

16 PAGE EXTRA

CIRCUIT IDEAS

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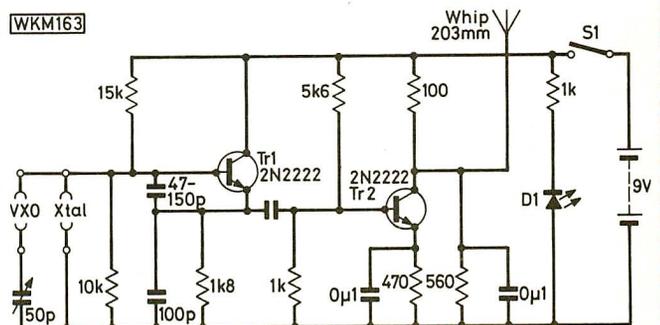
Low-cost Crystal Tester

One still finds in London radio shops boxes of crystals bearing dates in the 1940s, the last remnants of the great bonanza of electronic components which came on the market at the end of WWII. Mostly in the 3-9MHz range, they can be had at bargain prices, but from the handling they have suffered over 40-odd years, many prove to be cracked, open-circuit, or unwilling to oscillate.

Testing a suspect crystal in an existing circuit is not always the best procedure, and testing it in a new circuit may lead, if the crystal itself is faulty or sluggish, to fruitless troubleshooting elsewhere. Nor does one always want to make up a transistor oscillator specially.

The circuit given provides a quick and cheap method of testing crystals, both for oscillation, and for the ease with which they can be "pulled" in a variable crystal oscillator (VXO). It is also portable, and can be used in conjunction with any portable receiver which has a b.f.o. to reject dud crystals "in the field", or in the junk shop.

Four sockets are provided, one pair for straight crystal operation, the other for operation in a series-tuned variable crystal oscillator circuit. The transistors are American 2N2222s, but any suitable r.f. transistors could be substituted. No other parts are critical. In setting up the circuit, the feedback capacitor should be adjusted to give good oscillation with a known crystal in the VXO mode (47-150pF). The circuit is mounted on Punched board in a box 152 x 152 x 90mm; the antenna is a length of 16 s.w.g. copper wire covered with polyethylene tubing, which also serves as a feedthrough. Power is provided by a 9V battery.



In operation, the crystal is connected to the appropriate sockets by short crocodile-clip leads attached to "phono" plugs. The receiver is set to the crystal frequency with the b.f.o. switched on. After switching on the oscillator the beat note of the crystal can be detected and zeroed. The "phono" plugs are then shifted to the VXO configuration and the variable capacitor tuned through its range, noting the amount of shift in the crystal frequency. With large numbers of old crystals, this procedure might test not only the tolerance of the crystal but that of the shopkeeper. Less aggressive shoppers for parts will find it a useful addition to the shack, which can double as a receiver calibrator, however, and it is probably worth having one for this use alone.

A. Comfort MB
California

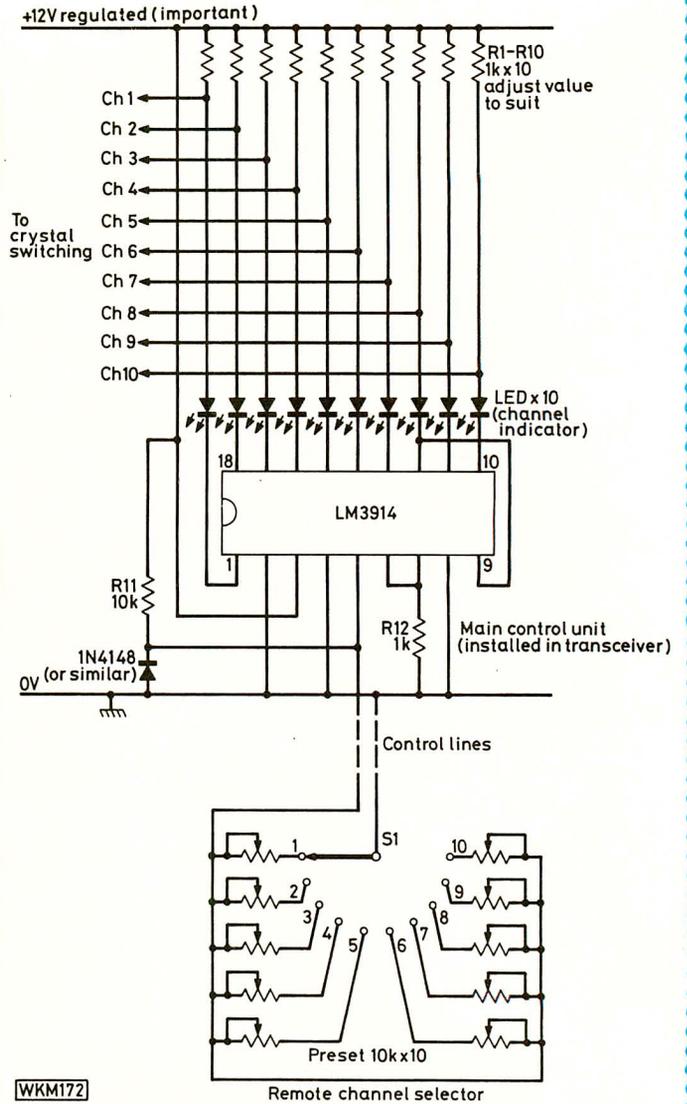
Two-wire 10 Channel Remote Selector

In the past there were several methods of switching channels remotely. A few to mention are: (1) To have an oscillator for each channel and power is supplied from a remote unit to the required oscillator. (2) Electro-mechanical switching. (3) Switching diode technique. All these types of remote switching needs more than two wires. The unit to be described here can easily replace methods (1) and (3). It can also be used in method (2) depending on the system itself.

This unit was originally made for a friend who uses a 10-channel v.h.f. set which had its antenna on the top of a 16-storey building. He found it too expensive to lay a good quality coaxial cable to his flat on the 2nd floor. Furthermore there would be a lot of unnecessary losses in the cable. He arranged to have his set at a friend's place on the 16th floor and managed to wire up the audio and TX/RX control line to his set using a 600Ω balanced line using 3 wires. He was able to transmit and receive on only one channel. He had to lay a 5½-pair cable to switch the channels. He approached me with the problem. For his set I needed only one extra wire to his existing 3 wires.

The heart of the system is an LM3914 integrated circuit, voltage level indicator. The i.c. can indicate the voltage in 10 levels by lighting up 10 l.e.d.s, and it can be programmed to display in the bar mode or dot mode. The input of LM3914 (as shown in the diagram) is fed from a remote channel selector by two wires. The remote channel selector consists of a single-pole ten-way switch plus 10 variable resistors. The input to the LM3914 depends on the voltage drop across any one of R1-R10. The voltage drop can be adjusted by varying R1-R10 to light up any one of the 10 l.e.d.s. By this way R1 is adjusted to light up LED1 and R2 to light LED2 and so on until LED10. All the l.e.d.s are connected to the positive supply with a resistor in series. When the l.e.d. lights up there is a voltage drop across the resistor in series with it. This voltage drop can be used to select the channel of a transceiver. If the crystal switching circuit requires a negative control voltage, the voltage across R1-R10 can be used directly. If the crystal switching requires positive voltage then the voltage across R1-R10 has to be inverted. The circuit has to be altered a bit to be used for different transceivers but the principle remains and the i.c. LM3914 will always be used.

- (1) The supply to the unit must be regulated and stable.
- (2) The 10 l.e.d.s can be fixed to the transceiver front panel to indicate which channel is switched on.
- (3) The variable resistors can be replaced with fixed resistors after finding out the required value.



WKM172

- (4) For more than 10 channels the LM3914 can be cascaded; you could use anything up to 10 i.c.s giving you 100 channels. Four LM3914s are required for the 40 CB channels.

Mr Ratnam
Malaysia

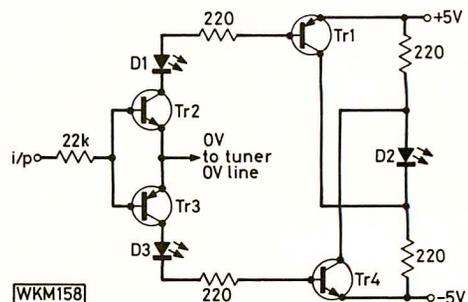
LED FM Tuning Indicator

An output, varying above and below 0V, dependant on tuning is available from most f.m. discriminators, and usually drives a centre-zero tuning meter.

This circuit provides a suitable replacement using 3 l.e.d.s for tuning indication.

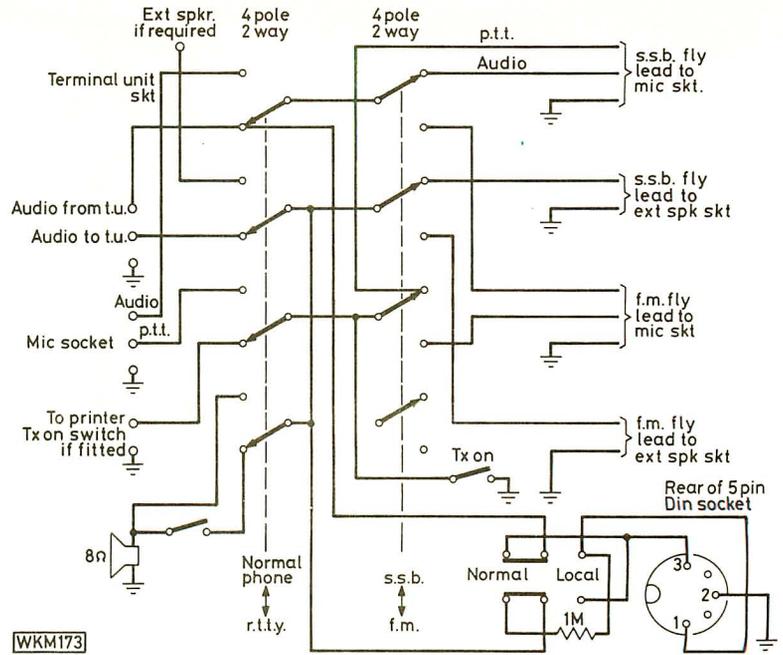
When a station is off-tuned, the discriminator output will vary above or below 0V, causing D1 or D3 to illuminate respectively. When the discriminator output is 0V, D2 will illuminate, indicating optimum tuning. Note that Tr1 and 3 are general-purpose, small-signal silicon pnp transistors, and Tr2 and 4 are general-purpose, small-signal silicon npn transistors.

I. Spital
Ilford



WKM158

Interface Unit for RTTY



When wishing to change from normal operating on phone over to RTTY, there is the tedious procedure of unplugging leads, looking for the RTTY leads which have usually fallen behind the bench, then plugging these into their various sockets before one can get started. Even then the jingle tones of the incoming signal tend to drive everyone up the wall, including the XYL.

To change back to normal phone operating was the reverse tedious procedure. When running across the bands listening to s.s.b. or f.m., one comes across a RTTY signal, and if tempted to change over the leads it has gone before you have got set up.

Something positive had to be done to effect rapid change-over to instant RTTY and type with muted audio from the normal phone condition, yet still be able to monitor the tones (or not) at will.

The circuit illustrated is composed entirely of switching with no complex electronics at all, it is simple and fast to operate from f.m. and s.s.b. to RTTY. The layout of the circuit is not critical at all, but screened leads should be used throughout to prevent hum. Only one mic is used for s.s.b. and f.m. when on phone.

The f.m. flying leads are plugged into the mic and extension speaker sockets, the s.s.b. flying leads into the s.s.b. transceiver, the leads from the RTTY terminal unit are then plugged into their respective sockets on the interface unit.

A transmit-receive switch was added only as a refinement. When switched to the phone position the speaker cannot be switched out of circuit. In the RTTY position there is a choice of speaker on or off for tone monitoring.

Next there is the normal-local switch, in the NORMAL position there is transceive on any mode on the air but recordings can be made. In the LOCAL position and switched to RTTY, local print record playback is effected but the station transceivers must be switched off or the speaker extension plugs removed.

The unit is built into a metal box 128 x 178 x 38mm. All the components are mounted on the front panel, a 1MΩ resistor was fitted to stop overloading the recorder in the normal received signal switched condition, and is out of circuit in the local position.

A. P. Teal
G3SGT

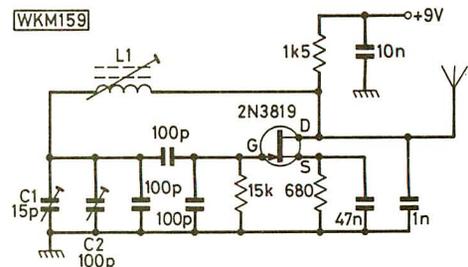
Simple SSB Reception

This circuit allows one to receive amateur s.s.b. transmissions using only a domestic broadcast-band receiver covering the short waves (a.m.).

It is an alternative to using a beat frequency oscillator (b.f.o.) to bring about the carrier re-insertion. Instead re-insertion takes place at the signal frequency, using a f.e.t. Vackar variable frequency oscillator operating in the bands required.

The circuit is built into a small metal box and placed next to the main receiver, the output wire being placed near the antenna coil.

The oscillator coil (L1) has 20 turns of 30 s.w.g. wire on a 10mm diameter dust-cored former. Initially the oscillator is brought onto the band (start with 7MHz) by adjusting the core of L1 and trimmer C2; fine tuning is made possible using C1 until a tone is heard on the main receiver.



A strong s.s.b. signal (very distorted) is found on the main receiver around 7MHz and the speech resolved by slowly tuning the unit. This technique (similar to using reaction) requires patience at first but is capable of surprising results.

The harmonic output produced allows operation on the 14 and 21MHz bands.

J. P. H. Blackie
Glasgow

An Overvoltage and Overload Trip

The possibility of damaging one's rig by applying excessive voltage is very real, and warned against in all the instruction manuals. Yet it may need only a small Zener diode in the p.s.u. to fail and up shoot the volts to alarming levels. It was this and other such gloomy thoughts which prompted the development of the following simple device. After rejecting the rather clumsy "crowbar" circuit it was decided to develop a "resettable" one.

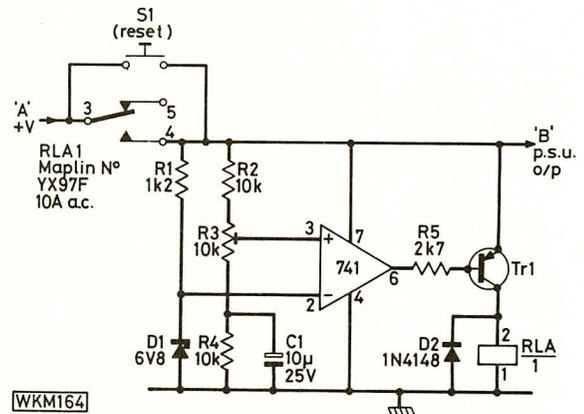
The p.c.b. unit described is intended for inclusion into an existing p.s.u. and not only provides overvoltage protection for your rig but also offers protection of the p.s.u. in the event of a short-circuit overload. Built on a p.c.b. roughly 50 x 25mm, it is easily housed and requires only three connections to be made, plus the reset push-button.

The lead to the existing output terminal of the p.s.u. is disconnected and taken to the p.c.b. (Terminal "B"). Terminal "C" of the p.c.b. is taken to the original output terminal. In addition a "push-to-make" switch is connected across these points and may be located at some convenient place on the p.s.u. front panel.

The diagram shows the circuit of the overload device from which it will be seen that at switch-on, the p.s.u. output voltage appears at "A". Pressing the reset button (S1) applies this voltage to the trip circuit and output. The voltage at pin 2 of the op. amp. is stabilised at 6.8V whilst that at pin 3 is set by means of R3 to about 6.5V. Under these conditions the op. amp. is driven into negative saturation. The output at pin 6 is at or near earth potential and the transistor Tr1 is driven on. The relay is energised and the contacts closed, holding the p.s.u. output when S1 is released. Should anything now occur to cause the p.s.u. output voltage to rise to the extent that the voltage at pin 3 exceeds the Zener voltage, the op. amp. will be driven into positive saturation and the voltage at pin 6 will rise to near supply potential, cutting off Tr1. The relay will now open, isolating the output. As the relay specified will open in under 5ms, no damage will be done to the rig for the short time during which these events occur.

Should a short-circuit occur on the output side, the voltage supply to the p.s.u. will collapse *ipso facto* and the relay again will open, isolating the p.s.u. from the damaging overload.

With the p.s.u. switched on the delivering its normal output, rotate the preset R3 slowly until the relay trips. Measure the voltage at pin 3. Back off R3 until this voltage is reduced by 0.3V. The circuit will not now trip until the output voltage rises above 13.8V by about half a volt, i.e., to about 14.3V. This is a "safe" margin as most 13.8V equipment can be run safely up to about 15V without danger.



The function of the 10µF electrolytic (C1) is to prevent any occasional "spikes" from tripping the relay. Resistor R5 is a base-current limiting resistor. The resistance of the coil of the relay is about 400Ω. Diode D2 protects Tr1 from the back e.m.f. from the relay coil.

In use over many months the circuit has been found very reliable. The need to operate the reset button on initial switch-on, far from being a nuisance, gives one a feeling of reassurance that all is working and that one's valuable gear is still being protected!

F. Jenkins GW8PYY & E. W. Nield GW8ARP
Swansea

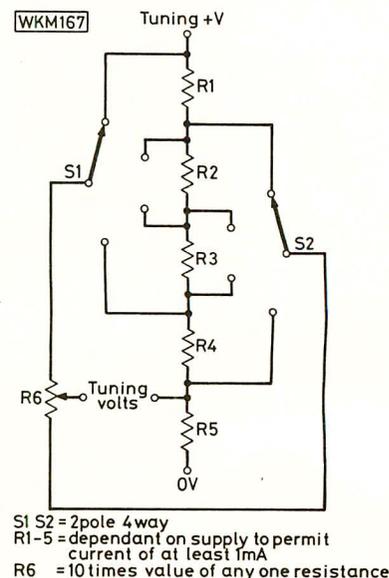
Fine Tuner for use with Varicaps

When I bought a Varicap v.h.f. tuner my mind went back many years to a 10-position capacitor, which used to be sold by Eddystone before the last war, much used in t.r.f. sets for band setting.

For simplicity the diagram shows a four-position switch. Basically for a tuning voltage of 20V the potentiometer is switched into one of four 4V bands — 4 to 8, 8 to 12, 12 to and 16 to 20 assuming all 5 resistors are the same value.

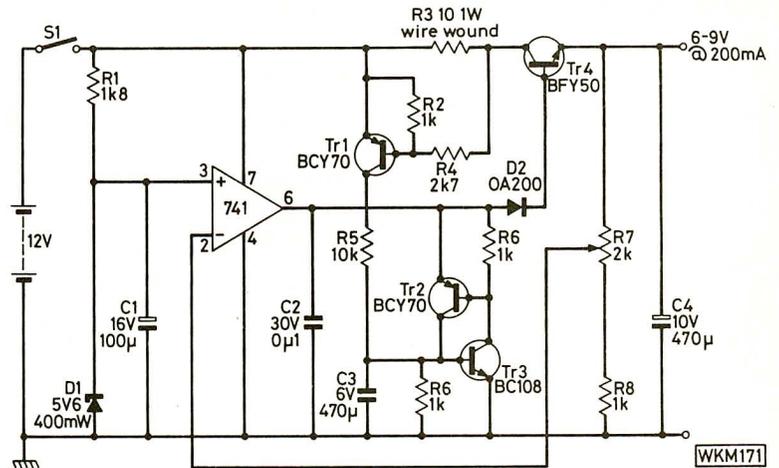
Up to 12 switch positions could be used. So that the voltage tapped down is about the same for each section the current through the network should be at least 1mA, and the potentiometer should have a fairly high value to minimise loading of the circuit.

W. Forsyth
Ross & Cromarty



S1 S2 = 2pole 4 way
R1-5 = dependant on supply to permit current of at least 1mA
R6 = 10 times value of any one resistance

Calculator PSU with Short Circuit Protection



The stabiliser part of the circuit is quite straightforward and uses a 741 op. amp. in its comparator mode. The output protection circuitry consists of transistors Tr1-3. Transistor Tr1 senses the voltage across resistor R3 and is made to conduct when a current of approximately 250mA or greater passes through R3. A minimum current of 250mA was chosen as this was the value at which a noticeable change in output voltage was seen. When Tr1 is conducting, C3 charges via the 10kΩ resistor R5, and after a period of two seconds, its voltage is sufficient to trigger Tr3 which together

with Tr2 forms a very sensitive thyristor. The voltage on pin 6 of the 741 then drops to a value of less than one volt and as diode D2 is in the base part of Tr4, causes Tr4 to be zero biased and thus it switches off. When S1 is opened the thyristor open circuits and on the closing of S1, the circuit is back to its operational state.

The quiescent current is less than 5mA and the current with the protection stage operating is 12mA.

*K. A. Last
Moulton*

A Constant Current Battery Charger

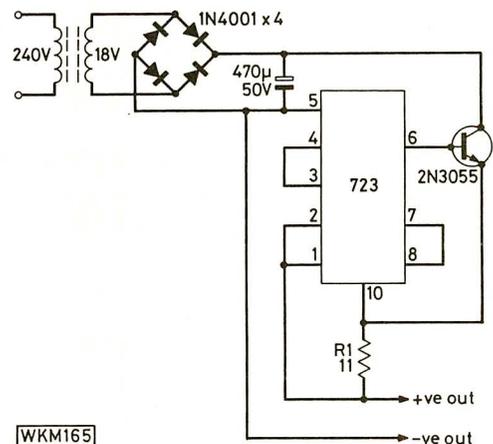
The main point of the charger is that it is required to produce a constant, stabilised current rather than a constant stabilised voltage which is the more usual output from the stabilised power supply.

Such a constant current source may be easily built using an i.c. more normally to be found in constant voltage applications, namely the well-known 723. This i.c., along with a small number of external components constitutes a constant current source such as required.

The transformer used has a 9-0-9V secondary giving a rectified voltage of around 25V, which is then reduced to a voltage in the range 0V-7.15V at 60mA. The additional transistor is necessary as the power dissipation in this mode of operation could be as high as 1.6W. This is in excess of that allowed by the 723, but easily coped with by the transistor with very little heat sinking.

When connected to a 100V supply, the transformer output voltage drops to around 9V, giving a rectified 13V, which is again reduced by the 723. The value of resistance is given as 11Ω, but other currents may be catered for using the equation: $R = 700/I$ (Ω, mA).

The output voltage upper limit is determined in this circuit by the V_{ref} voltage of the 723. This is nominally 7.15V, but may vary between devices over a range of 6.8V to 7.5V.



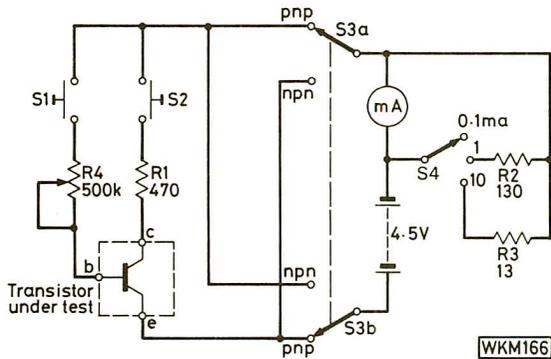
The construction of the circuit is not critical, except that it is worth noting that the external transistor should be mounted externally in free air, no heat sinking at all has been found necessary at the fairly low power involved. For preference, the unit should be run from a 3-pin supply, and all exposed metal earthed. The transistor may be covered with a suitable plastics cover available for this purpose.

*J. Mc Carthy
East Dulwich*

Simple Transistor Tester

This transistor tester has several advantages over commercial models:

- (a) It cannot be left on to run down the internal battery.
- (b) It is self-contained.
- (c) It could be used with an external meter in place of the internal one.
- (d) It will test and measure *npn*/*pn**p* transistors, Zeners and ordinary diodes.
- (e) Has additional leads to measure transistors or diodes external to the tester as well as its own socket.
- (f) Forward bias can be varied for various values.



It makes use of a known base/emitter current which is adjusted to $10\mu\text{A}$ and then the collector/emitter current is read in milliamps, the h_{fe} is the ratio of these two currents. As an example if the current in the base is $10\mu\text{A}$ and the emitter/collector current is 1mA then the ratio is 10:1000 or 100 which is the h_{fe} of the transistor. The two momentary push-buttons which are used for testing, when released automatically open the circuit and so prevent the battery from being run-down by leaving the circuit on. The test procedure is as follows — fit the transistor that is to be tested to the socket on the face of the tester. Put the appropriate switch to *npn* or *pn**p* and press S1 and adjust the I_b potentiometer R4 until the meter reads $10\mu\text{A}$; the meter switch S4 being set to 0.1. Release S1 and press S2 to read off leakage collector to emitter. Now switch S4 to 10 and press S2 to read the collector current in milliamps. Now multiply the result by 100 and the result is the h_{fe} of the transistor.

To test diodes connect the device across terminals e and b and press S1. A reading of $14\mu\text{A}$ in the conducting and zero in the non-conducting direction should indicate that it is alright.

J. Hillman
Lisburn
N. Ireland

£1.25

OUT OF THIN AIR...

A Guide to Aerial Theory, Design and Propagation

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Aerials and aerial accessories are very definitely among the most popular topics covered in *Practical Wireless*. In response to requests from readers, we've reprinted a selection of articles from the past three years, plus two new features—one by Ron Ham on v.h.f. propagation, the other describing the "Ultra-Slim Jim", a new version of that most popular 2-metre aerial design by Fred Judd.

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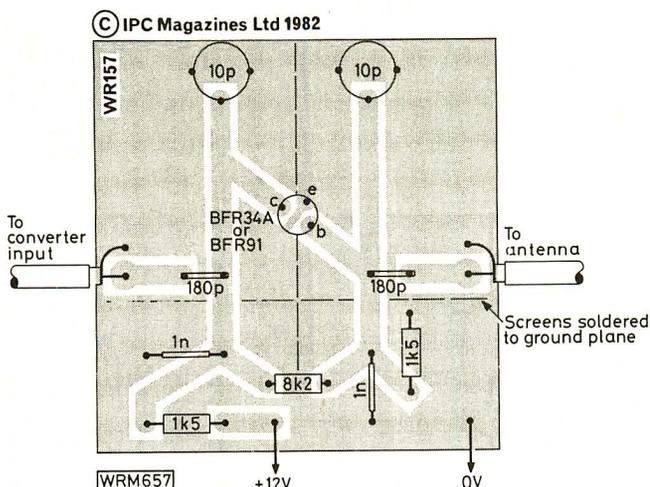
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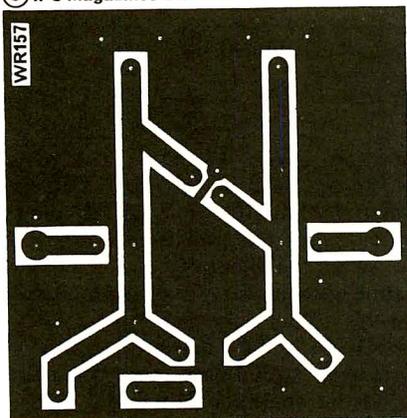
435MHz Input Pre-amp

The circuit diagram is the same as the pre-amp in the TV Up-converter, published in *PW*, April 1982.

Only the copper around the edges of the strips should be etched away, therefore leaving most of the copper around the strips for a ground plane. The trimming capacitors are tuned for minimum noise and the best contrast on the picture.



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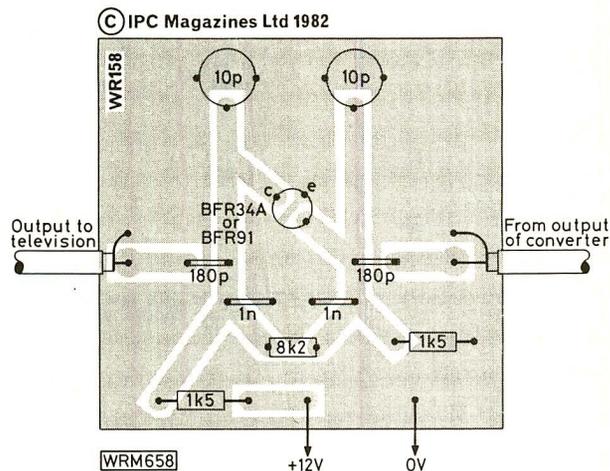
In both circuits I have used single-sided glass-fibre board and all components are mounted on the copper side. I used ordinary ceramic 1nF capacitors for the line decoupling instead of the feed-through types. I found feed-through capacitors hard to obtain, and with my layout no drilling of the board is required.

*P. Short G8RFD
Bristol*

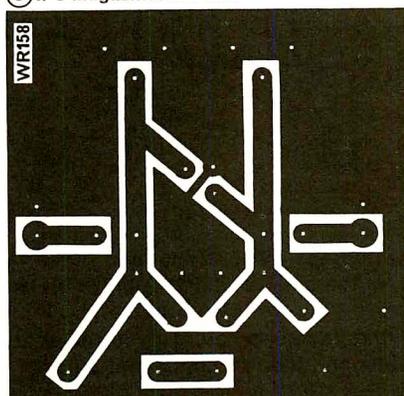
605MHz Output Amplifier

This amplifier was built by adapting the line lengths from the mixer stage of the converter and is constructed in exactly the same way as the 435MHz pre-amp.

The 695MHz amplifier was mounted in the same case as the TV Up-Converter, but I mounted the 435MHz pre-amp in a separate case in order to help prevent instability. The screens are included to prevent oscillation.



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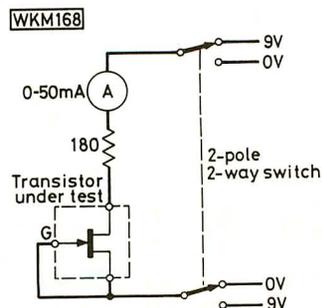
The addition of these two amplifiers to the up-converter brings about a tremendous improvement in its performance, resulting in a really sensitive ATV receiver.

Good-quality 4 to 5 grade pictures I have already received using this converter include G4BVK, G8UUE, G8ZQF, G8GLQ and G8KGH. The 605MHz amplifier also works well as a domestic TV signal booster for signals around channels 21-45, and with shorter lines would work on the higher domestic channels.

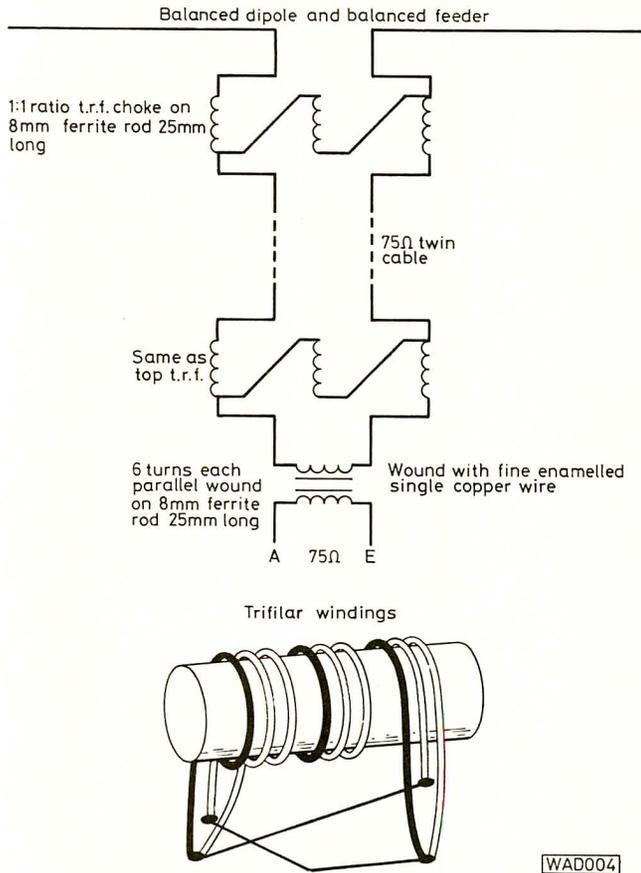
JFET Tester

This tester measures the d.c. drain current of junction field effect transistors with the gate connected to the source (i.e. $V_{gs} = 0$). this should be in the region of 1-40mA according to the device type and individual characteristics. The switch adjust the circuit for *n* or *p* channel transistors and is shown in the *n* channel position (i.e. +ve to drain).

*A. P. Cooper
Bournemouth*



Feeder Matching System



Being greatly troubled by that common curse to listening, TVI, I studied all the data I could get hold of on its cause and how to combat it.

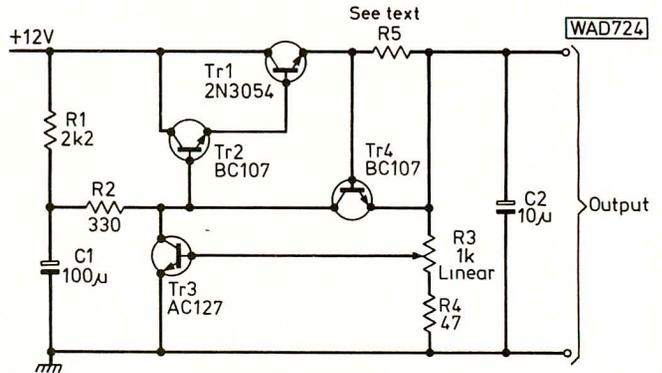
I made a trifilar choke and put it up at the antenna-feeder point, then made an identical choke and put it at the bottom of the feeder. This was then put to a bifilar coupling transformer to leave the antenna system floating free of any earth connections.

This resulted in no TVI interference and the signal strength rose 100 per cent; now listening was a pleasure.

*H. Tinto
Glasgow*

Low Voltage Regulated Power Supply

In use, regulation will be found to be quite satisfactory up to approximately 150-200mA, which makes the unit ideal for powering small 1.5V transistor radios, etc. the regulator can be powered by any d.c. source of around 12V, such as a car battery, an existing d.c. regulator, or from its own transformer and rectifier.



The voltage drop across R1/R2 is determined by the voltage applied to the base of Tr3. As Tr3 conducts, more current is drawn through R1 and R2, which lowers the voltage drive to the series transistor and decreases the output voltage. When the slider of R3 is rotated towards R4, Tr3 is cut off, thus drawing very little current through R1 and R2, increasing the output voltage.

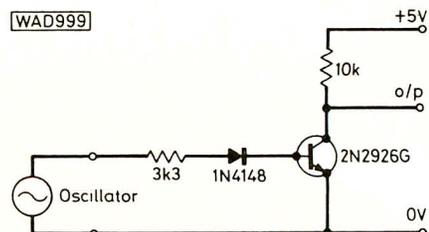
The network R1, C1 and R2 act to reduce the ripple, and Tr4 and R5 give short circuit protection, the actual value of R5 depending on the operation required.

*Mr. D. Watson
New Zealand*

TTL Interface

This simple interface enables an oscillator to drive t.t.l. or c.m.o.s. circuits. The oscillator may be sine, square or triangular and may swing above and below the centre reference point, or the 0V on the circuit diagram. The gain of the transistor used should square the output waveform and it is protected against negative swings by the input diode. The oscillator output should be fairly high, 3V amplitude or more if possible.

*A. P. Cooper
Bournemouth
Dorset*



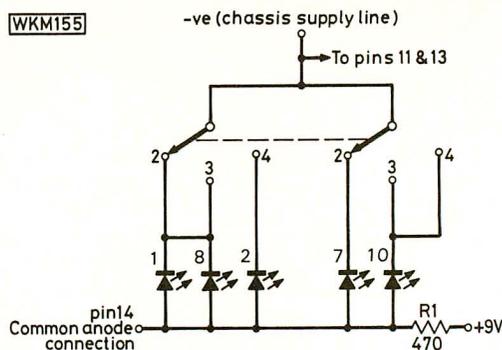
Station Indicator for Varicap Tuned FM Radio

This station indicator was originally made for a stereo f.m. tuner using the Mullard LP1186 Varicap front-end. It uses a DL707 common-anode 7-segment display to indicate the station received. As the tuner was preset to three stations Radio 2, 3 and 4 and so the DL707 is set to display 2, 3 and 4.

The original used a 3-pole 3-way rotary switch, but push-button units with the same switching functions can be used. Two poles of the switch control the DL707 indicator and the third selects the tuning voltage (via the preset potentiometer) for the station.

The DL707 is in a modified 14-pin d.i.l. package with pins 4, 5 and 12 missing. The DL707 is in effect 8 light-emitting diodes with a common anode connection. The eighth diode is the decimal point; in this circuit the decimal point is used as the stereo beacon.

On the diagram for the switch, the numbers above the i.e.d.s. are the connections to the DL707. The diodes connected to pins 11 and 13 are not switched since they are



segments common to 2, 3 and 4 and remain illuminated. Pin 6 on the DL707 can be connected via a $1.5k\Omega$ resistor to pin 6 of the MC1310 stereo decoder to function as a stereo beacon.

*R. N. Soar
S. Yorkshire*

A Low Current Flashing Indicator

It is very popular and convenient to use batteries to operate pre-amplifiers, signal injectors and probes. Batteries give ease of connection, without unwanted interaction, low noise and most importantly, safety. There is, however, one big disadvantage in that the unit can accidentally be left on, ultimately flattening the battery.

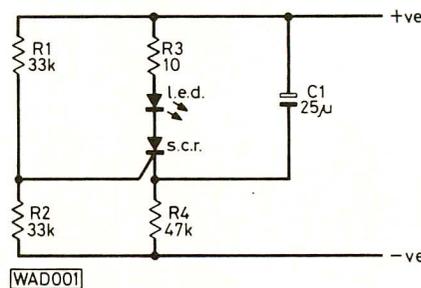
A simple i.e.d. indicator, if fitted with its current limiting resistor, will require a current of about 10mA if it is to be of practical use. A small battery such as the PP3 (6F22) will only last about 15 hours, even if the current taken by the rest of the circuit is negligible.

The circuit described provides a bright i.e.d. indication, takes less than 0.5mA from a 9 volt supply and will work without any component change between 6 and 24 volts d.c.

The principle is to flash the i.e.d. at a rate of 60 to 80 flashes per minute, each flash only lasting a few milliseconds. The flashes, however, are very bright since a comparatively high current is passed through the i.e.d.

The circuit uses a low cost s.c.r. in a relaxation oscillator mode. When the voltage is applied to the circuit the gate of the s.c.r. is held at half the supply voltage by the potential divider R1 and R2. Capacitor C1 charges up through R4 causing the cathode voltage to fall. When this voltage falls to a value of about one volt below that set on the gate, gate current will flow, triggering the s.c.r. into the conducting condition. The s.c.r. then provides a low impedance path for the capacitor to discharge through the i.e.d.

Resistor R3 is inserted in this circuit to limit the peak current to a value within the pulse current rating of the i.e.d. A resistor of 10Ω has been selected which gives the right limit for standard size indicators and circuit voltages of up to 24 volts.



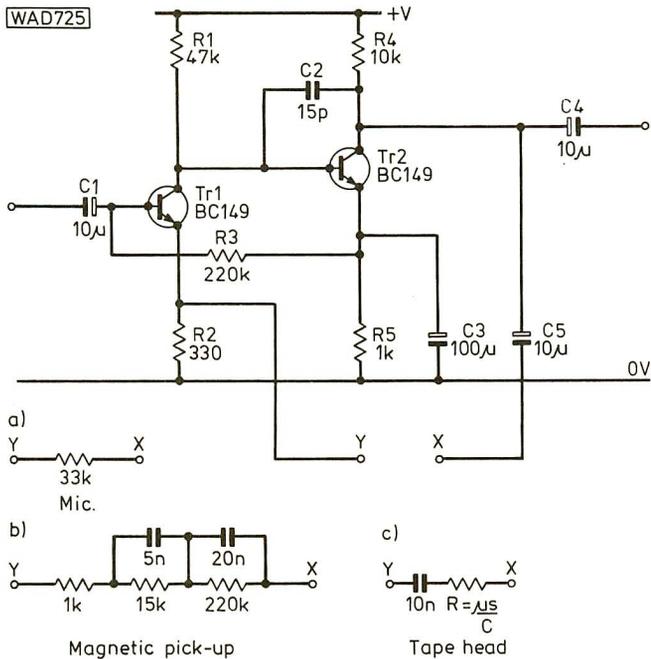
When the capacitor has been discharged the only source of current for the s.c.r. is through the resistor R4. The value of this current is below that required to keep the s.c.r. in a turned on state and thus it switches off, allowing C4 to start charging up and the cycle to repeat.

The correct selection of a suitable s.c.r. is important. It needs to have a high gate current sensitivity, I_{GTmin} , so that the values of R1 and R2 can be large to prevent current wastage. The rated holding current, I_H , has to be greater than the maximum current which will pass through R4 at the highest rail voltage. This will ensure that the s.c.r. will de-latch after the capacitor is discharged. Desired typical parameters are thus: $I_{GTmin}=0.2mA$ or less; $I_H=2mA$ or greater and an anode voltage, V_{RRM} , rating larger than the rail voltage to be monitored. Devices which meet this specification are the C106 series, TIC44-TIC47-2N3005-2N3008-2N5061-2N5064, etc.

*Mr. J. A. Brett
Manchester*

Experimenters Pre-amplifier

WAD725



The pre-amplifier has proved useful over the years for matching low-level signal sources into amplifiers without suitable inputs. A feedback pair of transistors is a very common arrangement for a pre-amp.

In this design, with two feedback paths available, special frequency responses can be obtained, such as equalisation for records or for reproduction from a tape-head. For these applications, the equalisation response is obtained by feedback from the collector of Tr2 to the emitter of Tr1 via a network between X and Y.

a) In the microphone mode one resistor is inserted and the ratio of this to R2 gives the gain.

b) The network shown for a magnetic pick-up gives a reasonable approximation to the RIAA equalisation curve and produces a gain of about 50 at 1kHz.

c) This network is for signals direct from tape-heads and the value of R is chosen to give the required time constant.

Sources with too much treble can be improved with the arrangement shown, but values will have to be found by experiment. The tape head arrangement shown is a treble boost circuit. The circuit is tolerant of supply line variation, with low voltage lines, reducing R3 and 100kΩ will improve operation.

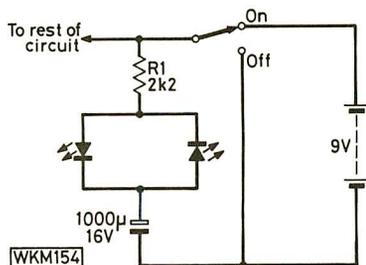
Mr. D. Griffiths
Surrey

LED On/Off Indicator for Battery Powered Equipment

This circuit uses two l.e.d.s to indicate switching on and off in battery-powered equipment.

Light-emitting diode D1 flashes on switching "on" and D2 flashes on switching "off".

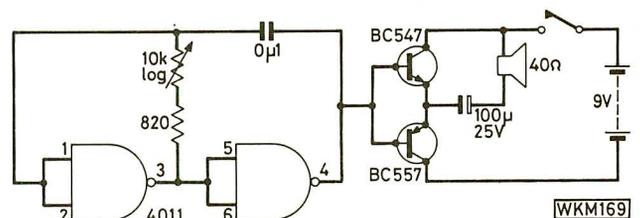
At switch-on a charging current flows through D1 to charge up the 1000µF capacitor. This causes D1 to illuminate, this then goes off as the capacitor charges up. The only current which then flows is a very small leakage current. On switching off, the 1000µF capacitor discharges via D2, which illuminates indicating that the circuit has been switched off. In the original circuit D1 was a red l.e.d. and D2 was a green l.e.d. A d.p.d.t. slide switch was used as the on/off switch.



R. N. Soar
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Morse Buzzer/Continuity Tester

This circuit uses a 4011 c.m.o.s. i.c. as a squarewave oscillator. This is buffered through an output stage, consisting of a complementary pair of transistors, which drive a speaker. The pitch of the note is controlled by a 10kΩ log potentiometer. Putting a Morse key in the supply line converts the circuit to a Morse practice oscillator. Alternatively the continuity of wiring of p.c.b. track can be tested by fitting two probes in place of the Morse key and placing these across the wire to be checked. A complete circuit will result in an audible tone from the speaker. Note that all unused inputs to c.m.o.s. gates must be taken to either the positive or negative supply rails.

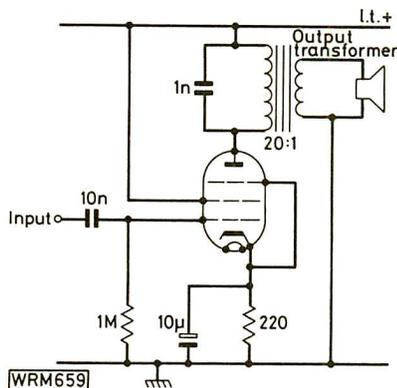


A. P. Cooper
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Output Transformers as Filters in Mobile Power Lines

For over four decades the standard low-power audio amplifier used in radio receivers and a thousand other applications consisted of a thermionic valve and an output transformer and very few other components. The basic circuit is shown here, and only in the last ten years or so has it been superseded, briefly by discrete transistors and now almost entirely by integrated circuits. Over the years many different types of valves were used — directly and indirectly heated types, triodes, tetrodes and pentodes — but the requirement for the transformer was almost always the same: it had to transform the high output impedance of the valve (generally between 2 and 20k Ω) to drive a loudspeaker with an impedance of between 3 and 16 ohms. This meant a turns ratio of between 10:1 and 100:1 and a secondary resistance which was low compared with the loudspeaker. In addition the inductance had to be unaffected by the primary current flowing to the anode of the valve working in class A.

Valves have a finite life and are mechanically fragile but valve output transformers are still readily and cheaply available, besides being present in significant numbers in many junk boxes and junk sales. They are the size of small mains transformers (approx 50 to 75mm cube) and weigh 500g or so. As mentioned above they have an important feature which mains transformers do not — their inductance is less affected by a d.c. bias current, making them ideal for use as smoothing chokes in medium current supply filters. If the secondary (loudspeaker) winding is used as a choke its inductance — of the order of 20mH — is not greatly affected by d.c. currents up to 2A.



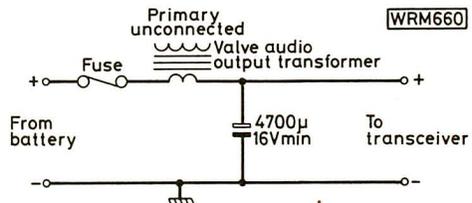
Modern "black box" mobile v.h.f. and u.h.f. transceivers are designed to operate from 13.6 volt automotive batteries and draw from 0.5 to 2A, depending on model and power setting. Many are inadequately protected from the large amounts of conducted noise present on motor vehicle supplies when the engine is running.

In-car entertainment — (radios and tape players) and CB equipment has similar power requirements and similar lack of immunity to supply noise.

It is not possible to use simple electronic regulators to remove this noise since they have an associated voltage drop which is rarely less than 2V and often as much as 4V. This reduces the voltage available to the equipment, particularly when the engine is stopped, to a level where it may malfunction and will certainly suffer loss of power.

A simple "L" filter using the secondary of a valve output transformer as a choke, and an electrolytic capacitor, will have a voltage drop determined only by its resistance and Ohm's law. The secondary resistance of such transformers is usually less than 0.2 Ω and the voltage drop, even at 2A, is therefore under 400mV. The circuit of such a filter is shown in Fig. 2.

An analysis of the spectrum of the noise from generators, ignition and other sources in a motor vehicle shows that the majority lies between 200Hz and 20kHz, although there is a substantial r.f. component as well. In general the power input of radio communications equipment is well decoupled from r.f. noise so the important band for the filter to operate is the two decades of frequency from 200Hz. This it does extremely well.



The theoretical attenuation of the filter rises at 12dB/octave from 45dB at 200Hz. In fact the inter-winding capacitance begins to have an effect above 1kHz and the response is nowhere near the theoretical above 4kHz. But the attenuation is still well over 70dB so from a practical point of view it does not greatly matter. Use of the filter effectively eliminates generator whine and supply-borne ignition noise provided the equipment and filter are intelligently earthed.

The filter, containing as it does only two components, is easily constructed and easily mounted. It is also very cheap, the components usually being to hand but if not the cost using surplus components will be under £1.50 or, with brand new components, about £5. Note that the working voltage of the electrolytic capacitor must be 16V or above.

Construction consists of attaching the capacitor to the transformer with either a capacitor clip or pvc insulating tape according to personal taste. The negative input and output leads are connected to the capacitor negative, the positive input lead, which should have an in-line fuse fitted is connected to one end of the transformer secondary and the output lead connected to the other and to the capacitor positive. The secondary can be identified, if necessary, by its low resistance. No connections should be made to the primary or to any secondary taps. The whole filter is then well insulated with more pvc tape.

The filter can be mounted on the radio itself, visually the least acceptable position but electrically the best, or tucked out of sight in a glove box, behind the dashboard, or under a seat. Best results are obtained if the radio is earthed only by the negative lead to the filter but this is not usually possible or necessary. The supply to the filter may be taken from the ignition switch, from the cigar lighter, from a lighting circuit,

or directly from the battery. The battery is the best place from a noise viewpoint but from a safety aspect it is essential that there be a fuse as near to the battery as possible. If the radio cannot be grounded only by the lead to the filter then the filter should be grounded as near as possible to the radio ground — a common ground is ideal. Wiring should be in 16/0.2mm (0.5mm²) or similar heavy flexible wire to prevent premature vibration fatigue.

I have built over ten of these filters at various times and all work well. At present there are four in my car (144MHz rig;

430MHz rig; CB rig; and radio/cassette) and three in my wife's (CB rig; radio/cassette; and socket for 144MHz rig when I steal her car). Although the electrolytic capacitor is connected to the battery for 365 days per year and the two oldest filters have now been in continuous service for over ten years they have never given any problem and the improvement in ignition and generator noise is enormous.

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Tone Burst Circuits

Even with the massive growth of all-purpose, multi-function, high-priced black boxes (the only accessory apparently missing being a tea-maker), many amateurs still happily "survive" with a simple rig. The author has often heard conversations on the air about adding a tone-burst, and it is hoped that this article will provide some ideas for experimentation.

Most 144MHz and 430MHz band repeaters require a tone-burst at 1750Hz for approximately 500ms duration. There is quite a large variation in the "acceptance gate" of individual repeaters, in other words how far from 1750Hz can the tone be before it fails to "open up the box". It is obviously preferable to stay as close to 1750Hz as possible. Circuits can range from a simple manually operated two-transistor multi-repeater to an automatic tone-burst (crystal controlled).

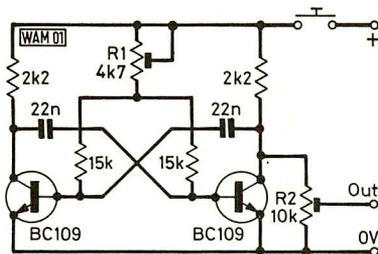


Fig. 1

The circuit in Fig. 1 is a standard cross-coupled multivibrator and R1 will adjust the frequency whilst R2 will adjust the deviation to the amount required. Its advantage is cheapness and simplicity, and if good quality components are used it should not drift far with the changes in temperature.

Simplicity of approach can also be said of the circuit in Fig. 2, which uses the common 555 in its astable mode to gener-

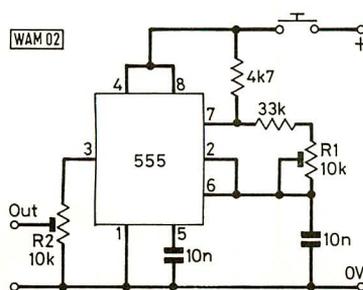


Fig. 2

ate the tone at pin 3. Again R1 adjusts the frequency and R2 the deviation. Because of current consumption it is suggested that the c.m.o.s. 7555 be used.

Fig. 3 uses two gates of a CD4011 quad NAND gate c.m.o.s. i.c. to generate the frequency, with the third gate acting as a buffer. Because it uses so little current it is as easy to place the push-button between supply and pin 1, making it a gated oscillator. Resistors R1 and R2 perform the same functions.

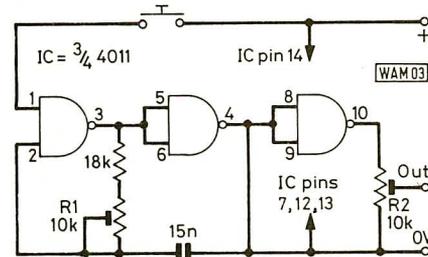


Fig. 3

Figs. 1, 2 and 3 are all timed manually, i.e. the tone lasts for as long as the pushbutton is pressed. Also they can be voltage-dependant, and one way of overcoming these disadvantages is to use the circuit in Fig. 4. Here the frequency of the c.m.o.s. oscillator is greatly increased to 1.792MHz, and then dividing the frequency by 2¹⁰ down to 1750Hz using a 4020 ripple binary counter. Assuming the reset pin 11 is low, divided outputs will appear on various pins, with the one we want on pin 14. If the reset pin was high, the outputs would be inhibited, and this facility means that with a simple resistor/capacitor combination, a timing network can be set up to make the tone last for e.g. 500ms. At the moment of switch on, activated by the p.t.t. switch, pin 11 is low, so the divided frequency appears at pin 14. However C1 immediately starts to charge up, and inhibits the outputs, stopping the tone-burst, irrespective of whether the p.t.t. button is still

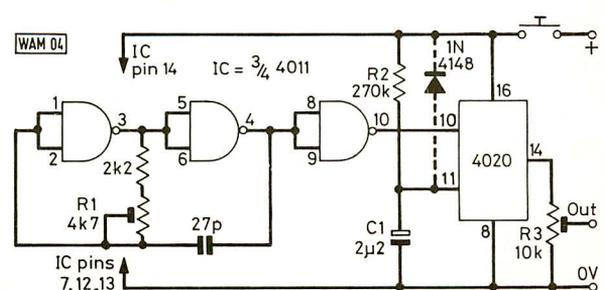


Fig. 4

pressed in. The values of R2 and C1 have to be found by experimentation because of the notorious lack of accuracy of electrolytic capacitors, but the author found 270kΩ and 2·2μF (tantalum) gave reliable results. As with all the circuits, good quality components will greatly aid the stability.

Much greater accuracy can be achieved using a crystal oscillator running at 7·168MHz because any changes due to e.g. temperature become negligible once divided down by 2¹² and many crystal manufacturers have this value as a stock item. Any simple crystal oscillator may be used, provided its output is of sufficient peak-to-peak swing to clock the 4020.

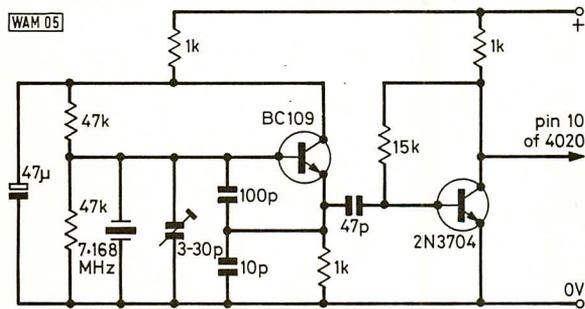


Fig. 5

At first the author used the circuit in Fig. 5, but found it needed the second transistor as a buffer amplifier. This didn't seem very economical in terms of components, so the much simpler circuit of Fig. 6, was tried and found to be satisfactory. It was after I had gradually found the component values by the "select on test" method (i.e. suck it and see), that I was told that an almost identical circuit was in the Vol 2 of the

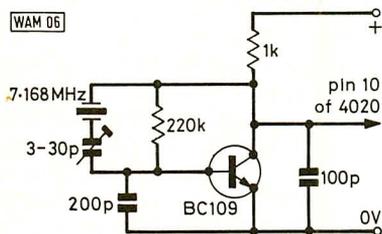


Fig. 6

excellent *Radio Communication Handbook*. Thus plagiarism is denied! I only wish I had seen the circuit earlier! Two supply decoupling capacitors were included, as well as a diode (shown in dotted lines in Fig. 4) to provide a faster discharge path for the capacitor, though the author's does work quite happily without this. The ÷ 2¹² output appears on pin 1 of the 4020.

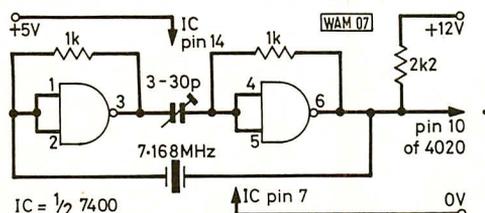


Fig. 7

Another common form of crystal oscillator is shown in Fig. 7, but there is a problem using t.t.l., because of its supply restriction of 5V, and the 4020 wasn't happy at running at 7MHz at 5V, preferring 12V. For this reason two voltages are needed, easily supplied with a resistor and Zener diode. A pull-up resistor ensures enough voltage swing to clock the 4020. In the Fairchild t.t.l. data book it is stated that most t.t.l. outputs can withstand a pull-up resistor to 10V, and the author's has behaved quite happily at 13·8V for over a year.

The final circuit of Fig. 8 uses a 4060 which is similar to the 4020 but has most of the crystal oscillator circuit built into it. With such few components the circuit can easily be mounted on a very small p.c.b., or even on the back of the i.c. itself and then potted. With the automatic tone-burst it is

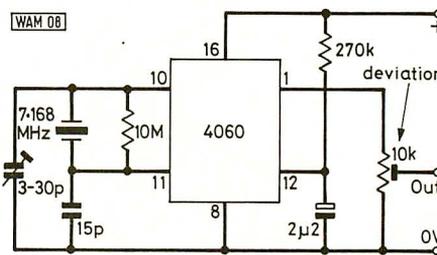


Fig. 8

probably best to power the unit from the p.t.t. switch, with an extra toggle switch in series, so that if the switch is closed, the tone-burst operates automatically every time the p.t.t. button is pressed.

None of the circuits above has waveshaping on the outputs, which will consequently be virtually squarewaves. It is obviously very difficult to state what values would suit individual applications, but if the outputs were adapted to include the circuit of Fig. 9 an approximate triangular waveform would result. This is because R1 slows down the charge rate of the capacitor, and R2 slows down the discharge rate, affecting the leading and trailing edges of the squarewave. The values stated should be experimented with to get the most pleasing sounds. Depending on the transmitter, a blocking capacitor (try 150nF polyester) should be placed in series with the output.

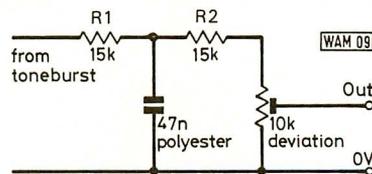


Fig. 9

It is certainly not the intention of the author that the law of Medes and Persians should apply to these circuits, and experimentation with them is encouraged to obtain the best results. They should, however, provide a base from which progress can be made, and should help those who can't whistle at 1750Hz.

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