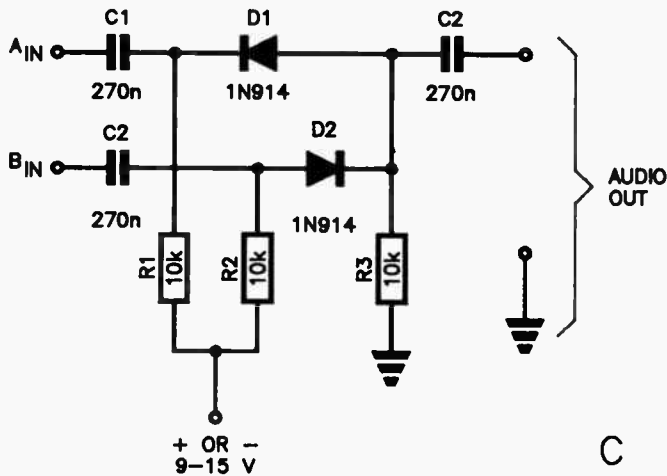
A telephone pickup coil, commonly available through electronics retailers, is attached on the handset behind the earpiece, or underneath the phone in the vicinity of the line hybrid transformer.

The signals induced in the coil [L1] are amplified by Q1, a common-base amplifier. Its collector is directly coupled to the non-inverting input of IC1, the output of which drives the bases of the complementary transistor output stage of Q2-Q3.

Feedback is provided by R5 and gain is controlled by RV1. Bias for Q1 is provided by R2-R3. C3 provides an ac bypass for the base of Q1. C2 provides some high frequency rolloff to reduce extraneous signals. D1 and D2 provide base bias separation for the output stage devices which are operated in class B.

The unit may be powered from any dc supply from 6 to 18 volts. Power output is around 1 to 1.5 W. Any suitable 8 Ohm speaker will do the job, but remember that larger speakers are more efficient than smaller diameter ones.

AUDIO



Audio switching with dc

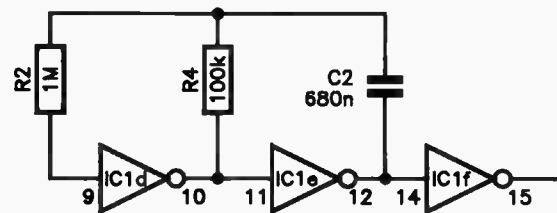
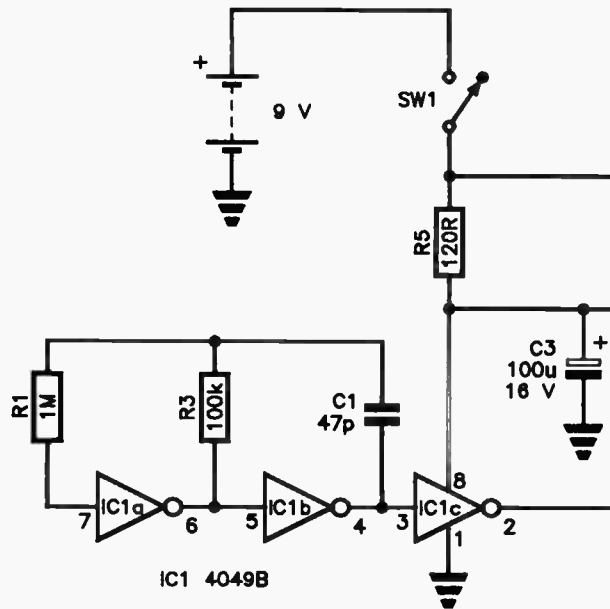
THESE three circuits show how you can use diodes for switching audio circuits where you don't want to, or can't, use mechanical switches. These circuits are meant for line level switching applications where signals are generally around 1 V, or up to 3 V (peak-to-peak), and impedances are in the medium to low range (10k or lower).

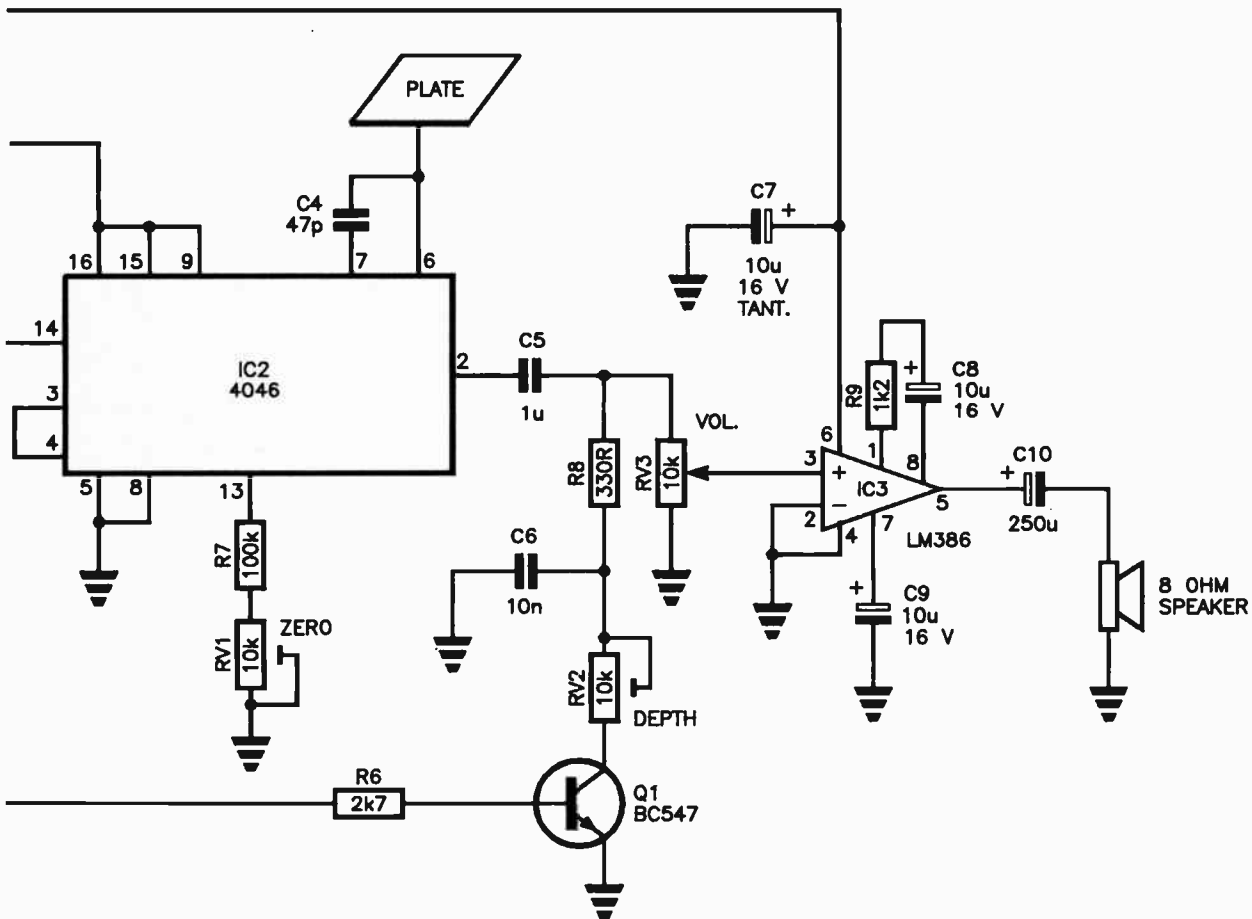
Circuit A shows how to switch a single channel. With S1 open, diode D1 has no bias and acts like an open circuit. Audio in does not get to audio out. Close the switch and D1 is forward biased. It looks like a short circuit and audio in goes

to audio out.

Circuit B shows how you can adapt circuit A to switch one input to either or both of two outputs. Switches S1 and S2 may be independent, or you could substitute a single pole, double-throw switch to get either/or switching between outlets A and B.

Circuit C shows how you can have one of two inputs switched to one output by simply reversing the polarity of the bias applied. Apply a positive bias and B only is switched through; apply a negative bias and A only is switched through.





Thimble theremin!

THE theremin is an ancient and venerable electronic musical instrument, producing sounds not unlike a slide whistle. It employs two oscillators, initially set with little or no difference between them — at or near 'zero beat', as they say. The frequency of one oscillator can be varied by hand capacitance — swinging your hand, or hands, near a capacity plate alters the oscillation frequency of one oscillator, the difference between them appearing as a frequency in the audio range. This is then amplified to drive a loudspeaker. A refinement involves adding a low frequency oscillator to amplitude modulate the audio output, providing some vibrato, which adds interest to the musical output. With a little skill and practice, quite entertaining results can be achieved!

Here, the fixed oscillator is a ring-of-two oscillator formed from buffers IC1a and IC1b from a 4049. This is buffered by IC1c which drives the signal in pin to the phase comparator of IC2, a 4046 phase-locked loop. The oscillator (VCO) in IC2 is the variable oscillator, its frequency-determining capacitor

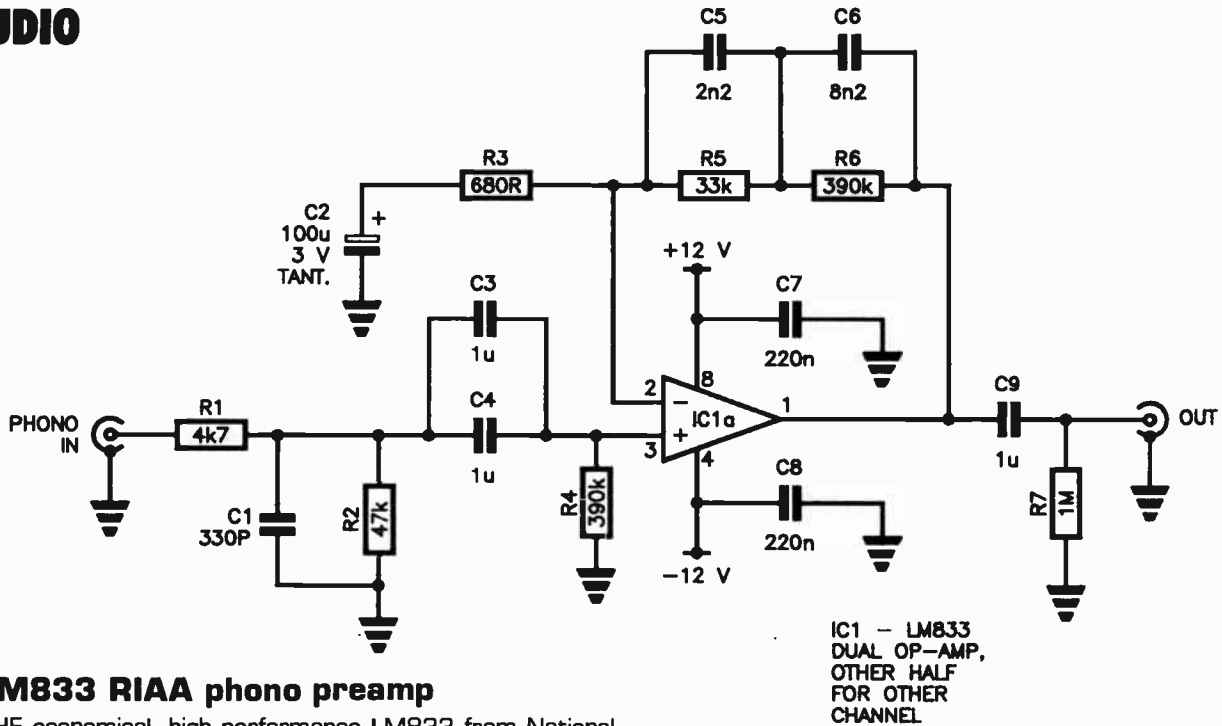
being connected to a plate over which you wave your hands.

The 4046 oscillator's output is connected to the other input of the phase comparator. The output is taken to the following audio stage which uses an LM386 IC power amp to drive the speaker. The two oscillators are zero-ed by adjusting RV1.

Another, low frequency, ring-of-two oscillator using buffers d and e from IC1 provides the vibrato oscillator. IC1f buffers its output to drive Q1. This amplitude modulates the audio by shunting the volume control pot. The depth is controlled by RV2. C6 rounds off the otherwise square vibrato pulses, for a more pleasing effect.

The plate need only be a square of blank pc board a few centimetres to a side. Some experimentation wouldn't go astray. You could also use a small telescopic whip antenna. The whole unit is powered from a 9 V transistor radio battery. Better audio output is obtained with a larger diameter speaker rather than a smaller one.

Now stand up and play God Save the Queen!



LM833 RIAA phono preamp

THE economical, high performance LM833 from National Semiconductors makes an excellent preamp for a magnetic cartridge. This circuit is straightforward, uses commonly available parts and the RIAA curve is within plus or minus 2 dB from 30 Hz to 15 kHz. Input sensitivity is 3.2 mV, overload is at 133 mV.

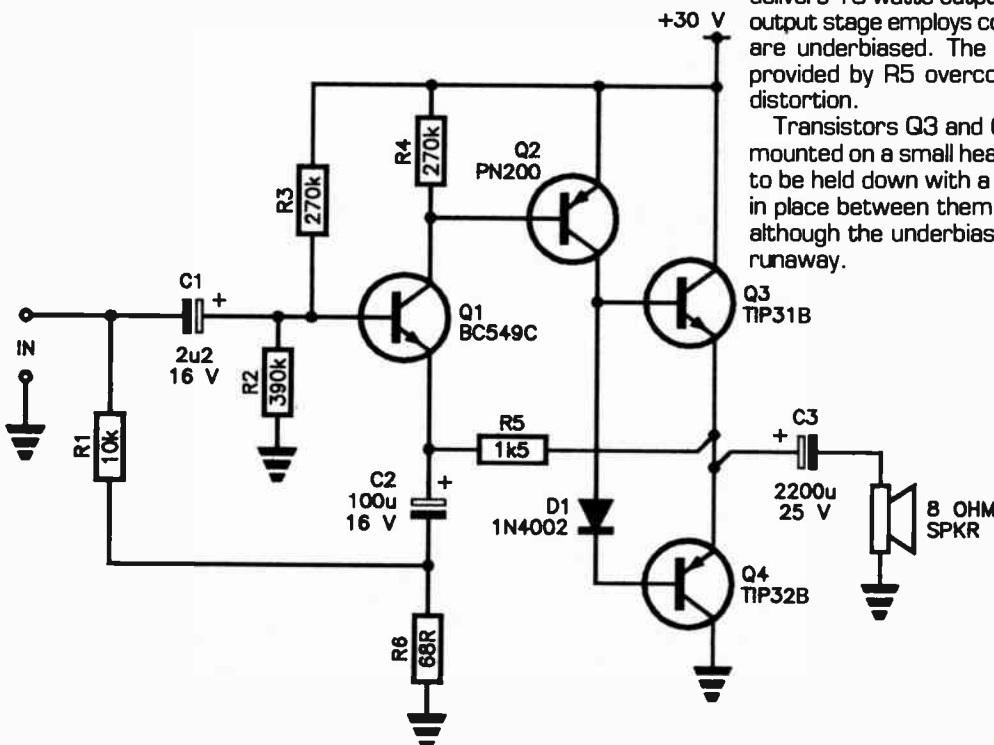
Use all metal film [1%] resistors; the capacitors should be high quality metallised polyester [MKT] or polypropylene [MKP] types rated at 50 V [they're the smallest size, generally]. As values above 1μ become bulky, expensive and hard to find, two 1μ capacitors are used in parallel at the input. Note that C3 is a tantalum. R1 and C1 provide RF interference suppression at the input.

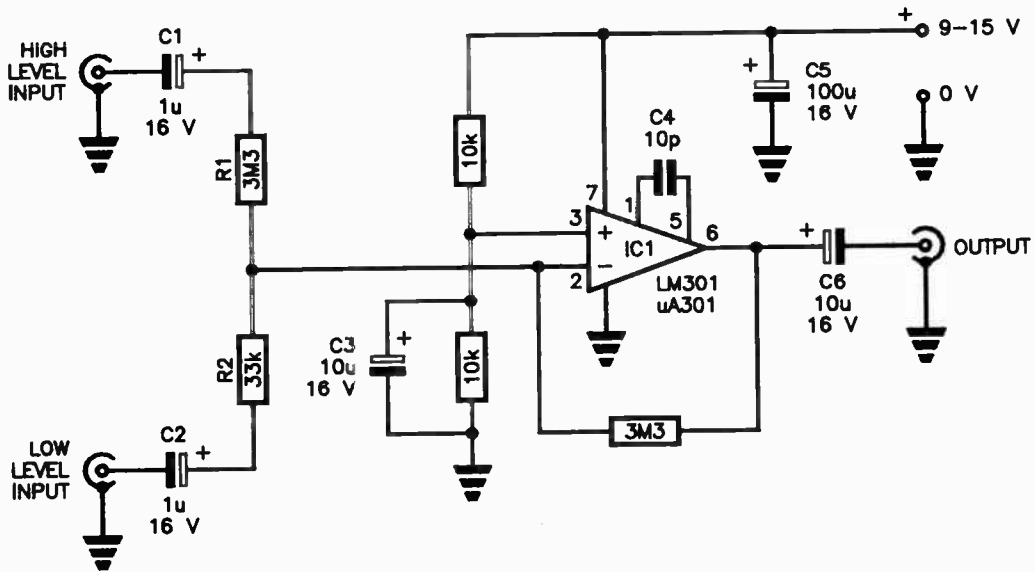
IC1 - LM833
DUAL OP-AMP,
OTHER HALF
FOR OTHER
CHANNEL

10 Watt audio amp

THIS is a very simple, economical audio power amp that delivers 10 watts output with the minimum components. The output stage employs complementary output transistors that are underbiased. The large amount of negative feedback provided by R5 overcomes the otherwise large crossover distortion.

Transistors Q3 and Q4 are tag type devices and must be mounted on a small heatsink; their construction allows them to be held down with a single bolt. Diode D1 can be epoxied in place between them for a measure of thermal feedback, although the underbiasing of Q3-Q4 helps prevent thermal runaway.

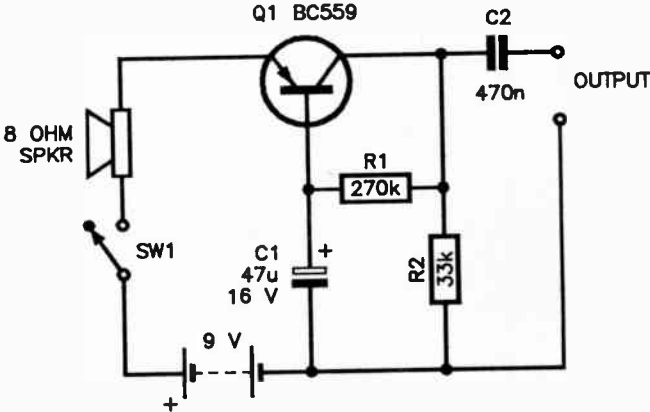




Mic mixer

YOU can mix a high level source with a [low level] microphone input for an amplifier using this simple circuit. The high level input has unity gain input-to-output, while the low level input has a gain of 100.

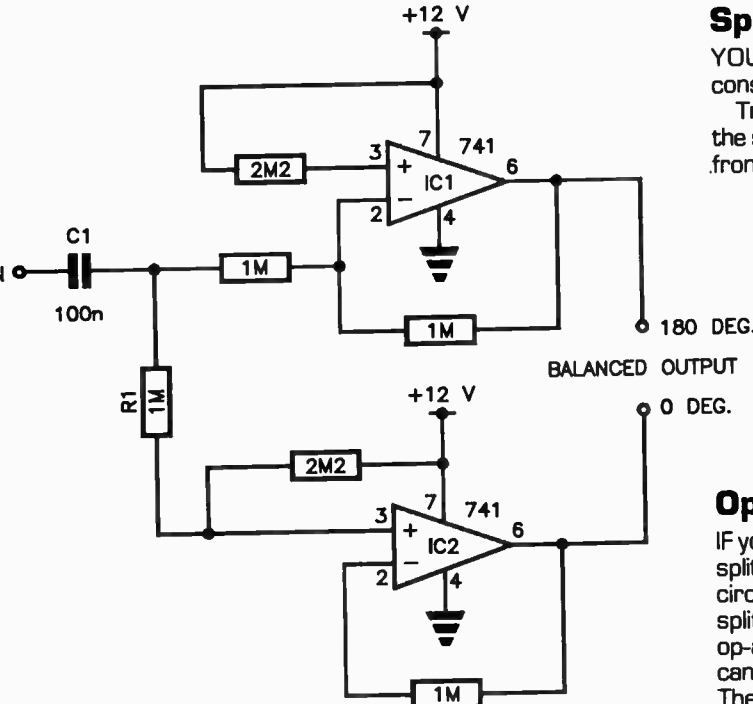
To avoid the necessity of split supply rails, the non-inverting input of IC1 is biased to half the supply rail voltage, this point being bypassed by C3. Capacitors C1, C2 and C6 provide ac coupling. C4 compensates IC1, while C5 bypasses the supply rail. It can be powered from a single 9 V transistor radio battery (don't forget an on/off switch!)



Speaker for a mic

YOU can use a small 50 mm speaker as a microphone by constructing this preamp circuit.

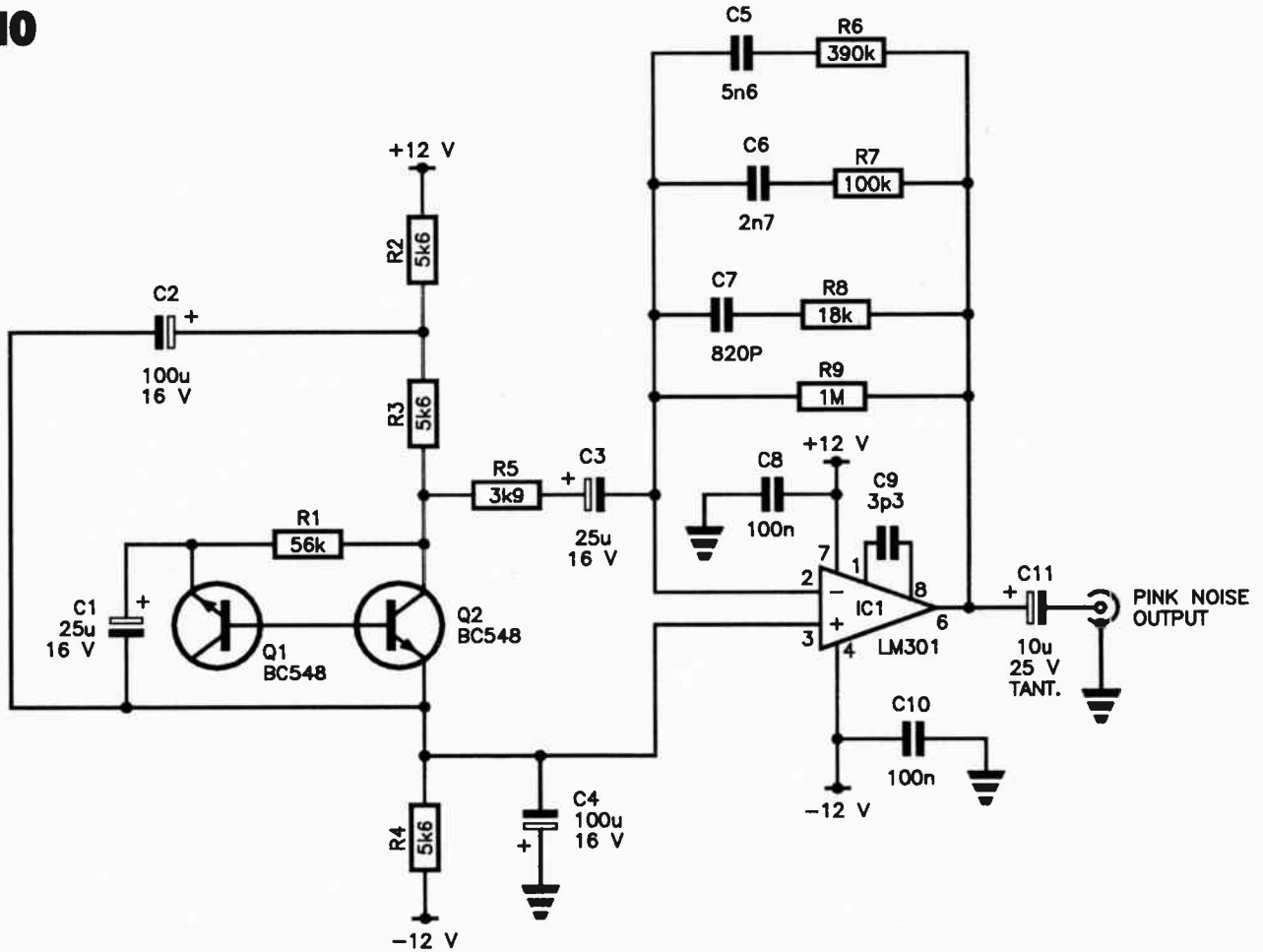
Transistor Q1 is arranged as a grounded-base amplifier, the speaker being in the emitter. Output is capacitively coupled from the collector. It works remarkably well!



Op-amp phase splitter stage

IF you are designing an audio amp circuit that requires a phase splitter and you've plenty of IC op-amp packages, try this circuit. It has unity gain to both outputs and uniform phase splitting over the whole audio range. A dual op-amp or two op-amps from a quad package may be used. The supply rail can be anything convenient that's within the op-amp's ratings. The output should be capacitively coupled.

AUDIO



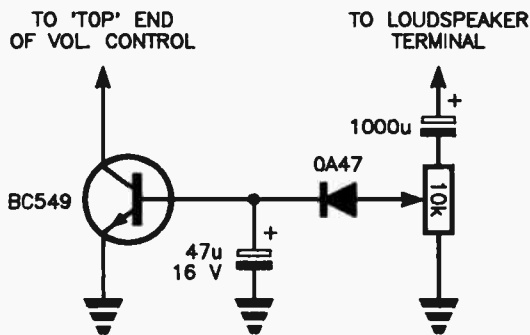
Audio pink noise generator

AN audio pink noise source, which is specially filtered white noise, is widely used in audio testing, being particularly useful for showing up loudspeaker faults, room acoustic problems, etc.

As in the white noise generator circuit here, a reverse-biased transistor emitter-base junction is used as a noise source. Q1 here provides the reverse-biased junction, which is part of the base bias circuit of Q2, a common-emitter

amplifier stage. Output from Q2's collector is coupled to the non-inverting input of IC1. The feedback network of this op-amp provides the complex frequency response required to produce pink noise at its output.

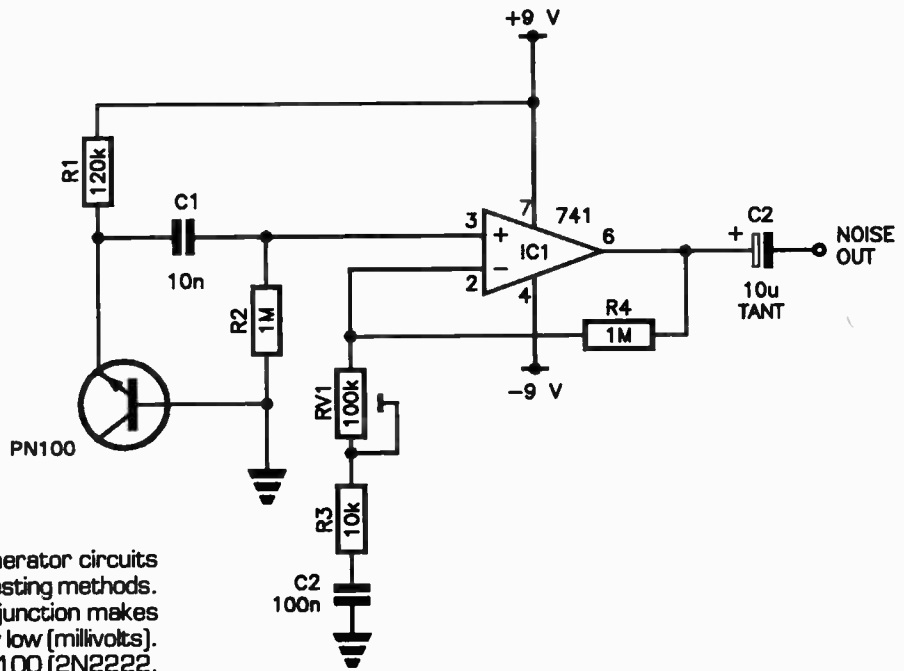
The unit is powered from ± 12 V rails. C2 is a supply rail bypass for Q2, while C1 is an ac return for the noise source, Q1.



Simple audio AVC

YOU can add-on this circuit to many solid state audio power amp stages, such as in a receiver, to provide some automatic volume control to maintain a more constant audio level output.

The signal across the loudspeaker is tapped off by the 1000μ capacitor and 10k pot, rectified by the 0A47 diode and the resultant dc applied to the base of the transistor. The rectified audio varies in level in step with the loudness variations of the audio. This varies the base current of the transistor which varies its collector resistance, shunting the volume control more with loud signals and less with soft signals. Thus a more constant audio level can be maintained. The 47μ capacitor provides a little hang so that sudden loud passages following a soft passage don't burst up loudly.



Audio white noise generator

WHITE noise is useful in electronic music generator circuits and sound effects, as well as for some audio testing methods.

A reverse-biased transistor emitter-base junction makes a good white noise source, but the level is very low (millivolts). Here, R1 applies bias to the emitter of the PN100 (2N2222, etc). The noise voltage is capacitor-coupled to the non-inverting input of IC1 which amplifies the noise. RV1 sets the gain (maximum of $\times 100$).

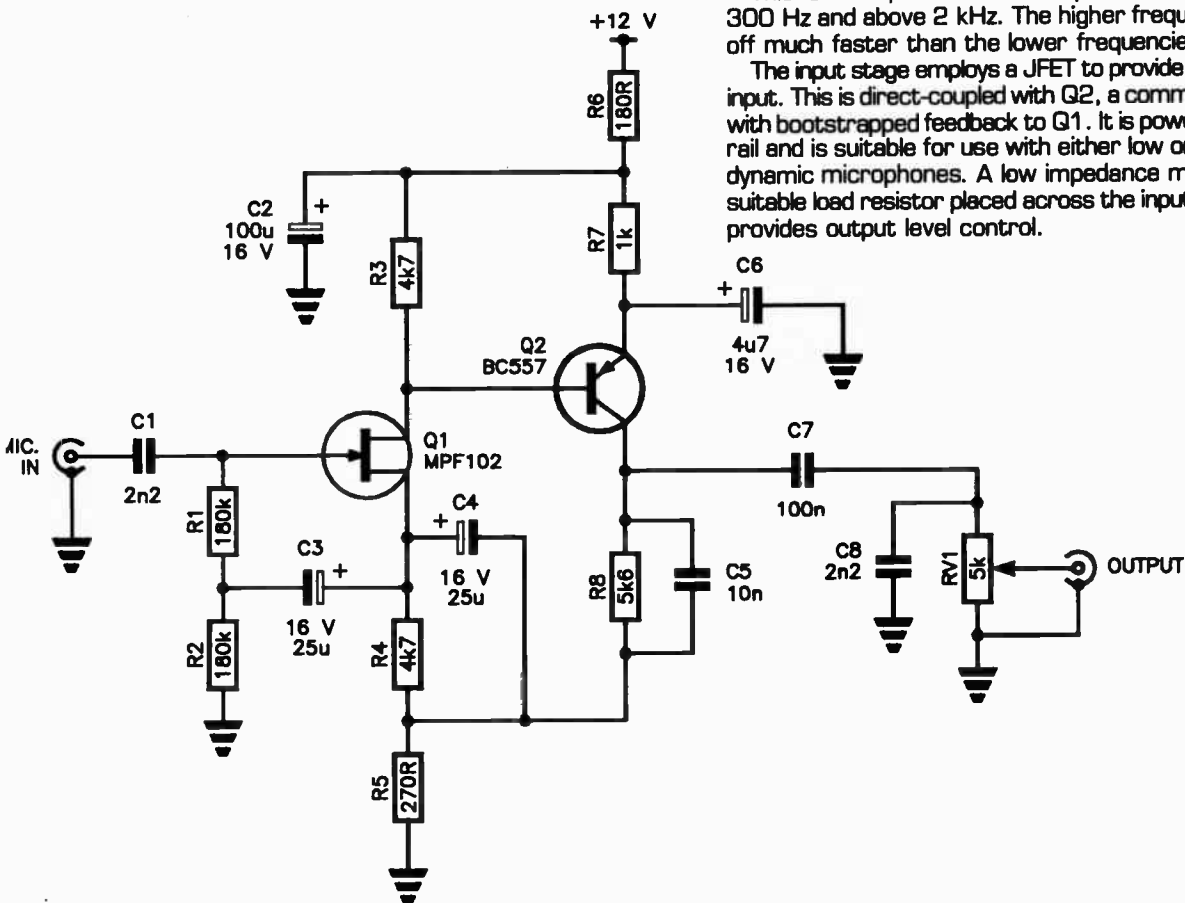
While supply rails of ± 9 V are shown, they may be as low as 6 V, or as high as 15 V.

Mic amp with speech-tailored response

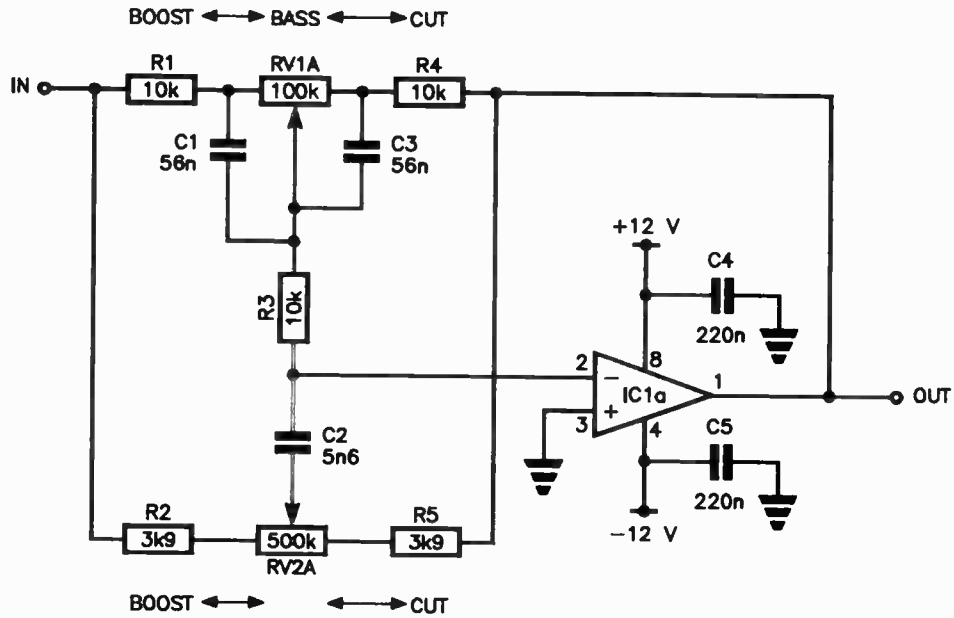
IN speech communications, tailoring the response of the preamp following the microphone will improve speech intelligibility and reduce extraneous background noise pickup affecting the signal.

This circuit provides the required rolloff slopes below 300 Hz and above 2 kHz. The higher frequencies are rolled off much faster than the lower frequencies.

The input stage employs a JFET to provide a high impedance input. This is direct-coupled with Q2, a common-emitter stage with bootstrapped feedback to Q1. It is powered from a 12 V rail and is suitable for use with either low or high impedance dynamic microphones. A low impedance mic may require a suitable load resistor placed across the input connector. RV1 provides output level control.



AUDIO



IC1 - LM833 DUAL OP-AMP,
OTHER HALF FOR OTHER
CHANNEL. RV1 AND RV2
DUAL-GANGED POTS, OTHER
GANGS FOR OTHER CHANNEL

LM833 tone control

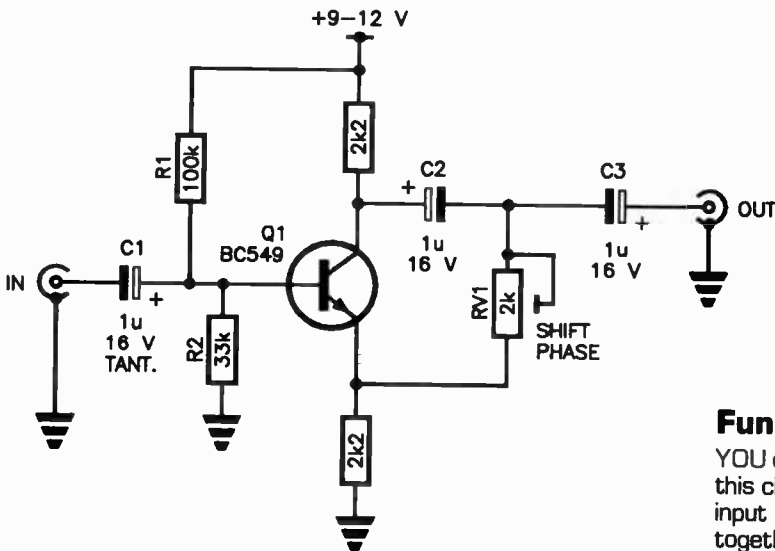
AN excellent stereo tone control circuit can be made with a single LM833. This dual op-amp features low noise and distortion and is ideal in such applications.

This circuit employs conventional boost/cut bass and treble filters, only half of the stereo circuit being shown. The controls

(RV1 and RV2) are dual-ganged types.

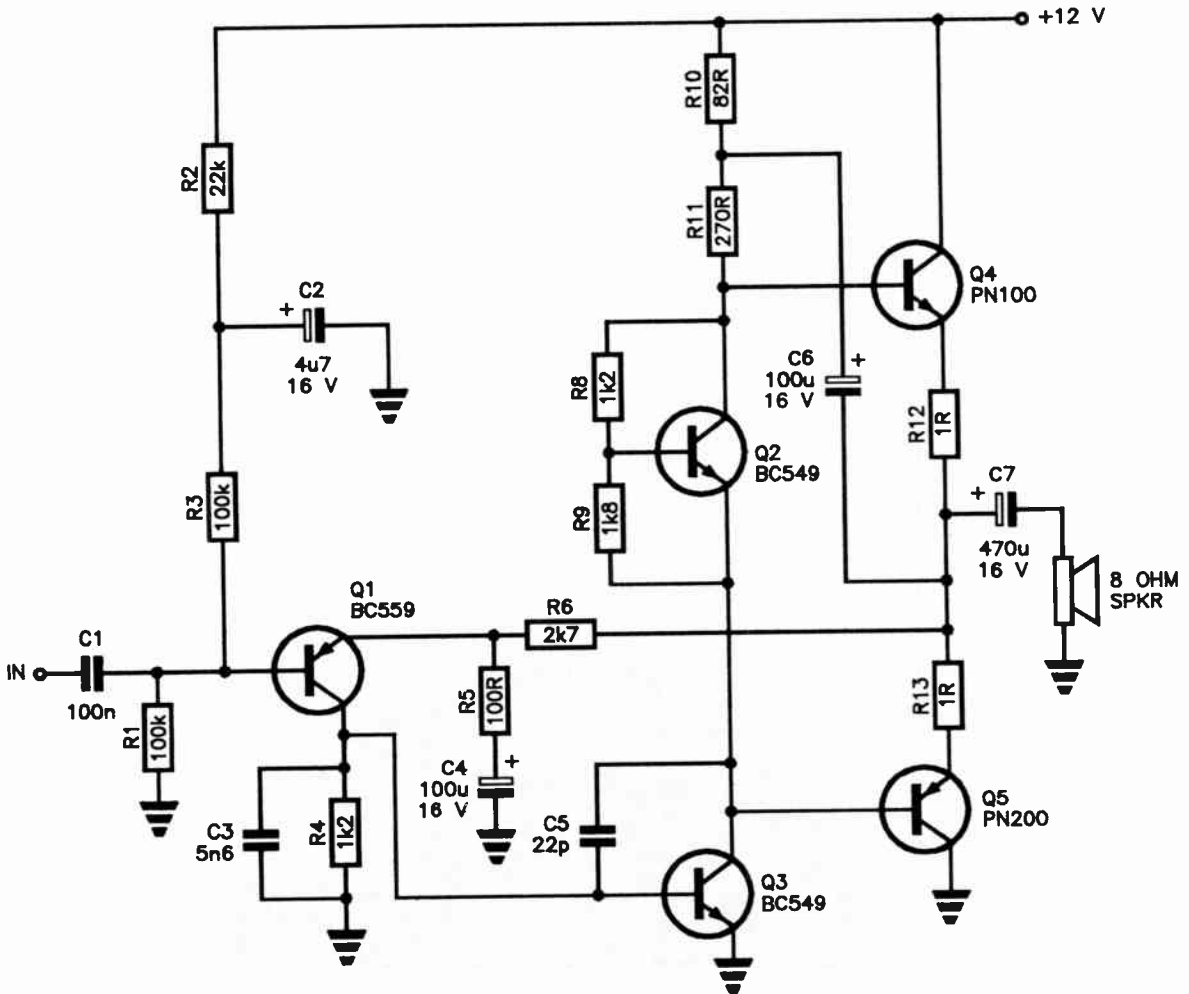
The rollover [3 dB] point for bass boost/cut is at about 300 Hz; maximum boost and cut is about 17 dB at 30 Hz.

The 3 dB rollover point for treble boost/cut is about 1 kHz, maximum boost and cut is about 17 dB at 10 kHz.



Fun with phase

YOU can have great fun with audio phase-shift effects using this circuit. Q1 is connected as a phase splitter, with signal input applied to the base. The two outputs are coupled together via C2 and RV1, output being picked off at their junction via C3. Varying RV1 shifts the phase back and forth.



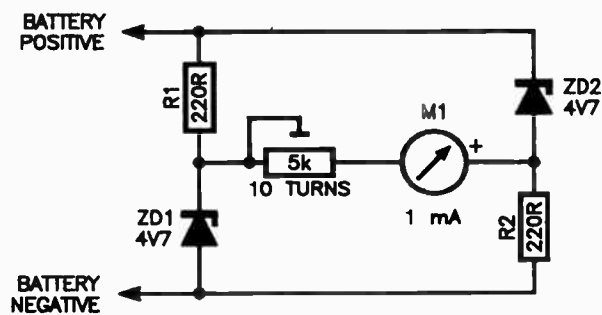
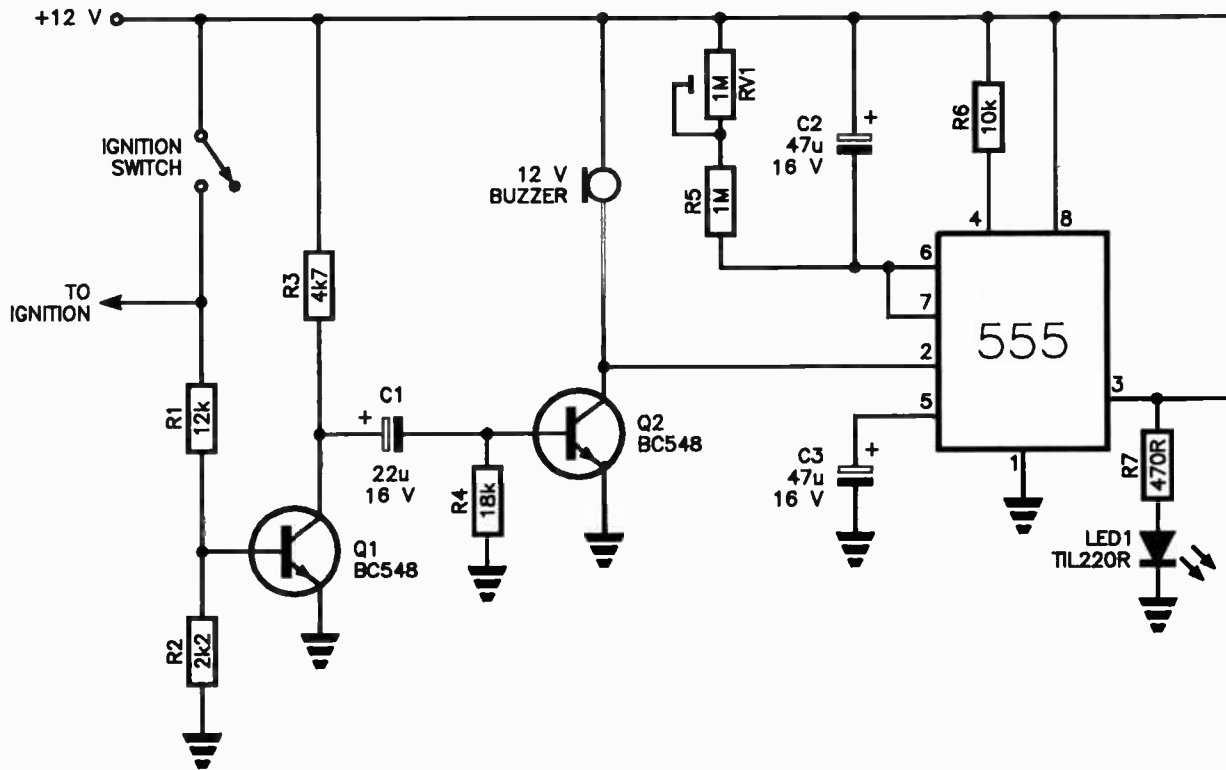
Simple transistor audio amp

YOU can get 1.5 watts output from this simple transistor audio amp which uses common transistors — and no heatsink is required. It provides low distortion and good frequency response. It is ideal for use in receivers or as a bench amplifier.

The output stage is a straightforward complementary pair, Q2 providing the required bias for class B operation of Q4-Q5. Transistor Q3 provides most of the gain, Q1 providing input gain and the feedback point. Capacitor C6 keeps the voltage across R8 very nearly constant to keep the current through Q2 (and thus the bias) constant. Transistors Q2, Q4 and Q5 are epoxied to a small scrap of aluminium a few centimetres per side for a heatsink.

Sensitivity is about 1 V input for 1.5 W output. A supply of between 9 V and 15 V can be used, there being less power output at the lower voltage, of course.

CIRCUITS FOR CARS



Car battery monitor

THIS circuit expands the scale of a meter so that it reads voltage between 10 and 15 volts, which can be used to check the health of your car battery.

Two zeners form opposite arms in a bridge, the meter being across the bridge output. No current will flow through the arms of the bridge until the input voltage exceeds about 10 V. The current through the meter will then depend on the input voltage. Maximum meter scale reading is set by the 5k trimpot. There are so few components, you could mount them directly on the back of the meter terminals.

Auto switch-on for car alarm

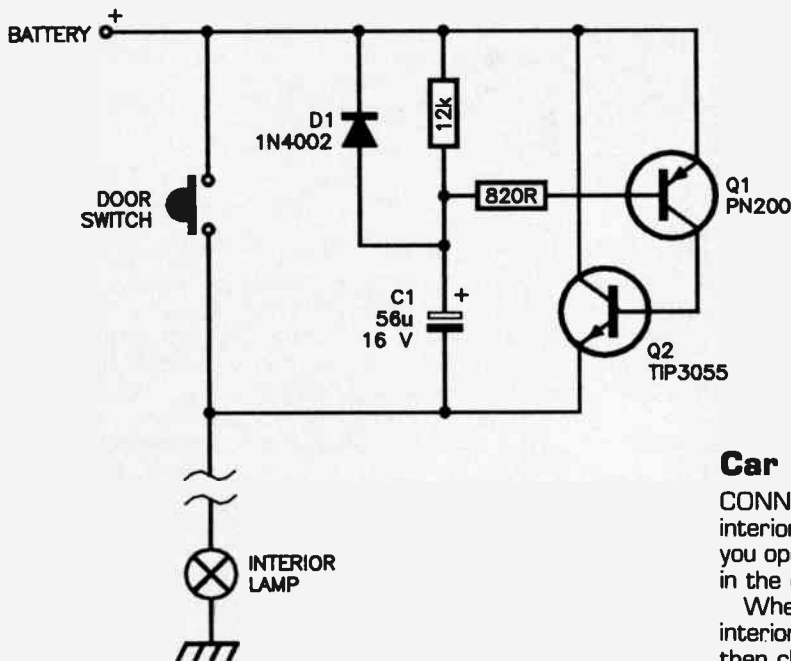
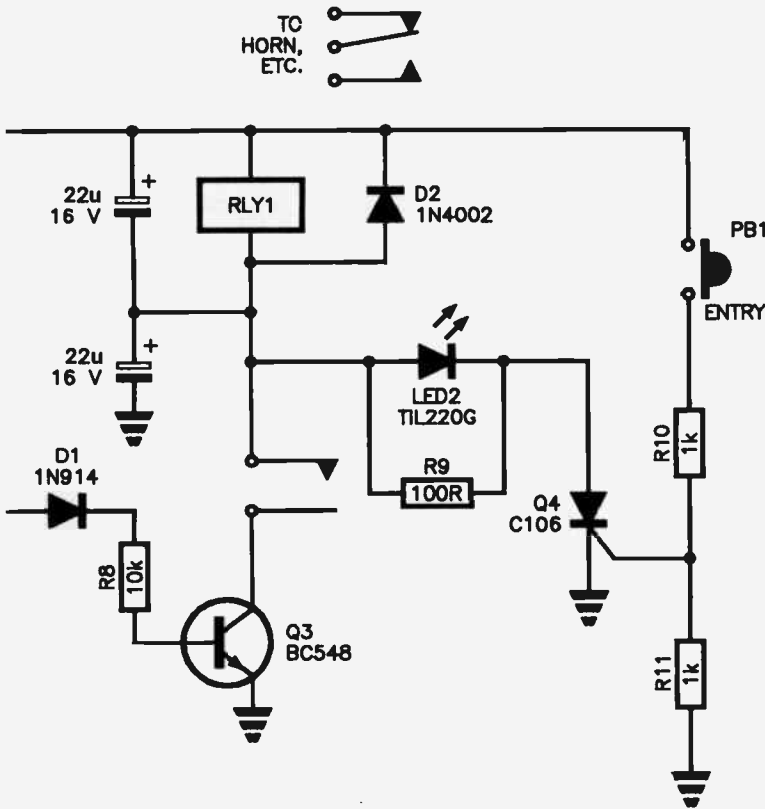
NO car alarm is any use unless you turn it on! This circuit will provide automatic arming for a car alarm as well as entry and exit delay.

When you enter the car with the alarm armed, you press PB1. This gates the SCR Q4 on (which stays on), lights LED2 and operates the relay. The normally closed contacts of the relay arm the alarm, so this disarms the alarm.

When the ignition is turned on, Q1 is on and C1 is discharged. The 555 is inhibited because pin 2 is held high via the piezo beeper.

When the ignition switch is turned off, Q1 turns off and C1 charges via R3. This allows Q2 to turn on, the falling collector voltage triggering IC1, while the buzzer sounds for the second or so it takes C1 to charge. This alerts you that the alarm is being armed.

As soon as IC1 is triggered, its output goes high and LED1 lights. This drives Q3 on, operating the relay and removing the anode supply from Q4, which turns off. The relay remains operated for a period which is determined by RV1. When IC1 completes its timing period, pin 3 goes low, LED1 goes out and Q3 turns off, de-energising the relay. The alarm is then armed via the normally closed contacts.

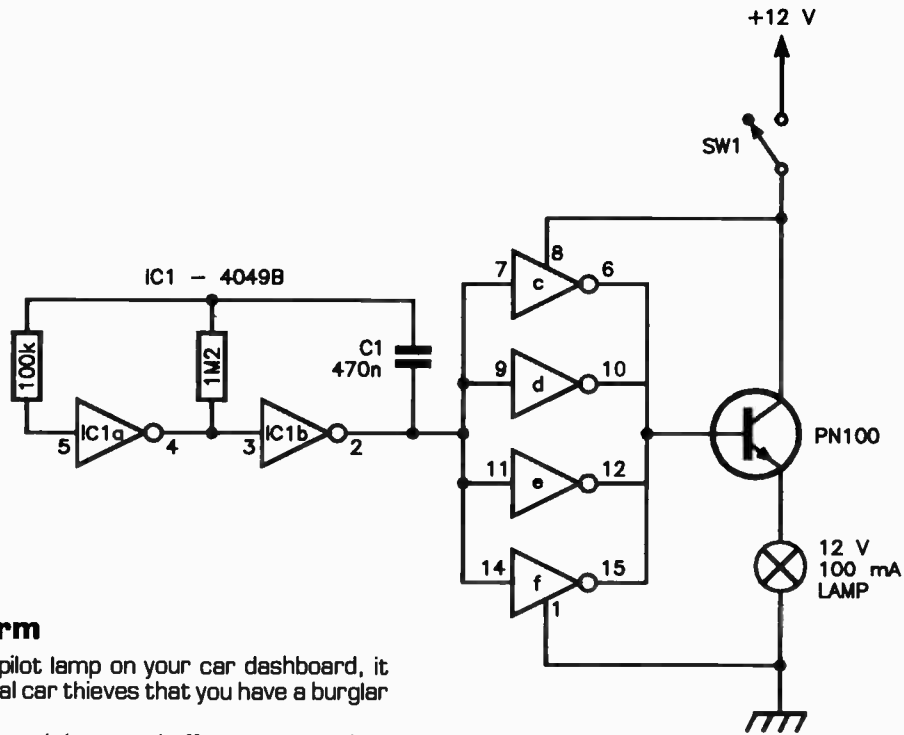


Car interior light 'keep on'

CONNECT this simple circuit in parallel with your vehicle's interior light and it will keep it on for 20 seconds or so after you open and close the door — handy for finding your keys in the dark, etc.

When the door switch closes as you open the door, the interior light goes on. This shorts the timer circuit. When you then close the door, C1 charges up slowly, supplying base current to Q1, turning on Q2, which keeps current flowing through the lamp. When C1 has charged sufficiently, there will be insufficient current flowing through Q1 and Q2 will turn off, turning the interior lamp off.

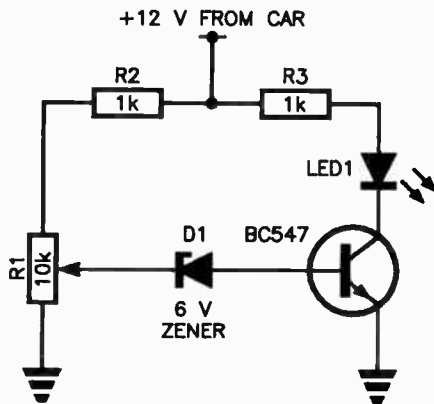
CIRCUITS FOR CARS



Dummy car alarm

IF you install a blinking pilot lamp on your car dashboard, it will serve to fool potential car thieves that you have a burglar alarm.

A 4049 hex inverter pack has two buffers connected as a ring-of-two oscillator. The oscillator's output drives the other four parallel-connected buffers which drive the base of the transistor which turns the lamp on and off. The switch turns the dummy alarm on and off. A push-on/push-off switch is ideal. Some types have an integral lamp which are perfect for this application.

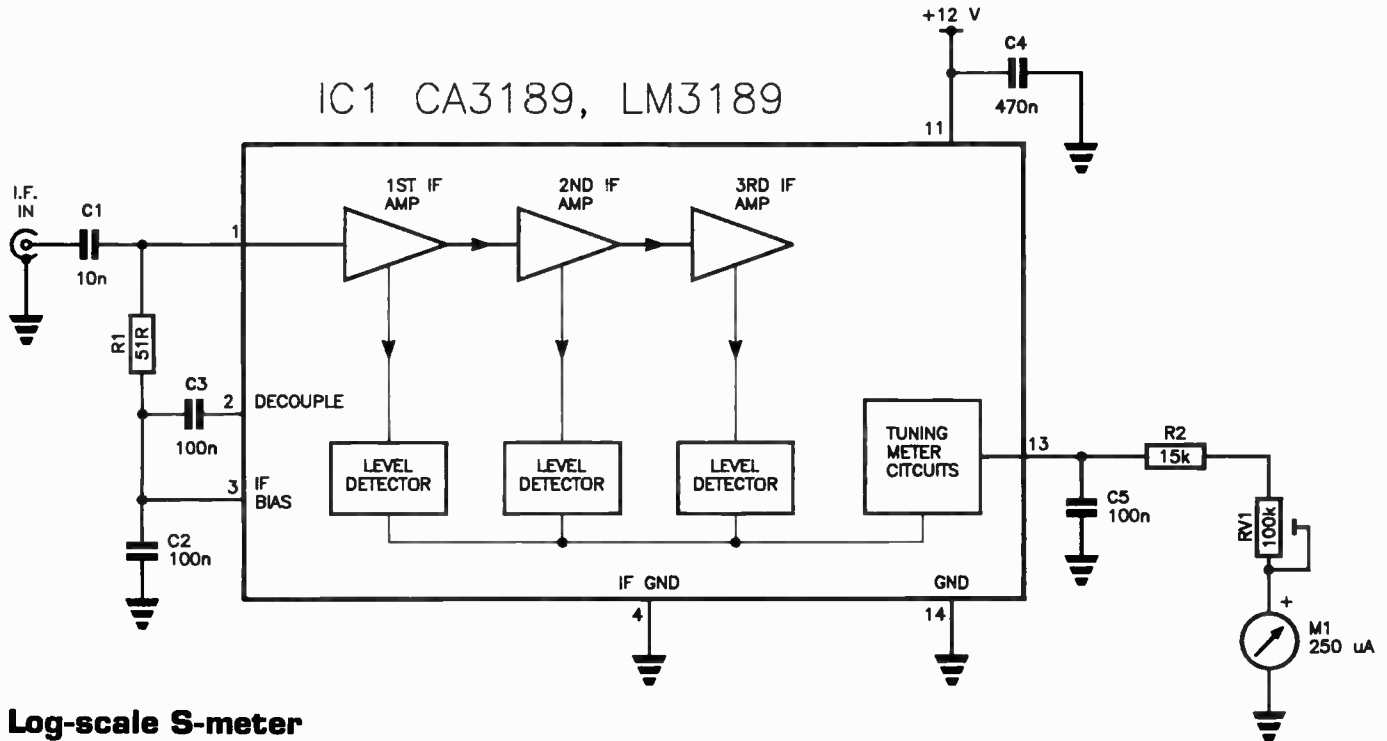


Car battery monitor

HERE'S a very simple monitor for your car battery; you don't need to keep your eye on a meter. With the battery terminal voltage at a reasonable level — say 12.5 V as measured with a DMM or good meter — R1 is adjusted so that the LED lights. When the battery voltage falls below this level, the zener will snap to a non-conducting state, starving the transistor of base current. There will be no collector current then and the LED will go out.

If you don't see that little light glowing on the dashboard, you're in trouble! Better make that a green LED. For R1, best use a 10-turn trimpot.

DISPLAYS & INDICATORS



Log-scale S-meter

THE CA3189 (RCA) or LM3189 (National Semiconductor) FM receiver IF system IC provides an ideal basis for an S-meter in a receiver. It has a three-stage wideband amplifier inside with level detectors on each stage that provides a pretty good log-response dc output to drive a meter.

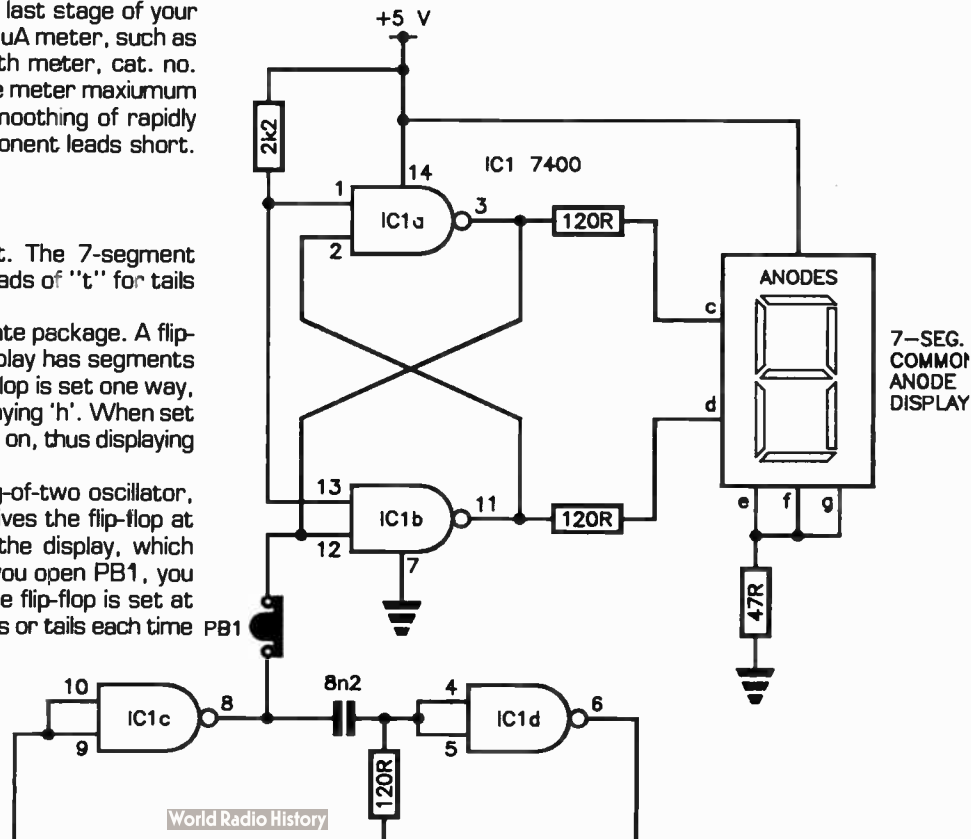
It's so simple! Drive its input from the last stage of your receiver's IF (low impedance). Use a 250 uA meter, such as the Dick Smith Electronics signal strength meter, cat. no. Q-2100, or similar. Trimpot RV1 sets the meter maximum reading. Capacitor C5 provides some smoothing of rapidly changing signal variations. Keep all component leads short.

'Come in, spinner!'

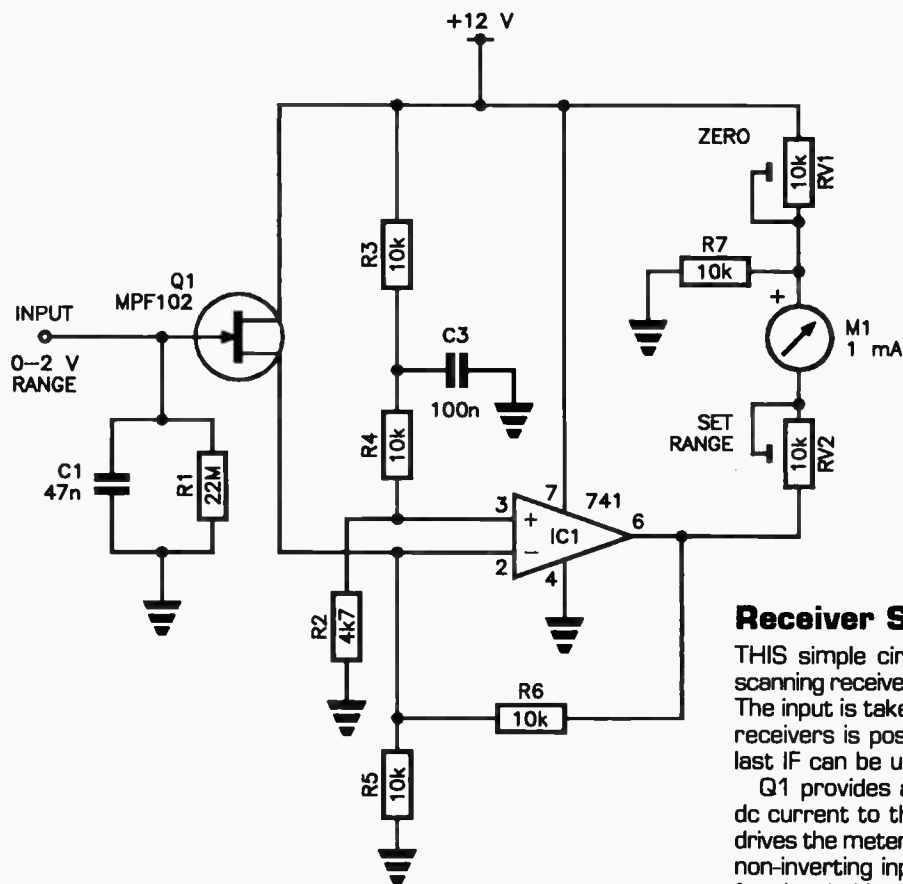
HERE'S a cunning little coin toss circuit. The 7-segment display is made to show either 'h' for heads or 't' for tails when you press the pushbutton PB1.

The circuit uses a 7400 quad NAND gate package. A flip-flop is made from IC1a and IC1b. The display has segments e, f and g permanently on. When the flip-flop is set one way, the c segment will be driven on, thus displaying 'h'. When set the other way, the d segment will be driven on, thus displaying 't'.

IC1c and IC1d are connected as a ring-of-two oscillator, running at a fairly high frequency. This drives the flip-flop at a pace too fast to see the changes in the display, which appears to show 'b'. This means, when you open PB1, you won't be able to predict in which state the flip-flop is set at the moment and it will randomly show heads or tails each time PB1 you press the pushbutton.



DISPLAYS & INDICATORS



Receiver S-meter

THIS simple circuit is easily added on to a shortwave or scanning receiver to provide relative signal strength indication. The input is taken to the AGC line, which in most solid state receivers is positive, otherwise a simple rectifier from the last IF can be used.

Q1 provides a high impedance input, providing a variable dc current to the inverting input of IC1. The output of IC1 drives the meter circuit. R6-R5 provides some feedback. The non-inverting input of IC1 is biased up a bit to compensate for the dc bias applied to the other input because of Q1's quiescent drain current.

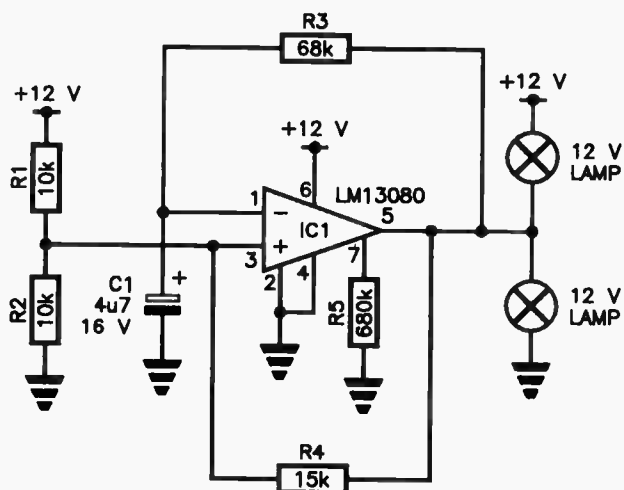
RV1-R7 jacks up the positive meter terminal to compensate for the quiescent dc level at IC1's output; varying RV1 zeros the meter. RV2 sets the maximum meter deflection. The meter deflection will be maximum with +2 V at the input.

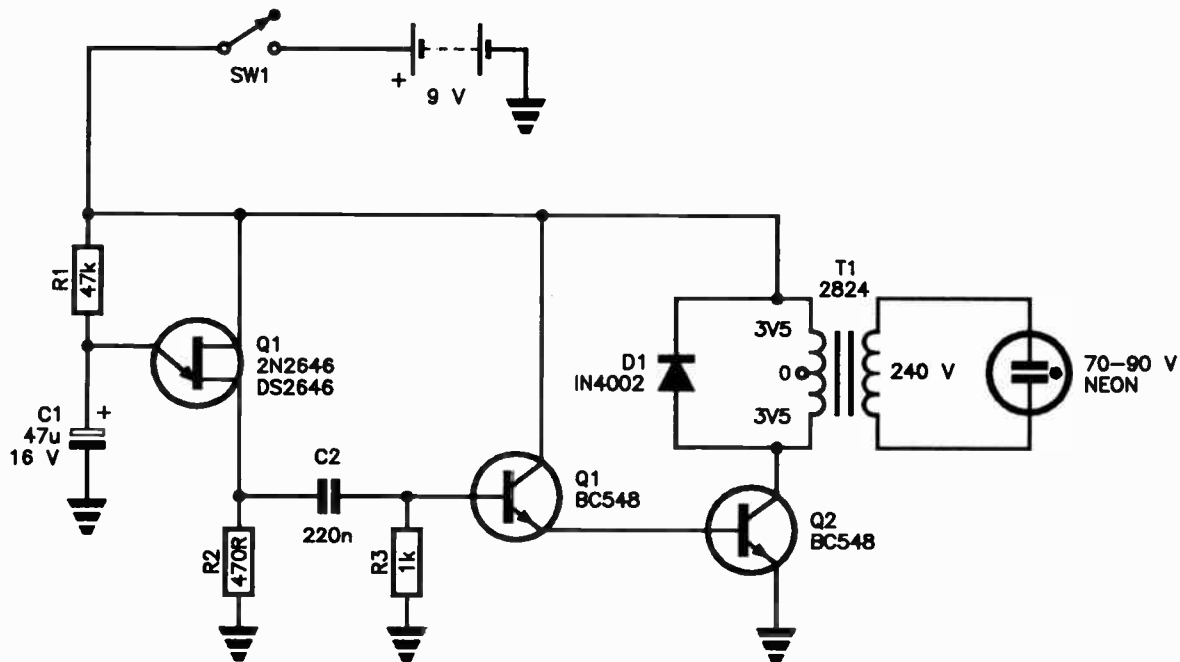
Twin lamp flasher

Here's a simple circuit that will flash two 12 V lamps alternately. The LM13080 power op-amp is arranged as a simple oscillator, the rate being determined by R3-C1.

The op-amp's non-inverting input is biased to half the supply rail voltage. At power-on, C1 is discharged, so IC1's output will rise towards the positive supply rail, charging C1 through R3. When the voltage on C1 exceeds the voltage at pin 3 of IC1, the output of IC1 will swing towards zero and C1 will discharge via R3.

The LM13080's output will swing between ground and 12 V. When it's at ground, the top lamp will light; when it's at 12 V, the bottom lamp will light.





Battery-operated neon flasher

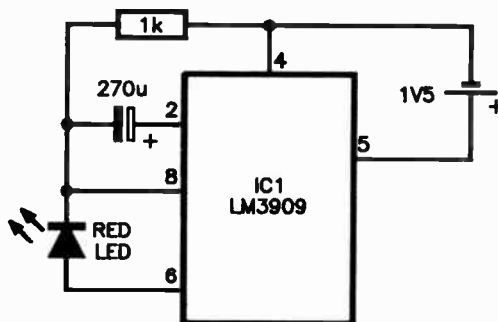
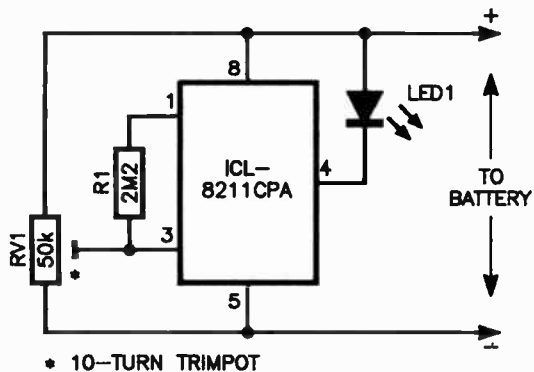
NEED to have a flashing neon indicator operated from a battery circuit? This simple circuit is cheap and cheerful and uses common parts.

A UJT oscillator pulses the base of Q1 via C2. When Q1 turns on, Q2 turns hard on, drawing current through the primary (normally the secondary) of T1. This provides a voltage pulse at the secondary of T1 sufficient to cause the neon to 'strike', and it flashes. When Q1 and Q2 turn off, when the pulse returns to zero, the field created by the primary current in T1 collapses, but the back-emf generated

is shorted by D1 so that it won't damage Q2.

Transformer T1 is a cheap 2824 type 3.5-0-3.5 V secondary mains transformer, commonly available in electronics stores. A 9 V transistor radio battery is sufficient to power the circuit.

If you want to trigger and inhibit the flasher, to turn it on and off as part of another battery-operated piece of circuitry, simply arrange to clamp the base of Q1 to ground with a transistor collector-emitter junction or a gate output, to inhibit the flasher, releasing the clamp to trigger it.



Battery monitor

SEMICONDUCTOR manufacturer Intersil makes a range of useful and interesting devices for a wide variety of applications. The Intersil ICL-8211CPA makes a very interesting battery monitor, using this simple circuit.

The trimpot RV1 is adjusted such that when the battery voltage falls to a critical predetermined level, the LED lights. Simple! A 10- or 20-turn trimpot is recommended.

DISPLAYS & INDICATORS

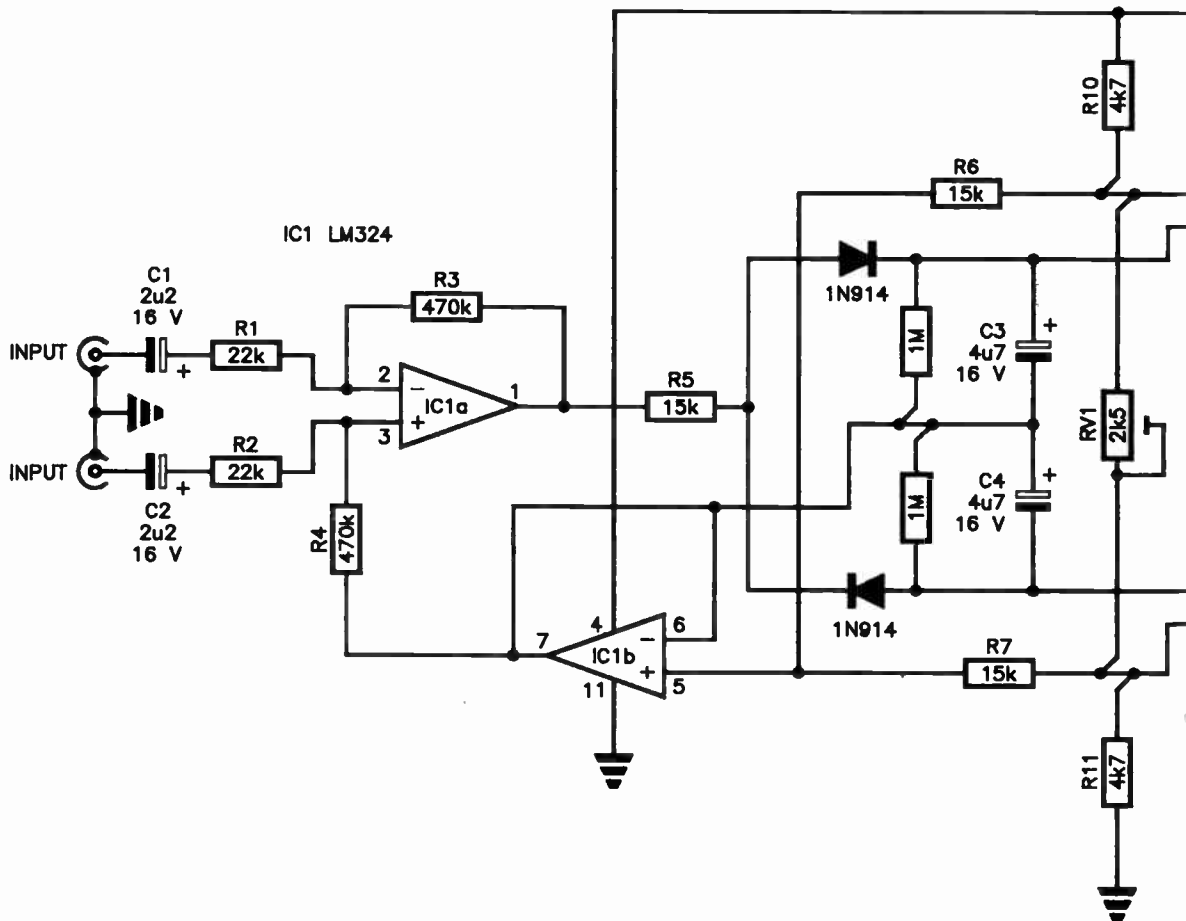
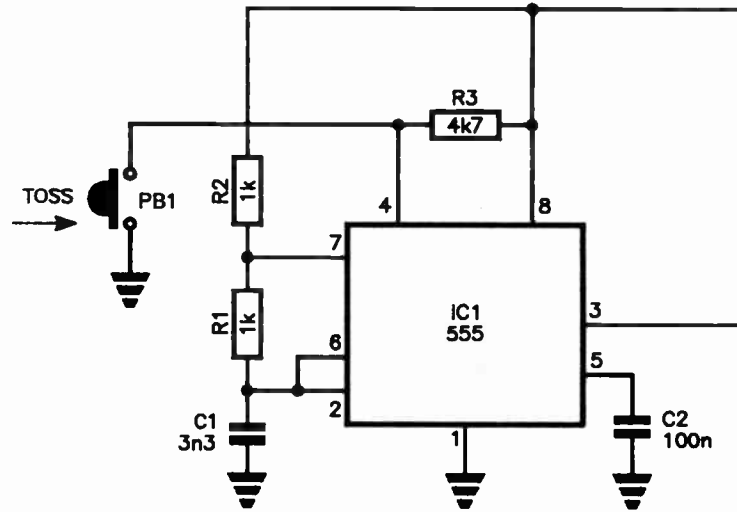
Electronic coin tosser

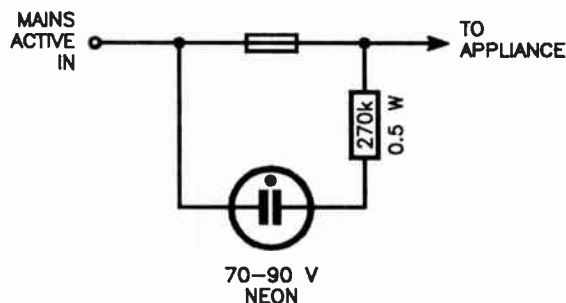
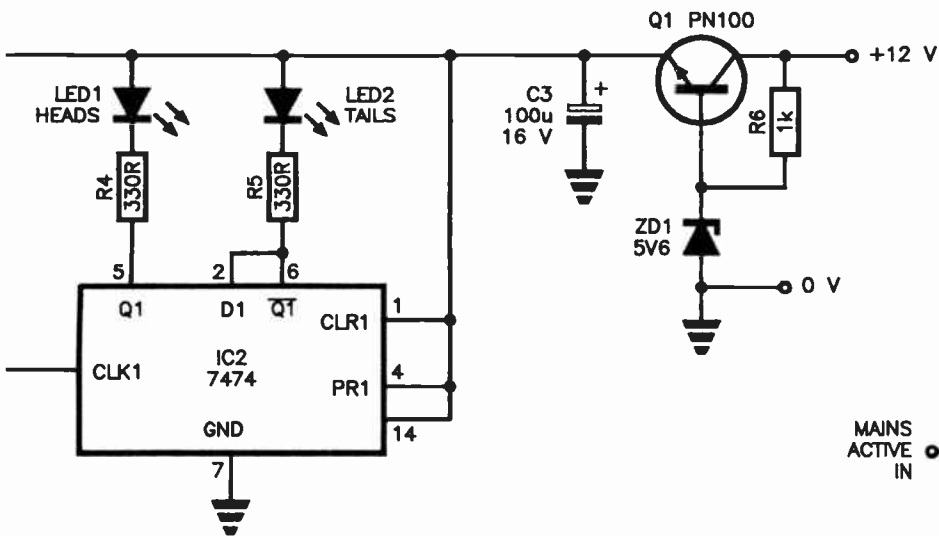
LOTS of electronic coin tossers use simple circuits that are rarely truly random in heads/tails selection. This circuit doesn't suffer that problem.

The 555 (IC1) oscillates at a high rate in the kilohertz region. Its output clocks the 7474 (IC2) dual-D flip-flop, which has a truly symmetrical output. The Q1 and Q1' outputs alternately switch the LEDs on and off. Because this is very fast, you cannot tell which one's on at any one moment.

Press the Toss button (PB1) and you stop the oscillator at some random point. The clock to IC2 ceases and the flip-flop (IC2) will stay in its last state – which you can't predict.

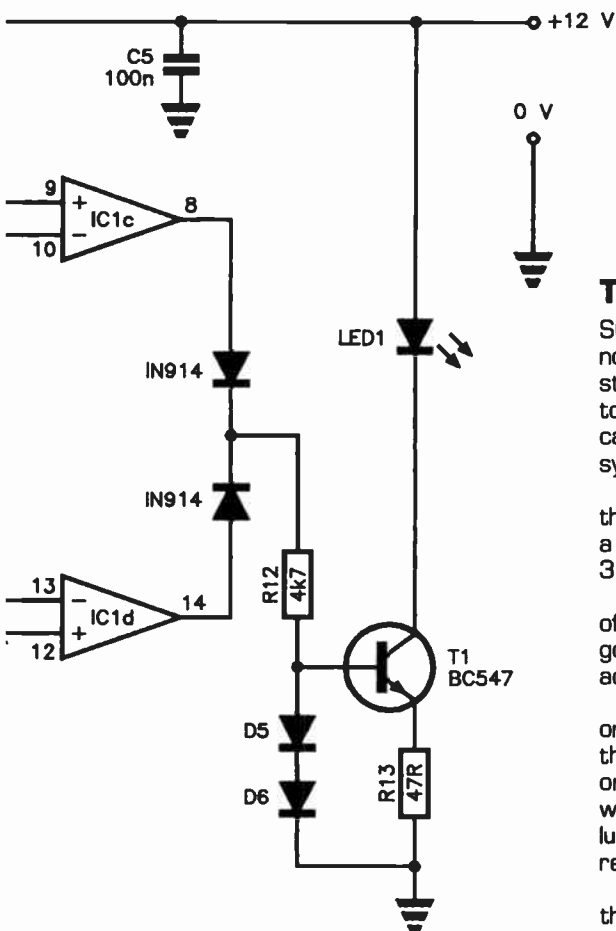
Let PB1 go and the LEDs will roll again. It could be run from a 9 V supply, rather than the 12 V supply indicated, if you wish.





Fuse blown indicator

KNOWING whether the mains fuse has blown on a piece of equipment, like a power amp in a PA system, can be a real time and trouble saver. Just connect a neon across the fuse, as shown. Use a neon bezel and mount it on the equipment's front panel — it's an excellent fault indicator. Some neon bezels have an integral resistor, note.



True stereo indicator

SOME FM stereo and TV stereo sound transmissions are not true stereo. Some stereo video recordings are not entirely stereo, either! Even with FM stereo signals, the 19 kHz pilot tone does not necessarily indicate a stereo signal. This circuit can be added in to a tuner or receiver, or in an A-V stereo system to indicate when true stereo is present.

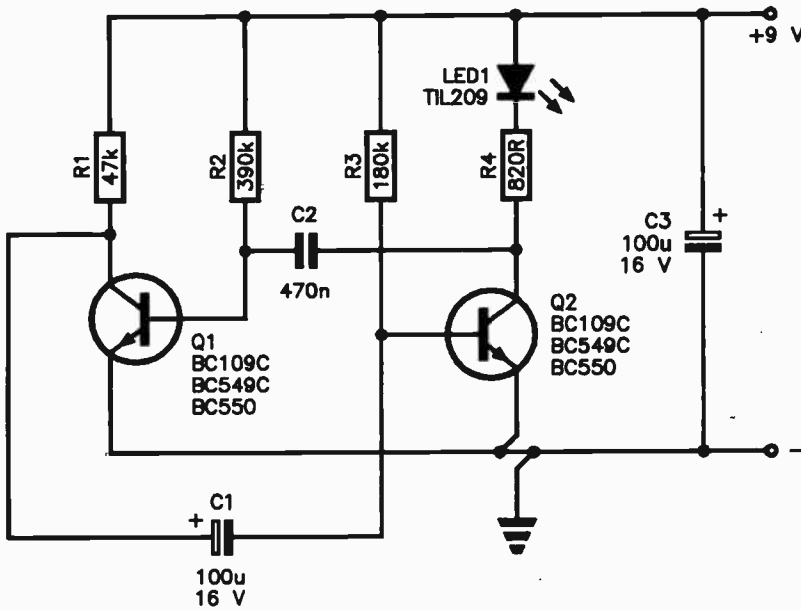
The circuit detects the difference between the two channels that is always present with true stereo signals. IC1b provides a virtual ground at half the supply voltage, referenced to pin 3 of IC1a, setting its output, pin 1 and half the supply rail.

The left and right inputs are applied to the differential inputs of op-amp IC1a, which amplifies their differences. Its output goes positive or negative with respect to virtual ground accordingly, charging C3 via D1 or C4 via D2, respectively.

Op-amps IC1c and IC1d are arranged as comparators. One or the other will switch on, driving the LED driving circuit via the OR-gating circuit of D3-D4. When either output of IC1c or IC1d goes high, Q1 will turn on and the LED in its collector will light. Capacitors C3 and C4 hold their charge during brief lulls in the signal as they will only slowly discharge via the 1M resistors across them.

You can accurately set stereo balance in a system using this unit by applying a mono signal and adjusting the balance to that the LED goes out, indicating no difference between the two channels.

DISPLAYS & INDICATORS



LED winker

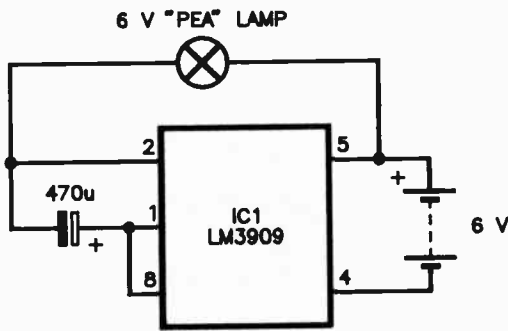
SO you wanna flash your LED? Here's a simple little circuit that can be knocked together from parts in your junk box or spares drawer.

The two transistors are connected as a conventional multistable vibrator, with C1 chosen to provide a turn-on/turn-off rate of about once a second. When power is applied C1 looks like a short circuit and the base of Q2 will receive a pulse of current. C2 also looks like a short circuit, but it must charge via LED1 and R4, which will take a little time. Hence Q2 turns on first. The LED will light.

C2 will charge via R2 until the voltage across it exceeds the base turn-on voltage of Q1, which then turns on. Meanwhile, C1 will have charged, and it will now discharge via the collector-emitter of Q1 and the base-emitter of Q2. Q1 will then try to charge in the reverse direction via R3. When the voltage across it rises to half a volt, Q2 turns on again. Q1 will be turned off because the voltage across C2 will reverse the bias on Q1. C1 now charges via R1 and C2 charges via R2.

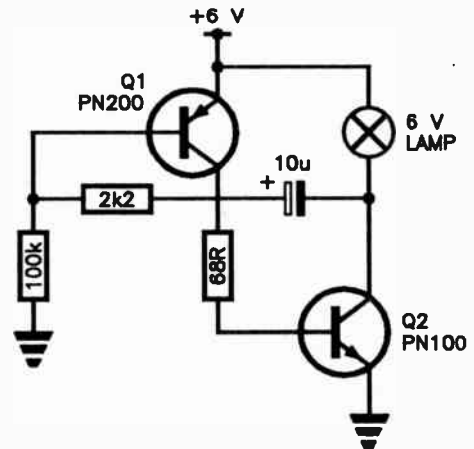
When the voltage across C2 rises above half a volt, the whole circuit flips over once again and the cycle repeats. The LED winks on and off once a second.

The circuit can be powered by a supply ranging between about 4.5 and 12 volts. Capacitor C3 is a supply rail bypass.



Pea lamp flasher

WANNA wink a little lamp? Here's how! The LM3909 flasher will pulse the 6 V torch globe or pea lamp at a rate of about once a second. Great for an add-on in a small, handheld torch. This circuit also works with 4.5 volt globes (use a 4.5 V battery!).

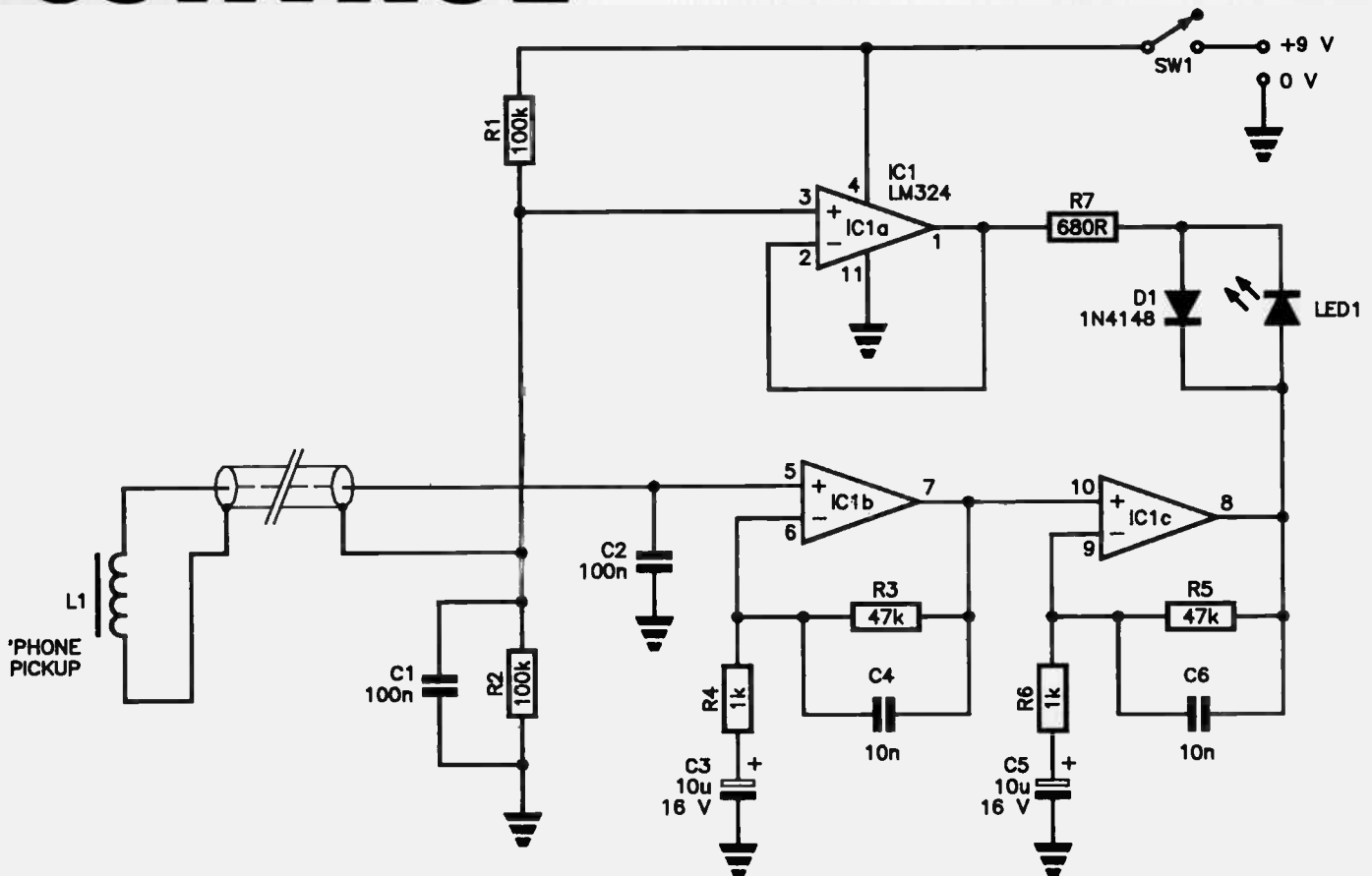


6 V lamp flasher

THIS makes a great add-on continuous flasher for an Eveready Dolphin torch. The PNP-NPN transistor pair is connected as a non-inverting amplifier with feedback from output to input via the 10u capacitor and 2k2 resistor. It oscillates at a Hertz or so, flashing the lamp on an off at a slow rate.

For a 12 V lamp, use a 12 V battery!

THE MAINS & POWER CONTROL



Mains wiring locator

DOING some house renovations and need to find where the mains wiring is before you hack into that wall? This simple circuit will do the job.

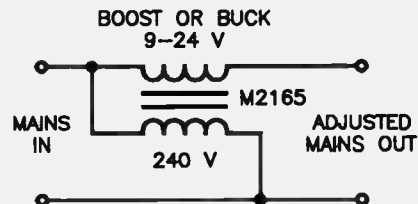
A telephone pickup coil is used as an inductive pickup. The field around the mains wiring will induce a small 50 Hz current in the coil. This is amplified by a filter-amp and rectified to light a LED.

An LM324 quad op-amp package is used. To avoid the necessity of dual supplies, one op-amp is used as a half supply splitter. R1 and R2 provide a voltage of half the 9 V supply at their junction. IC1a is hooked up as a voltage follower, providing a 4.5 V reference at its output, capable of sourcing or sinking tens of milliamps of current.

The pickup coil is connected to the input of IC1b. This op-amp and IC1c are high gain (each $\times 50$) low-pass filters. A small amount of mains hum induced in L1 will be greatly amplified. D1 will rectify this and LED1 will light.

The half-supply bias from R1-R2 is applied to the pickup coil to bias the input of IC1b at this virtual earth point. Capacitor C2 rolls-off the high frequency response of L1.

Wave L1 over the surface of your wall and the LED will peak in brightness as you pass over the mains cable lying beneath.



Mains voltage adjuster

If you have low or high mains voltage, you can adjust it by using a stepdown transformer as shown here.

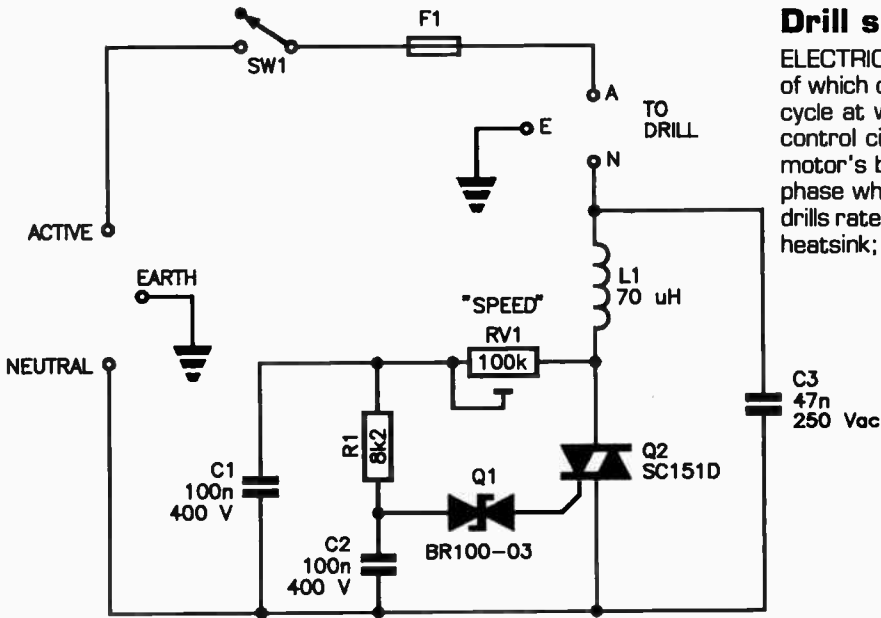
The primary and secondary windings are connected in series, the secondary winding being in series with the output, the primary in parallel with the incoming mains.

Connect the secondary in series-aiding to boost the output by the required amount, in series-opposing to reduce the mains as required. For example, if your mains is 10% low, use the 24 V secondary connections, series aiding. The 24 V adds on to the mains.

If your mains is 5% high, use the 12 V connections in series-opposing (bucking). The 12 V subtracts from the mains.

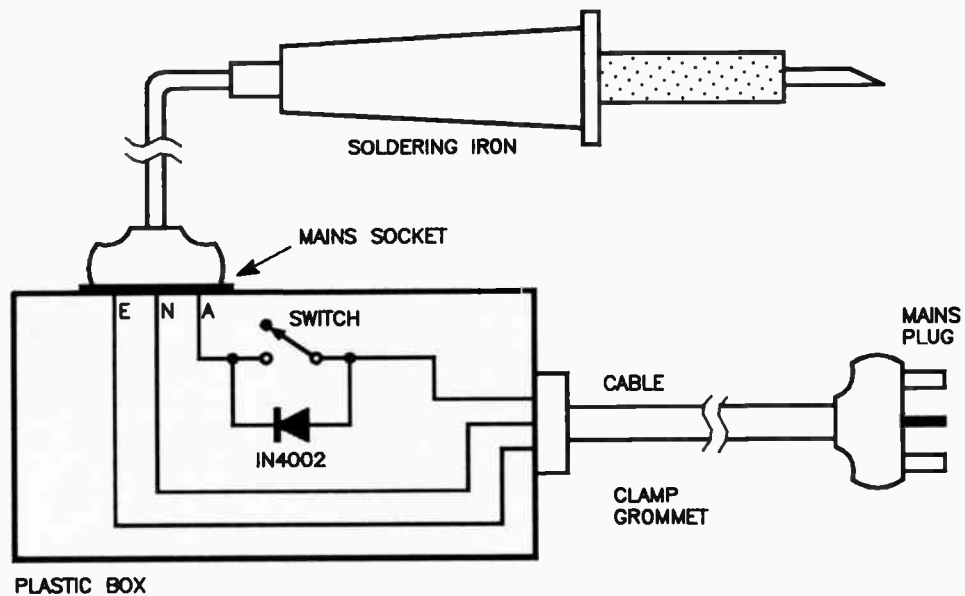
The M2165 transformer specified has a 2 A secondary current rating and will suit equipment rated to 500 watts (or 500 VA).

THE MAINS & POWER CONTROL



Drill speed controller

ELECTRIC drills are powered by a universal motor, the speed of which can be varied by varying the part, or phase, of the cycle at which the triac, Q2, conducts. The simple phase-control circuit here provides wide speed variation and the motor's back-emf provides some feedback to advance the phase when the motor's under load. The circuit will control drills rated to 500 VA. Q2 should be mounted on a small tag heatsink; F1 is a 4 A fuse. L1 is a high current choke.

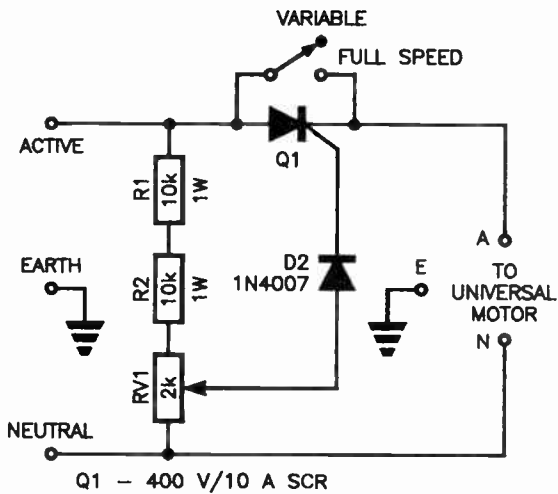


Soldering iron tip saver

IF you have a fixed power soldering iron, no doubt you're familiar with how often you need to refurbish or replace the tip because of corrosion.

You can reduce to corrosion by cutting back the iron temperature during the period of non-use or intermittent soldering where you need to keep the iron on between joints.

This simple adjunct works wonders! Just put a diode rectifier in series with the iron. The heater will receive half-wave pulses, reducing the power and reducing the heating of the tip. A switch in parallel with the diode allows the application of full power when you need it; meanwhile, the tip is not wasting away.



This circuit boasts a minimum parts count and provides a speed variation up to 75 per cent of the motor's maximum speed. The switch permits full speed operation.

The resistive divider and D1 provides half-wave pulses of adjustable amplitude to the gate of the SCR, Q1. Assume the motor is stationary at first, the SCR's cathode will be at zero and the SCR will turn on at the first positive-going half wave from the mains. The motor will start and the voltage developed across it will reduce the gate-cathode voltage of the SCR. As the motor speeds up the power delivered reduces until the motor stabilises at a speed determined by the setting of RV1.

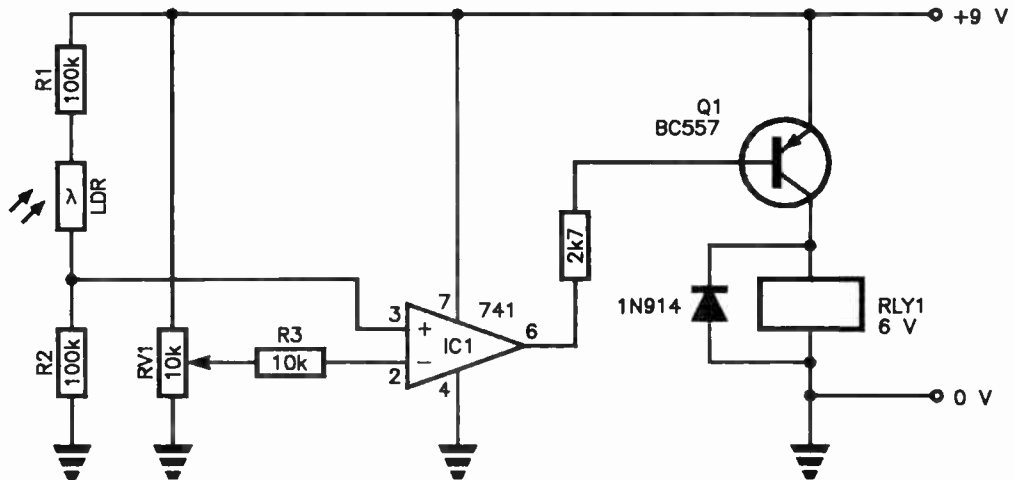
When the motor is loaded, it will tend to slow down and the voltage across the motor will tend to drop, but the SCR's time of firing during the cycle will advance, supplying more power to the motor, thus compensating for the load on the motor which will keep rotating at the same speed. Thus, the speed will remain relatively constant, once set, regardless of the load on the motor.

Diode D1 protects the SCR gate against excessive reverse voltage which would destroy the SCR. The SCR used must have a comparatively sensitive gate. If more gate current is required to give effective firing of the SCR, then R1 and R2 can be reduced to 4k7 each.

Simplest motor speed controller

THIS simple motor speed controller provides effective slow-speed control of universal electric motors, particularly drills. Even two-speed drills have a low speed that is too high for some applications, such as in sheet metal drilling.

OSCILLATORS & SWITCHES & TIMERS



Dark switch

WANT to turn something on when the light goes out? Or turn something off, for that matter? This circuit uses a light-dependent resistor (LDR) to sense a change in light levels. This change is amplified by an op-amp whose output drives a transistor which operates a relay.

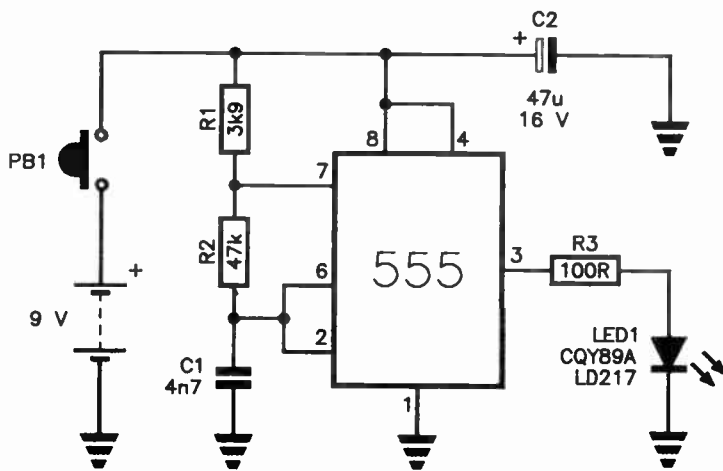
R1 and the LDR form one leg of a bridge and R2 its corresponding leg; RV1 forms the opposite legs. The op-amp's differential inputs are connected across the bridge's output. When light is falling on the LDR, its resistance is low. RV1 is adjusted so that difference between the inverting and non-inverting op-amp inputs sets the output [pin 6] high. Thus,

there is no base current to Q1 and the relay is not energised.

When the light level falls, the LDR's resistance increases, the bridge's output will put the op-amp's non-inverting input [pin 3] at a lower voltage than its inverting input [pin 2] and the output will go low, driving Q1 on and energising the relay.

RV1 can be adjusted so that the relay operates only when the light level decreases by a predetermined amount; this may be small, or quite large. It can be sensitive enough to detect the drop in light level from a hand waved in front of the LDR. A 10-turn trimpot is best used for RV1.

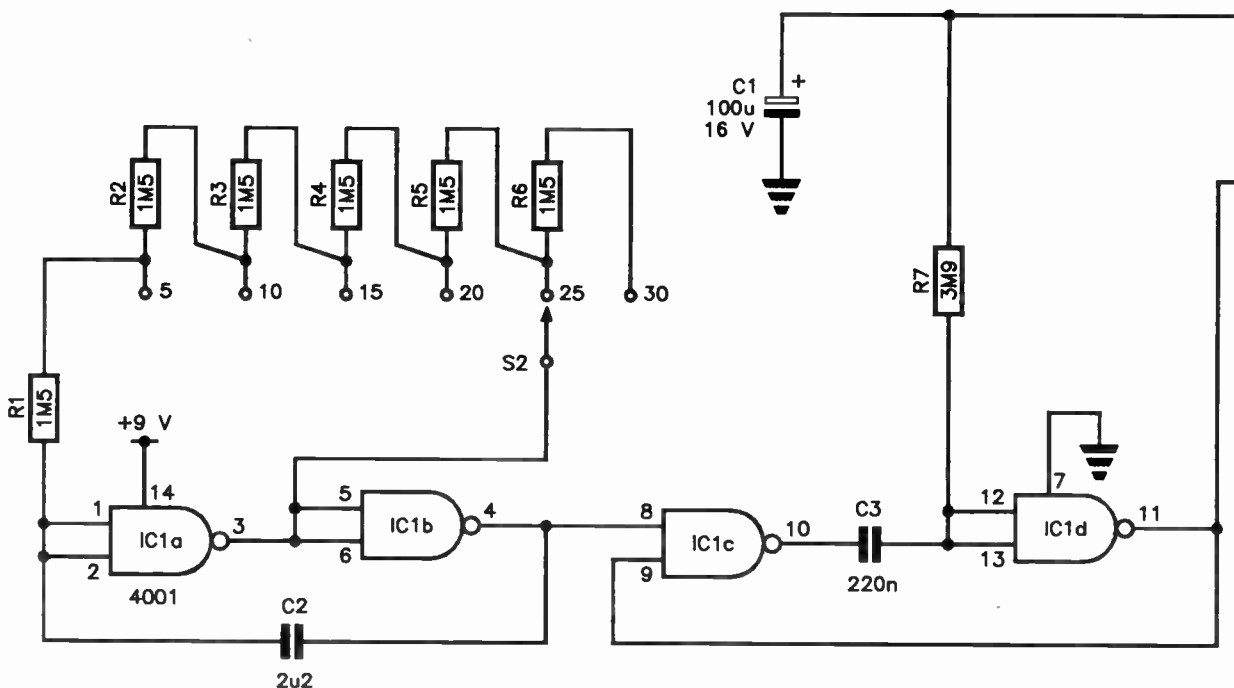
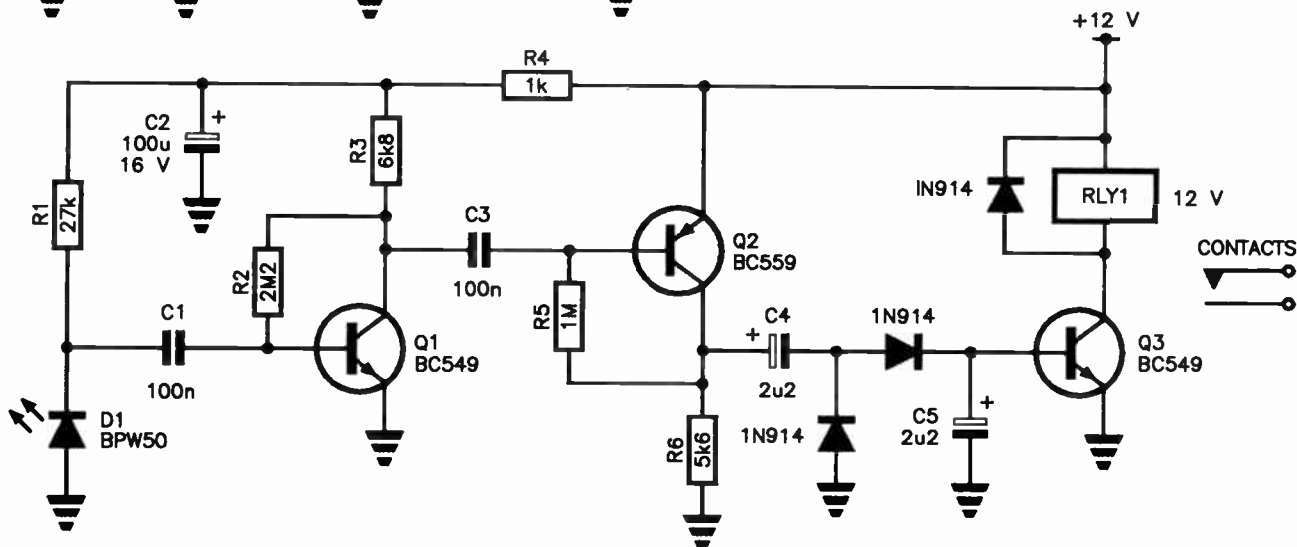
OSCILLATORS & SWITCHES & TIMERS

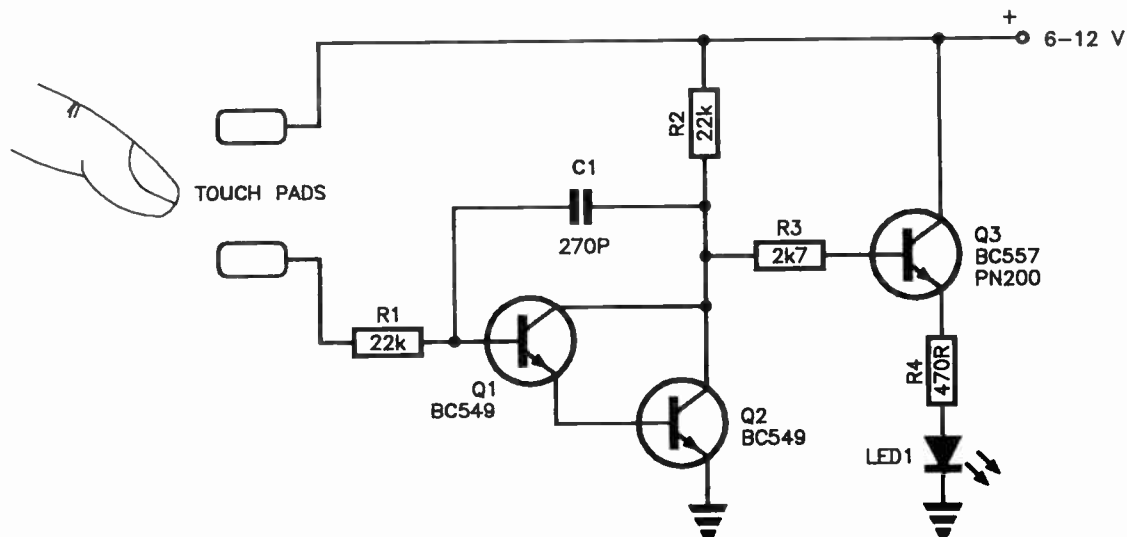


Infra-red switch

HERE'S a simple little infra-red switch for remote control of anything. A common IR LED and IR diode detector pair are used, the CQY89A/BPW50. The 555 provides a train of pulses for the IR LED. These pulses are detected by the BPW50 detector, amplified by the high gain amplifier using Q1 and Q2. The output from Q2 is rectified by a voltage doubler rectifier which provides base current for the relay driver, Q3, thus operating the relay.

The transmitter is housed in a convenient small handheld box, operated from a 9 V transistor radio battery. The receiver is powered from a 12 V dc supply (eg a plugpack). Note that all parts are commonly stocked by electronics retailers.





Simple touch switch

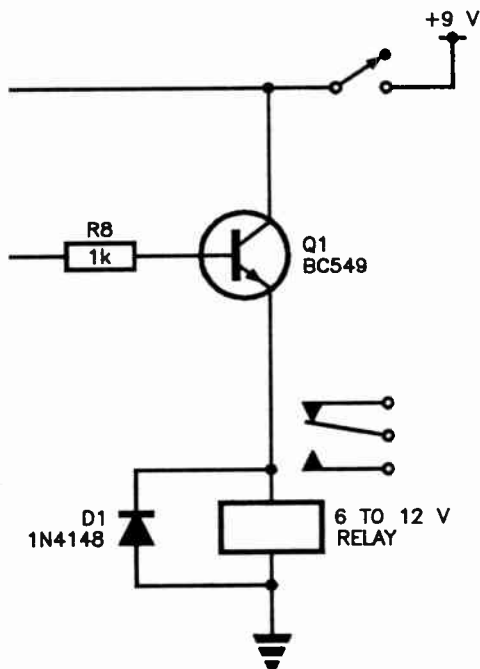
This circuit uses the tiny current that flows via your skin's resistance when you bridge the two contacts with your finger.

The input circuit — Q1 and Q2 — consists of a Darlington pair, which has a very high gain. Using BC549s, gain of the pair will be typically 1000. The collector current of this pair, will be drawn through the base-emitter junction of Q3 once the collector current is sufficient to drop about 0.6 V across R2. Thus, Q3 turns on, lighting the LED.

Skin resistance bridging the touch pads need only be

between one and two megohms to light the LED. Capacitor C1 serves as a speedup, to turn on Q1 and Q2 more rapidly. A sensitive relay could be connected in the collector circuit of Q3, instead of R4 and LED1. Or, the collector voltage could drive a CMOS Schmitt buffer, the output of this driving a relay driver circuit.

The circuit's turn-on threshold may be adjusted by varying the value of R2. Reduce R2's value to increase the threshold [lower skin resistance required].



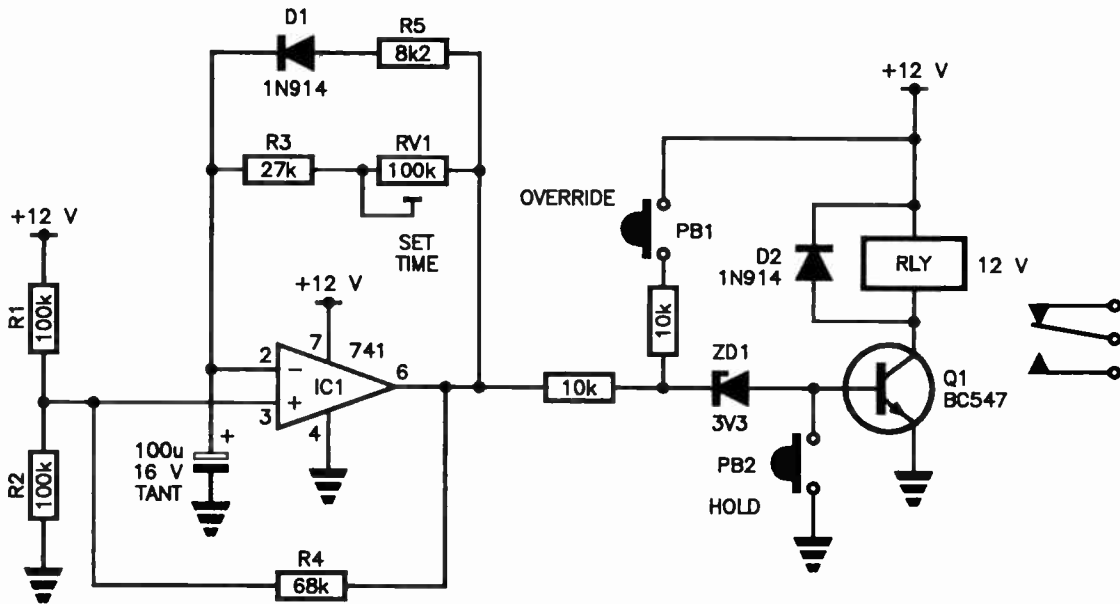
Repeating timer no. 1

THIS timer will pulse a relay at selectable intervals of 5, 10, 15, 20, 25 or 30 seconds. It's ideal for automated operation of a slide projector for talks or presentations.

It's based on a 4001 quad two-input NOR gate, IC1. Two gates, IC1a and IC1b, are connected as an oscillator with a period set by C2 and whatever resistor combination of R1-R2-etc is selected by the switch S2. The output of IC1b triggers the pulse timer comprising IC1c, IC1d and C3-R7. The output of IC1d goes high for a second or so when this stage is triggered, turning on Q1, which operates the relay briefly. The relay contacts operate the projector advance contacts.

The supply you use will depend on the relay chosen: use a 6 V supply with a 6 V relay; some 12 V relays will happily operate from a 9 V supply, but some types may require a 12 V supply for reliable operation.

OSCILLATORS & SWITCHES & TIMERS

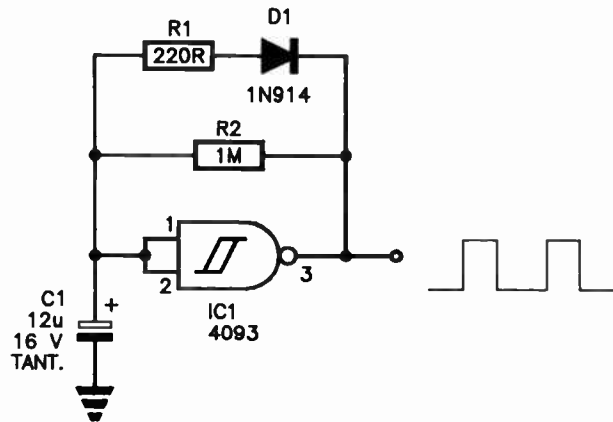


Repeating timer no. 2

THIS circuit is ideal as an automatic repeating timer for displays or slide-show presentations, etc. IC1 is simply a long-period square wave oscillator with a low mark: space ratio provided by the diode in the feedback network. So that IC1's output swings from near ground to near the positive rail, its non-inverting input is biased up to half the supply rail.

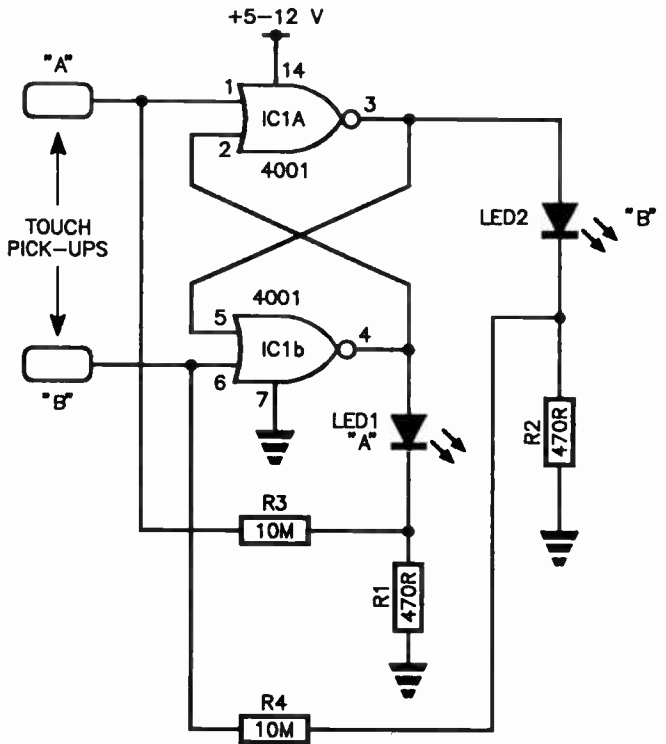
When IC1's output goes high, it biases on Q1, operating the relay. The period between pulses can be set anywhere between about five and 30 or so seconds, determined by RV1. The period for which the relay operates is determined by R5.

An Override button and a Hold button are provided. The former allows you to pulse the relay between automatic pulses; it need only be operated momentarily, or you can use a momentary-action pushbutton. The hold button prevents the relay operating for as long as you hold it down.



One-second trigger

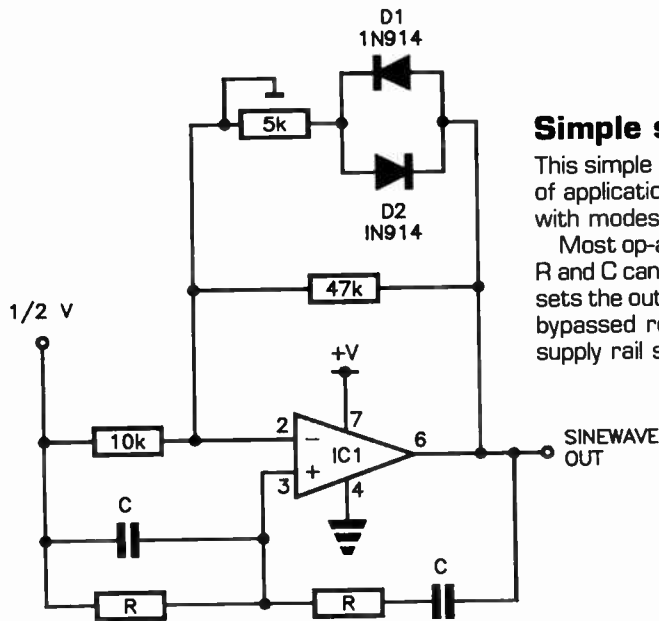
Many circuits call for a trigger pulse at about one second intervals. A CMOS Schmitt NAND gate makes a simple, neat pulse oscillator, as shown in the circuit. The output gives short duration pulses at about one second intervals, determined largely by C1-R2. Reversing D1 will reverse the mark-space ratio. Leaving R1-D1 out will result in an oscillator with a more even mark-space ratio as D1 discharges C1 quickly.



Touch-on, touch-off capacity switch

TWO touch contacts that depend on body capacitance operate this digital touch-on/touch-off switch. Two CMOS NAND gates from a 4001 quad NAND gate package are connected as a bistable flip-flop here.

When powered up, one of the LEDs will light; let us say, LED2 [B]. If you then touch pickup A, the flip-flop will change state and LED1 [A] will light. If you then touch pickup B, the flip-flop will change again and LED2 will light once more.



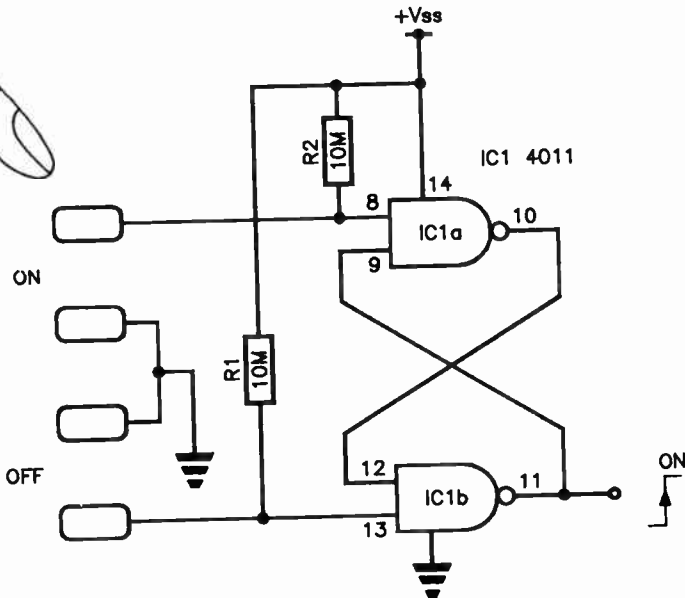
Simple sine oscillator

This simple sinewave oscillator can be used in a wide variety of applications which call for a sine wave of fixed frequency with modest distortion.

Most op-amps can be used, e.g: 741, 301 etc. Values for R and C can be determined using the formula. The 5k trimpot sets the output level. The 1/2 V point may be fed from a well-bypassed resistive divider from the supply rail, or from a supply rail splitter circuit.

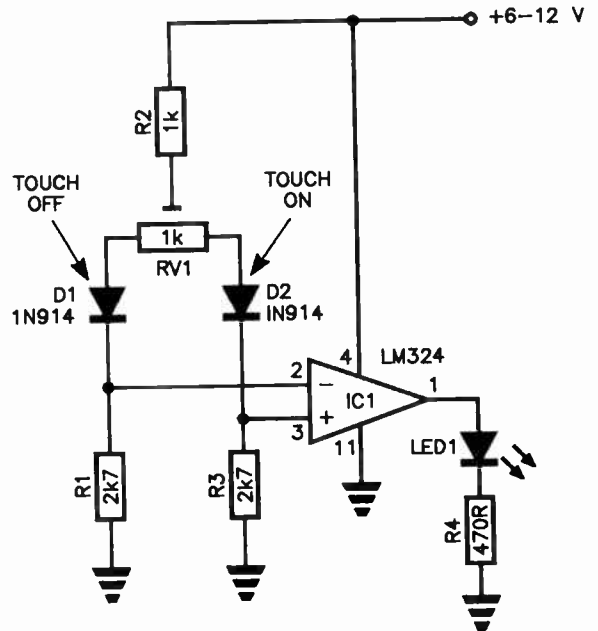
$$\text{FREQUENCY} = \frac{1}{2\pi RC}$$

R=15k, C=12n FOR \approx 1kHz



Touch-on, touch-off contact switch

TWO NAND gates are arranged as a set-reset flip-flop. Skin resistance will generally be lower than the 10M bias resistors. Assuming the flip-flop is set with the output [pin 11] low, bridging the two On contacts with a finger will cause the flip-flop to change state, and pin 11 will go high. To change it back again, bridge the Off contacts with a finger. The output can drive the base of a simple transistor relay driver.



Temperature touch switch

THIS circuit senses the change in temperature of a diode when you touch it with your finger and switches a LED on or off. The output could drive a transistor to switch a relay, too.

IC1 is connected here as a comparator. Its non-inverting and inverting inputs monitor the voltage drops across R1 and R3 respectively. RV1 is carefully set so that just a little more current flows through R1 than through R3. This puts IC1's inverting input above its non-inverting input, driving its output low and thus the LED will be off.

Touch D2 and its temperature will rise from the warmth of your finger. Its forward current will rise slightly, driving pin 2 above pin 3. Pin 1 will go high and the LED will light. Take off your finger and the LED will go out.

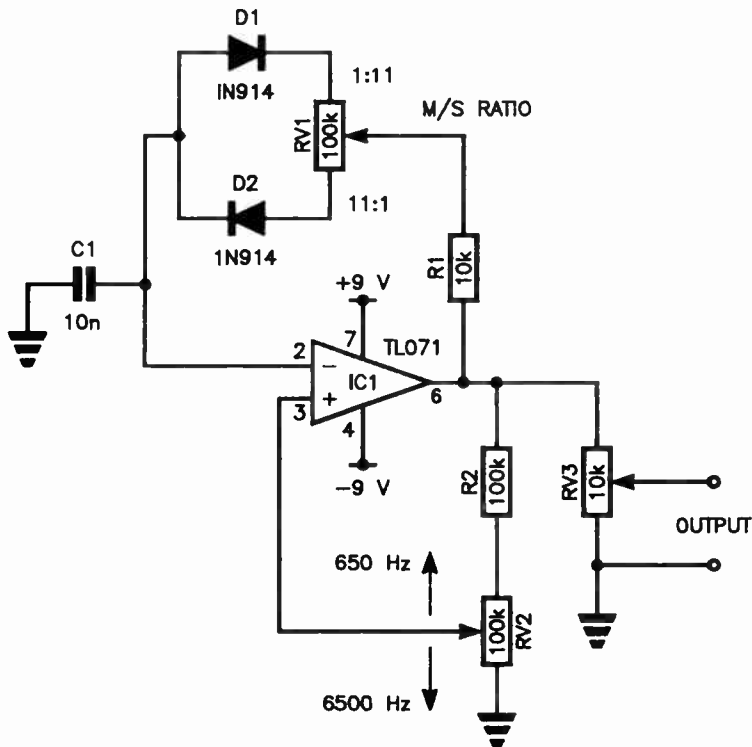
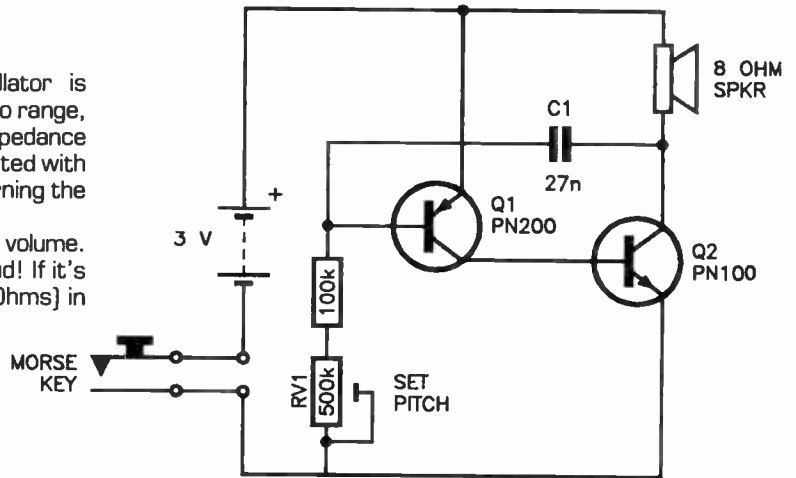
If the ambient temperature is high enough — above average body temperature — then the LED will light; to turn it off, touch D2.

OSCILLATORS & SWITCHES & TIMERS

Two-transistor Morse practice oscillator

THE old familiar PNP-NPN two-transistor oscillator is arranged here to provide an oscillator in the mid-audio range, driving an 8 Ohm loudspeaker (or you can use low impedance headphones). The pitch of the oscillator can be adjusted with RV1. The Morse key is in the battery line, simply turning the oscillator on and off.

Only a 3 V battery is required to produce adequate volume. A supply of up to 9 V may be used — but it gets loud! If it's too loud at 3 V, a low-value resistor (22 to 100 Ohms) in series with the speaker will reduce the volume.

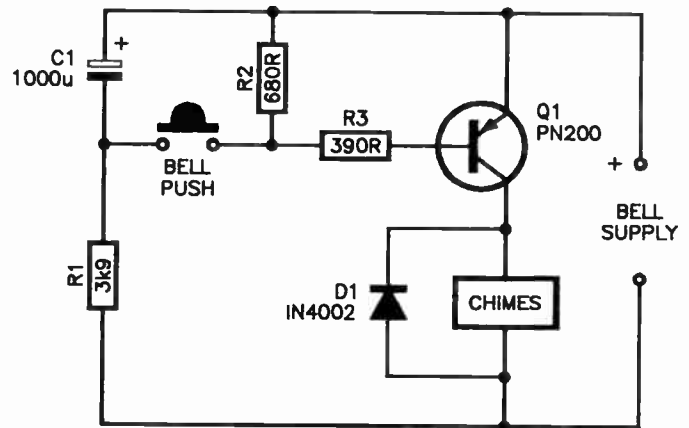


Op-amp variable squarewave oscillator

YOU can get a very wide range variation of mark:space ratio using this arrangement with an op-amp squarewave oscillator.

The feedback charge and discharge paths for C1 are separated by diodes D1 and D2. RV1 varies the amount of in-circuit resistance during charge and discharge, thus varying the mark:space ratio. It can be varied from 1:11 to 11:1.

Potentiometer RV2 provides frequency variation range of 10:1, from about 650 Hz to 6.5 kHz. RV3 provides output level control.



Delay those chimes blues!

SICK of callers repeatedly pushing the door chimes button, or holding it down? Fix 'em with this simple circuit.

When powered up, C1 charges via R1. Q1 is not biased on and the chimes are quiet as no collector current flows through Q1. When the bell push is operated, generally being held down for a second or two, bias is applied to the base of Q1 because C3 discharges via R2 while the button is held down. In a second or so, C1 is discharged and the chimes stop. When they release the bell push button, C1 takes some time to charge once more, and if they push the button once again within a few seconds (as people are wont to do), nothing happens because C1 will not have charged sufficiently to bias Q1 on again. What's more, it will discharge again via R2, frustrating their efforts. That'll learn 'em!

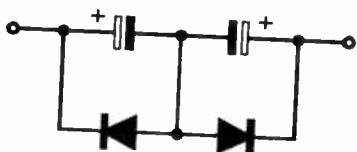
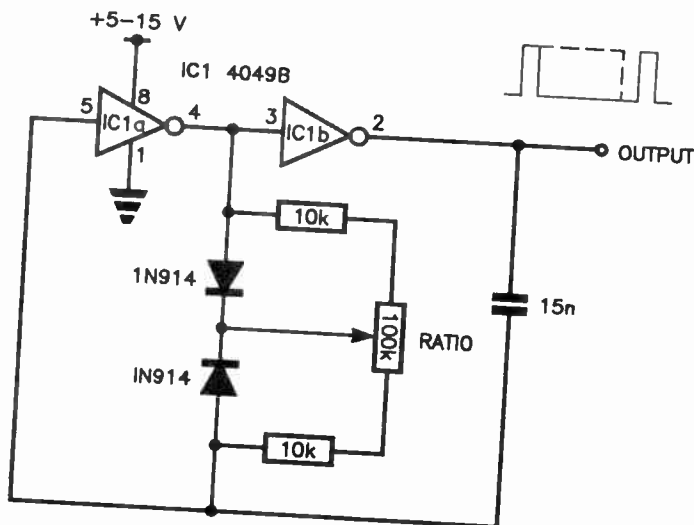
Variable M-S ratio oscillator

YOU can vary the mark:space ratio of a simple CMOS ring-of-two oscillator over a very wide range using this simple adaptation of the circuit.

The timing resistor has a pot and two diodes added in the arrangement shown. When pin 4 is high, the upper diode shorts out the top 10k resistor and the upper part of the pot and charges the capacitor via the lower part of the pot, the lower 10k resistor and pin 2 of IC1b, which is low.

When pin 4 is low, the capacitor discharges via the lower diode and the upper part of the pot, the upper 10k resistor and pin 4.

The proportion of the pot selected by the wiper determines the charge and discharge periods and thus the mark:space ratio. A variation of 1:11 to 11:1 can be obtained here. For a lower frequency, increase the capacitor value. To raise the frequency, decrease the capacitor value.

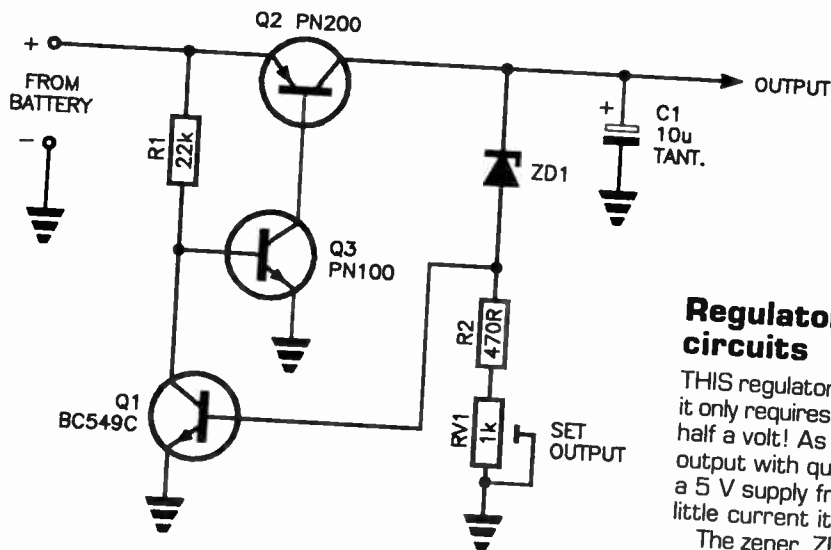


Bipolarising electrolytics

WHEN you need a large value bipolar capacitor, you can connect two electrolytics of twice the required value in series, back-to-back. But different leakages affect the result and suitable values may be hard to come by.

The solution is to use electrolytics of the required value, connected back-to-back, but with a diode wired across each as shown here. Simple.

POWER SUPPLIES

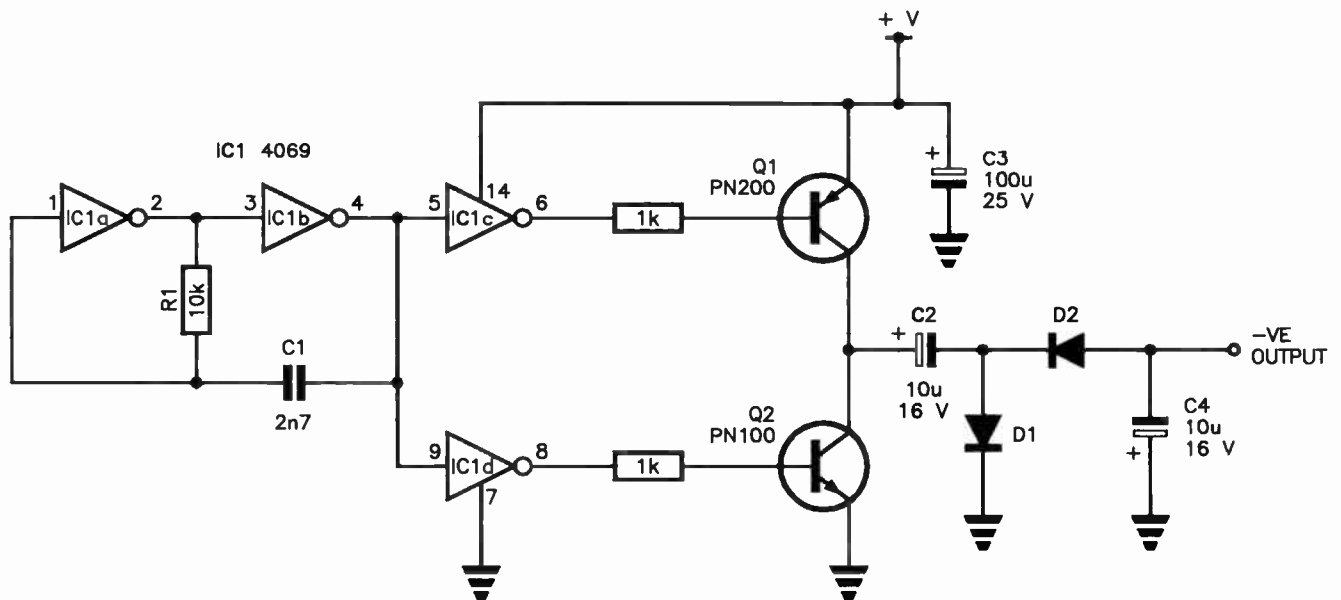
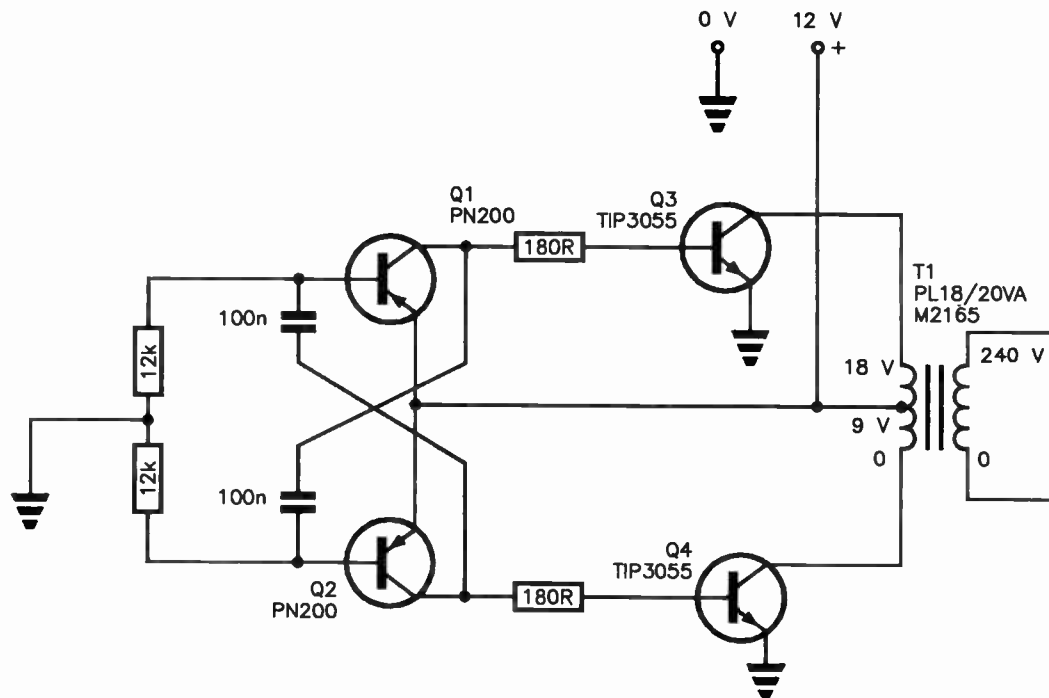


Regulator for battery-powered circuits

THIS regulator circuit is ideal for battery-powered circuits as it only requires an input-output voltage differential of less than half a volt! As a consequence, it will still provide a regulated output with quite flat batteries. Alternatively, you can have a 5 V supply from a 6 V battery, etc. The circuit uses very little current itself.

The zener, ZD1, is selected to provide the required output, which will be only just above the zener voltage itself. The output voltage can be trimmed with R1. The regulator can supply output currents to 300 mA or so.

POWER SUPPLIES



Negative rail generator

GOT just a positive rail and need a negative rail for an op-amp or other special IC? This circuit is an oscillator and charge pump that charges two capacitors to develop a negative rail almost equal to the positive rail voltage.

Two gates from 4069 hex inverter are connected as a ring-of-two oscillator. The output of the oscillator is buffered so as to drive Q1 and Q2 on and off alternately. When Q1 turns on, Q2 turns off. C2 charges to the value of the positive supply via D1 [less the diode forward voltage drop] and D2 is reverse biased. Q2 then turns on, and Q1 off. This connects the plus of C2 to ground, reverse biasing D1 and forward biasing C4,

which charges to the voltage across C2 [less the diode forward voltage drop of D2].

Q2 now turns off and Q1 turns on again, topping up the charge on C2. When Q2 turns on again the charge on C2 then tops up the charge on C4, and so on. The negative supply rail is limited only by the maximum voltage rating of the 4069 [15 V]. D1 and D2 should be able to switch at the rates encountered — 1N914s are good if only 50 mA or so consumption is required of the negative rail.

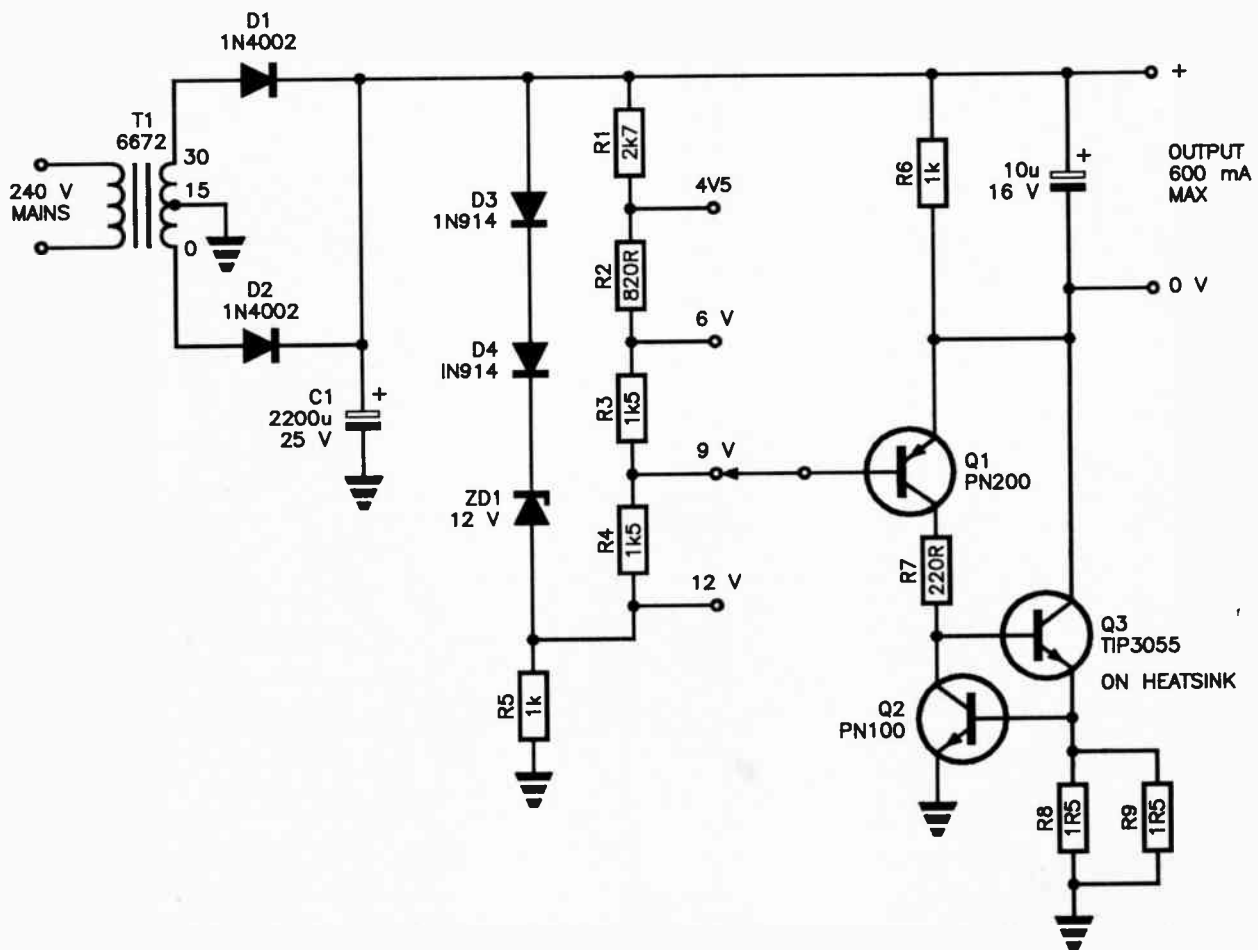
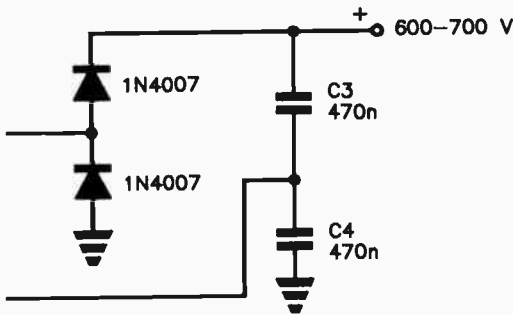
High voltage dc-dc converter

THIS inverter will generate a voltage of around 600 volts or so from a 12 V battery. No special inverter transformer is required. T1 is simply a common mains transformer having a centre-tapped 18 V secondary, or two 9 V windings.

A flip-flop oscillator using Q1 and Q2 provides base drive to switching transistors Q3 and Q4. These switch the 12 V supply across each half of the 9 V windings in turn, which become the primary here. The 240 V mains winding becomes the secondary here, driving a full-wave voltage-doubler rectifier.

The oscillator runs at about 1 kilohertz or so, at which frequency the transformer still works well. No electrolytic capacitors are needed for the rectifier, reducing space and cost and improving reliability. C3 and C4 need only be 400 V rated polyester caps [greencaps].

Nine volt windings on the transformer are used rather than 12 V as there is some collector-emitter voltage drop in the switching transistors. Note that Q3 and Q4 should be mounted on a heatsink.



Simple bench supply

THIS simple, low-cost bench supply is ideal for the enthusiast's work bench. All components are commonly stocked by electronics retailers. The 6672-type transformer is a multi-tapped tranny that can supply up to one amp output.

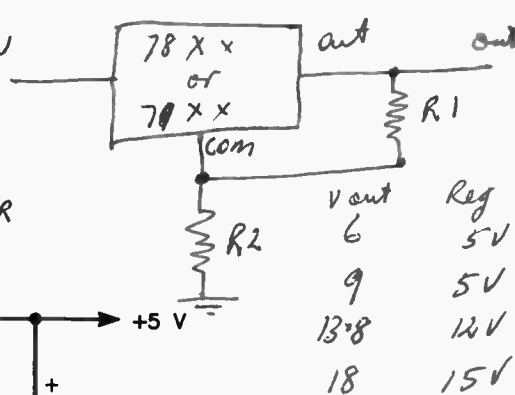
A full-wave rectifier is used to provide around 21 V unregulated dc. A zener and two diodes provide a regulated reference voltage for the regulator circuit. Resistors R1 to

R4 provide suitable taps across the reference to provide output voltages of 4.5, 6, 9 and 12 volts. R5 provides bias current for the zener. The three transistors Q1, Q2 and Q3 provide a conventional series regulator. The 10 µF capacitor across the output terminals ensures the ac impedance of the supply is low.

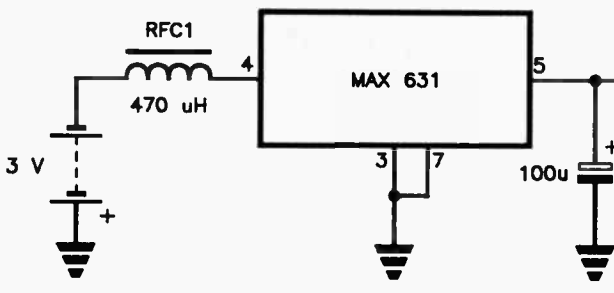
POWER SUPPLIES

$R_1 = V_R / .02$
 $V_R = \text{Normal reg voltage}$

$R_2 = V_B / .025$ W
 $V_B = \text{Booster voltage above } V_R$



V_{out}	Reg	R_1	R_2
6	5V	220 Ω	39 Ω
9	5V	220 Ω	150 Ω
13.8	14V	560 Ω	68 Ω
18	15V	680 Ω	120 Ω

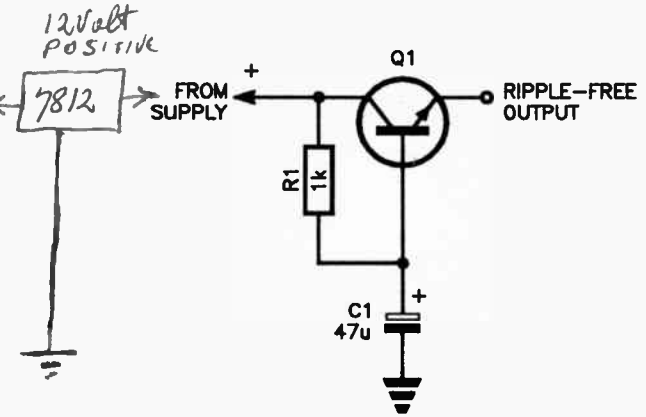


Using 5 V circuits on a 3 V battery

SPECIALIST semiconductor manufacturer, Maxim, has produced a nifty little dc-dc inverter/converter chip which develops a 5 V rail from a 3 V battery. And it's simple to use! What could be simpler than this here circuit?

RFC1 is an ordinary RF choke. There's not much else to say about it! Current output is in the tens of milliamps range.

for 6 volt see above in B180 writing



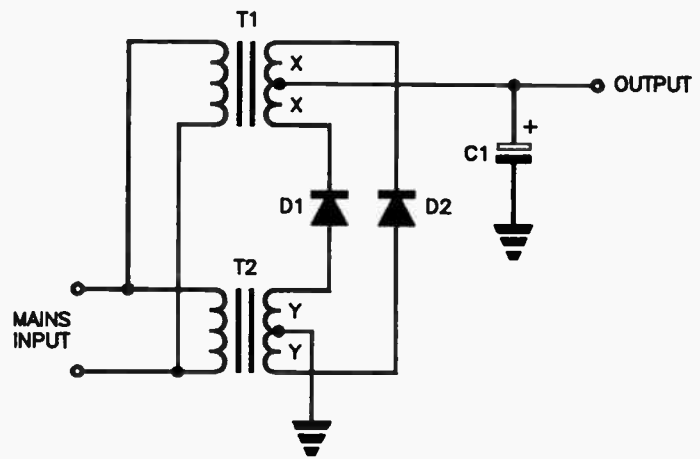
Reduce that ripple

THE popular plug pack dc supplies are great for safely powering lots of electronic projects and circuits. However, in some applications they have too much ripple which adversely affects sensitive circuits, particularly audio and some oscillator circuits.

Here's the simple way to fix it. The transistor effectively multiplies the value of the capacitor C1 by its gain (beta). The higher the gain of Q1, the better the ripple attenuation. But you have to choose a transistor that will suit the current drawn by your circuit.

If the supply current is 100mA or less, a BC549 will work well and effectively multiply the capacitance by some 500-1000 times! Where your circuit draws up to 500 mA, use a PN100 or 2N3643, or perhaps a BD139 or TIP3055.

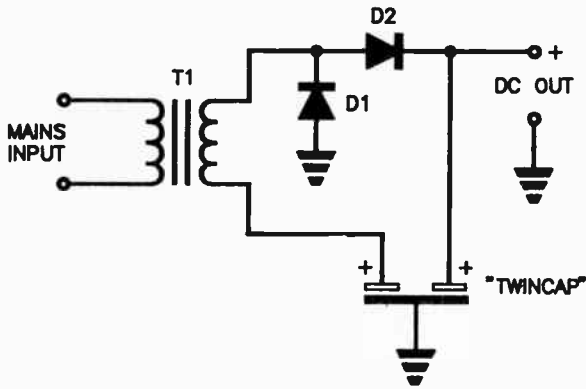
You may increase the value of C1 up to, say, 1000 uF.



Odd trannies power supply

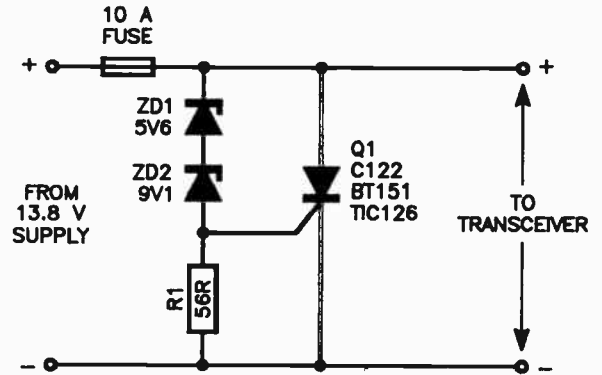
IF you want an odd dc supply voltage, or want to use a couple of transformers with different secondary voltages to make up the required supply rail, here's how to do it.

The mains primaries are connected in parallel and the secondaries connected 'series aiding' via D1 and D2, to provide the required voltage. The output voltage will be the peak (1.41 times) the RMS output of X and Y. The value of C1 is chosen as usual to provide the required smoothing. It should have a voltage rating at least 20 to 50% or more above the dc output voltage. The diodes should have a PIV rating of the same voltage, or greater.



Twincap power supply

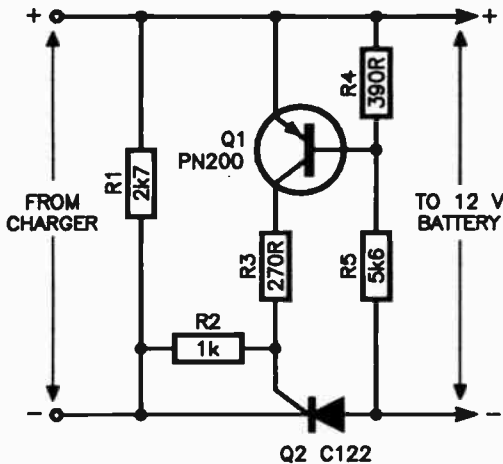
DUAL or twin electrolytic capacitors are often found at bargain prices in the surplus bins at various electronics retailers. They can save on space in a power supply such as the full-wave voltage doubler shown here. The dc output is 2.8 times the RMS secondary voltage.



Crowbar protection for battery eliminator supplies

YOU don't want your expensive transceiver blown up if your 13.8 V battery eliminator supply collapses and goes overvoltage on its output terminals.

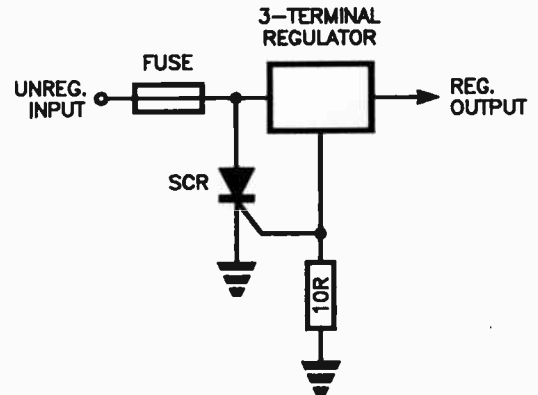
This circuit will apply a short circuit to the transceiver supply connection in the event of an overvoltage condition occurring. If the supply output exceeds 15 volts, the zeners will conduct, providing gate current to the SCR, Q1. This turns on — very fast — shorting the supply and blowing the fuse.



Battery charger protector

YOU can protect your battery charger's rectifier diodes against shorts and reverse connection of the battery using this circuit. It relies on the fact that even a flat lead-acid battery has some terminal voltage. Without that, the SCR, Q2, cannot be gated on. The charger typically puts out half-wave pulses of ac and, with the battery properly connected, the SCR will turn on each half cycle of the rectifier output as it rises above the battery voltage.

If there is no voltage because the battery is not connected or the leads are shorted, or if the battery's been connected in reverse, the SCR cannot conduct. Also, if a 6 V battery is connected, Q1 will not conduct, and thus Q2 cannot conduct.

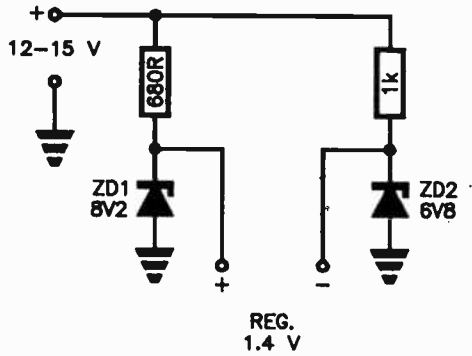


Overvolt protector for 3-terminal regulators

YOU can provide crowbar overvoltage protection for a three-terminal regulator by using its reference terminal bias current to gate-on an SCR crowbar to blow a fuse in series with the input to the regulator.

If the unregulated input rises too high, the reference current sources a considerable increase in current, gating the SCR on. You'll need to choose the resistor to provide sufficient bias to trigger the SCR. Use a sensitive-gate SCR.

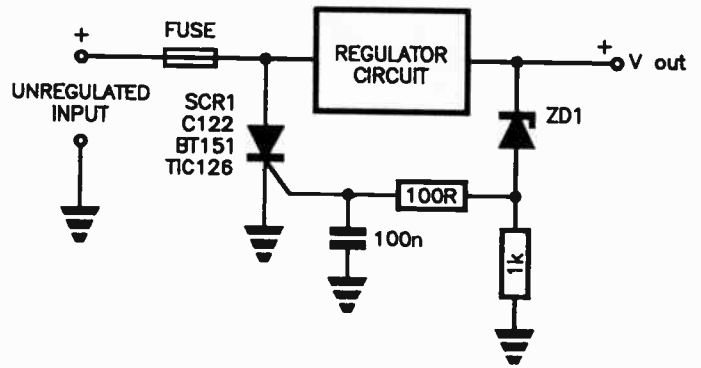
POWER SUPPLIES



Very low regulated voltage

IF you need a very low regulated voltage, the difference between two zeners can be exploited as shown in this circuit example.

The difference between the 8.2 V and the 6.8 V zeners is 1.4 V. Make sure each zener is biased with the required current.

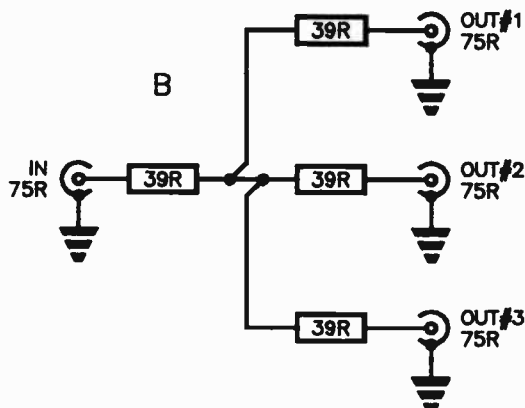
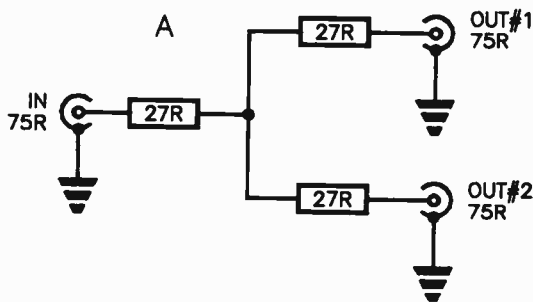


Overvoltage crowbar for a power supply

SHOULD the series-pass regulator of a regulated power supply fail, it may apply the full unregulated voltage to the output, with perhaps disastrous consequences for whatever's connected to the supply's output. This circuit will quickly cut off the output should the regulator fail.

The zener, ZD1, is chosen to have a voltage just above the supply's maximum output voltage. When the output commences to go a volt or so above its maximum, the zener conducts, the drop across its bias resistor supply gate current to the SCR, which conducts. This blows the fuse in series with the regulator circuit's input. The 100nF capacitor from the SCR's gate to ground prevents spikes from triggering the SCR.

RADIO FREQUENCY



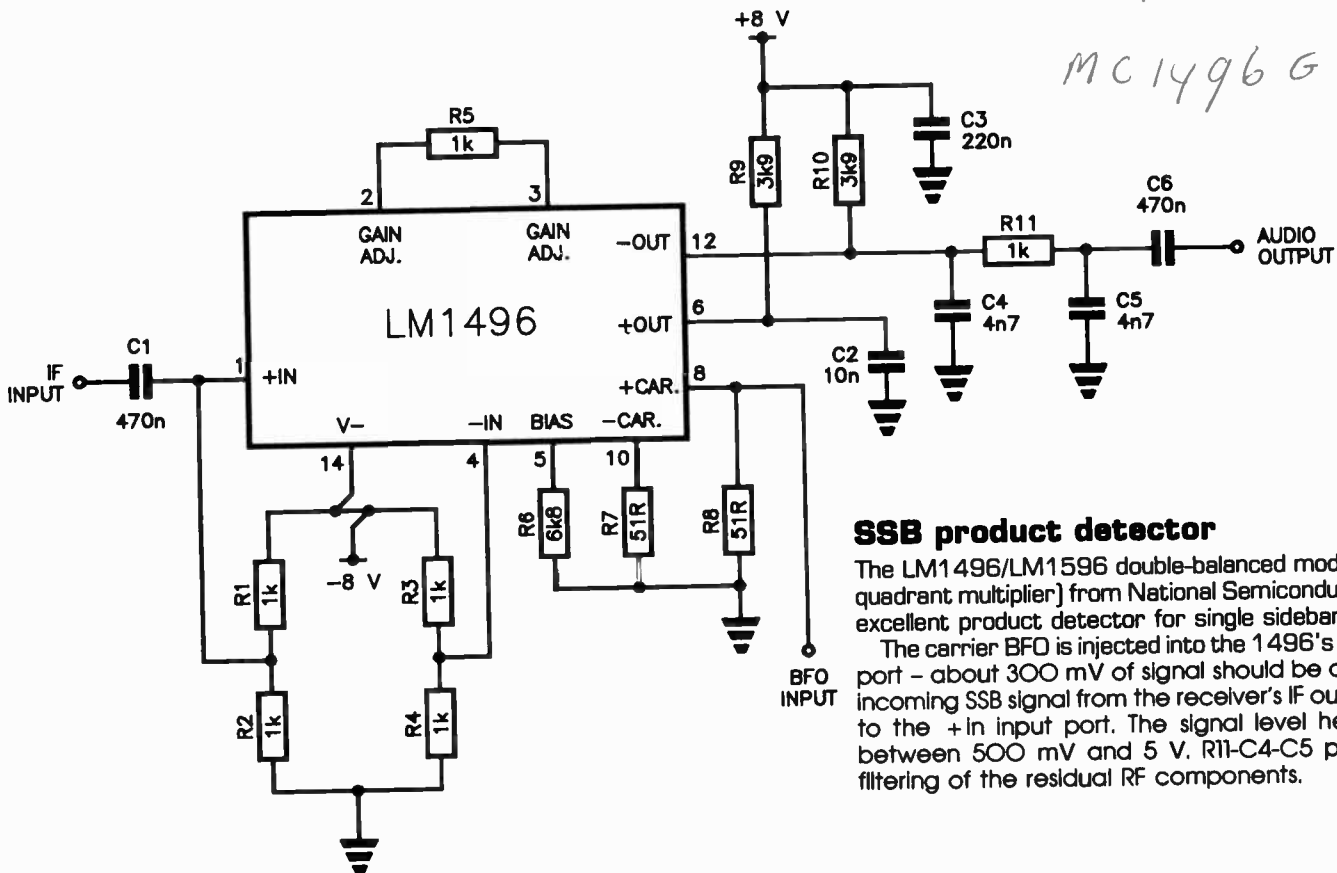
TV/video splitters

HERE are 1-to-2 and 1-to-3 splitters for TV or video applications. If you have one antenna and two TV sets, or want to run, say, one TV set and a VCR-TV set combination from a single antenna, the circuit A is the answer. This provides good isolation between OUT#1 and OUT#2, but minimal attenuation between the input and either output. Likewise with circuit B, where three outlets are required.

If you unplug any unused outlet, insert a 75 Ohm resistor dummy load in it (two 150 Ohm resistors in parallel will do nicely).

MC1496 F or K or L

MC1496 G \$4-4c
J-car



SSB product detector

The LM1496/LM1596 double-balanced modulator (or four quadrant multiplier) from National Semiconductor makes an excellent product detector for single sideband reception.

The carrier BFO is injected into the 1496's + carrier input port - about 300 mV of signal should be adequate. The incoming SSB signal from the receiver's IF output is applied to the +in input port. The signal level here should be between 500 mV and 5 V. R11-C4-C5 provide output filtering of the residual RF components.

Novel RF wattmeter

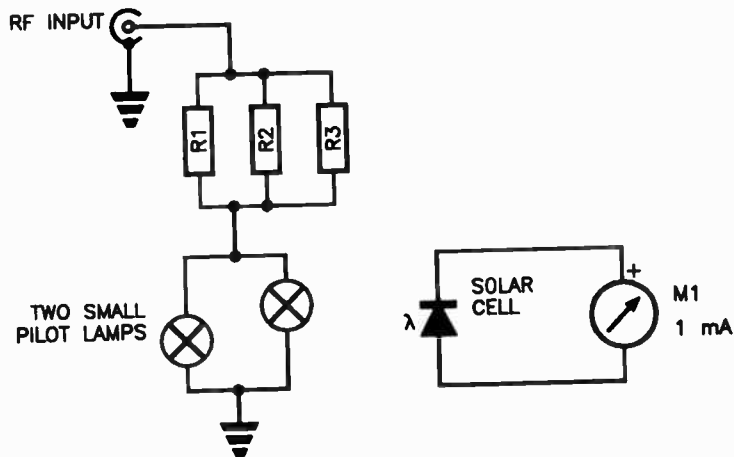
This RF wattmeter and dummy load uses a solar cell to provide a sensitive detector at low power levels [5 W and under] - and permits calibration using a low voltage power transformer!

The problem with many commercial SWR/RF power meters is that they are not too sensitive at low [GRP] power levels and can be too expensive to justify for experimenting with GRP transmitter circuits.

This circuit is simple, comparatively low in cost and has good sensitivity at quite low powers. Two small, low current Lilliput Edison Screw (LES) pilot lamps are mounted over the surface of a small solar cell, or solar cell piece. This picks up the light generated by the two lamps. As their light output depends on the level of RF power applied, the cell's output drives current through the meter and this is a direct measure of the input power.

The values of R1, R2 and R3, and their wattage, will depend on the lamps' resistances and the expected maximum power. For 5 W maximum power, three 68 Ohm/2 W resistors will do the job; 6 volt LES (or even MES) lamps are typically rated at 100 mA. This will result in a load near enough to 50 Ohms.

A transformer with a 15 V/1 A secondary can be used to calibrate the meter. Applying the secondary to the RF input should result in full-scale (or near full-scale) deflection. An RMS-reading voltmeter should confirm you have 15-16 volts ac at the RF input. You can adjust the full-scale reading by adjusting the distance between the lamps and the solar cell. A 1000 Ohm wirewound potentiometer can be used to



provide an adjustable voltage at the RF input to allow calibration at lower power levels, using your RMS-reading voltmeter to set the required voltages.

An accuracy of 5-10%, which is quite adequate for experimentation, can be obtained with this circuit.

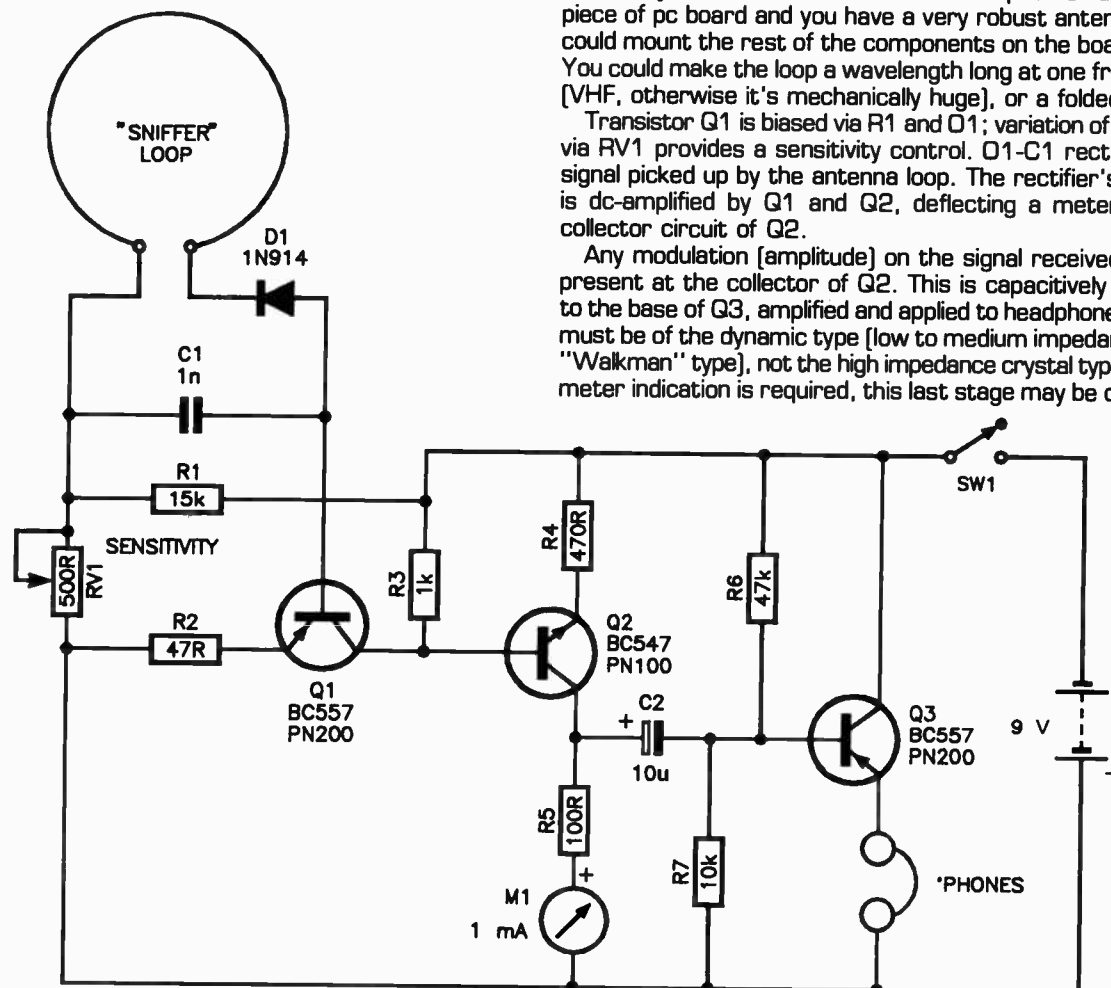
RF sniffer

This handy little gadget can be used in hidden transmitter hunts (great sport!), when you get in close to the transmitter and the traditional beam and receiver fall down, or as a transmitter monitor, permanently mounted. No tuning coils required! The device is powered from a 9 V transistor radio-type battery.

The loop antenna can be any suitable size — for transmitter hunts it might only need to be a handspan's diameter (about 250 mm), or even less. Etch a circle or square on a suitable piece of pc board and you have a very robust antenna. You could mount the rest of the components on the board, too. You could make the loop a wavelength long at one frequency (VHF, otherwise it's mechanically huge), or a folded dipole.

Transistor Q1 is biased via R1 and O1; variation of the bias via RV1 provides a sensitivity control. O1-C1 rectifies the signal picked up by the antenna loop. The rectifier's output is dc-amplified by Q1 and Q2, deflecting a meter in the collector circuit of Q2.

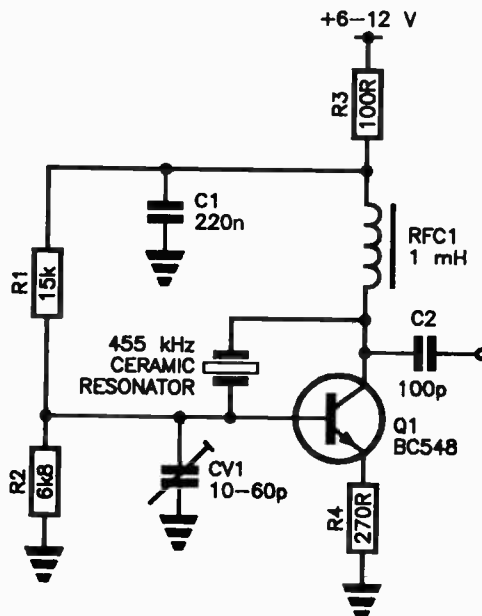
Any modulation [amplitude] on the signal received will be present at the collector of Q2. This is capacitively coupled to the base of Q3, amplified and applied to headphones which must be of the dynamic type [low to medium impedance; i.e. "Walkman" type], not the high impedance crystal type. If only meter indication is required, this last stage may be omitted.

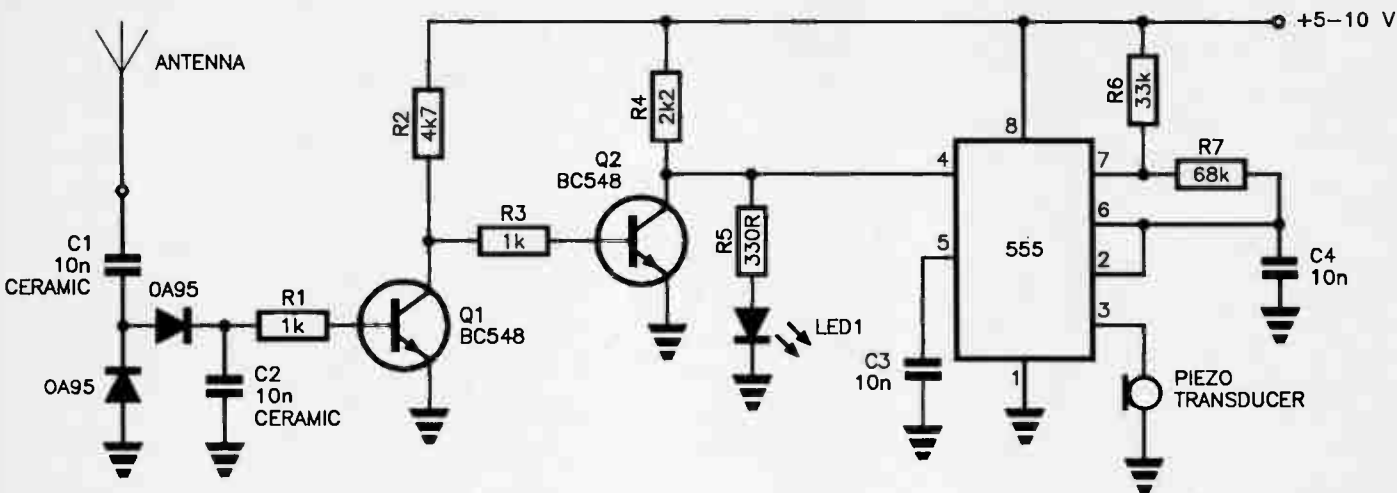


IF oscillator

A COMMON 455 kHz ceramic IF resonator can be used as the frequency-determining element in an alignment oscillator or BFO using this simple circuit.

The resonator used is the two-terminal type intended as a frequency-dependent bypass in an amplifier stage. Here it is connected between the collector and base of a transistor amplifier stage to provide feedback at the resonator's frequency. The trimmer, CV1, provides for a little frequency pulling in BFO applications. Modulation can be applied from a low impedance source by capacitively coupling audio into the emitter of Q1, across R4. A wide variety of transistors can be used for Q1.





Off-air Morse monitor

FOR radio amateurs who are keen Morse operators, this simple circuit provides an off-air monitor that works on all bands — even up to two metres — without requiring any tuning. It provides both audible and visual indication, using a piezo transducer and an LED, respectively.

The RF bursts are picked up by the antenna which is coupled to a voltage doubler rectifier made up from the two OA95 germanium diodes. These charge C2 which provides base current to Q1. This turns on for the duration of each dot and dash; C2 is discharged quickly to about half a volt by Q1's base current with each RF burst.

Normally, Q2 is on because base current to it flows via R2 and R3. This holds pin 4 of the 555 [reset] low, inhibiting the 555. With each RF burst, Q1 turns on and Q2 turns off. The

555 will oscillate then in time with each RF burst. It is set to oscillate at a high audio pitch which the piezo transducer reproduces. Also, LED1 will light when Q2 is turned off with each RF burst, because current flows via R4 and R5.

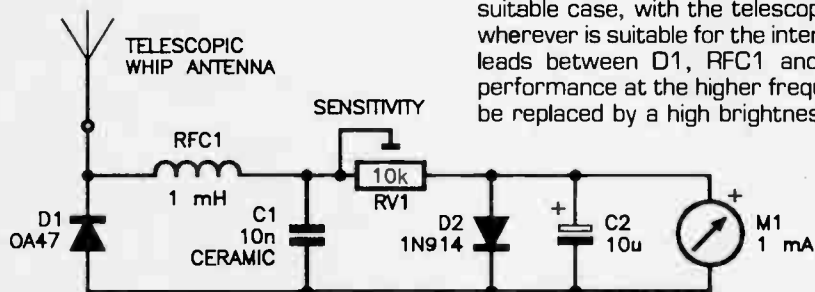
You can power the circuit from any supply between about 5 and 10 volts. To reduce the loudness of the piezo transducer you can connect a resistor in series with the 555's pin 3 and the transducer. A value between a few hundred and a few thousand Ohms will do the job. The antenna can be a short telescopic whip, adjusted for adequate pickup. This whip and diodes C1 and C2 can be mounted near your antenna for best sensitivity, while the rest is housed in a suitable jiffy box in the shack.

Passive field strength meter

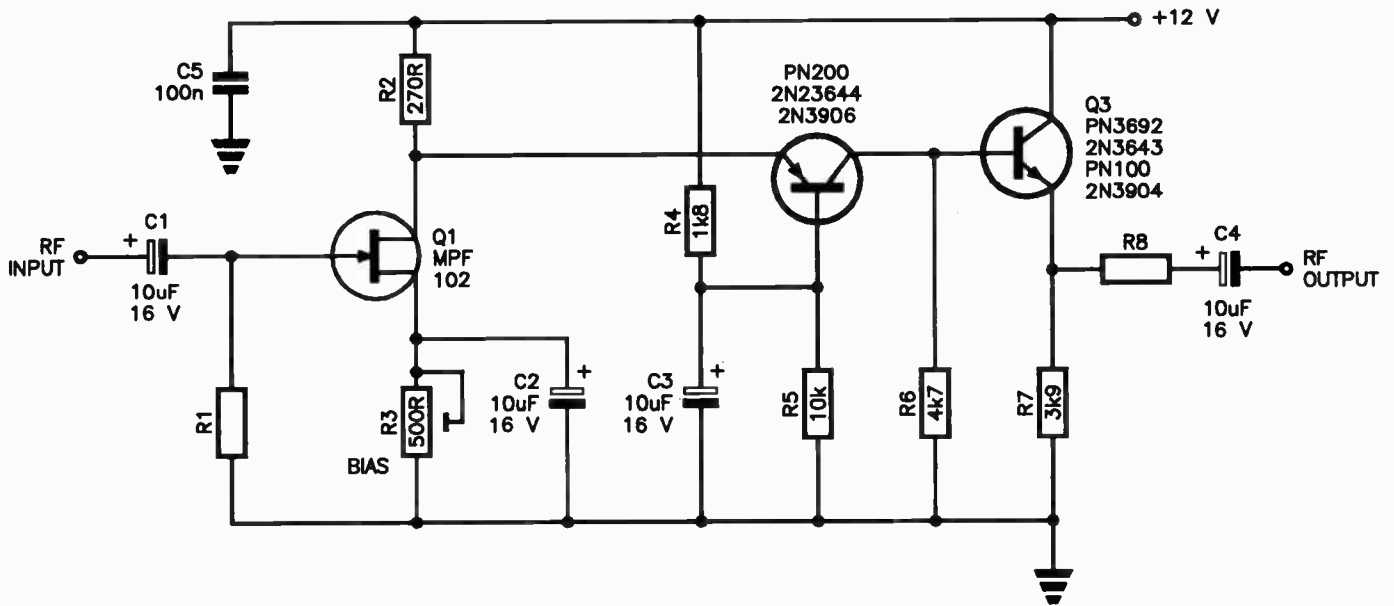
THIS untuned, unpowered field strength meter is very useful for checking antenna system operation, mobile transceivers and antennas, radio control systems, etc.

Signals picked up the telescopic whip antenna are rectified by the OA47 germanium diode. Positive-going half-wave pulses have the RF blocked by RFC1 and the dc charges C1 to drive current through RV1 and the meter. C2 smooths out modulation variations, while D2 prevents slamming of the meter with strong signals. Varying RV1 varies the sensitivity of the circuit.

The meter can be conveniently mounted on the face of a suitable case, with the telescopic whip mounted on top, or wherever is suitable for the intended application(s). Keep the leads between D1, RFC1 and C1 short to obtain good performance at the higher frequencies. Note that D2 could be replaced by a high brightness LED.



RADIO FREQUENCY



Stable, wideband RF amp

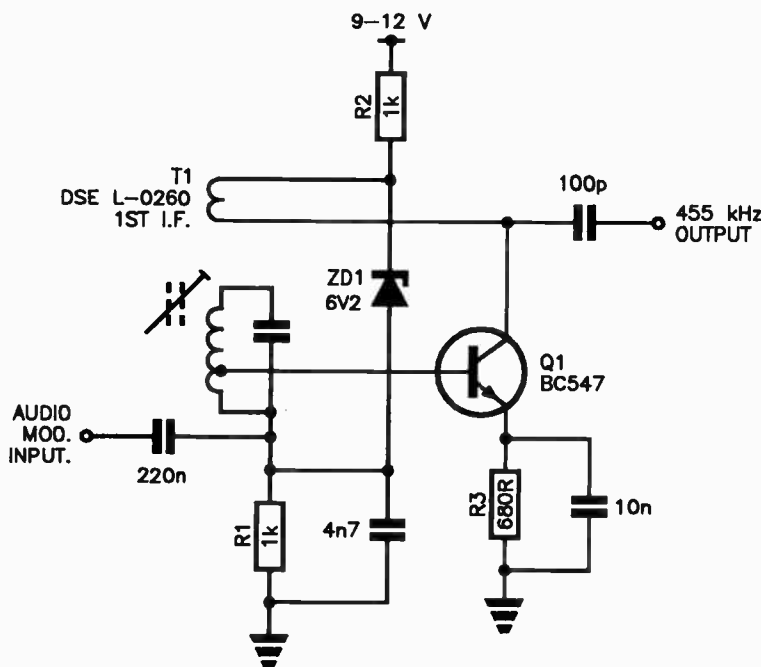
THIS wideband RF amplifier has good gain and stability, with a bandwidth extending from around 100 kHz to about 4 MHz. The input stage employs a JFET common-source amplifier (Q1) which is then direct-coupled to a grounded base stage, Q2. An emitter follower, Q3, then provides a low impedance output. The grounded base second stage provides gain and good input-output isolation and hence ensures good stability.

All the polarised capacitors are tantalum types. The supply rail bypass should be a ceramic type.

The value of R1 will determine the input impedance. You can make this a low value if you require a low impedance, or

a high value, up to several hundred kilohms, for a high impedance source. Likewise, R8 can be selected to set the output impedance. Typically, it may range from 39 to 560 Ohms. If the output feeds into a medium to high impedance, R8 may be left out.

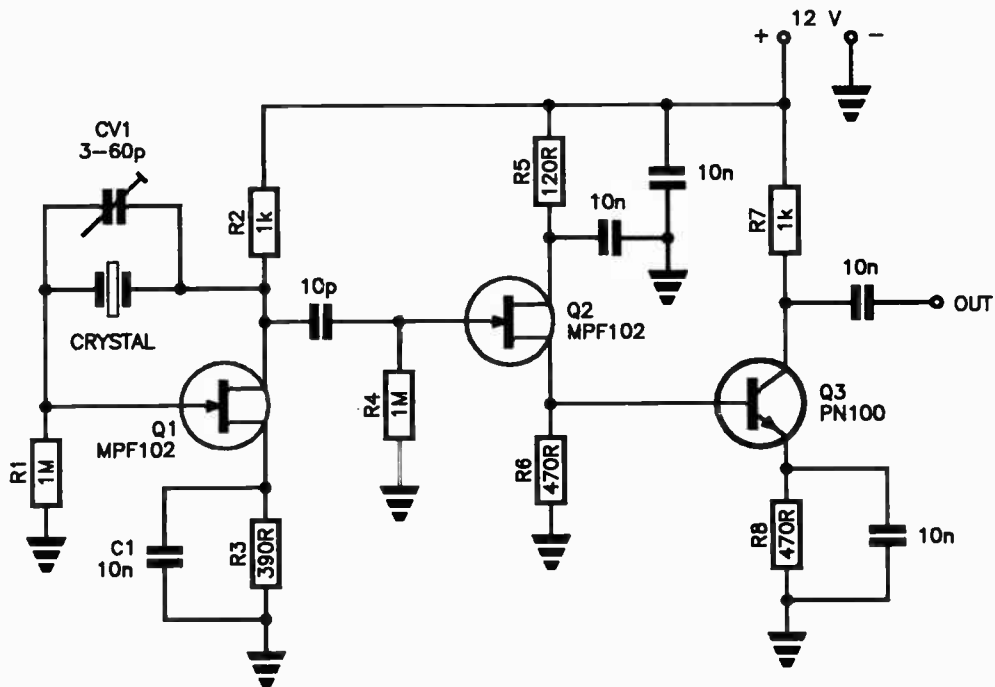
When setting up the amplifier, R3 is adjusted to obtain about 10.5 volts at the drain of Q1, and may be adjusted slightly for best results afterwards. The trimpot can be substituted by a suitable value resistor once the optimum setting of R3 is found. A wide variety of transistors may be used for Q2 and Q3.



455 kHz oscillator

THIS simple oscillator can be used as a receiver BFO or as an IF alignment generator. It uses one of the IF coils from the slug-tuned IF/OSC coil sets commonly available from electronics retailers, such as the L-0260 set from Dick Smith Electronics.

The base is connected to the tuned circuit tap, bias being applied to the bottom end of the coil. The collector has the coupling coil connected in series, phased so that the circuit oscillates. The zener diode stabilises the base-collector voltage so that this junction capacitance is stabilised, improving frequency stability. Audio modulation can be applied to the base circuit via a capacitor, as shown.



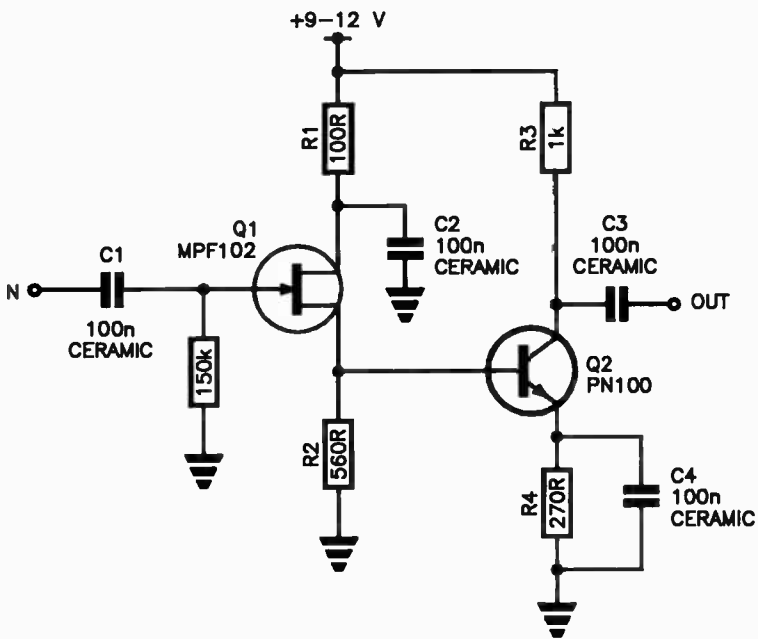
Broad range crystal oscillator

HERE'S a universal crystal oscillator with integral buffer for crystals operated in their fundamental [parallel resonant] mode.

The crystal provides the feedback for Q1, output being lightly coupled via the 10pF capacitor to Q2, a source-follower, providing a high impedance input and minimum load on the oscillator stage. Q3 is directly coupled to Q2. This stage is

configured as a common-emitter amplifier, output being taken from the collector via a 10nF capacitor.

The Q2-Q3 buffer provides a wideband amplifier with a little gain, while Q1 is a simple aperiodic oscillator. It may be powered from any supply ranging from about 7 V up to 15 V. For best stability and low noise output, a regulated supply should be used.



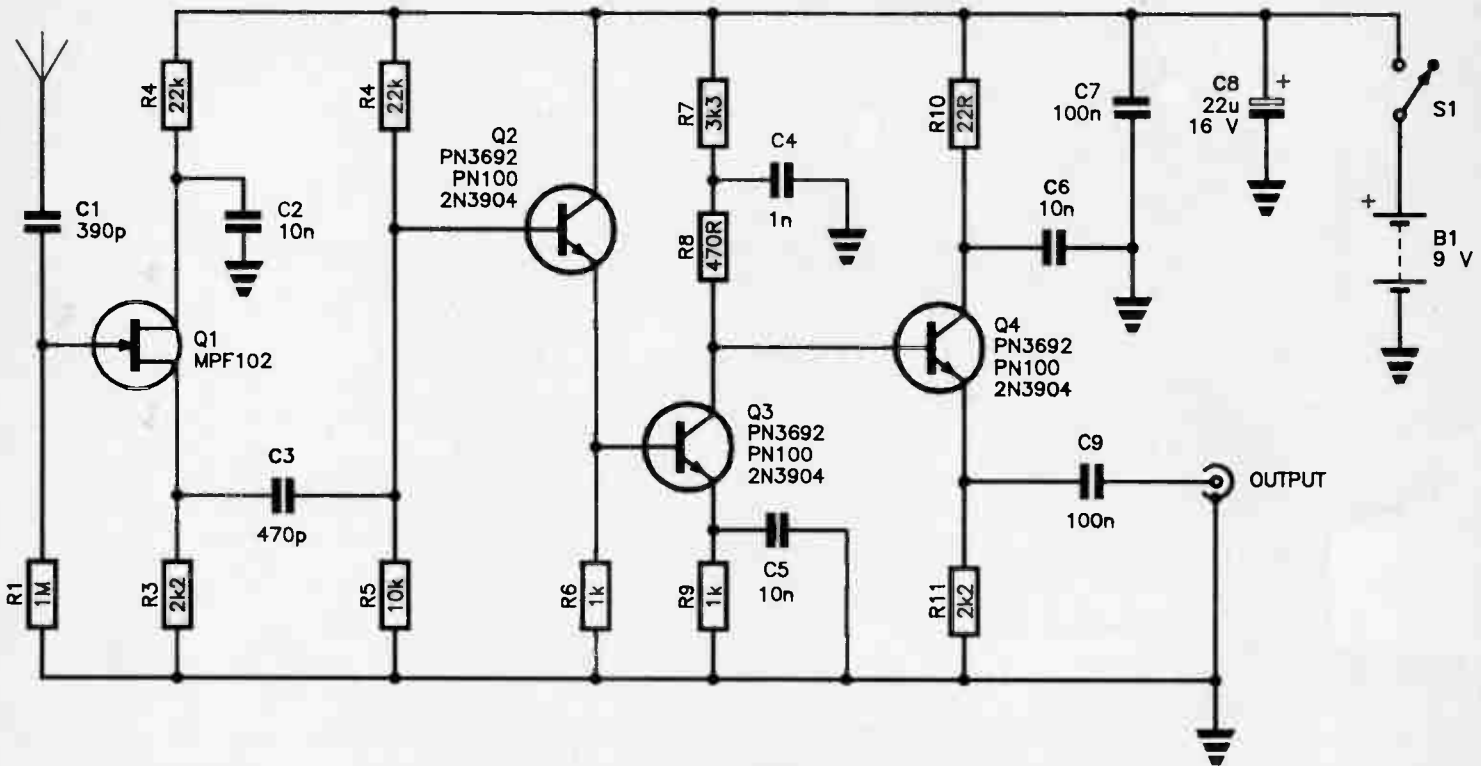
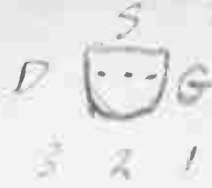
Wideband buffer

THIS circuit makes an ideal buffer for RF oscillators from 100 kHz up to 20 or 30 MHz. It has a small amount of gain is quite stable and exhibits a high input impedance and comparatively low output impedance. It makes a good impedance stepdown circuit, too.

Q1 is a JFET operated as a source-follower. Q2 is directly coupled to it and operated as a common-emitter amplifier with output from the collector.

Ceramic capacitors are specified throughout for best RF performance as they exhibit low self-inductance.

RADIO FREQUENCY



Active AM band antenna

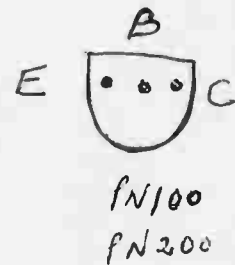
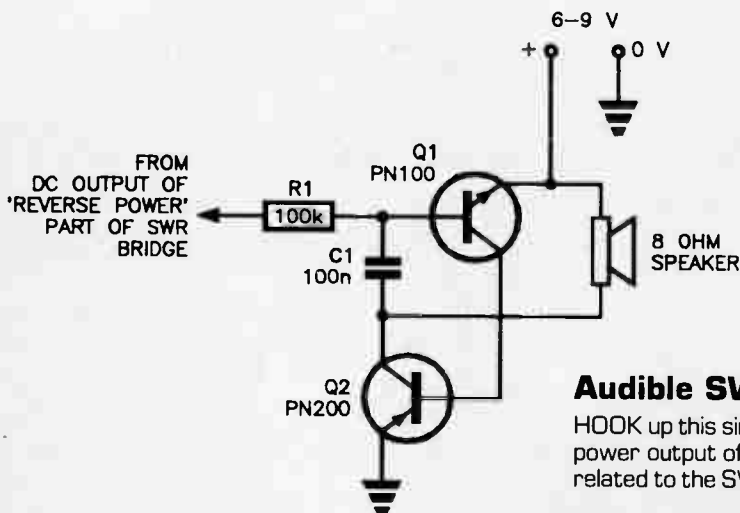
If you've trouble with weak reception on the AM broadcast band, this circuit can make a great improvement. It's a four-stage wideband amplifier with a high impedance input suitable for use with a vertical whip antenna of modest proportions.

The antenna is coupled straight into the gate of the first stage which uses a JFET, Q1. As short whip antennas have a high feedpoint impedance, this stage was designed for a high input impedance. Q1 is connected as a common-drain stage, the signal at the source being coupled via C3 to the base of Q2, a common-collector stage. This arrangement

provides good input-output isolation.

The emitter of Q2 is direct-coupled to the next stage, Q3, operated as a common-emitter amplifier. Its collector is direct-coupled to the base of Q4, an emitter follower [common-collector] amplifier. This stage provides a low impedance output, the signal being capacitively coupled via C9. Only part of the collector load of Q2 is operative at RF, the load resistance being split, bypassed at the split by C4.

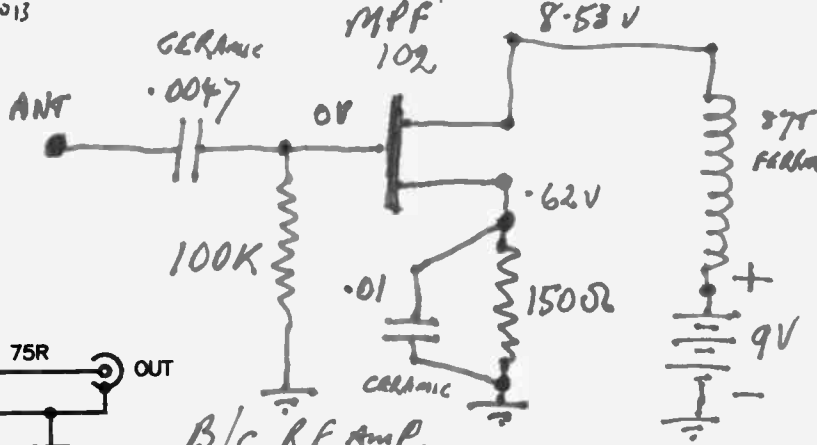
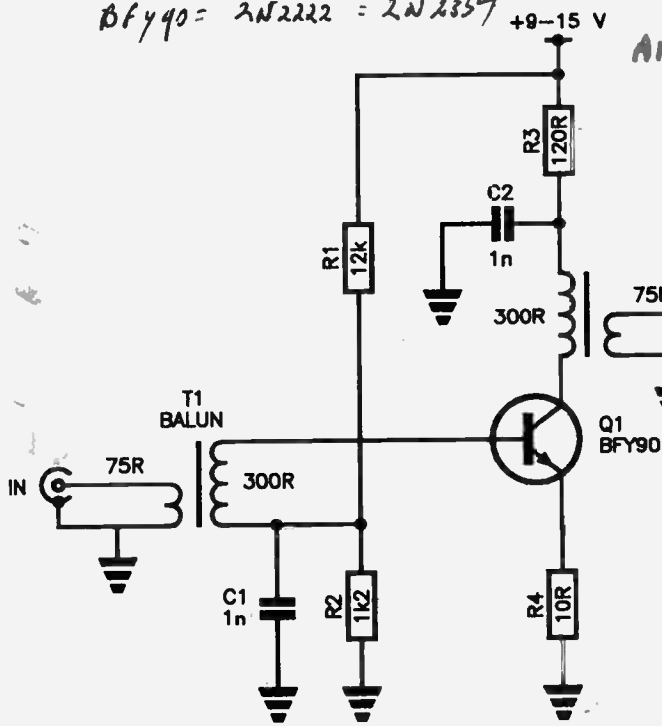
The circuit is powered from a transistor radio battery as current consumption is quite low.



Audible SWR meter

HOOK up this simple oscillator to the dc output of the reverse power output of your SWR meter and you get an audio tone related to the SWR. Minimum SWR gives lowest audio pitch.

BFY90 = BF169 = BF357 = M7106 = 2N3013
 BFY90 = 2N2222 = 2N2357



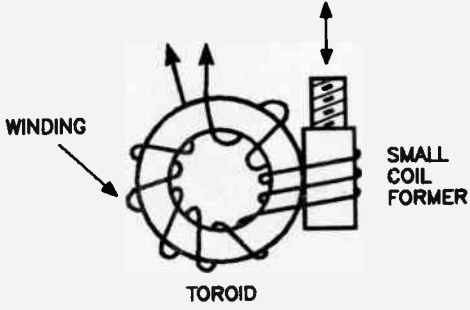
Booster amp for TV or scanners

HERE's a wideband, low noise VHF amp to boost TV or scanner reception. It's simple to build and gives no trouble. No tuning is required.

A standard 75 to 300 Ohm TV antenna balun couples the incoming signals to the base of Q1, a BFY90. Base bias is provided by R1-R2, bypassed by C1, current flowing via the 300 Ohm winding of T1.

A little emitter degeneration [negative feedback] for Q1 is provided by R4. Another balun, the same as T1, couples signals to the output connector. Collector voltage for Q1 is fed via the 300 Ohm winding of the output transformer, bypassed by C2 and decoupled by R3.

It can be powered from a 9 V battery or any suitable supply up to 15 volts. All leads should be kept short and the input and output laid out opposite each other to avoid coupling which may result in uncontrolled oscillation. The two balun transformers may be gutted from TV in-line balun assemblies.



Tunable toroid inductance

THE drawback with toroid coils in tuned circuits is the fact that they're more or less fixed in inductance. Sure, spreading or compressing the turns around the toroid achieves a small variation, but often it's insufficient to be practical.

Gluing a small, slug-tuned coil former to the side of a toroid and winding some of the required turns over it as shown here will give you a tunable toroid inductance!

FET AM receiver

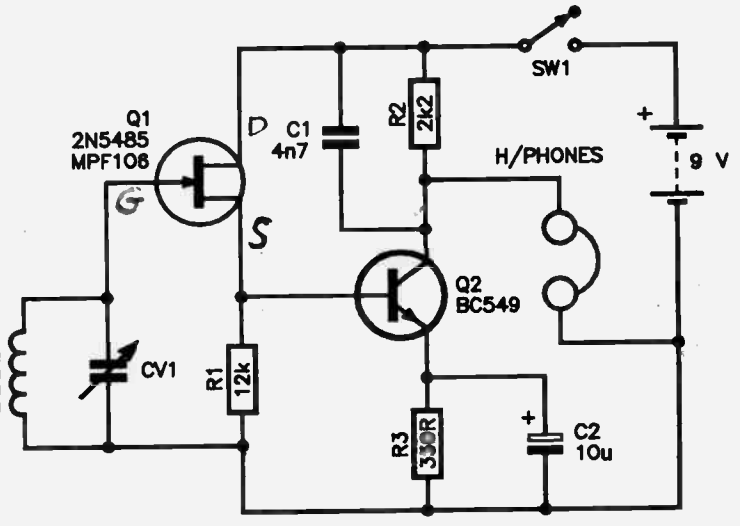
THIS little AM broadcast band receiver performs remarkably well despite having so few components.

The tuning coil (L1) and capacitor (CV1) may be stripped from a junked transistor radio, L1 being the loopstick antenna.

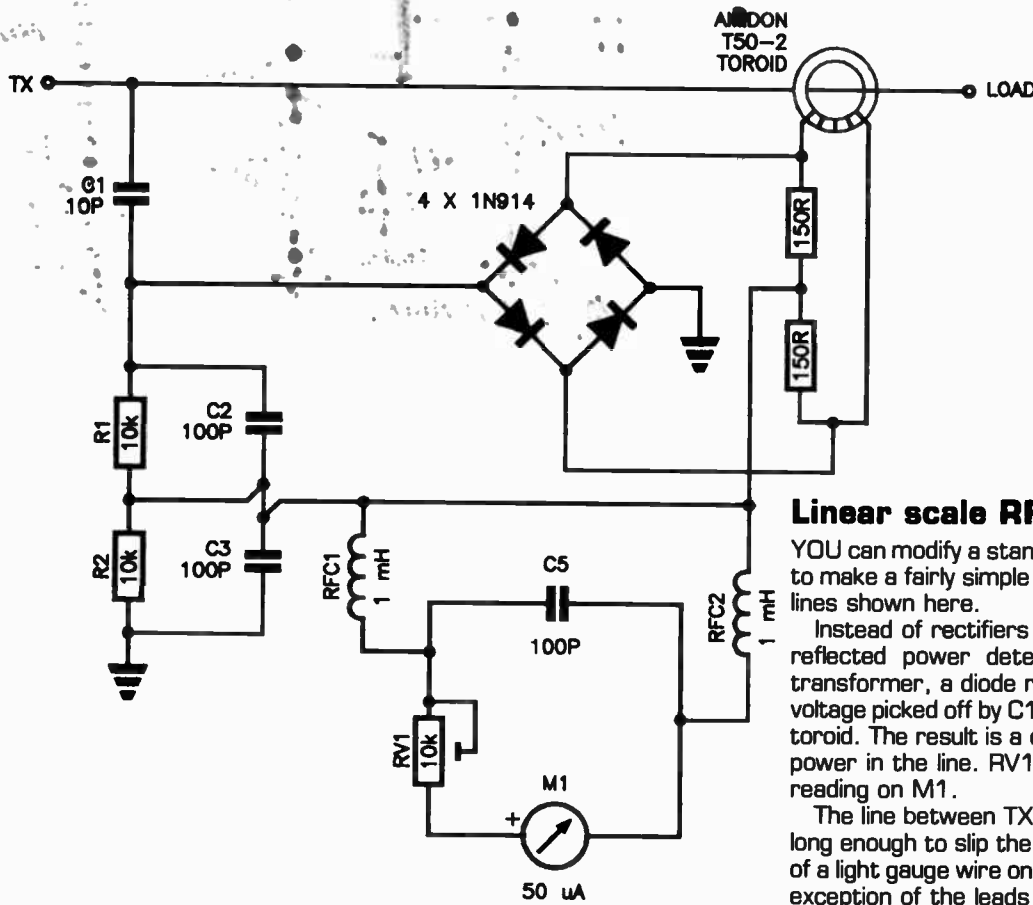
A JFET, Q1, is used as a high impedance source-follower, direct-coupled to transistor Q2 which is used here as an amplifier and collector-bend detector, the transistor's collector characteristics providing rectification of the signal to develop the audio across R2. C1 bypasses the rectified RF. Q2's emitter bias resistor R3 is bypassed by C2, which should be a tantalum type for best results. Connect high impedance headphones for good level audio output.

The circuit may be powered by a 9 V transistor radio (no. 216) radio battery.

"LOOPSTICK" ANTENNA AND TUNING CAP. FROM JUNKED TRANSISTOR RADIO.



RADIO FREQUENCY



*Kotlex
Floper.*

Linear scale RF wattmeter

YOU can modify a standard RF reflectometer (SWR) bridge to make a fairly simple linear scale RF wattmeter, along the lines shown here.

Instead of rectifiers to generate dc for the forward and reflected power detected by the in-line toroid current transformer, a diode ring bridge is used to multiply the line voltage picked off by C1 and the line current picked off by the toroid. The result is a dc voltage output proportional to the power in the line. RV1 serves to set the maximum meter reading on M1.

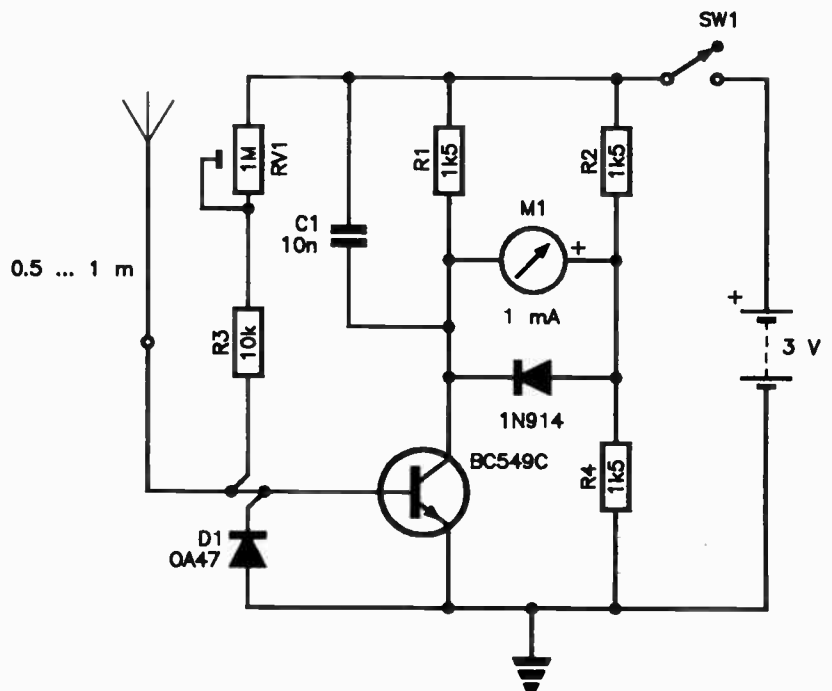
The line between TX and Load should be kept short, just long enough to slip the toroid over. Wind a coil of 18 turns of a light gauge wire on the toroid. Keep all leads short, with exception of the leads to RV1 and the meter.

Sensitive field strength meter

THIS field strength meter works well from very low frequencies through VHF. A short, telescopic whip does as the pickup antenna. Signals are half-wave rectified by D1, the resultant positive pulses being applied to the base of Q1, which has a little bias applied via RV1-R3.

The meter is in a bridge circuit, the collector-emitter of the transistor and R4 forming two arms, resistors R1 and R2 forming the other two arms. Current flowing through the transistor's collector, via R1, unbalances the bridge and current flows through the meter. RV1 zeros the meter by varying the base current. Capacitor C1 bypasses the rectified RF at the transistor's collector. The diode across the meter prevents the meter slamming.

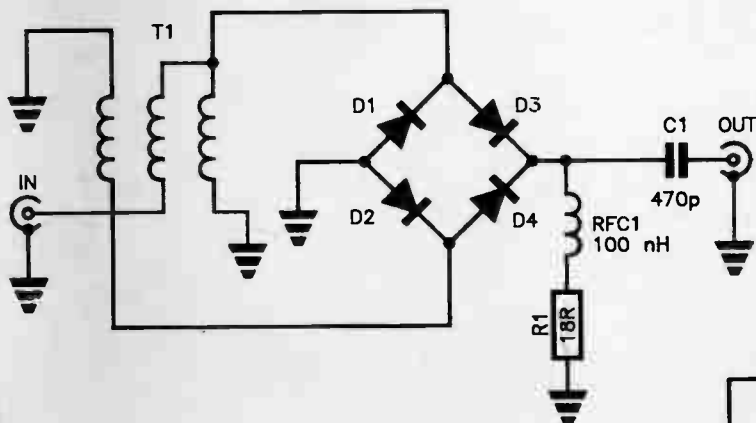
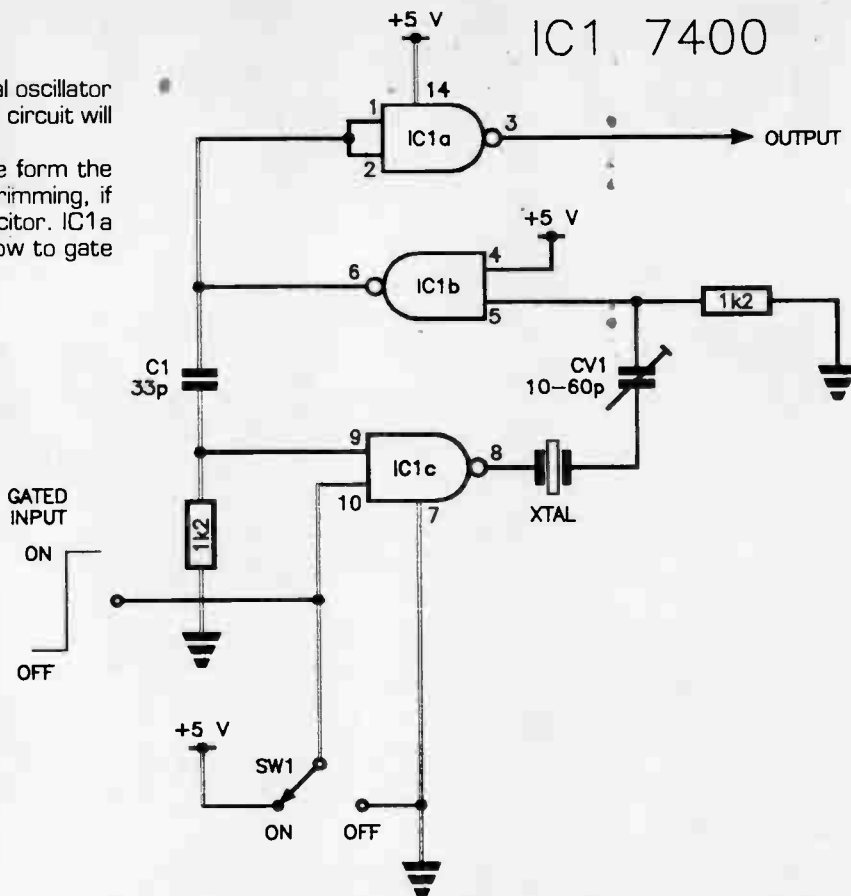
Only a 3 V battery is needed to power this very sensitive instrument. Note that D1 is a germanium diode for best sensitivity, although an ordinary silicon diode, such as a 1N914, will do, with some sacrifice in sensitivity on low signal strengths.



Crystal oscillator with gate

FOR applications where you need to turn a crystal oscillator on and off with a switch and /or digital signal, this circuit will do the trick.

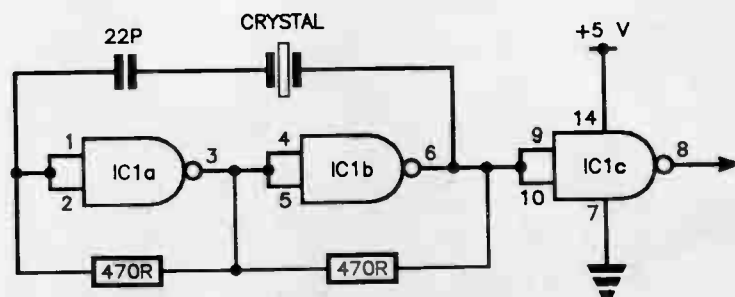
Two gates from a 7400 quad NAND package form the crystal oscillator. CV1 provides for frequency trimming, if required. Otherwise, replace it with a 33pF capacitor. IC1a buffers the output. One input of IC1c is taken low to gate the oscillator off, high to gate it on.



Wideband frequency doubler

TO extend the frequency range of a signal generator, this doubler comes in very handy. It uses a diode bridge rectifier, driven by input transformer T1. RFC1 and R1 provide a load for the bridge rectifier. C1 provides dc isolation for the output. The input transformer can be wound on a standard two-hole ferrite balun core. Take about three lengths of very light hookup wire each about half a metre long and twist them together, about three twists per centimetre. Then wind the trifilar wires around the core's centre leg. Connect the three wires as per the diagram. The four diodes are H-P type 5802-2800 Schottky types.

All leads should be kept short to obtain the best frequency response. This will ensure it works well into the VHF range. Input and output impedances are around 50 Ohms.



TTL crystal oscillator

CRYSTAL oscillator circuits using TTL logic are often reported to suffer from unreliable starting, intermittent oscillation and other problems. This circuit works every time!

A pair of two-input NAND gates are chained as a non-inverting buffer. Bias is applied between the output and input of each stage by the two 470 Ohm resistors. The crystal offers zero phase reversal at its resonant frequency, providing positive feedback and hence oscillation at only that frequency. Another gate is used as a buffer.

Note that this works with 74-series, 74LS- and 74HCT-series logic.

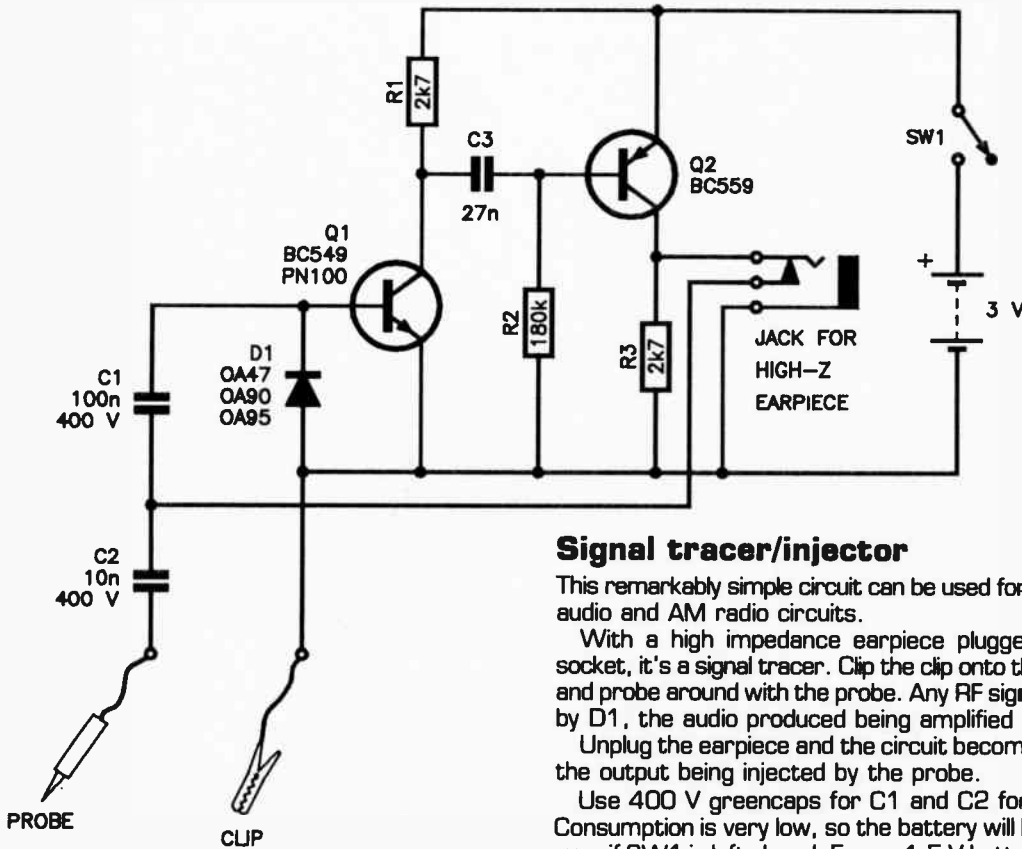
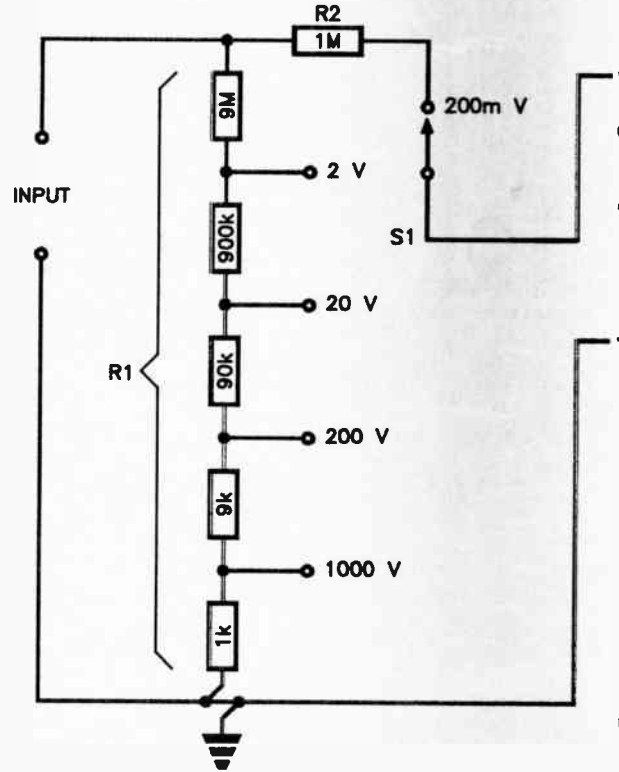
TEST INSTRUMENTS

RMS-to-DC converter

IF your digital multimeter (or analogue multimeter) does not include an RMS function, this handy little add-on circuit will prove most useful.

The whole RMS-to-DC conversion job is done with Analog Device's cheap and nifty AD736 true RMS converter, IC1. Switch S1 and the R1-R2 network provide the required input attenuation, D1 and D2 provide overload clipping. Switch S2 provides selection of ac or dc coupling.

The output goes to your multimeter input, set for the 200 mV range. The circuit may be powered from a 9 V transistor radio battery.



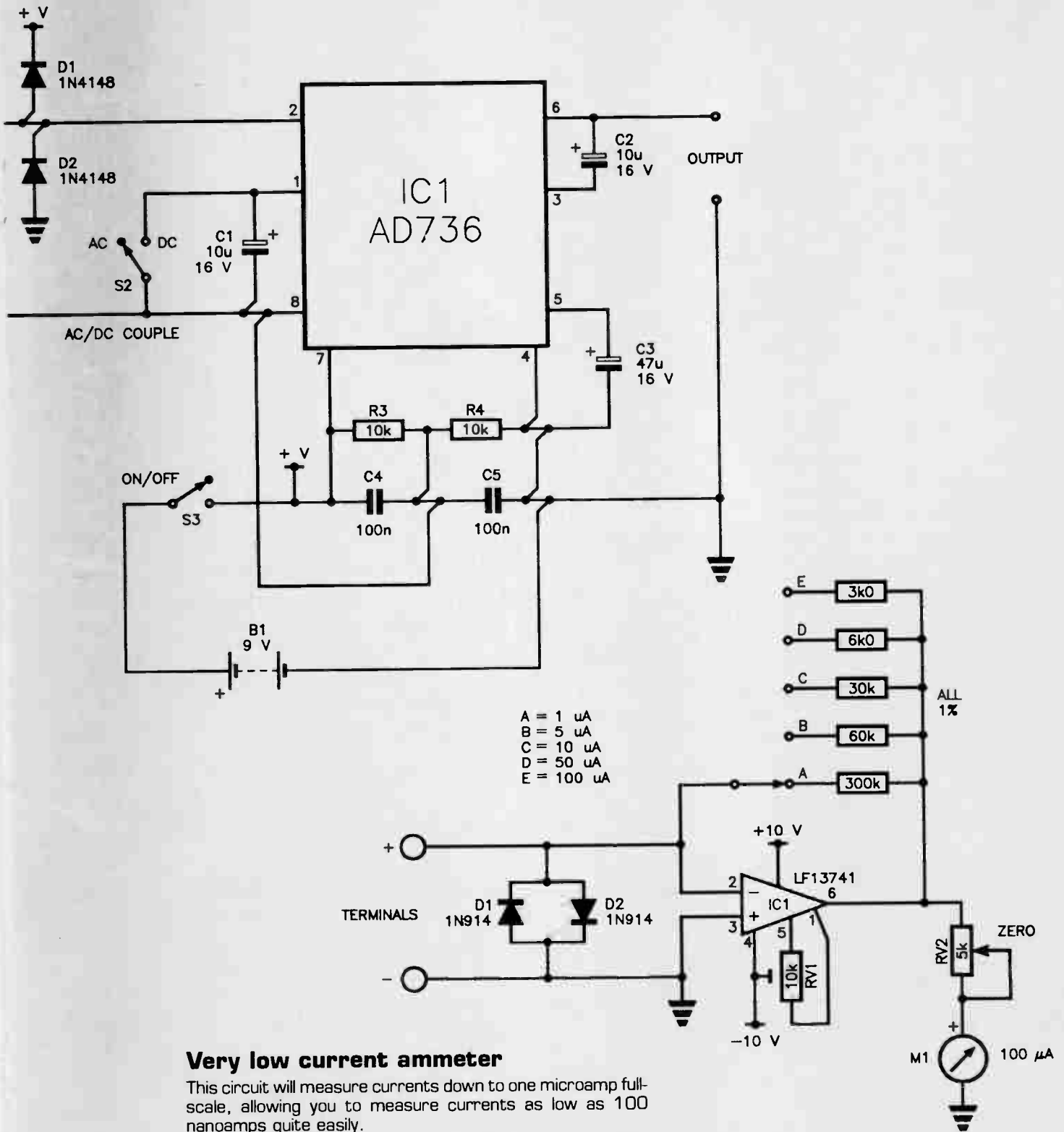
Signal tracer/injector

This remarkably simple circuit can be used for troubleshooting audio and AM radio circuits.

With a high impedance earpiece plugged into the jack socket, it's a signal tracer. Clip the clip onto the circuit ground and probe around with the probe. Any RF signals are rectified by D1, the audio produced being amplified by Q1 and Q2.

Unplug the earpiece and the circuit becomes an oscillator, the output being injected by the probe.

Use 400 V greencaps for C1 and C2 for safety's sake. Consumption is very low, so the battery will last a long time, even if SW1 is left closed. Even a 1.5 V battery may be used.



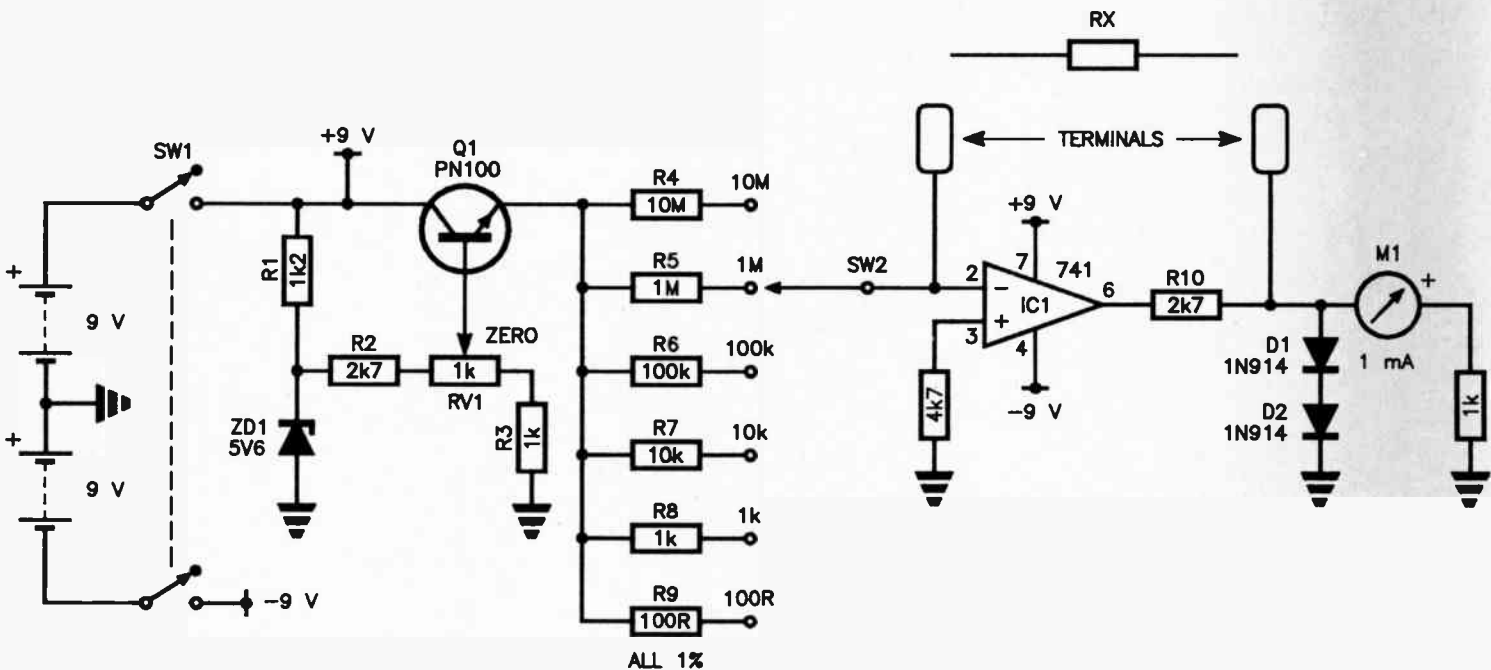
Very low current ammeter

This circuit will measure currents down to one microamp full-scale, allowing you to measure currents as low as 100 nanoamps quite easily.

The circuit is based on a precision JFET-input op-amp, type LF13741 from National Semiconductor. RV1 is a trimpot to initially set the output offset. It should rarely need adjustment. RV2 sets the meter zero.

The op-amp's gain is selected by the switch, giving the required full-scale reading. Diodes D1 and D2 prevent the input voltage drop exceeding 0.6 V, providing some protection.

TEST INSTRUMENTS



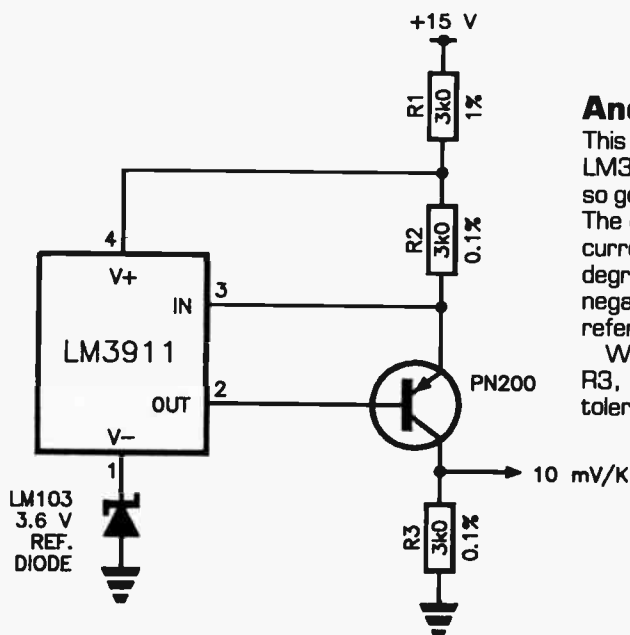
Linear scale ohmmeter

AN ohmmeter with a linear scale is so much more convenient, unless you are prepared to fork out for a digital multimeter. This'll be cheaper!

A constant current source involving Q1 and selected range resistors (R4 to R9) provides a constant current drive to the inverting input of op-amp IC1. The unknown resistor is connected between the op-amp's inverting input and its output. The output voltage will be linearly proportional to the ratio of RX to the range resistor selected.

R10 limits the maximum output current of IC1, while diodes D1 and D2 limit the voltage across the meter circuit, preventing slamming of the meter.

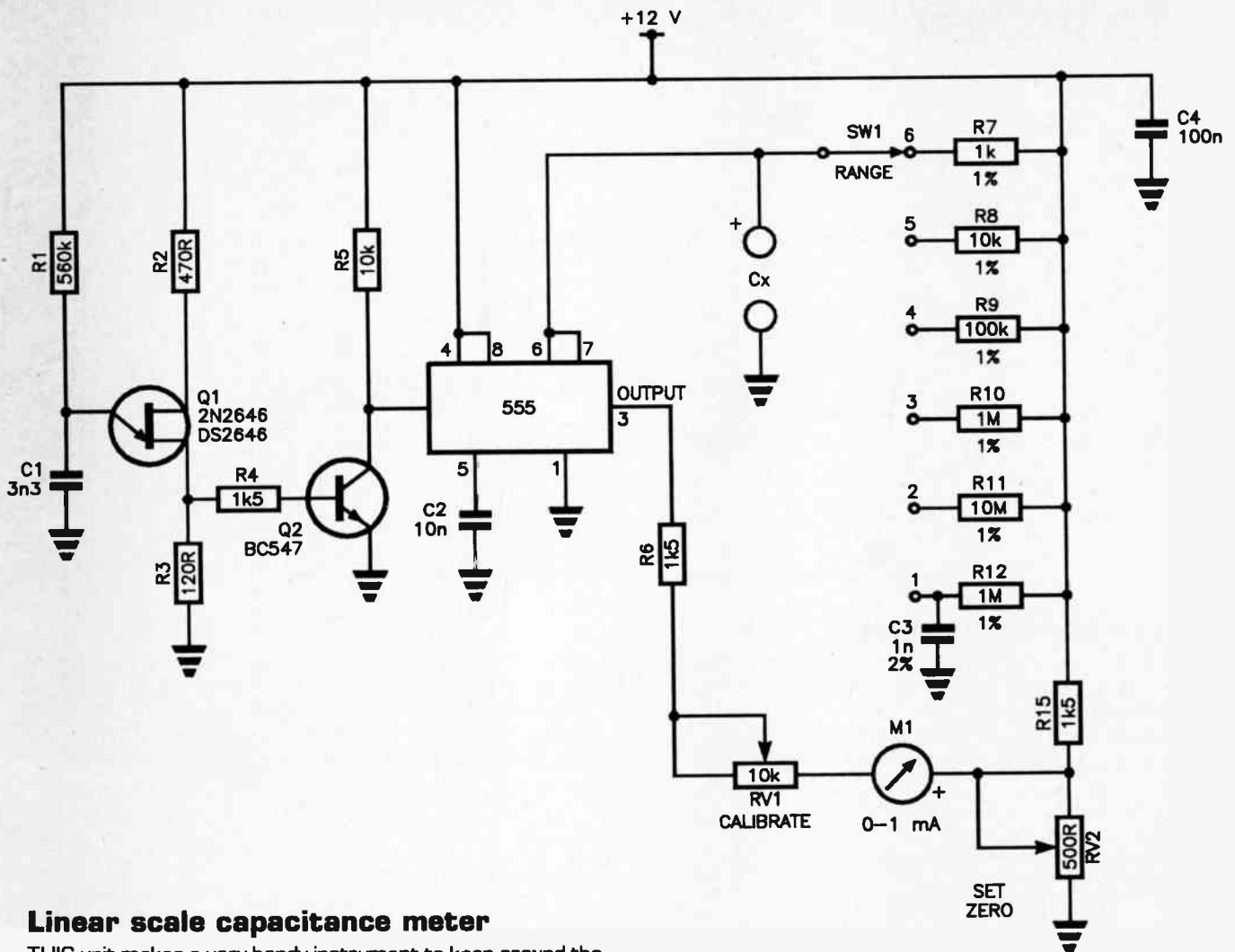
All the range resistors are 1 or 2% types; meters better than Class 2, which have a full-scale accuracy of 2%, are expensive and hard to come by so you don't need to do better than that. RV1 allows setting of the source current, and thus zero setting of the meter. Two 9 V transistor radio batteries are used to supply the circuit.



Another electronic thermometer

This electronic thermometer uses the low-cost National LM3911, which is good for sensing air temperature, but not so good in contact temperature measurement applications. The output drives the base of a transistor, whose collector current is scaled to give an output variation of 10 mV per degree Kelvin about ambient (20 degrees C). The LM3911 negative terminal is biased up with an LM301 precision reference diode.

While 0.1% precision resistors are specified for R2 and R3, 1% resistors can be used if less precision can be tolerated.



Linear scale capacitance meter

THIS unit makes a very handy instrument to keep around the workshop. It will certainly find uses for itself!

Capacitance can be measured to the accuracy of the meter. An ordinary panel meter is a class 2.5 type with 2.5% accuracy, so you can measure capacitors to a degree of accuracy better than most off-the-shelf capacitors available.

Q1 is a UJT relaxation oscillator, providing short pulses across R4. Each pulse turns on Q2, the collector voltage of which falls for the duration of the pulse, triggering the 555. Q1 oscillates at about 1 kHz, so the 555 is triggered about once every millisecond.

Between trigger pulses, pin 2 of the 555 is held high, setting the internal flip-flop, turning the internal slave transistor on, shorting pin 7 to ground and this shorting the unknown capacitance, Cx.

When the 555 is triggered, the short across Cx is released, allowing the capacitor to charge via whichever resistor is selected by the range switch, SW1. The voltage across Cx then increases exponentially for a period that is determined by the value of Cx and the selected range resistor, thus:

$$t = 1.1 R_r C_x$$

where R_r is the range resistor. At the end of the period, the 555's comparator resets the flip-flop which then causes the internal slave transistor to turn on, discharging Cx. The 555's pin 3 goes low once again and the cycle repeats each time the 555 is triggered.

As the range resistor is fixed, the on:off ratio of the output pulse will be determined by the value of Cx which will be independent of Q1's frequency of oscillation.

Pin 3 of the 555 drives current through R6, RV1 and the meter, which deflects according to the on:off ratio. The low-to-high voltage from pin 3 does not swing from 0 V to the positive supply rail, so the resulting dc offset is compensated by raising the positive end of the meter above ground by the voltage divider consisting of R13-RV2. Thus, RV2 provides zero setting for the meter.

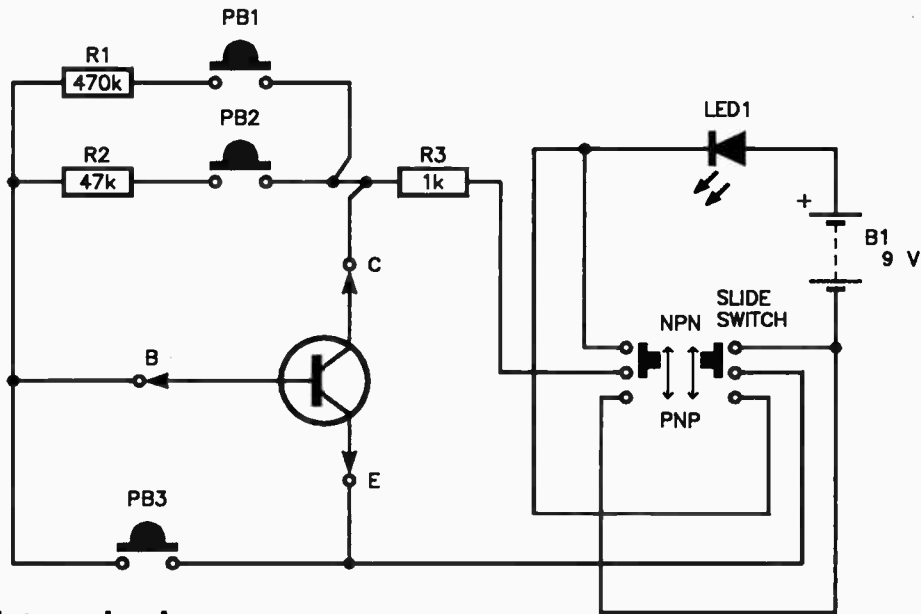
All the range resistors are 1% types, although 2% types will do. You'll find 1% types more common, though. Position 1 on the range switch is for calibration, C3 being a 2% mica or polyester capacitor. This allows adjustment of RV1 for full-scale deflection on the meter with nothing connected to the Cx terminals.

On the range switch, position 2 is 100 pF full-scale, position 3 is 1 nF [1000 pF], position 4 is 10 nF [0.01 μF], position 5 is 100 nF [0.1 μF] and position 6 is 1 μF full-scale.

The zero set control only really needs to be used on the 100 pF range. Keep the leads between the Cx terminals, SW1 and the 555 to an absolute minimum.

If you substitute a 500 microamp meter for M1, full-scale deflection of the meter will then be 50 pF on to 500 nF [0.5 μF]. If you use a 556, one half can be used to replace Q1 and Q2.

TEST INSTRUMENTS

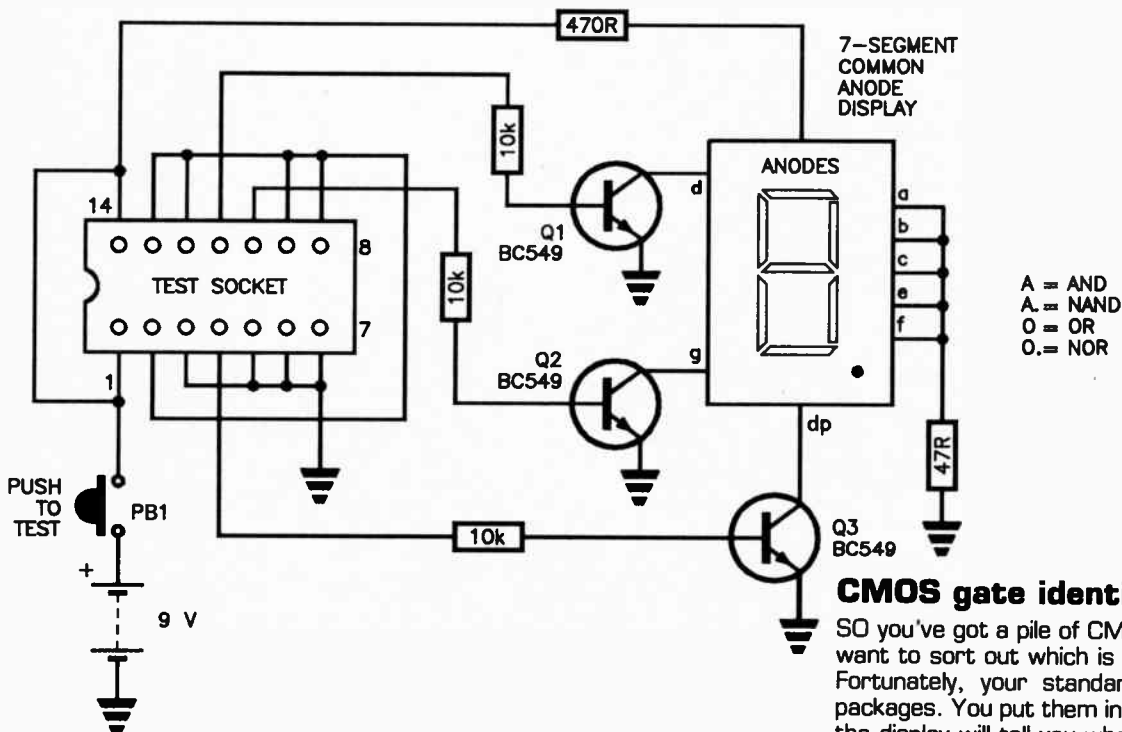


Yes/no transistor checker

GOT a lot of odd used transistors in your junk box? This simple little checker will give you a yes/no indication of what to keep and what to chuck out.

Just identify the base, emitter and collector leads, set the slide switch to PNP/NPN according to the transistor type,

clip the device in place and stand by for the pressbuttons. Press PB1 and the LED will light for medium to high-gain transistors. If it doesn't light, or glows only weakly, press PB2 and it should light — indicating a low-gain device. Press PB3 for leakage test. The LED shouldn't light, or only weakly.

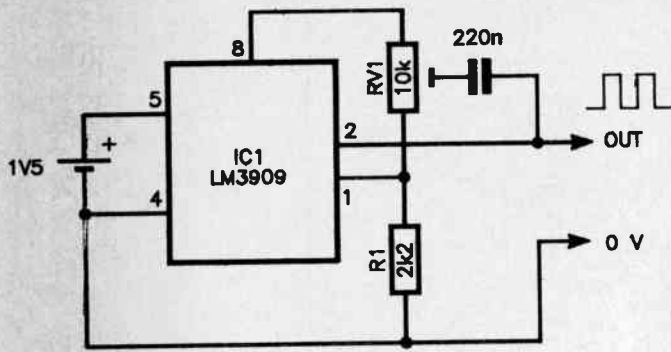


CMOS gate identifier

SO you've got a pile of CMOS gates in your spares bin and want to sort out which is what? Here's a simple checker. Fortunately, your standard quad gates come in 14-pin packages. You put them in the test socket, press PB1 and the display will tell you what it is indicating like so:

- 'A' means it's an AND gate package
- 'A.' means it's a NAND gate package
- 'O' means it's an OR gate package
- 'O.' means it's a NOR gate package

It would be a good idea to use a zero insertion force [ZIF] socket here.



Mini signal injector

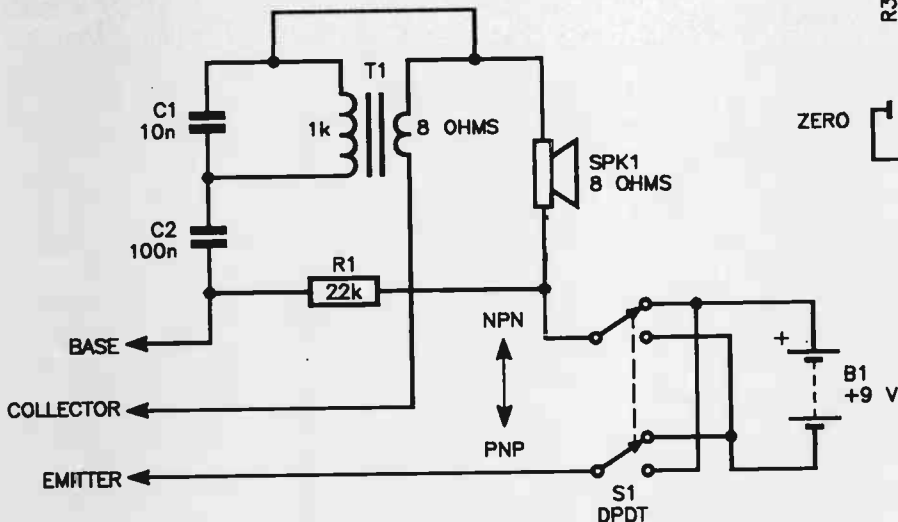
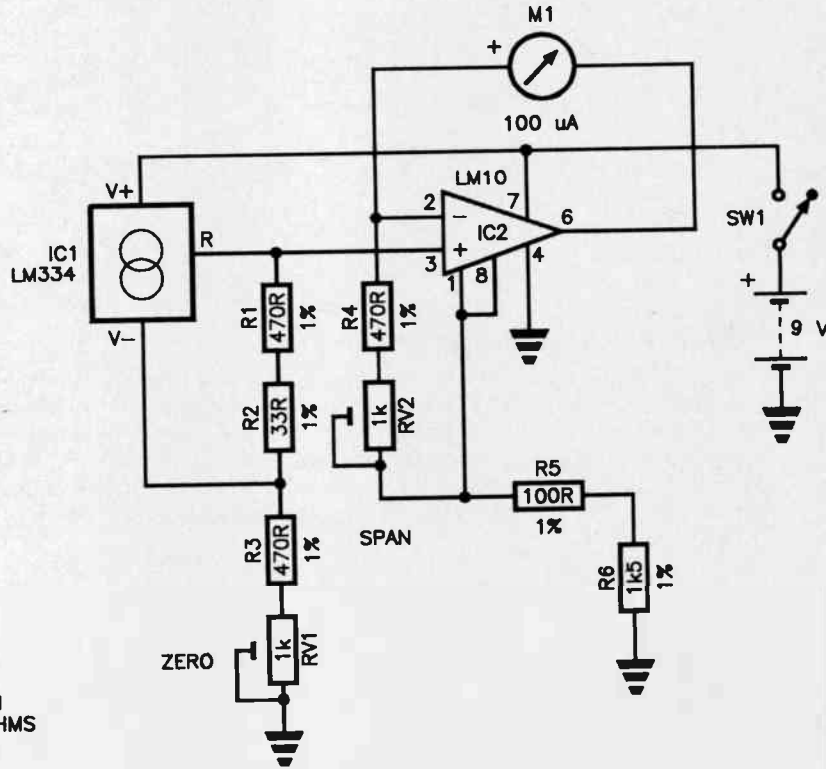
THE LM3909 can be pressed into service as an audio pulse oscillator and used to provide a signal injection source. As it can be powered from a single 1.5 V cell, this circuit can be housed in a convenient probe case, with a clip lead for the common [0 V] connector and probe point for the injection signal output. While power consumption is very low, it is recommended you connect a switch in series with the positive lead to the battery.

Centigrade electronic thermometer

NATIONAL Semiconductors' precision current source/temperature sensor, the LM334, provides the basis for a very good 0-100 degrees Centigrade thermometer. In this circuit it provides a variable voltage input to a precision op-amp, the LM10 (IC2).

The resistor network comprising R1-R2-R3-RV1 provides the required bias for the LM334, RV1 setting the zero degree point.

As the meter is in the feedback network of IC2, R4-RV2 set the feedback, thus RV2 sets the temperature range maximum, or span. Use cermet trimpots and 1% resistors. It can be calibrated by dipping IC1 into just-melted ice water for the zero point, and into just-boiled water for the 100 degree point.



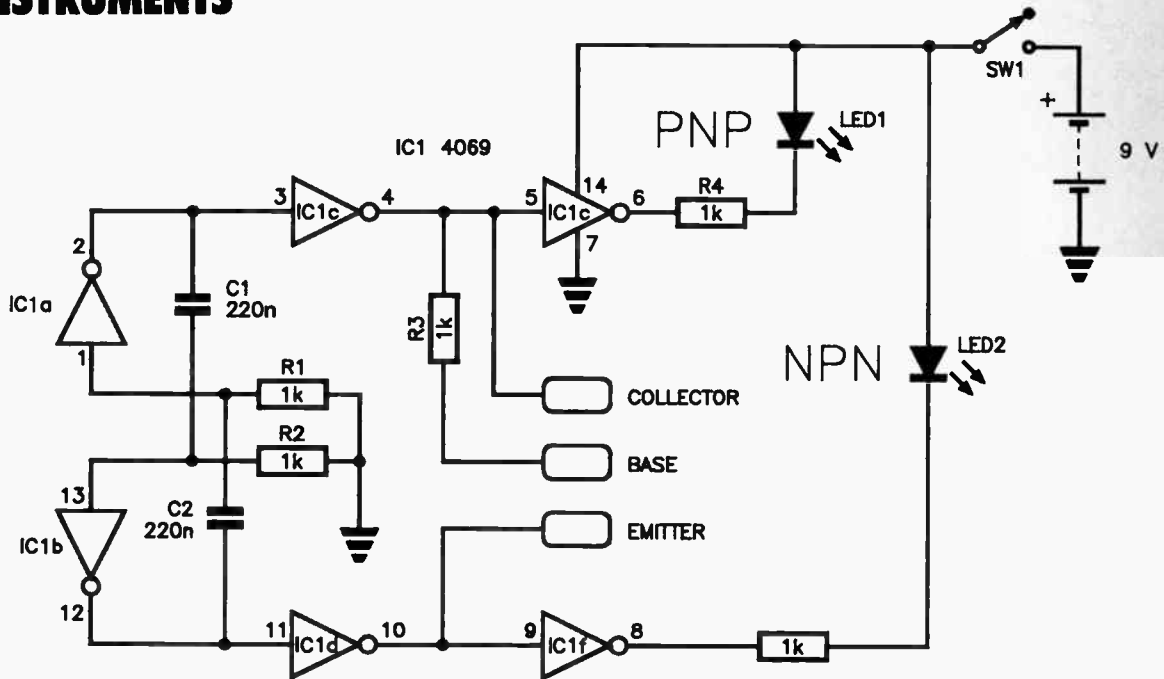
In-circuit transistor checker

THIS nifty little checker circuit allows you to check transistors in-circuit, which is ideal for servicing.

The leads labelled Base, Emitter, Collector have hook-type clips attached so you can make connection to a device's legs on the circuit board, or wherever it's mounted.

The circuit is a simple feedback audio oscillator, with the primary of T1 resonated with C1 and base-emitter feedback provided by C2 and the secondary of T1, which is a transistor audio transformer, such as the Dick Smith cat no. M-0216, or similar. Base bias is provided by R2. The speaker may be a small 50 mm type, but any suitable size speaker will do the job, indeed, even its impedance is not too important.

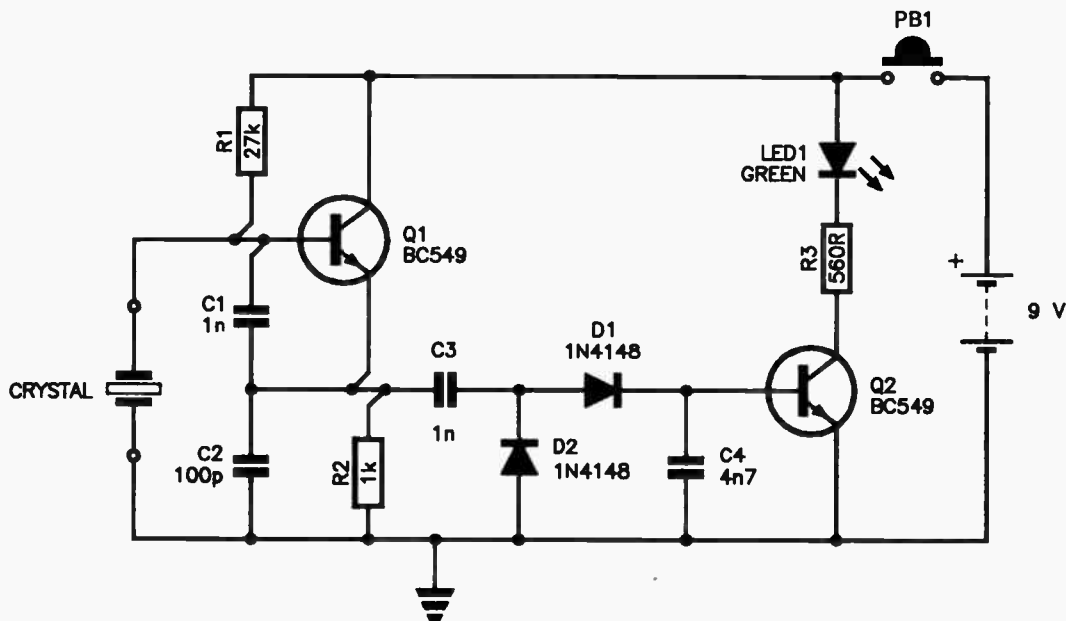
TEST INSTRUMENTS



PNP/NPN transistor checker

CAN'T sort out which of all those transistors in your junk box or spares drawer are PNP and which are NPN? No problem! This circuit features a flip-flop that drives a couple of buffers, their outputs driving the two LEDs. If you hook up an NPN device, the drive to IC1c is inhibited because the transistor conducts each time IC1c's output goes high and

only LED2 lights. The oscillation rate of the IC1a-IC1b flip-flop is very high and the persistence of vision ensures you only see a constant glow from the LED. Insert a PNP device and the drive to IC1f is inhibited because the device conducts each time IC1d's output goes high, allowing only LED1 to light.

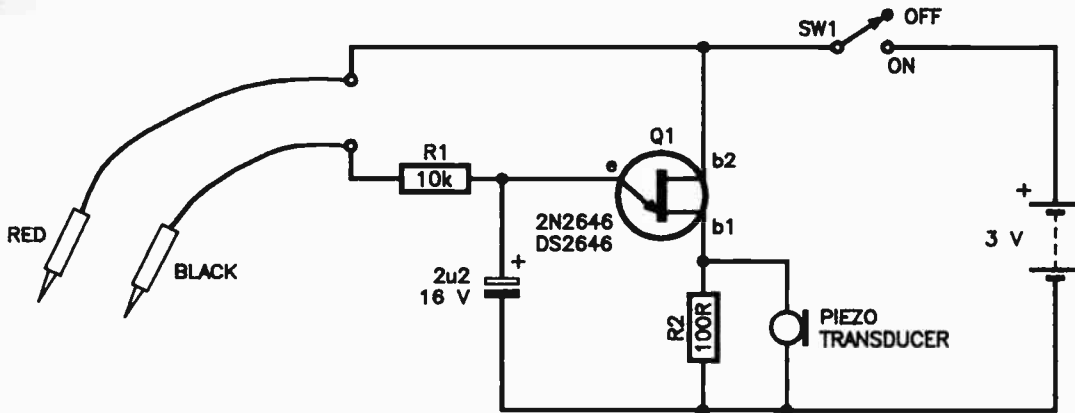


Wide range crystal checker

THIS crystal checker works with crystals having a fundamental frequency up to 20 MHz or more. Q1 is connected as a standard wideband Colpitts oscillator. Output from its emitter is rectified by a voltage doubler rectifier which supplies current to the base of Q2. Thus, if the crystal is good, it will oscillate and the resultant rectified RF turns on Q2, the collector current causing the LED to light.

The circuit may be powered from a 9 V transistor radio battery, although 4.5 V or 6 V batteries will do, too. Press the pushbutton and watch the LED! A set of suitable crystal sockets may be wired in parallel to accept crystals to be checked; spring clips or binding posts can be used to take crystals with leads.

UJT CIRCUITS



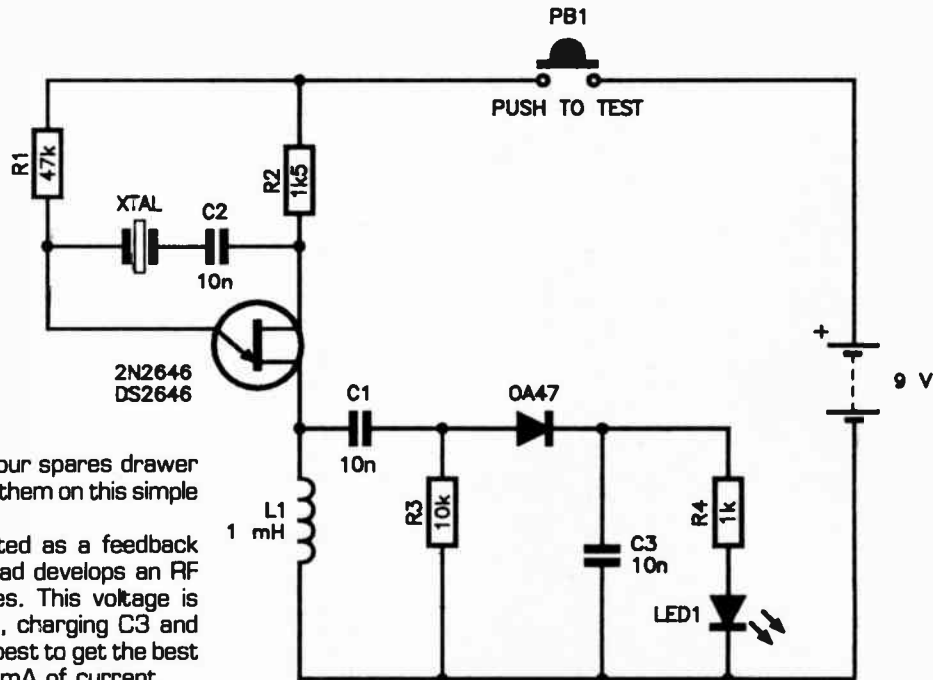
UJT audible continuity checker

AUDIBLE continuity checkers are great — you don't have to watch a meter scale, leaving you to concentrate on where you're putting the probes!

The UJT here is configured as a simple oscillator in the audio range, using a piezo transducer as the audible output. A suitable transducer would be the Dick Smith Electronics L-7024, or similar.

When the red and black probes are connected, the

oscillator circuit is completed, Q1 oscillates and the voltage pulses developed across R2 operate the piezo transducer — you hear the beep. The oscillator pitch can be changed by changing the value of the 2u2 capacitor or by varying R1. You will note that in circuits under test that show a resistance around 1k or higher, the output pitch decreases. This can be useful!



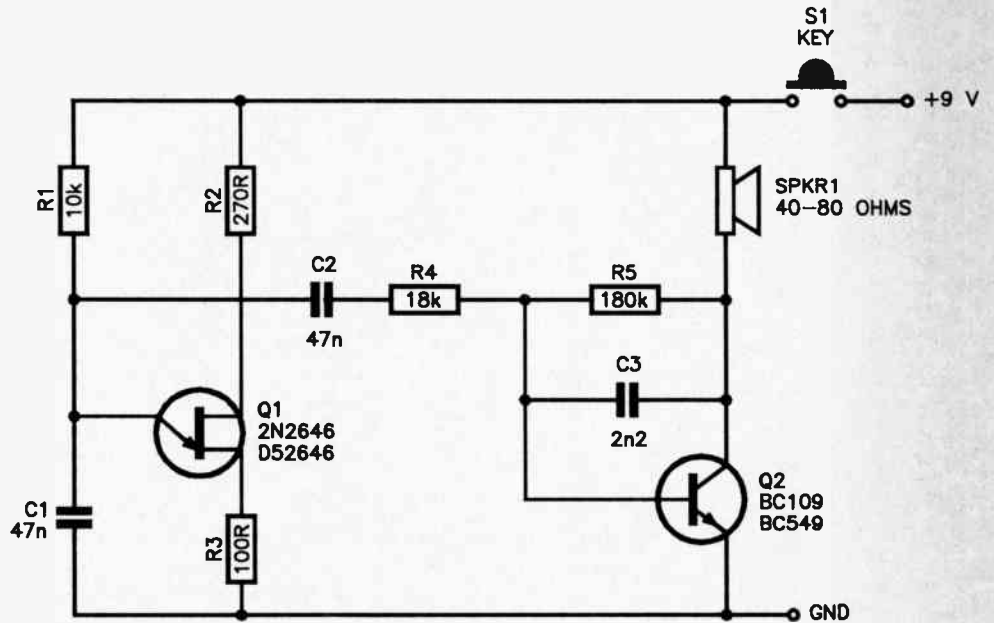
UJT crystal checker

GOT some odd crystals lying around in your spares drawer and don't know if they're good or not? Try them on this simple go/no-go crystal checker.

The 2N2646/DS2646 UJT is operated as a feedback oscillator. The RF choke in its base 1 lead develops an RF voltage across it if the crystal oscillates. This voltage is rectified by the OA47 germanium diode, charging C3 and lighting the LED. A high brightness LED is best to get the best sensitivity; they will light on less than 1 mA of current.

The circuit is powered from a 9 V transistor radio battery. A bank of suitable crystal sockets can be connected in parallel to take the various crystal pin spacings; spring terminals can be used for pigtail leaded crystals. Just press the button for a few seconds and see that the LED lights. The circuit works with crystals up to 7-8 MHz, although this depends on the individual UJT's characteristics. Overtone crystals with a fundamental in the range below this will work, too. It's great for checking computer clock crystals, TV crystals and other low frequency crystals.

UJT CIRCUITS

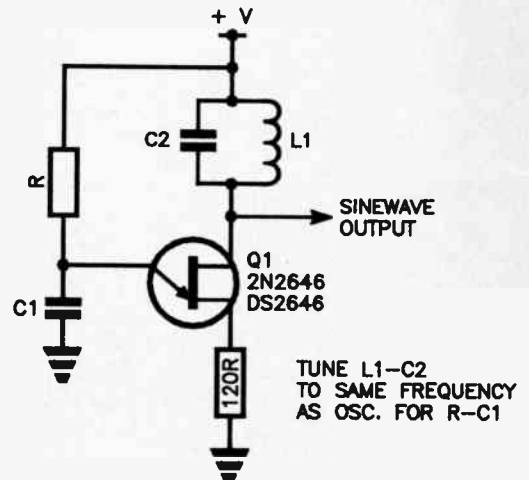


UJT Morse practice oscillator

MAKE a Morse practice oscillator with just a UJT, a transistor and a handful of parts!

Q1 is connected as a conventional UJT oscillator, operating at a few hundred Hertz. The sawtooth waveform across C1 has an amplitude of a few volts and this is applied to the base of the output amplifier, Q2, via C2 (dc decoupling) and R4. Bias for Q2 is provided by R5.

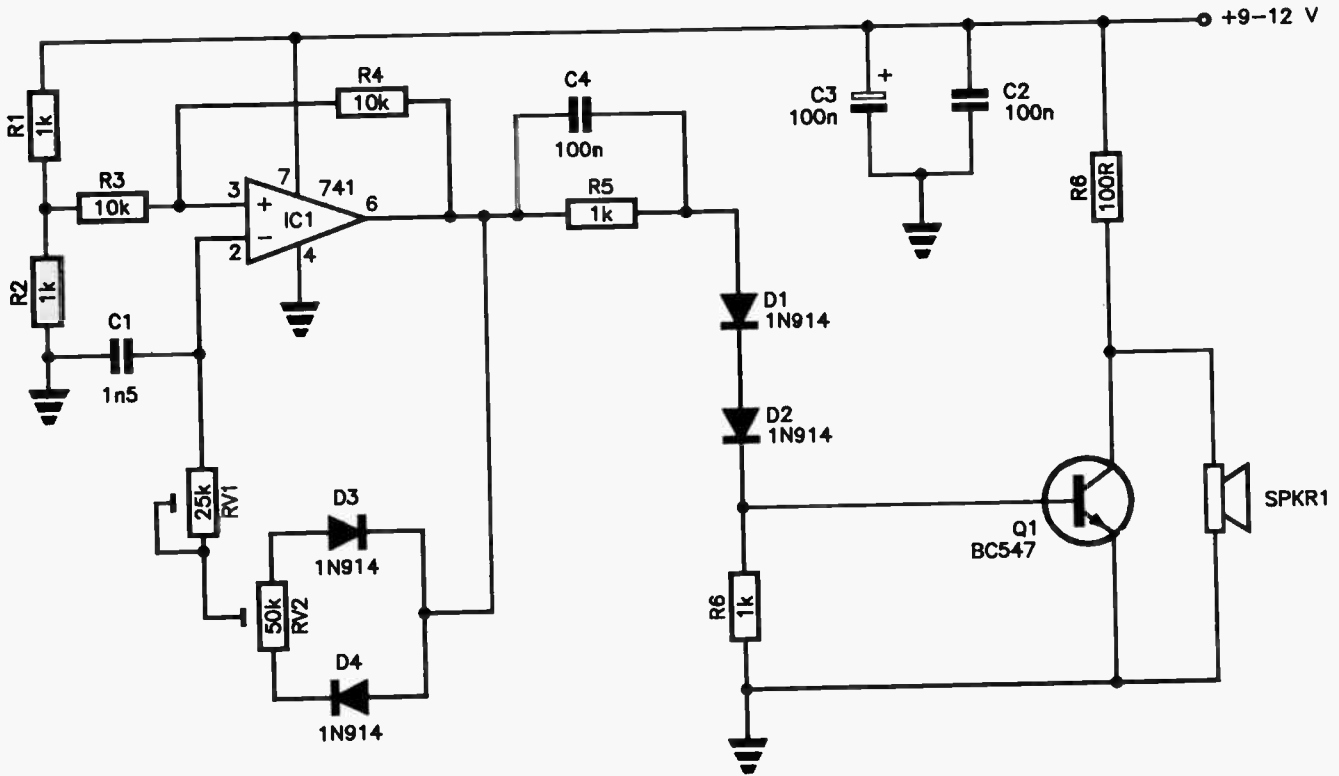
A high impedance speaker is required, or you can use low impedance [dynamic] headphones (which will save you annoying everyone). The key contacts are simply inserted in series with the positive rail to the 9 V battery. Capacitor C3 smooths out some of the roughness in the sawtooth note from the UJT oscillator.



UJT sinewave oscillator

A SINEWAVE output for a UJT oscillator can be arranged by putting a parallel tuned circuit in series with base 2. The UJT's relaxation frequency is set to the tuned circuit's frequency. The base 2 current pulses that occur each time the emitter fires will cause the L-C tuned circuit to ring, generating a quite respectable sinewave output.

MISCELLANEOUS



Dog chaser

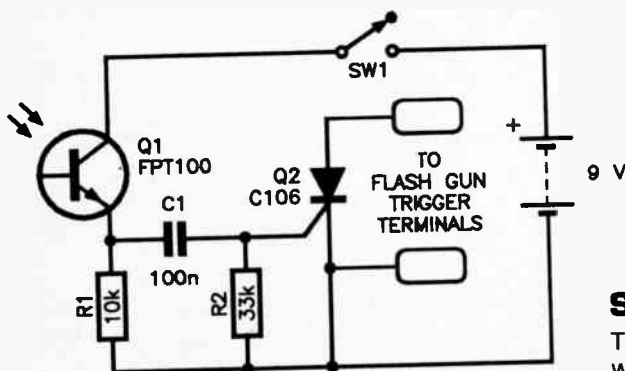
DO the neighbourhood dogs dig up your front lawn? This high pitched screamer will chase them away!

IC1 is connected as a high frequency oscillator, generating narrow pulses. You can set the frequency with RV1 and the mark:space ratio with RV2. The output of IC1 drives the base of Q1 via R5 and D1-D2. The pulses at Q1's collector drive SPKR1, a piezo horn tweeter. These operate well above our

hearing range and will put out very loud sounds audible to dogs and other four-legged garden pests.

Diodes D1 and D2 are there to build out the turn-on voltage for Q1 as the output of IC1 does not swing right down to zero volts.

Some experimentation with RV1 and RV2 will optimise results.

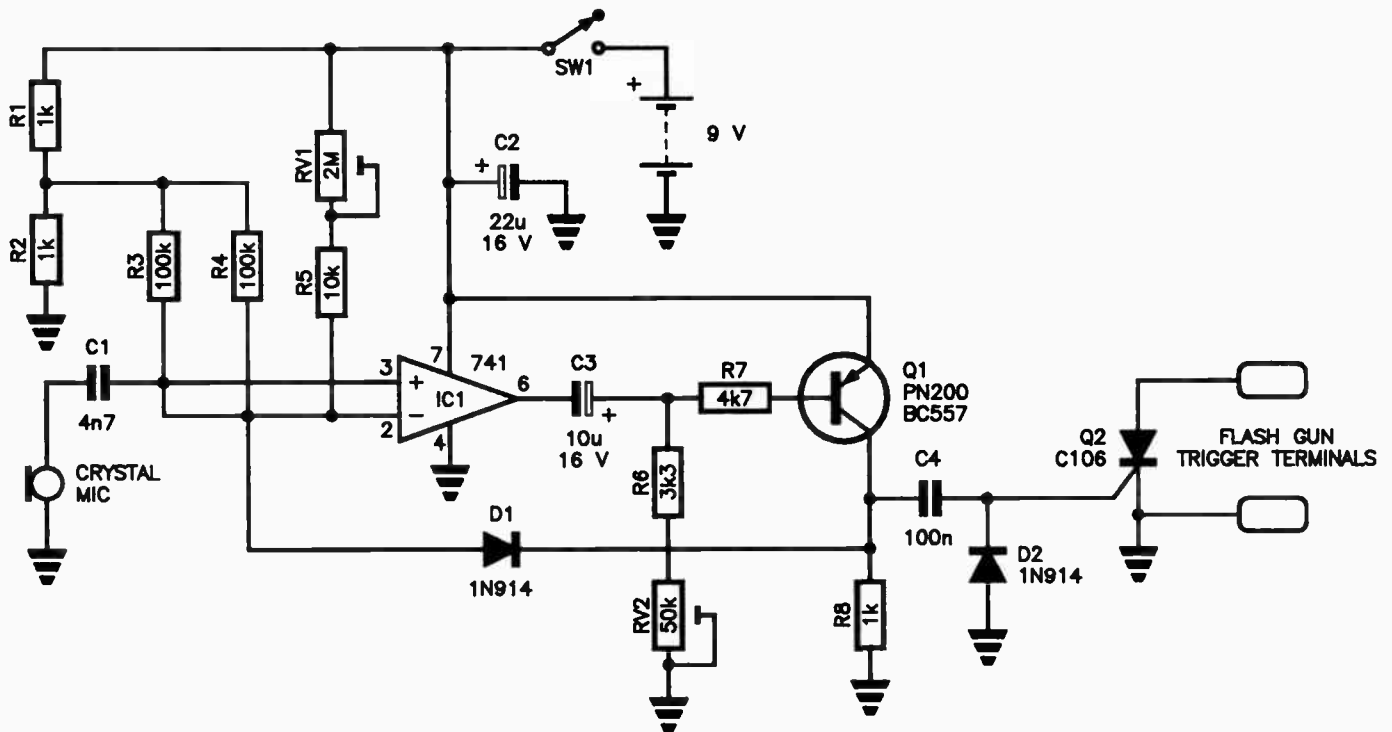


Slave flash trigger

TO trigger a fill-in flash remotely when taking photographs without trailing wires across the floor, use this circuit.

When your main flash fires, the phototransistor [Q1] conducts and a pulse appears across R1. This is capacitively coupled to R2 and thus the gate of Q2, an SCR. The SCR then conducts, shorting the remote flash gun's trigger terminals.

MISCELLANEOUS



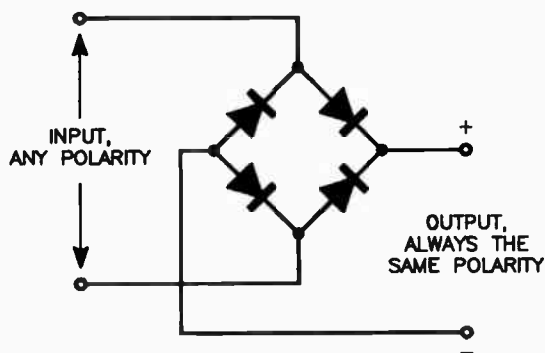
Sound trigger for photo-flash

YOU can freeze the action of events which make a sound to take some spectacular photos — balls bouncing, light globes breaking, etc. This circuit picks up the sound, amplifies it and triggers your flash gun after a preset delay.

IC1-Q1-D1 amplifies and rectifies the incoming sound picked up by the crystal mic, providing positive-going pulses at the collector of Q1. These are coupled to the gate of Q2,

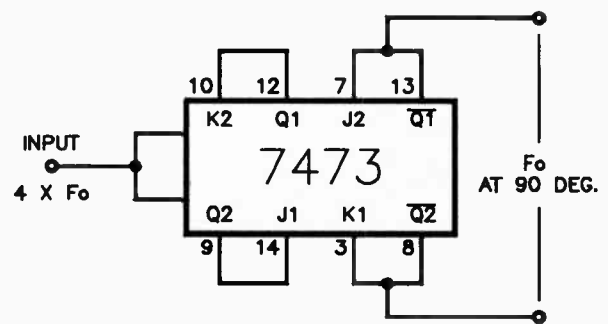
and SCR which is used to trigger the flash gun. RV1 sets the sensitivity, while RV2 sets the delay so that you can take the picture after some milliseconds, or immediately.

Check the setup first with a dummy run. Then, in darkness, open the camera shutter and go! Repeat with different delays for different effects.



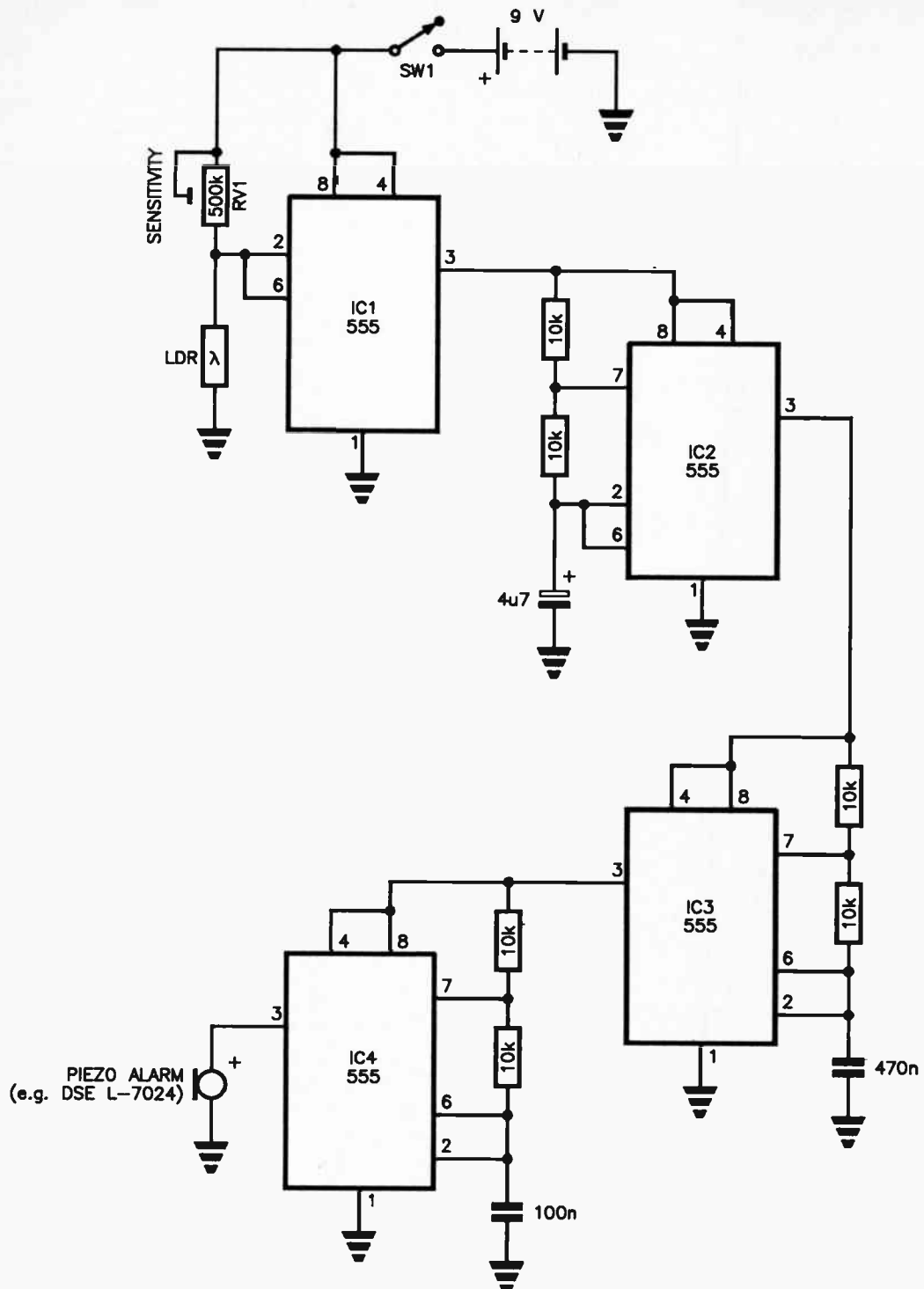
Polarity protector

YOU can protect the polarity of any circuit which may be endangered by wrong-polarity supply connection, using a simple diode bridge. The diodes should be rated for the voltage and current likely to be encountered. Prevention is better — and cheaper! — than a cure.



Digital quadrature phase generator

THE 7474 dual J-K flip-flop can be connected to provide two outputs at 90 degrees phase difference. The input frequency needs to be four times the output frequency.



The mysterious chirrup

DRIVE your family nuts! This circuit can be left hidden in a room and will begin to make mysterious chirrup sounds like a tree frog or a cricket. But, turn the light on to find it and it stops chirruping!

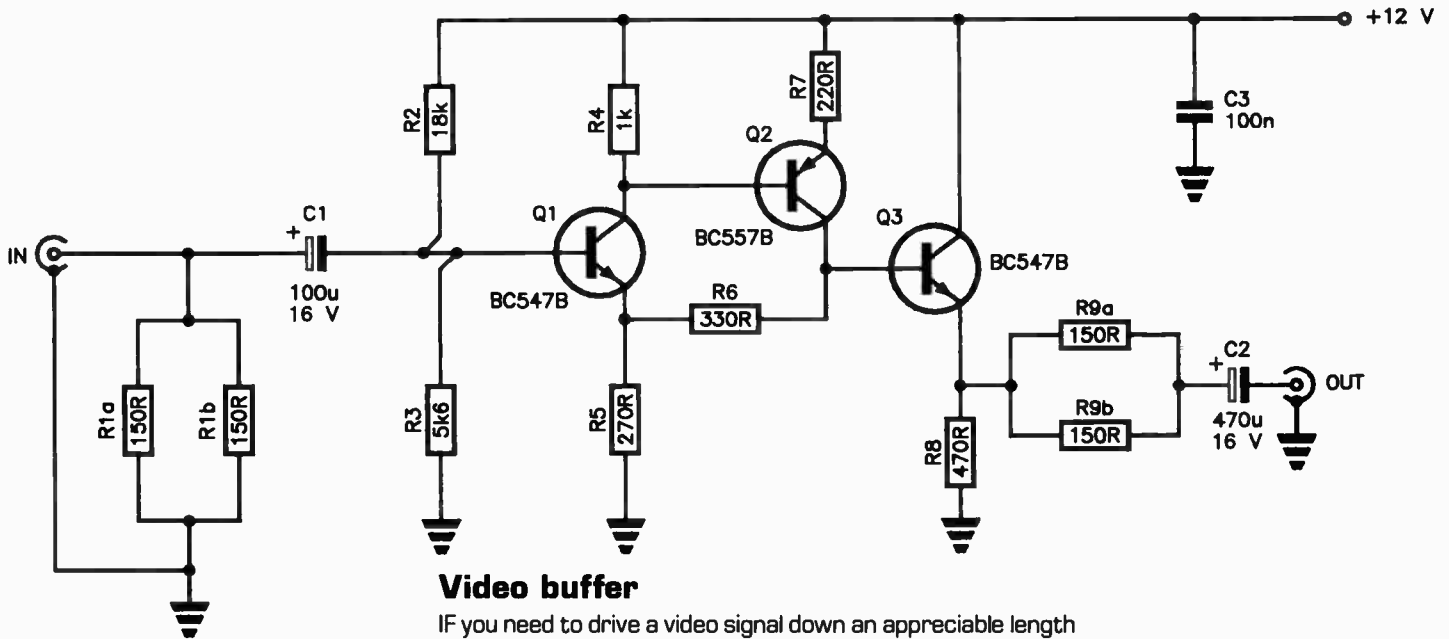
Four 555s are used. IC1 is a light-operated trigger. In the dark, the LDR has high resistance and IC1's output goes high because the voltage divider formed with RV1 pulls IC1's trigger and threshold inputs (pins 2 and 6) high. The high output on pin 3 of IC1 provides supply for IC2, a long-period oscillator which pulses high its output pin for a second or so every few seconds.

IC2's pin 3 output turns on IC3, a low-frequency oscillator, which in turn pulses IC4 on and off. IC4 oscillates at an audio

rate, which is heard from the piezo transducer. ICs 3 and 4 provide the chirrup, which sounds every so often, according to the period of IC2.

When someone switches on the light to find out what's making the noise the LDR goes to a low resistance, pulling IC1's pins 2 and 6 low, making its output go low, turning off the rest of the circuit.

The whole thing is powered from a 9 V transistor radio battery. A suitable piezo transducer is the Dick Smith Electronics L-2074, or similar. You can lower the pitch by increasing the value of the capacitor from pins 2 and 6 of IC4 to ground. This makes it sound like more of a croak.



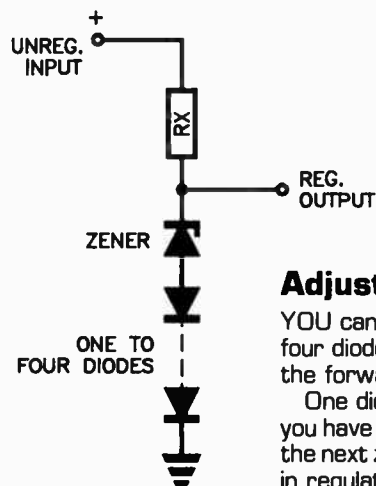
Video buffer

IF you need to drive a video signal down an appreciable length of coax or need to overcome the loss of splitters, etc, then this buffer is ideal for the job.

The circuit provides a gain of some 6 dB [4 ×] and has input and output impedances of 75 Ohms. All parts are readily obtainable. The circuit is directly coupled, C1 and C2 providing dc isolation. Q1 and Q2 are common-emitter stages with feedback via R5 which is common to Q1's emitter and Q2's collector circuits.

Q3 is a common-collector stage, providing output buffering and the low impedance source.

During construction, keep all leads short and lay out the input opposite the output to avoid unwanted feedback. The circuit is powered from a 12 V supply, which should be regulated to avoid unwanted modulation on the video signal.

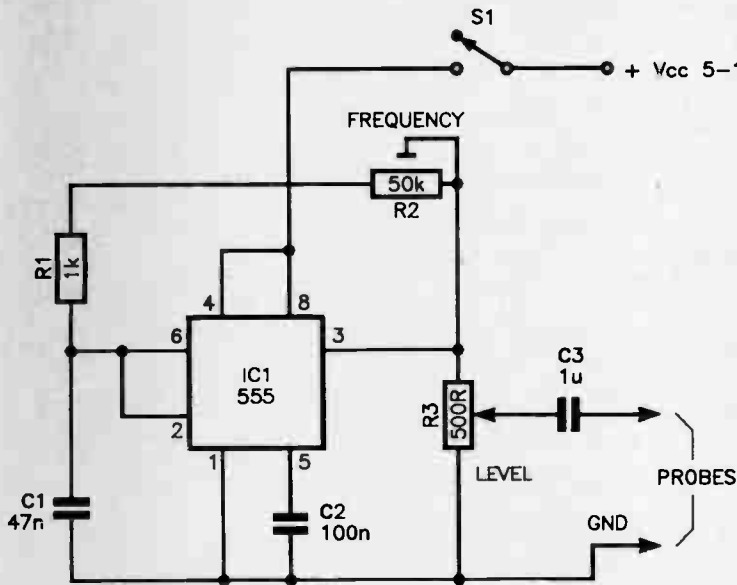


Adjusting a zener

YOU can adjust the voltage of a zener by connecting up to four diodes in series with it, jacking up the zener voltage by the forward voltage drop of each diode.

One diode raises it by about 0.6 V, two by 1.2 V, etc. If you have to put more than four in series then you should get the next zener voltage in the series or suffer some decrease in regulation.

555 CIRCUITS

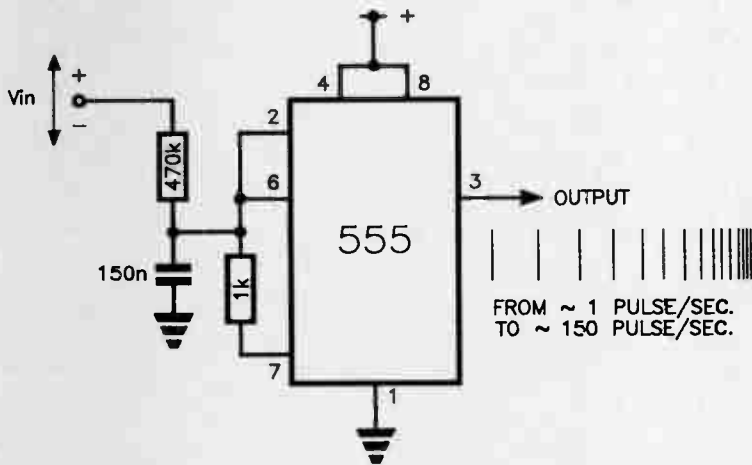


555 Signal injector

THE 555 makes a wonderful signal injector for fault tracing in audio and radio circuits.

With pins 2, 6 and 7 connected together and connected to the R-C timing circuit of RV1-R1-C1, the 555 puts out very narrow, very fast pulses which produce harmonics well into the MHz region.

The fundamental oscillation frequency is set by adjusting RV1. Output level is set by potentiometer RV2. The circuit can be powered from the circuit under test, picking up a voltage between 5 and 15 volts, or from a 6 V or 9 V battery.



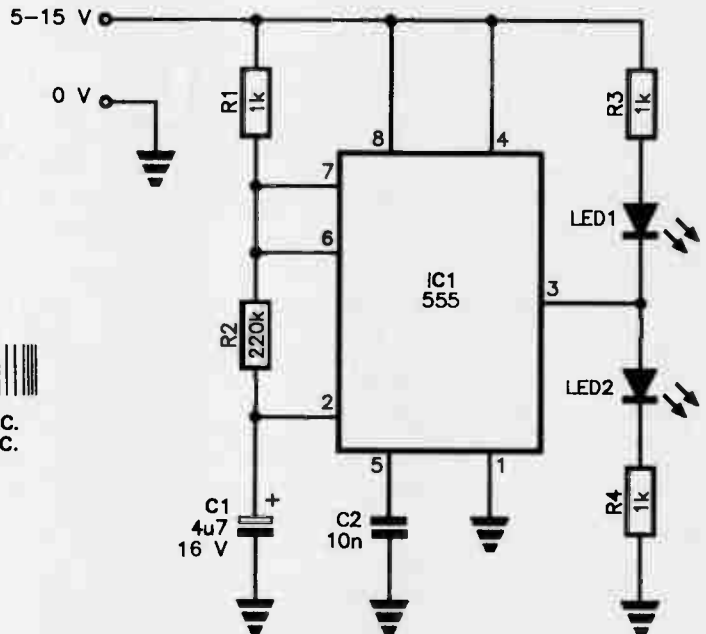
A 555 VCO

HERE is a phenomenally simple voltage-controlled oscillator using the 555. VCOs are very useful in a wide variety of applications. This circuit provides a range of well over 100:1.

Instead of returning the timing capacitor to the positive supply rail, you take it to a variable voltage. This varies the trigger and threshold voltages and hence the period it takes the capacitor to charge, thus varying the oscillator frequency.

This circuit provides very good voltage-to-frequency linearity and a range of several decades. With the values shown, the output frequency varies from about one pulse per second to about 150 pulses/second when V_{in} is swung over a range of several volts.

The 1K resistor from pins 2-6 to pin 7 stretches the output pulse. You can delete it if output pulse width is unimportant.



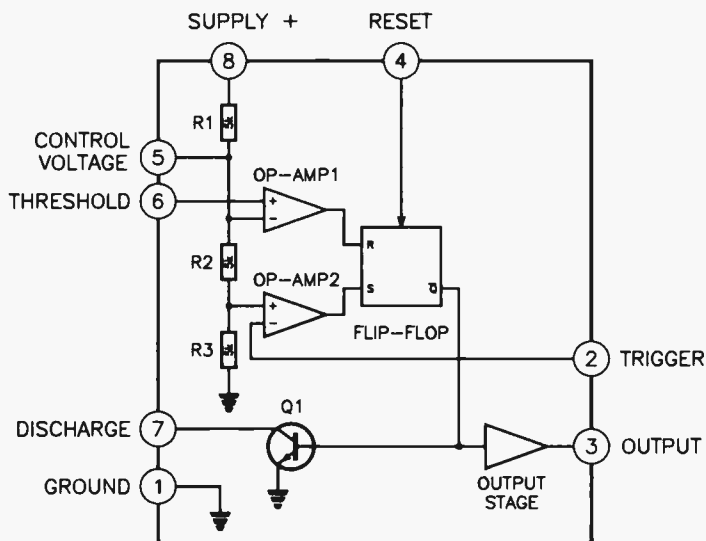
555 twin flasher

BECAUSE the output circuit of the 555 is a transistor totem pole, it can both source and sink current and can thus be arranged to turn on LED1 in the low state and LED2 in the high state.

The 555 here is arranged to flash at a slow rate in the conventional astable arrangement, the timing dependent on R1-R2 and C1.

R3 and R4 limit the current drawn by LED1 and LED2 respectively.

555 CIRCUITS



The 555 — how it works

THE diagram shows the internal block circuit of the 555. This IC was first introduced by Signetics (NE555) and is now sourced by most major semiconductor manufacturers. National Semiconductors list it as the LM555, SGS as the SE555, etc. It is an extremely versatile device.

Internally, the 555 has some 23 transistors, two diodes and 15 resistors. These are arranged to provide two voltage comparator op-amps, a reset-set (R-S) flip-flop, a transistor slave and a low power complementary output stage. The output stage can source current when high, and sink current when low.

A potential divider runs between the supply pin and ground, consisting of three 5k resistors — R1, R2, R3. Thus, $\frac{2}{3}$ of the supply voltage appears at the junction of the R1-R2, and $\frac{1}{3}$ of the supply voltage appears at the junction of R2-R3. The inputs of op-amp 1 (pin 6, threshold) and op-amp 2 (pin 2, trigger) are high impedance inputs.

The inverting input [-] of op-amp 1 is connected to $\frac{2}{3}$ Vs, while the non-inverting input of op-amp 2 is connected to $\frac{1}{3}$ Vs. The outputs of these two comparators drive the flip-flop's R-S control inputs. The active-low output of the flip-flop drives the output stage and the base of Q1, the slave transistor. The state of the flip-flop's output can also be controlled by the 555's reset terminal, pin 4.

Pins 2 and 6 are the primary control inputs for the flip-flop which controls the output. The trigger points can be varied by supplying a voltage to pin 5 (control voltage). Whenever the flip-flop output goes high, Q1 is turned on and the output pin (3) goes low. If the reset pin is held low, the flip-flop will not operate until it is pulled high. Note that pin 3 does not go fully to ground when the slave transistor (Q1) is on.

The 555 can be used in two fundamental modes: as a monostable, or one-shot, timer and as an astable multivibrator.

The monostable mode is used for timing applications where the output is activated for a given period in response to a single negative-going input pulse to the trigger terminal.

The astable mode is used for oscillator applications.

The 555 will operate from supplies ranging over 4.5 to 18 volts. The pin 3 output terminal can source or sink up to 200 mA and will operate LEDs, lamps, relays and buzzers.

555 monostable timer design

THIS is the fundamental circuit for a 555 monostable timer. The trigger input circuitry and any output devices are omitted for clarity. R1 and C1 determine the timing period, the voltage across C1 being applied to pins 6 and 7 which are tied together.

When power is applied, the flip-flop output is normally high, which turns the slave transistor (Q1) on and the output pin (3) goes low. The collector-emitter junction of the slave transistor shorts circuit C1 so that it cannot charge. This also holds the threshold pin (6) low.

The trigger pin (2) is normally held high and a negative-going pulse applied to trigger the 555. As soon as pin 2 goes low, the flip-flop output goes low, turning the slave transistor (Q1) off and driving the output pin (3) high. C1 can then charge via R1. It charges exponentially, note.

When C1 charges to $\frac{2}{3}$ of the supply voltage (Vs), pin 6 (and thus the non-inverting input of op-amp 1) will be at $\frac{2}{3}$ Vs and its output will change state. This causes the flip-flop's output to go high, turning the slave transistor on, which discharges C1, and the output (pin 3) goes low again, completing the timing cycle.

The slave transistor, being on, also pulls the threshold pin (6) low again. The voltage on op-amp 1's non-inverting input is then below that on its inverting input and its output will change state again.

The trigger input (pin 2) must be taken high again before the end of the timing period, setting op-amp 2's inverting input high and its output low. These conditions re-establish the initial conditions of the 555, ready for the next cycle to be triggered.

During the timing period, the reset pin (4) must be held high. If it is taken low before the end of the timing period, the flip-flop will be reset and the output (pin 3) will immediately go low, cutting short the timing period.

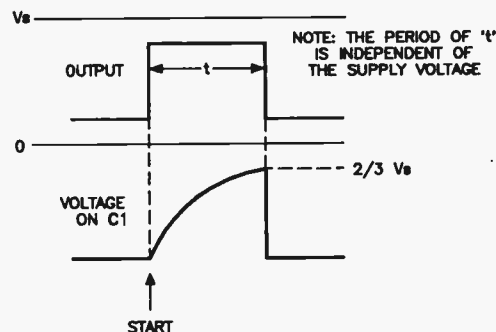
The timing interval is independent of the supply voltage because the voltage on C1 and the threshold level of op-amp 1 are both directly proportional to the supply voltage. The period is given by the equation:

$$t = 1.1 \times R1 \times C1$$

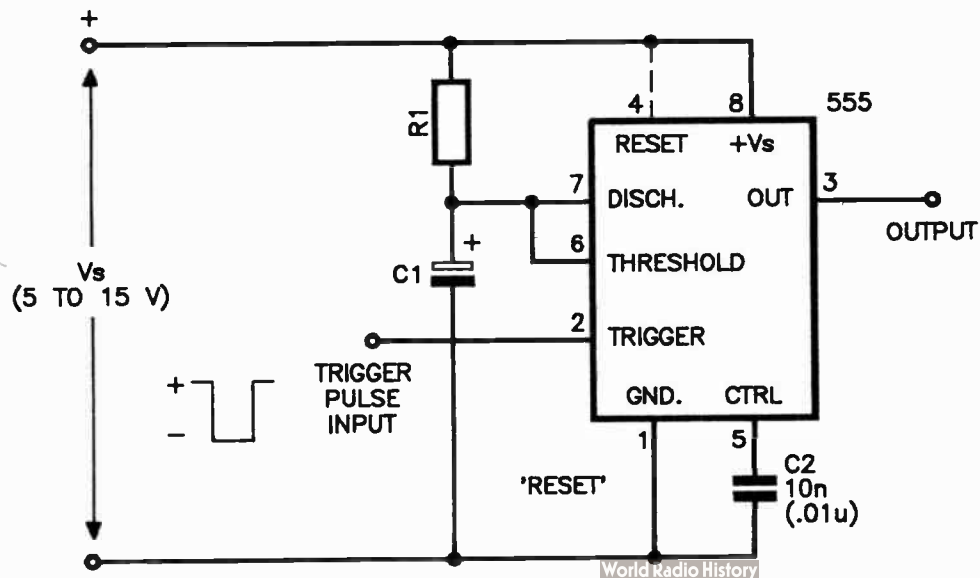
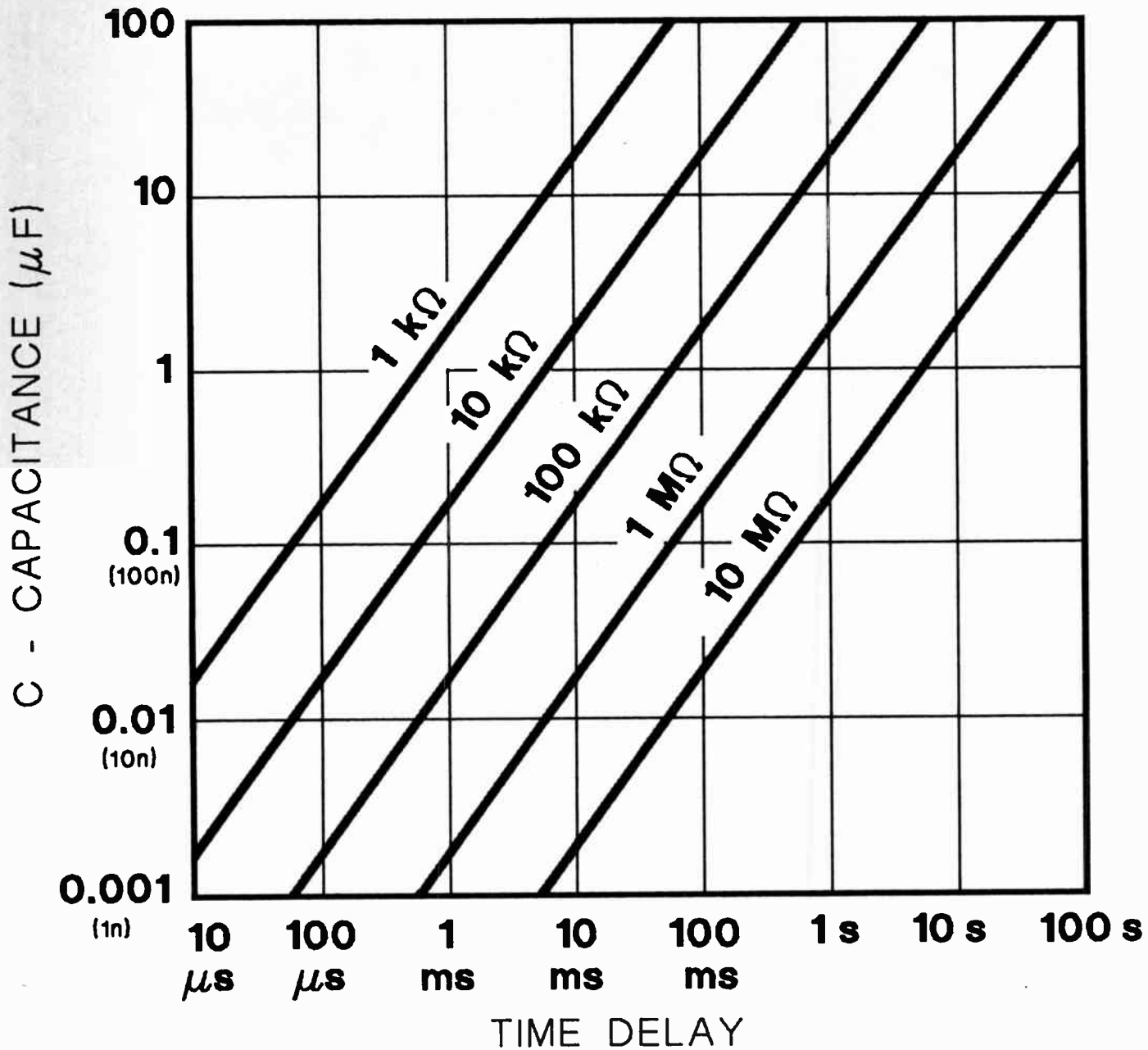
where t is the period in seconds. So, if R1 is 1M and C1 is 10 μ F, the period will be 11 seconds. The nomograph here allows you quickly to choose components for any required time period between 10 microseconds and 100 seconds. The scales on the nomograph are at logarithmic intervals.

Note that C1 must be a low-leakage component, so use polyester capacitors (greencaps or MKTs) below about 1 μ F, and tantalum or low-leakage electrolytics (RBL or RTLL types) above that. Off-the-shelf electrolytics may be used where timing periods are not critical. Part of R1 can be a trimpot for accurate setting of the timing period, if required.

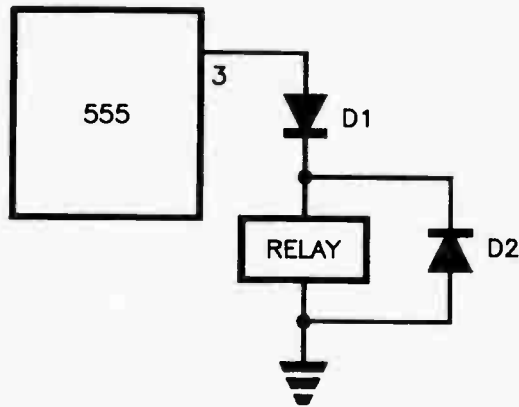
Only a narrow negative-going trigger pulse is necessary. It must start above $\frac{2}{3}$ Vs and fall below $\frac{1}{3}$ Vs to trigger the 555. Additional trigger pulses will have no effect while the output (pin 3) remains high.



RESISTANCE LINES: R1



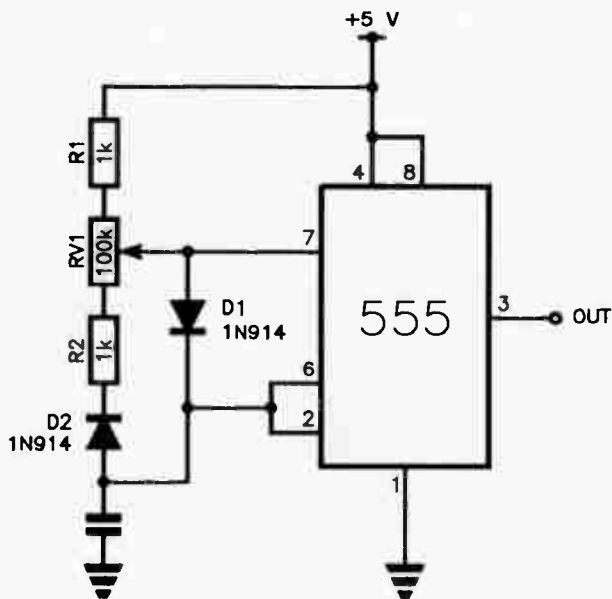
555 CIRCUITS



Driving a relay with the 555

If you want to drive a relay from the 555, here's how. Diode D1 counteracts the 555's output off voltage [which does not go to zero]. Diode D2 absorbs the relay's back-emf when the coil current is turned off. Note that the relay current cannot exceed the 200 mA output current rating of the 555.

Diode D1 should be rated to carry the relay current. A common 1 A rectifier diode is DK [1N4002, etc]. D2 can be a 1N914 or 1N4002.



555 duty cycle variability

THE 555 timer's threshold [pin 6] and discharge [pin 7] pins control the charge and discharge of the external RC timing circuit used with the IC. In this circuit, the charge and discharge paths are separated by a pair of diodes.

During that part of the cycle where the capacitor is charging, D1 shorts out part of RV1 and R2 and only the resistance of R1 and part of RV1 controls the time it takes the capacitor to charge to 2/3 of the supply rail.

During the discharge part of the cycle, the capacitor discharges via D2 and R2 and the selected part of RV1, this resistance determining the period it takes the capacitor to discharge to 1/3 of the supply rail voltage.

Varying RV1 varies the charge and discharge ratios and thus the output mark:space ratio.

The 555 as an oscillator

THE circuit here shows the fundamental configuration of the 555 as an astable multivibrator, or oscillator. The trigger and threshold inputs are tied together, the voltage on them depending on the voltage across C1, which charges via R1 and R2. The slave transistor inside the 555 is connected to the junction of R1 and R2.

When power is applied, C1 will initially be discharged and look like a short circuit. Pins 6 and 2 will be low, setting the flip-flop output low and the output pin [3] high. C1 will commence charging exponentially via R1-R2. When the voltage across C1 reaches 2/3 Vs, pin 6 will be at 2/3 and op-amp 1's output will change state. This will change the state of the flip-flop's output from low to high, turning the slave transistor [Q1] on and driving pin 3 low.

The slave transistor then connects R2 across C1, discharging C1 until the voltage across it drops to 1/3 Vs whereupon the output of op-amp 2 will change state, setting the flip-flop output low once again. This turns the slave transistor off, allowing C1 to charge again, and the cycle repeats. You could say it's a self-retriggered monostable. Note that the voltage on C1 swings between 2/3 Vs and 1/3 Vs with each cycle [except for the first cycle].

The charging period is determined by R1-R2 and C1, while the discharge period is determined by R2 alone. By choosing the values, you can choose the mark:space ratio [but you won't get them equal using this circuit].

The mark period of the output wave form is given by:

$$t_1 = 0.693[R1 + R2]C1$$

And the space period is given by:

$$t_2 = 0.693 \times R2 \times C1$$

where the period is in seconds if the resistance is given in Ohms and the capacitance in Farads.

Add the two periods [t1 + t2] to get the total period, then divide this into 1 to get the frequency. Or use this formula:

$$f = 1.44/[R1 + 2R2]C1$$

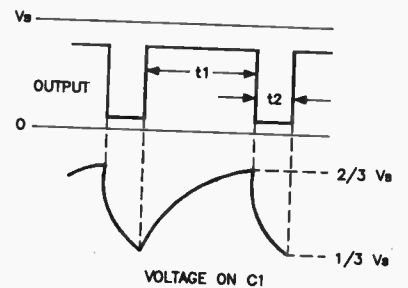
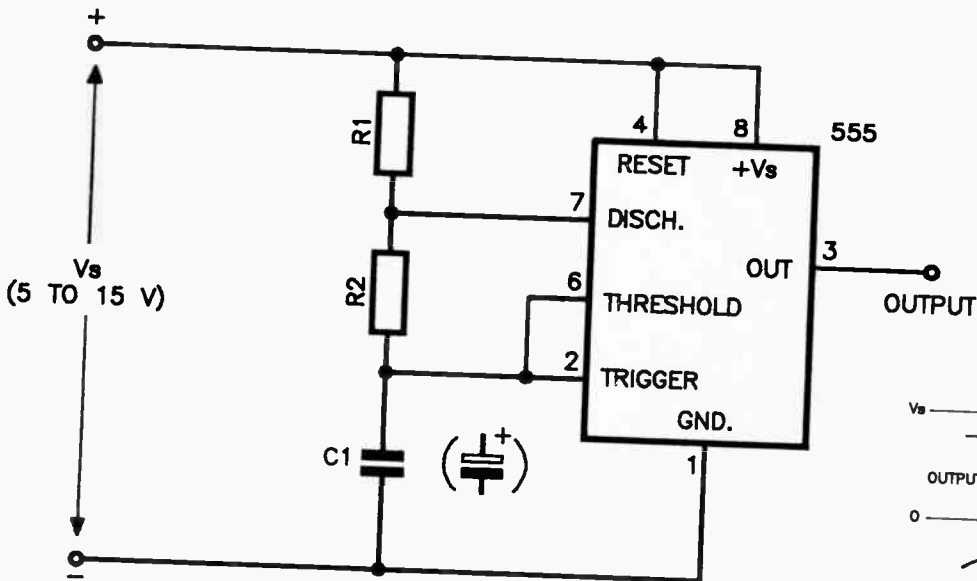
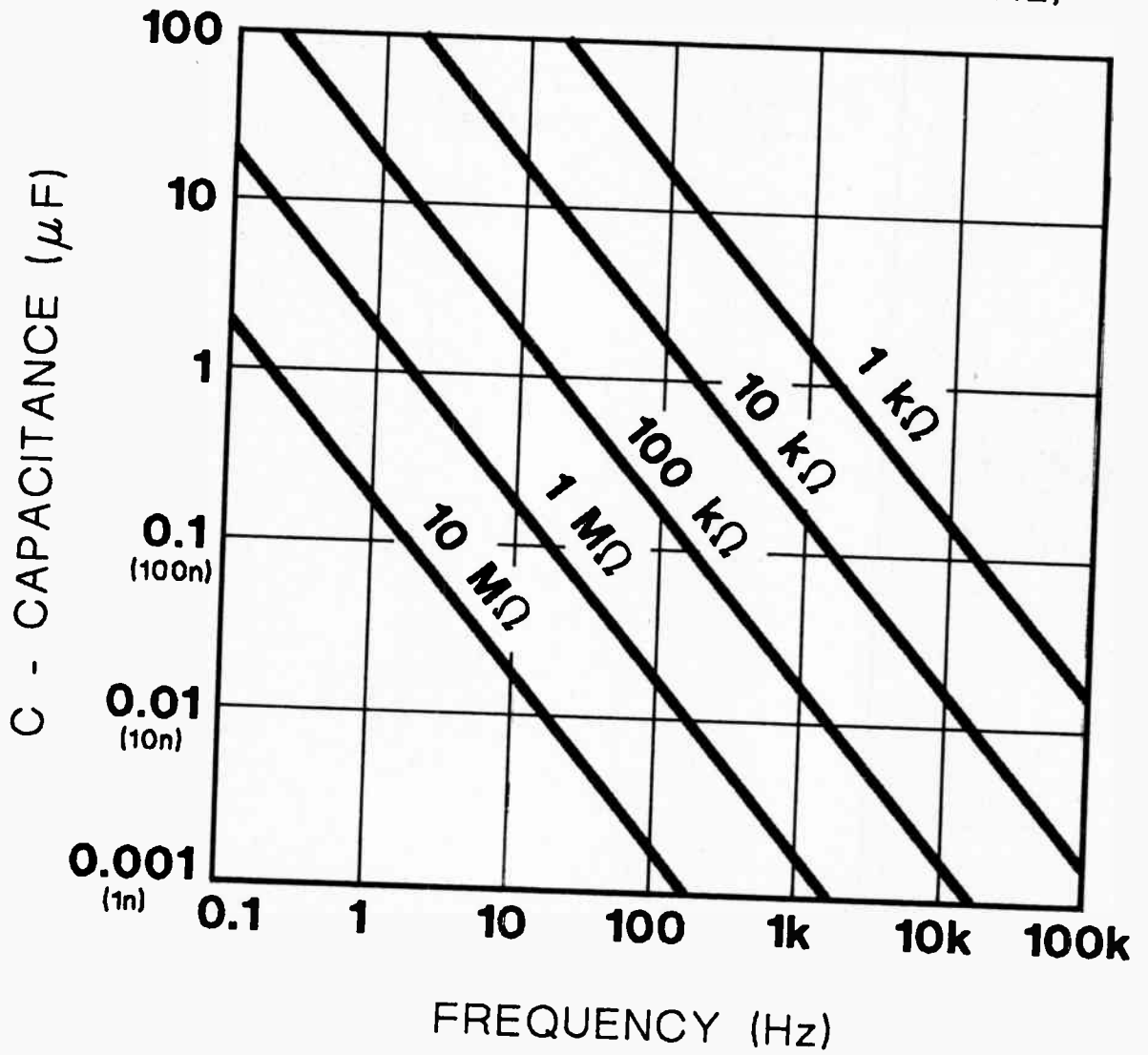
The nomograph here permits quick selection of suitable values for C1 and R1 + R2. If R2 is comparatively large compared to R1 [say, 5 to 10 times the value], the frequency is largely determined by R2 and you can use the nomograph directly. This puts the mark:space ratio very nearly equal.

Alternatively, R2 can be made much smaller than R1, giving a very low mark:space ratio [narrow output pulses]. You can use the nomograph directly in this case, too. You can actually reduce R2 to zero — tying pins 2, 6 and 7 together. This gives very narrow output pulses, but that doesn't matter in some applications. Another trick is to make R1 equal to R2 and use the nomograph directly.

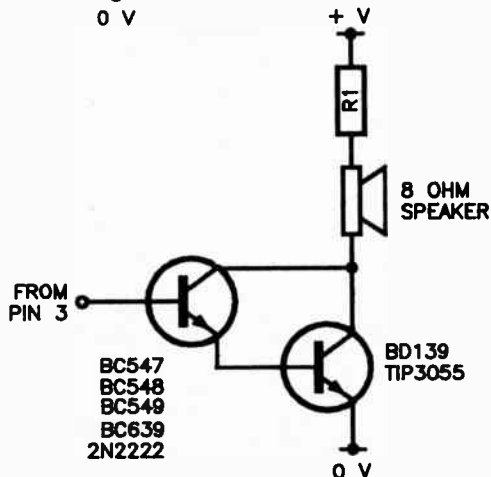
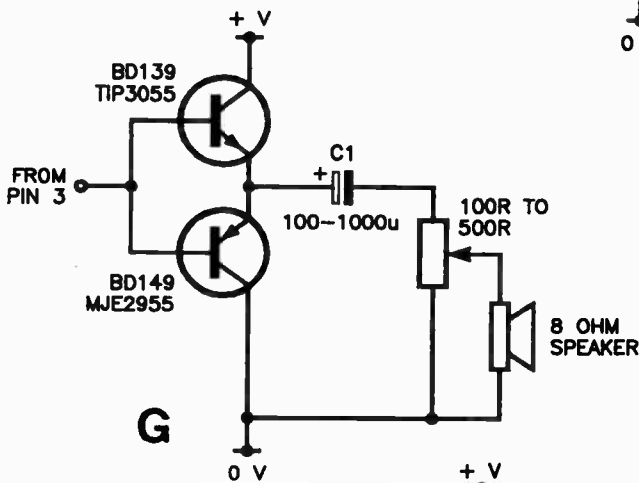
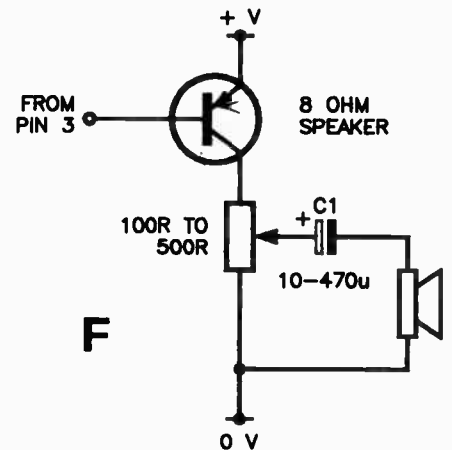
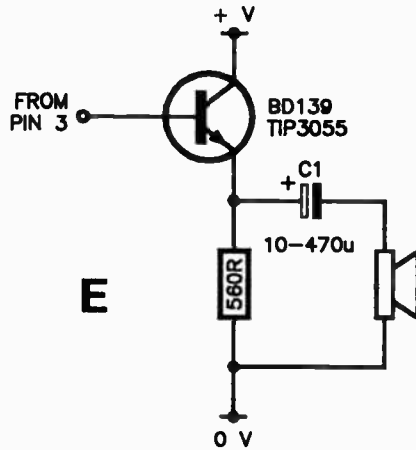
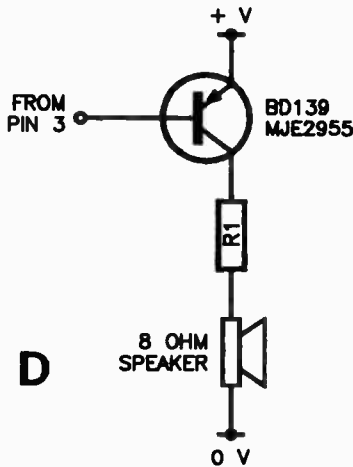
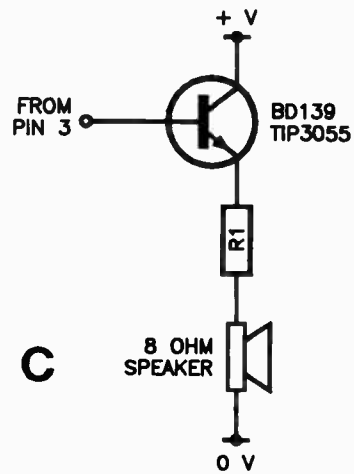
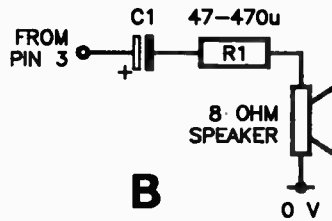
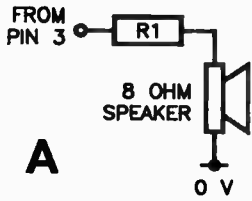
Values for R1-R2 can range from around 1k to tens of megohms in practice. Note that the value of R1 greatly affects current consumption, since pin 7 is shorted to ground by the slave transistor during C1's discharge period.

As the charge and discharge periods are independent of the supply rail voltage, the frequency is independent of supply voltage variations. A variable voltage applied to pin 5 will vary the two threshold voltages, thus varying the frequency of oscillation. Pin 5 is thus normally bypassed with a capacitor to hold it steady in freerunning oscillator applications.

RESISTANCE LINES: (R1 + 2R2)



555 CIRCUITS



Driving a speaker from the 555

HERE are eight ways of driving a loudspeaker from the 555 time/oscillator.

Circuit A is pretty simple. The resistor is there to limit the output current from the 555. It can be any value ranging between 22 Ohms] for low voltage supplies, 5-7 V[, up to 120 Ohms (for supplies up to 15 V).

To sweeten the sound a little, try Circuit B, which puts a capacitor of 47u to 470u in series.

Circuits C and D provide more volume, using either an NPN or a PNP transistor current amplifier, respectively.

Circuits E and F will provide yet more volume! C1 can range in value from 10u to 470u. For a bit of volume control, turn the resistor into a pot, as in Circuit F.

To really frighten old ladies and the punks in the squat down the street, use Circuit G. Boy, is this LOUD! A pair of complementary transistors really drives that loudspeaker to distraction. The pot is for a bit of volume control, if you really need it.

To drive a speaker from the CMOS version of the 555 (7555, TL555CP), use Circuit H. This is simply a Darlington transistor switch. R1 can be between 10 and 150 Ohms, depending on power supply voltage and how loud you want the output.



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- S53 EA Stereo Simulator
- S54 EA Headphone Amp
- S55 AEM 6500 60W Utility Amp Module
- S56 AEM 6500 100W Utility Amp Module
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16 EA 4 Digit L.C.D. Clock or Control Timer

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- CE41 ETI 735 UHF to VHF TV Converter
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- CE43 HE 106 Radio Microphone
- CE44 EA R.T.T.Y. Demodulator
- CE45 EA Voice Operator Relay
- CE46 ETI 733 RTTY Converter for Microbee
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- TE46 ETI 548 Variable Logic Probe
- TE47 ETI 544 Microwave Level Leak Detector
- TE48 ETI 558 Simple Analog Frequency Meter
- TE50 EA Digital Capacitance Meter
- TE51 ETI 589 Digital Meter
- TE52 EA 1.5V 100 Ohm Adapter
- TE54 EA XTAL Locked Pattern Generator
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- TE56 EA Capacitance Sub Box
- TE57 EA Cascade Capacitance Sub Box
- TE58 EA Resistor Capacitance Sub Box
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- WS15 EA 10 Ghz Radar Alarm
- WS16 EA Light Beam Relay
- WS17 ETI 747 Soil Moisture Indicator
- WS18 ETI 250 Simple House Alarm
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- WS20 ETI 585 CAR Intrusion Switch
- WS21 ETI 330 Car Alarm
- WS22 ETI 327 Over Rev Car Alarm (no gas)
- WS24 ETI 1506 Xenon Bike Flasher
- WS25 ETI 340 Car Alarm
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- PH3 ETI 514B Sound Light Flash Trigger
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- PS4 ETI 213 Power Supply
- PS4 ETI 214 Power Supply
- PS4 ETI 1976 Regulated Power Supply
- PS5 EA A.B. Power Supply
- PS6 ETI 152 Power Supply for 1976 TV Aerial (protected)
- PS7 ETI 551 Power Supply
- PS7 ETI 552 Dual 1.7V Supply
- PS8 EA Power Supply
- PS12 ETI 480 PPS Power Supply for ETI 480 100 watt Amp
- PS18 EA Bench Metric Utility Amplifier Power Supply
- PS20 ETI 584 40 w 1.5 V
- PS21 EA Bench Metric Utility Amplifier Power Supply
- PS22 ETI 162 1.3-10 Volt Fully Adjustable
- PS23 ETI 251 OP AMP Power Supply

COMPUTER AND DIGITAL UNITS

- D1 ETI 630 Video System Board
- D2 ETI 622M Part 1 Memory Board 1.5M
- D3 ETI 622M Part 2 Memory Board 1.5M
- D4 ETI 632A Part 3 Control Logic V.I.D. II
- D5 ETI 632B Part 4 Keyboard Logic V.I.D. II
- D6 ETI 632C Part 5 Character Generator V.I.D. II
- D7 ETI 632 D A.R.T. Board
- D9 ETI 631 Keyboard Encoder
- D10 ETI 631 A Six Keyboard Encoder
- D11 ETI 631 B Six Keyboard Encoder
- D12 ETI 631 C Full Character Generator
- D13 ETI 631 D Binary Hexa Number Converter
- D17 ETI 730 Getting Going on Radio Tele Type
- D24 ETI 760 Video RF Modulator

C25 EA Eprom Programmer

- C26 ETI 668 Microbee Eprom Programmer
- C27 ETI 733 RTTY Computer Decoder
- C28 EA Video Amp for Computers
- C29 ETI 649 Microbee Light Pen
- C30 ETI 675 Microbee Serial to Parallel Interface
- C31 ETI 688 Programmer for Fusible Link Bipolar Proms
- C32 ETI 676 RS232 for Microbee
- C33 ETI 678 Rom Reader For Microbee
- C34 ETI 659 VIC 20 Cassette Interface
- C35 ETI 683 Mindmaster - Human Computer Link
- C36 EA Eprom Copier/Programmer
- C37 ETI 699 300 Band Direct-Connect Modem
- C38 AEM 3500 Listening Post
- C39 AEM 4600 Dual Speed Modem
- C40 ETI 1601 RS 232 For Commodore
- C41 AEM 4504 Speech Synthesizer

BIO FEEDBACK

- BF1 ETI 546 G.S.R. Monitor (less probes)
- BF2 ETI 544 Heart Rate Monitor
- BF3 ETI 576 Electromyogram

AUTOMOTIVE UNITS

- A1 ETI 317 Rev. Monitor
- A2 ETI 081 Tachometer
- A3 ETI 316 Transistor Assisted Ignition
- A4 ETI 240 High Power Emergency Flasher
- A6 ETI 312 Electronic Ignition System
- A7 ETI 301 Var. Wiper
- A14 EA Owl Meter
- A22 ETI 318 Digital Car Tachometer
- A23 ETI 319A Variwiper Mk 2 (no dynamic braking)
- A24 ETI 319B Variwiper Mk 2 (for dynamic braking)
- A25 ETI 555 Light Activated Tacho
- A26 ETI 320 Battery Condition Indicator
- A27 EA Transistor Assisted Ignition
- A28 ETI 324 Twin Range Tacho less case
- A29 ETI 328 Led D.R. Tacho less V.D. probe
- A10 ETI 321 Auto Fuel Level Alarm
- A11 ETI 321 Stethoscope
- A12 ETI 325 Auto Probe Tests Vehicle Electricals
- A13 ETI 313 Reversing Alarm
- A14 EA 1.5V 100 Ohm Adapter
- A15 ETI 326 Led Expanded Voltmeter
- A16 ETI 329 A Meter Expanded scale
- A17 ETI 327 Turn and Hazard Indicator
- A18 ETI 328 Expanded Scale Voltmeter
- A19 EA Optoelectronic Ignition
- A20 ETI 325 Wiper Controller
- A41 EA Ignition Killer for Cars
- A42 EA 1.5V 100 Ohm Adapter
- A44 ETI 311 Automatic Car Alarm Controller
- A45 ETI 280 Low Battery Volt Indicator
- A16 ETI 322 Over Rev Alarm
- A47 ETI 325 Demister Timer

ELECTRONIC GAMES

- EG1 ETI 043 Heads and Tails
- EG2 ETI 068 L.C.D. Dice Rollout
- EG3 EA Electronic Roulette Wheel
- EG4 ETI 567 Reaction Timer
- EG5 ETI 874 Dixy Dice
- EG6 EA Snufflot
- EG7 HE 101 Electronic Dice
- EG8 EA Photon Torpedo
- EG9 HE 102 Aerial Invaders
- EG10 EA Roulette Wheel
- EG11 EA Dice Rolling Pre-Made

MISCELLANEOUS KITS

- M1 ETI 604 Articulated Beat Metronome
- M3 ETI 617 Telephone Bell Extender
- M4 ETI 044 Two Tone Doorbell
- M5 ETI 539 Touch Switch
- M6 EA Digital Metronome
- M7 ETI 439 Combination Lock (55000)
- M8 EA Power Saver for induction motors
- M4R EA Universal Pattern Generator
- M5 EA Universal Pattern Generator
- M5 EA Photo Litter Selector
- M6 ETI 586 Handing Meter
- M5 ETI 587 Universal Relay (Driver Board)
- M6 EA Simple Metronome
- M9 ETI 1503 Neg. Ion Generator
- M10 ETI 576 Sure Start for Model Aeroplanes
- M11 ETI 323 Peak Level Display
- M12 ETI 1515 Motor Speed Controller
- M13 ETI 576 W. Webpad Amplifier
- M14 EA Photo Minder
- M15 EA Simple 1.5V Clock
- M16 EA Ultrasonic Rule
- M66 AEM 1500 Simple Metronome
- M69 AEM 5501 Negative Ion Generator
- M70 AEM 4501 8 Channel Relay Interface
- M71 EA Pest Off
- M11 ETI 604 Electronic Beating Fork
- M12 ETI 494 100 Ohm Digital Resistor

PLUS MANY, MANY MORE KITS WHICH WE CANNOT LIST HERE!!!
JUST CONTACT US FOR PRICE & AVAILABILITY.

PLUS — A HUGE RANGE
OF COMPONENTS
COMPANY & SCHOOL ACCOUNTS AVAILABLE.