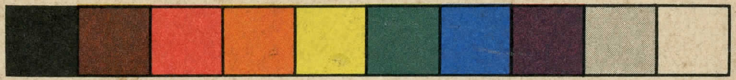
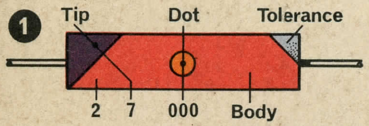
PRACTICAL WIRELESS DATACARD SYSTEM OCT. 1973 1

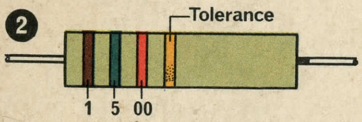
RESISTOR COLOUR CODE



The colour code shown above is used to indicate the nominal value of a resistor in OHMS. Resistors are generally marked with the colours in one of two ways:—

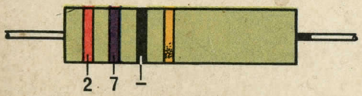


In this method the colour of the body of the resistor gives the first significant figure of the resistor's value, the tip colour gives the second figure and the dot indicates the multiplier or number of noughts following the first two figures. In the example shown above the value can be seen to be 2 (red), 7 (violet) and orange representing three noughts i.e. 27000 ohms or 27kΩ (kilo-ohms).

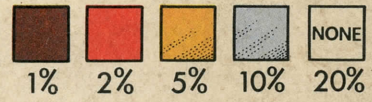


In this alternative method of marking resistors coloured bands are used and decoded as in the previous example. The resistor shown has a value of 1500 ohms or 1·5kΩ.

NOTE: If the multiplier colour (dot or third band) is black there are no noughts after the first two significant figures (multiplier = x1) as shown in this example of a 27 ohm resistor.



TOLERANCE. The dot or band, shown in the examples, indicating tolerance represents the limits of the actual value of the resistor relative to the marked nominal value. A resistor marked as 10000 ohms with a silver (10%) dot or band can have an actual value between 9000 (10000 − 1000) and 11000 (10000 + 1000) ohms.



PREFERRED VALUES. The common range of twelve values of resistance is known as the E12 Series:—

1·0 1·2 1·5 1·8 2·2 2·7 3·3 3·9 4·7 5·6 6·8 8·2 together with their decades such as 47 470 4700 47000 etc.

The E12 Series can be expanded to the E24 Series by adding the following intermediate values:—

1·1 1·3 1·6 2·0 2·4 3·0 3·6 4·3 5·1 6·2 7·5 9·1 and their decades.

1·0	1·1	1·2	1·3	1·5	1·6
1·8	2·0	2·2	2·4	2·7	3·0
3·3	3·6	3·9	4·3	4·7	5·1
5·6	6·2	6·8	7·5	8·2	9·1
E12		E12		E12	

RESISTANCE CODE (BS 1852)

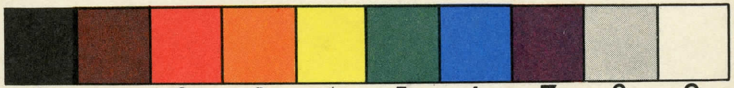
Increasing use is being made of the British Standards (BS 1852) method of marking resistors with their value and tolerance using figures and letters only instead of a colour code. The multiplier is represented by a single letter:—

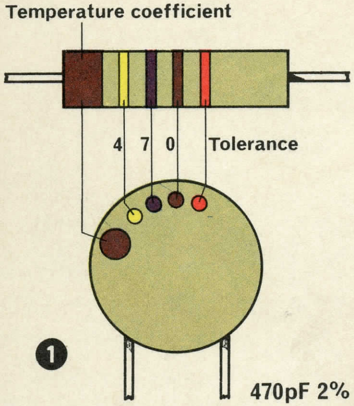
R = x1 K = x1000 M = x1000000

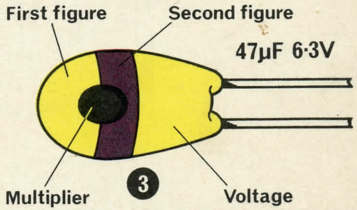
which replaces the decimal point when indicating the value of the resistor, thus:—

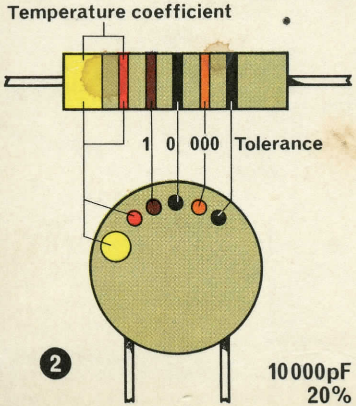
PRACTICAL WIRELESS DATACARD SYSTEM OCT. 1973 2

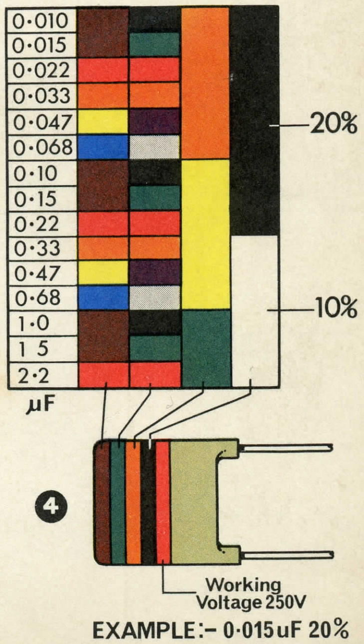
CAPACITOR COLOUR CODE











Nom. value	Becomes
15Ω	15R (multiplier = x1)
330Ω	330R („ = x1)
5·6kΩ	5K6 (multiplier = x1000)
47kΩ	47K (multiplier = x1000)
1·2MΩ	1M2 (mult = x1000000)
18MΩ	18M (mult = x1000000)

TOLERANCE. The marking indicating the nominal value of the resistor has a single letter added to it representing the tolerance figure:–

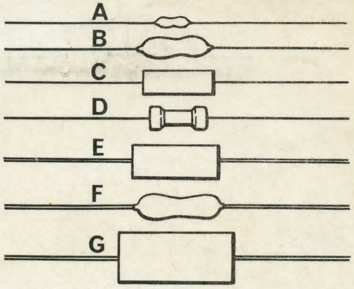
F = ± 1% G = ± 2% J = ± 5%
K = ± 10% M = ± 20%

Examples:—		
	2M2F signifies	2·2MΩ 1%
	1K8G „	1·8kΩ 2%
	120KJ „	120kΩ 5%
	15RK „	15Ω 10%
	6R8M „	6·8Ω 20%

When an odd value of resistance is needed it is useful to know the actual spread of each preferred value, for both 5 and 10% tolerance resistors. The following table gives these spreads for the E12 series. It will be noted that the 10% spread provides almost continuous coverage of the range of values.

	10% Spread	5% Spread
10	9—11	9·50—10·50
12	10·8—13·2	11·40—12·60
15	13·5—16·5	14·25—15·75
18	16·2—19·8	17·10—18·90
22	19·8—24·2	20·90—23·10
27	24·3—29·7	25·65—28·35
33	29·7—36·3	31·35—34·65
39	35·1—42·9	37·05—40·95
47	42·3—51·7	44·65—49·35
56	50·4—61·6	53·20—58·80
68	61·2—74·8	64·60—71·40
82	73·8—90·2	77·90—86·10

These figures can be used for any decade of the series, for example, a 6·8kΩ resistor of 10% tolerance may have a value between 6·12kΩ and 7·48kΩ or a 1·2MΩ of 5% between 1·14MΩ and 1·26MΩ.
With the advent of transistorised equipment and consequent lower operating voltages the power rating of resistors used in this field has been reduced to as low as one twentieth of a watt whereas one quarter of a watt used to be the common minimum. The physical size of a resistor is governed to some extent by its type of construction and the illustrations show some typical resistors, full size, while the table gives some of the more important characteristics of resistors available in the ratings from 1/20th to 1 watt.



Type	Rating (W)	Length (mm)	Characteristics	Tolerances
A	$\frac{1}{20}$ (0·05)	4	LN-HS-CF	5
B	$\frac{1}{8}$ (0·125)	9·5	LN-HS-CF	5/10
C	$\frac{1}{4}$ (0·25)	9	LN-HS-CF	10
D	$\frac{2}{5}$ (0·40)	7	VLN-MF	2
E	$\frac{1}{2}$ (0·50)	11	LN-HS-CF	5
F	$\frac{1}{2}$ (0·50)	9·5	VLN-MO	2
G	1	16	LN-HS-CF	5/10

CF—Carbon Film HS—High Stability
LN—Low Noise VLN—Very Low Noise

GRADE 1 RESISTORS

These are generally classed as High Stability and they are formed by the deposition of a film of carbon or metal oxide on a rod or tube of ceramic material. A spiral groove can be cut into the film to increase or adjust the final value of the resistor The spiral groove, in effect, creates a small inductor which can have a considerable impedance at VHF and UHF so care must be taken not to use these types of resistor where they could adversely affect the operation of a circuit. Generally their noise figure is good.

GRADE 2 RESISTORS

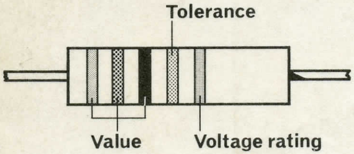
The more common resistors are of Grade 2 being formed from a composition of carbon and other materials into a rod usually with leadout wires moulded into the ends of the rod. Sometimes a metal cap is incorporated into the lead, fitting closely over the end of the rod.
As the size of, say, a $\frac{1}{2}$ watt resistor is the same for any value in the series it is necessary to change the ratio of the carbon to other material in the composition of the rod in order to achieve this. These resistors are not noted for their stability and also introduce a certain amount of noise into circuits in which they are used.

In general the resistor colour code also applies to the markings found on some capacitors. In addition to value and tolerance the code is sometimes used to indicate the temperature and/or the voltage rating of a capacitor The unit of capacitance shown by the colour code is the PICOFARAD (pF) For ceramic dielectric capacitors two methods of marking are in general use, using either five or six coloured dots or bands, as illustrated, Figs. 1 and 2.

The actual tolerance limits marked depend upon the nominal value of the capacitor and these are shown in the table below:—

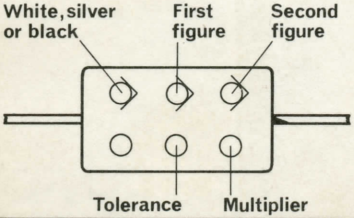
Colour	More than 10pF	10pF or less
Black	± 20%	—
Brown	± 1%	± 0·1pF
Red	± 2%	± 0·25pF
Green	± 5%	—
White	± 10%	± 1pF

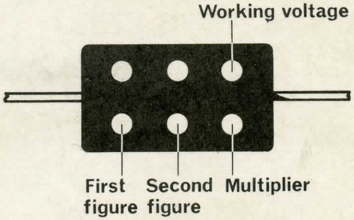
NOTE. If the multiplier colour is grey or white the multiplier is 0·01μF or 0·1μF respectively. A variation of the normal style of marking sometimes encountered provides for indication of the voltage rating of the capacitor:—



WORKING VOLTAGE. When the working voltage of a capacitor is indicated by a coloured spot or band this is decoded as the colour number times 100. e.g. a green spot represents a working voltage of 5 x 100 or 500 volts. Note that a white spot (9) is used to indicate a working voltage of 1000 volts.

MOULDED MICA CAPACITORS. Several styles of marking have been utilised in the past for these capacitors. Two forms are shown with information on their more important characteristics:—





TANTALUM BEAD CAPACITORS. The table below must be used when deciphering the colour code on these capacitors, Fig. 3. Values of capacitance are in μF

	1st/2nd Figure	Multiplier	Voltage
Black	0	x 1μF	10
Brown	1	x 10μF	
Red	2	x 100μF	
Orange	3		
Yellow	4		6·3
Green	5		16
Blue	6		20
Violet	7		
Grey	8	x 0·01	25
White	9	x 0·1	3
Pink	–		35

MINIATURE FOIL CAPACITORS. (Mullard C280 series and others)
Values of capacitors in this range may be readily identified from the chart; Fig. 4.

CAPACITANCE CODE (BS 1852)

Capacitors can also be marked with their nominal value using figures and letters in place of the conventional colour code. The three multiplier letters in common use are:—

$$p = 10^{-12} \quad n = 10^{-9} \quad \mu = 10^{-6}$$

of the capacitance in FARADS.
As the practical unit of capacitance is usually taken as 1μF then:—

$$1nF = \frac{1}{1000}\mu F \text{ and } 1pF = \frac{1}{1000000}\mu F$$

Hence 1nF = 1000pF

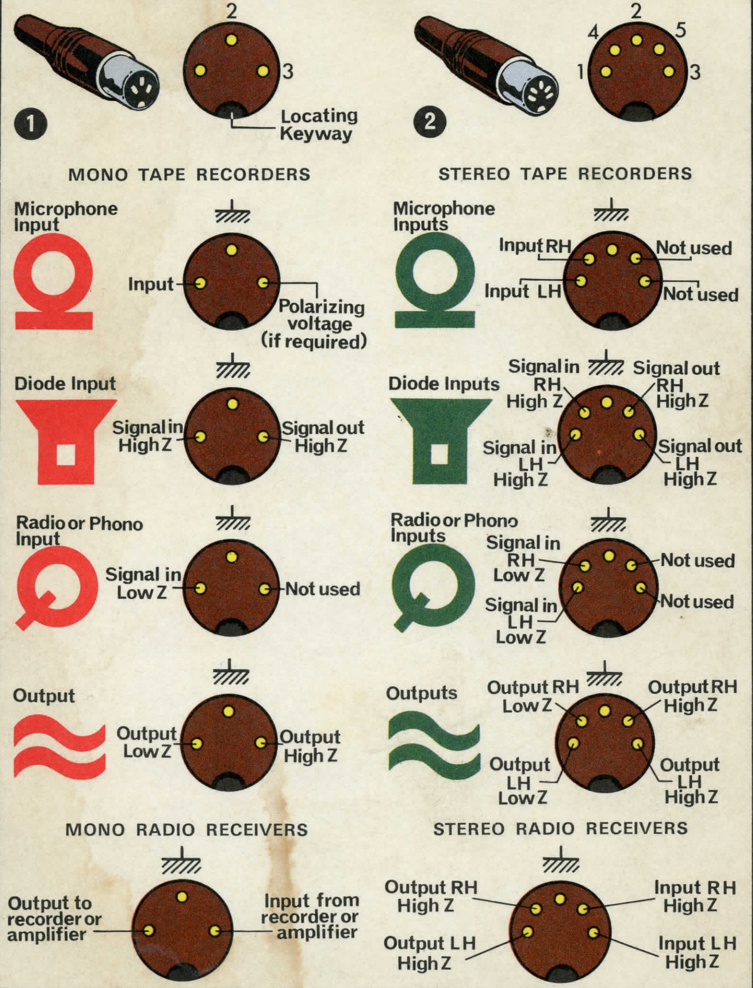
Using the multiplier letter to replace the decimal point in the nominal value of a capacitor:–

Nominal value	Becomes
1pF	1p0 (mult x 1)
330pF	330p („)
1000pF	1n0 (mult x 1000)
4700pF	4n7 („)
10000pF	10n („)
1μF	1μ0 (mult x 1000000)
6·8μF	6μ8 („)

NOTE. The letter u is permissible in place of μ.

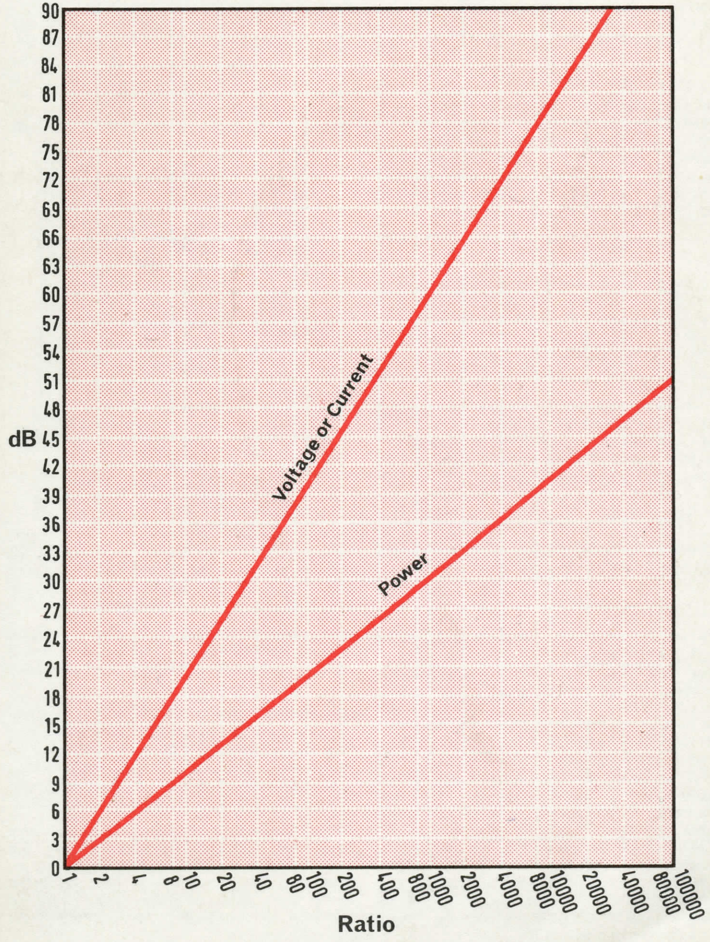
PRACTICAL WIRELESS DATACARD SYSTEM NOV. 1973 3

AUDIO PLUGS AND SOCKETS



PRACTICAL WIRELESS DATACARD SYSTEM NOV. 1973 4

USING DECIBELS

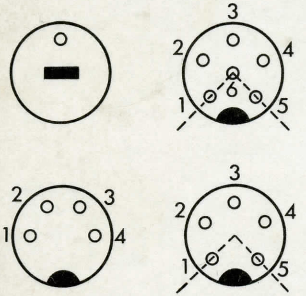


The DIN series of plug and socket connectors was devised by the German Industrial Standards Board and, in the absence of any other acceptable guide-lines, has become widely accepted for the inter-connections of pickups, tuners, tape recorders, audio amplifiers and loudspeakers.
The basic DIN **plug** for monophonic audio circuits is the 3 pin type, **seen from the soldering tags.** Fig. 1
It will be found that pin 2 is generally connected to earth (chassis) In the diagrams Z indicates the impedance of the circuit to which the pin should be connected. e.g., High Z indicates a high impedance circuit.

For stereo audio circuits the 5 pin DIN plug is utilised which has the two additional pins located between pins 1 and 2 and between pins 2 and 3 of the basic 3 pin plug. Again, in all cases the pin 2 is earth or chassis. Fig. 2.

DIN plugs may ideally, be wired using multi-way screened cable (known commercially as 'Metvinsmall') or, more generally, with single or twin screened cable where required. Twin unscreened wire may be used for loudspeakers.

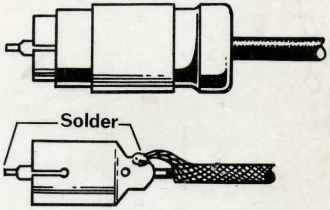
Other DIN plugs that may be encountered include the following pin configurations:—



The connector with the one flat pin and one round pin is intended for use with loudspeakers since it is not reversible. This factor is most important with loudspeakers in a stereo system where correct 'phasing' of the speakers must be maintained once it has been correctly determined.

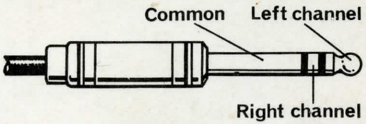
'PHONO' PLUGS AND SOCKETS

These single pole connectors are also widely used on audio equipment, using single way screened cable for input connections, such as from a microphone or pickup, or twin cable for the wiring of loudspeakers. Phono sockets sometimes incorporate a switch which is operated when the plug is inserted into the socket.

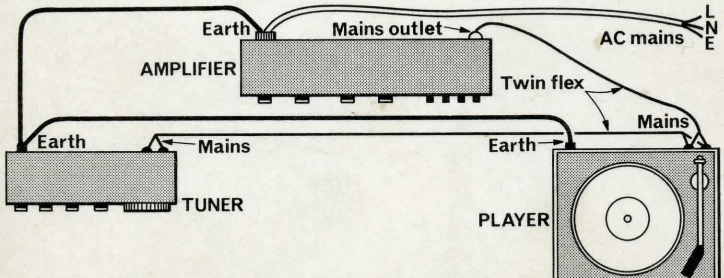


JACK PLUGS AND SOCKETS

The standard jack plug is $\frac{1}{4}$ in diameter and is mostly used on microphones, for which all-metal shielded versions are available, and on headphones. The connections for the jack plug used with stereo headphones are:—



Miniature plugs and sockets, frequently found on transistorised radios, are either 2·5 or 3·5mm in diameter



INTERCONNECTION OF UNITS TO AVOID HUM LOOPS

Contrary to popular usage and belief the DECIBEL is not a unit of anything, as is the volt or ampere or ohm, but rather a ratio of sound levels in audio work or a ratio of voltages or currents or power levels in the electronics field. The human ear can detect sounds over a very wide range of power levels but its response is not linear As the sound level increases the ear's apparent sensitivity decreases. A sound which is doubled in actual intensity does not seem to be twice as loud to the ear
The ear in fact works on a logarithmic scale hence measurements on sound levels or on equipment that produces sound must be on the same logarithmic scale if they are to make sense.

THE DECIBEL CHART

The chart shown on this card is the one most suitable for measurements on audio amplifiers and associated equipment, with one scale showing the ratio of power or voltage or current plotted against the decibel scale (dB). If specific examples need to be worked out the following formula can be used:—

$$\text{dB} = 10 \log \left(\frac{P1}{P2}\right)$$

where P1 and P2 are the two power levels. If the output power is greater than the input power then the ratio, in dB, is positive, e.g. +6dB. If the output is less than the input the ratio is expressed as a negative value, e.g. 12dB. In either case P1 is the larger of the two values.
The formula assumes that the input and output impedances are the same. If they are not then due allowance must be made in the formula.
If the voltage or current is being considered the above formula becomes:—

$$\text{dB} = 20 \log \left(\frac{V1}{V2}\right) \quad \text{or} \quad \left(\frac{I1}{I2}\right)$$

The formula for taking into account differing input and output impedances is:—

$$\text{dB} = 20 \log \frac{V1}{V2} + 10 \log \frac{Z1}{Z2}$$

for voltage gains or losses, or substituting I1/12 for currents.
The importance of taking the input and output impedances into consideration when calculating the gain of, say, an audio amplifier can be seen in the following case. Suppose that on feeding a one volt RMS signal at 1kHz into an audio amplifier that a signal of 1 volt RMS appears across the low impedance speech coil of the loudspeaker It is not necessary to use any formula to realise that since the output voltage is the same as the input voltage the amplifier's gain appears to be unity (x1) but from experience we know that in fact the amplifier has considerable gain. It is the formula that must be modified and this is done by taking the input and output impedances into account.

Assuming that the input impedance to the amplifier is 1MΩ (1,000,000) and the output impedance is 1Ω then the modified formula for gain can be used:—

$$\text{dB} = 20 \log \frac{1}{1} + 10 \log \frac{1{,}000{,}000}{1}$$
$$= 10 \log 1{,}000{,}000$$
$$= 60 \text{ (dB)}$$

SOME AUDIO TERMS EXPLAINED

The specification for the performance of an audio amplifier system will often include terms using decibels above or below (±) some standard, usually maximum power output at some stated amount of harmonic distortion. Using the chart it is possible to see what these figures mean in terms of actual power. Since negative values or losses are frequently involved the following table will prove a valuable addition to the chart.

Loss —dB	Power Ratio (approx.)	V or I Ratio (approx.)
0	1·0	1·0
1	0·8	0·9
2	0·6	0·8
3	0·5	0·7
4	0·4	0·6
5	0·3	0·56
6	0·25	0·5
10	0·1	0·3
15	0·03	0·18
20	0·01	0·1
30	0·001	0·03
40	10^{-4}	0·01
50	10^{-5}	0·003

Power Bandwidth:—Audio bandwidth, typically 30Hz to 20000Hz, at which points the power output has fallen by 3dB (−3dB). The chart or table shows this to mean a loss of power of one half at these points.

Frequency Response:—Typically stated as 20Hz to 20000Hz ± 1dB which means a reduction to 0·8 (8/10 ths) of maximum power output at these limits.

Signal to Noise Ratio:—Typically, 50dB relative to maximum power. From the chart or table this is a ratio of 100000 to 1 If the maximum power output is 50 watts (50000mW) the noise level at maximum volume should not exceed 50000/100000 or half a milliwatt.

Tone controls or Filters:— These may have their performance specified by the altered response they provide at the top or bottom of the audio range, such as "from +15 to 15dB at 50Hz and +13 to −15dB at 10000Hz" for variable tone controls.

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PRACTICAL WIRELESS DATACARD SYSTEM DEC. 1973 5

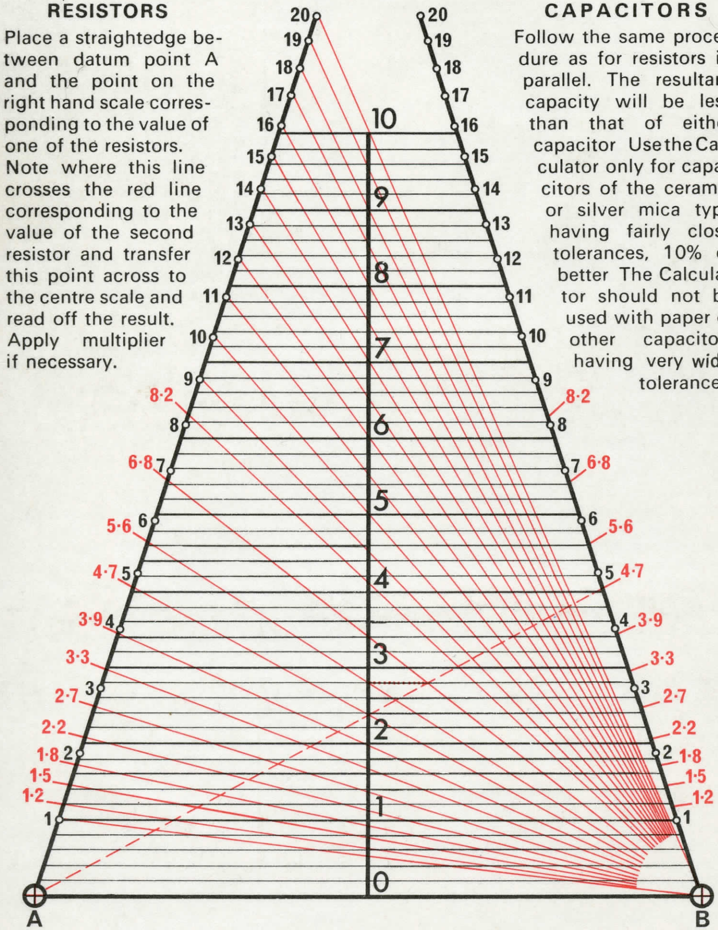
RESISTANCE AND CAPACITANCE CALCULATOR

RESISTORS

Place a straightedge between datum point A and the point on the right hand scale corresponding to the value of one of the resistors. Note where this line crosses the red line corresponding to the value of the second resistor and transfer this point across to the centre scale and read off the result. Apply multiplier if necessary.

CAPACITORS

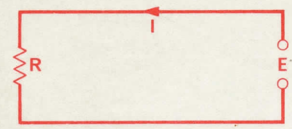
Follow the same procedure as for resistors in parallel. The resultant capacity will be less than that of either capacitor Use the Calculator only for capacitors of the ceramic or silver mica type having fairly close tolerances, 10% or better The Calculator should not be used with paper or other capacitors having very wide tolerances.



PRACTICAL WIRELESS DATACARD SYSTEM DEC. 1973 6

DC CIRCUITS

In an electrical circuit carrying direct current (DC) the current I will be directly proportional to the applied voltage E, provided that the resistance R of the circuit remains constant.



This may be expressed as:—

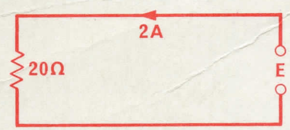
$$I = \frac{E}{R} \text{ thus } E = IR \text{ and } R = \frac{E}{I}$$

the current being expressed in AMPERES, the applied voltage in VOLTS and the circuit resistance in OHMS.

In such a circuit the power being dissipated W is proportional to the square of the current flowing since if the applied voltage is doubled then the current in the circuit will also be doubled (from the formula above) Thus:—

$$W = EI \text{ or } \frac{E^2}{R} \text{ or } I^2R$$

the unit of power being expressed in WATTS.

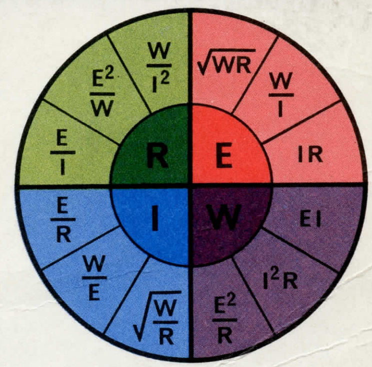


For example, if a resistor of 20 ohms (R) is carrying a current of 2 amperes (I) the formula to find the wattage being dissipated by the resistor (W) can be seen to be I^2R (from the W quadrant of the Wheel) = 4 x 20 = 80 watts.

Any one of the four values can be determined by using the Formula Wheel to find the appropriate formula, given two of the remaining three values.

Frequently the values of current, resistance etc. are found to be either much smaller or much larger than the basic units used in the above formulae, namely volts, amperes, ohms and watts, and due allowance must be made to ensure that the correct value, in basic units, is entered in the formulae.

Some common values that may be encountered in electronics and their conversion to basic units:—



FORMULA WHEEL

Current:
1 milliampere (mA) $= \frac{1}{1000}$ A or 10^{-3}A

1 microampere (μA) $= \frac{1}{1000000}$ A or 10^{-6}A

Resistance:
1 kilohm (kΩ) = 1000Ω or 10^3Ω
1 megohm (MΩ) = 1000000Ω or 10^6Ω

Voltage:
1 kilovolt (kV) = 1000V or 10^3V

1 millivolt (mV) $= \frac{1}{1000}$ V or 10^{-3}V

1 microvolt (μV) $= \frac{1}{1000000}$ V or 10^{-6}V

Power:
1 megawatt (MW) = 1000000W or 10^6W
1 kilowatt (kW) = 1000W or 10^3W

1 milliwatt (mW) $= \frac{1}{1000}$ W or 10^{-3}W

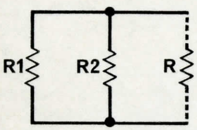
Example:— Suppose that it is required to find the voltage drop across a resistor of 10kΩ which is carrying a current of 250μA. Converting to basic units 10kΩ becomes 10000Ω and 250μA becomes $\frac{250}{1000000}$A.

From the Formula Wheel E = IR so:—

$$E = IR = \frac{250}{1000000} \times 10000 = 2{\cdot}5 \text{ (V)}$$

RESISTOR AND CAPACITOR CALCULATOR

Not infrequently a resistor is needed having a value that does not correspond to any value in the preferred range of resistors. While the required value may fall within, say, the 10% tolerance range of a preferred value resistor it is not generally feasible to run through a batch of such resistors in order to find one of the precise value required. Such odd value resistors may be used in attenuators, meter multipliers or special bias circuits. The value can often be arrived at by using one of two methods, resistors in series or resistors in parallel. Since the series method merely entails adding the individual values, R1 + R2. etc. no further explanation is necessary. When the resistors are connected in parallel the formula $\frac{1}{R} = \frac{1}{R1} + \frac{1}{R2}$ etc. is used. The Calculator on this Datacard gives the resultant value of two resistors in parallel without recourse to a formula.



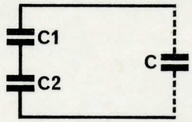
$$\frac{1}{R} = \frac{1}{R1} + \frac{1}{R2}$$
or
$$R = \frac{R1 \times R2}{R1 + R2}$$

It is advisable to have a rough idea of the value to be expected from two resistors connected in parallel, if only to check that the Calculator is being used correctly. If the resistors are roughly similar in value their paralleled resistance will be around half the value of one of them. At the other extreme, if one resistor is relatively low in value then a high value resistor in parallel with it will have very little effect. By this means a resistor slightly higher than the required value can be brought down by paralleling it with a resistor several times its own value.

If resistors having, say, 5% tolerance limits are used in parallel then the resulting value will also be subject to a 5% tolerance.
Where a close tolerance is specified for a resistor it is important to use a type of resistor that is capable of maintaining its value inside the tolerance limits. Composition resistors are poor from the stability aspect and should not be used in critical circuits.

Metal oxide and carbon film resistors are preferable to composition ones, having good long term stability as well as a low temperature coefficient over a wide range of temperatures. They should also be used where a low noise level is important such as in audio circuits.
The usual tolerance limits commonly available for these high stability resistors are 1% and 2%.

With capacitors in series the same type of formula holds as was used for resistors in parallel, namely $\frac{1}{C} = \frac{1}{C1} + \frac{1}{C2}$ etc. so the Calculator can also be used to find the equivalent value of two capacitors in series. This value will always be less than the value of either capacitor



$$\frac{1}{C} = \frac{1}{C1} + \frac{1}{C2}$$
or
$$C = \frac{C1 \times C2}{C1 + C2}$$

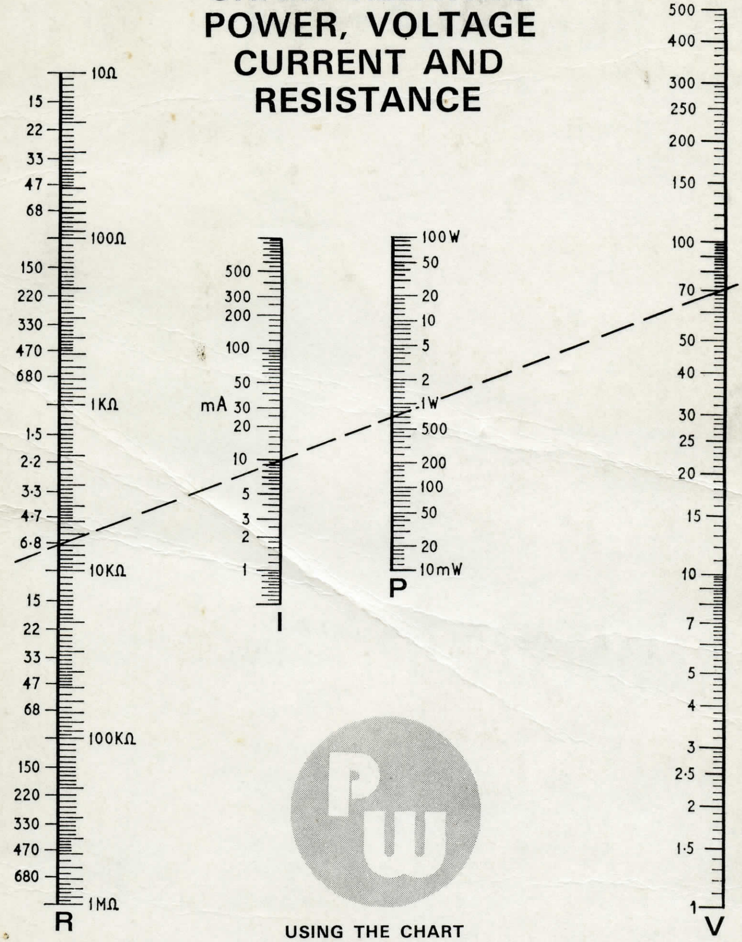
If three resistors are connected in parallel, or three capacitors in series, the Calculator can be used to find their equivalent value. First find the resultant of any two as previously described and then use this with the value of the third resistor or capacitor in a similar calculation again. This method may be used for any number of resistors in parallel or capacitors in series.

In the case of two capacitors in series the lower working voltage of the two should be taken as the maximum working voltage across the pair.

Notes on Calculator

The example on the Calculator shows the resultant value of two resistors of 6·8kΩ and 4·7kΩ in parallel. The line from datum point A to 4·7 on the right hand scale crosses the red line from 6·8 on the left hand scale at a point corresponding to 2·8 on the centre scale. Combined value of resistors is 2·8kΩ. With higher values of resistor it may be necessary to divide both values by a factor in order to bring them on to the scales. For example, 180000Ω (180kΩ) and 68000Ω (68kΩ) may be divided by 10000 to give 18 and 6·8 on the scales. The answer from the centre scales is then multiplied by 10000, in this case 4·9 x 10000 or 49kΩ.
The Calculator can be used to indicate the value of capacitors connected in series. For example, to find the effective value of a 2700pF capacitor in series with one of 8200pF first divide both figures by a factor of 1000 giving 2·7 and 8·2 which can now be applied to the Calculator in the same way as for resistance measurement. The result on the centre scale is approximately 2 which must be multiplied by the factor of 1000 to give an answer of 2000pF
The Calculator has been drawn with prominence given to the preferred scale of values applicable to both resistors and capacitors. However reference lines for the whole numbers up to eight can be drawn in when required.

CHART RELATING POWER, VOLTAGE CURRENT AND RESISTANCE



USING THE CHART

To use the chart place a straightedge between the points on the appropriate scales corresponding to the two known values, and cutting the two remaining scales. The third and fourth values can be now read off these two scales.
In the example shown on the chart it is required to find the value and the power dissipated by a resistor when dropping 70 volts and carrying a current of 10mA. First place a straightedge between 70 on the voltage (V) scale and 10 on the current (I) scale. The line crosses the resistance scale at 7kΩ and the power scale (P) at 700mW. As will be seen from the R scale the nearest preferred value of resistor is 6·8kΩ and in practice a resistor with a power rating of at least 1 watt (1000mW) would be selected.

PRACTICAL WIRELESS DATACARD SYSTEM MAR. 1974 7

FM AERIAL SYSTEMS

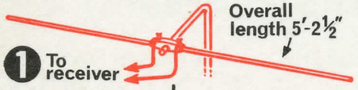
Broadcasting in the UK is carried out on the long waves (LW), medium waves (MW) and the very short waves (Band II) The relationship of wavelength and frequency together with the modes of transmission employed are shown in the table.

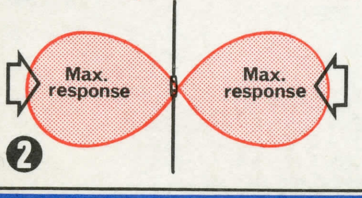
BAND	WAVELENGTH	FREQUENCY	DESIGNATION	MODULATION
LW	1875 to 1176m	160 to 255kHz	Low Frequency	Amplitude (AM)
MW	571 to 187m	525 to 1605kHz	Medium Frequency	Amplitude (AM)
II	3·4 to 3·1m	88 to 97·6MHz	Very High Frequency	Frequency (FM)

kHz = Kilohertz = 1000 cycles per second　MHz = Megahertz = 1000000 cycles per second or 1000kHz

With medium and long wave receivers a short wire aerial, telescopic aerial or ferrite rod aerial is usually sufficient to provide an adequate signal from UK stations. On the VHF band (FM signals) the situation is different. There is a very extensive BBC network of main and relay stations spread across the country carrying three different services into most areas on VHF. IBA (commercial) stations have begun operations on VHF and MW and the network will spread rapidly. BBC Local Radio stations also operate on VHF and MW.

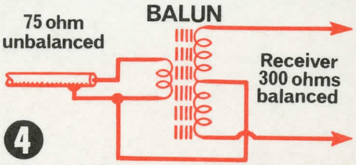
The VHF band, also known as Band II, is split into channels of 200kHz bandwidth and since the range of a main station is only about 75 miles the same channel may be used by more than one station, given adequate geographical separation between stations. To take advantage of the better reception offered by VHF, compared to MW and LW stations, adequate signal strength at the input terminals of the receiver is essential. Near to a transmitter, not more than 10 miles, a simple half wave dipole aerial, Fig. 1 will suffice,





providing maximum signal when arranged at right angles to the direction of the station, Fig. 2. The aerial may be constructed from two lengths of aluminium tubing mounted on a central insulator with the coaxial feeder connected to the inner ends of the tubing, Fig. 3. The other end of the feeder is terminated by a plug to fit the receiver input socket.

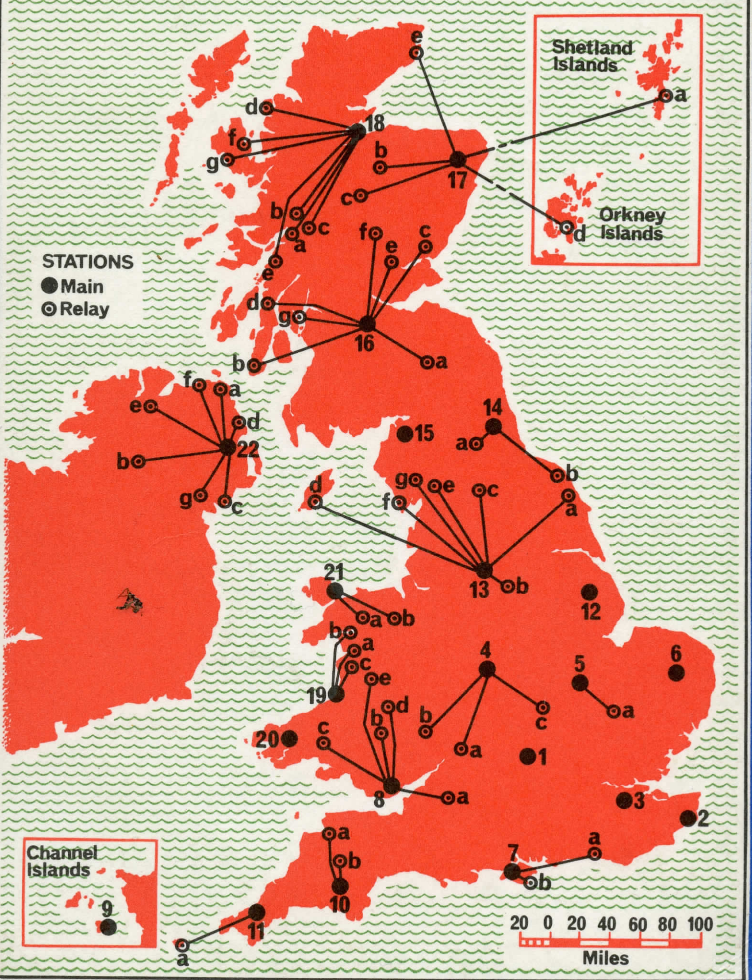
The coaxial feeder should have an impedance of 75 ohms to match the impedance at the centre of the dipole. If the receiver has an input impedance of 300 ohms it is still preferable to use 75 ohm coaxial feeder, with a balun (impedance matching transformer) with a ratio of 4·1 to match receiver, Fig. 4.

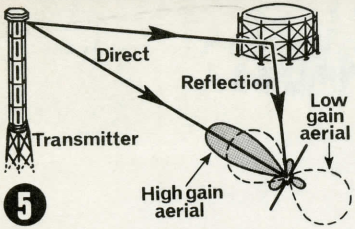


This aerial, like any other aerial, should be mounted as high up as possible and clear of any buildings, wall or large metal objects or structures. VHF signals will bounce off buildings, hills, gasholders etc. arriving at the aerial slightly after the main direct signal from the transmitter, Fig. 5, causing a deterioration in the quality of the reproduction, particularly on stereo transmissions. If the broad angle of the maximum response, Fig. 2, can be narrowed the indirect signal can be reduced or even eliminated.

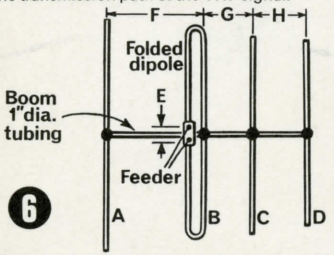
PRACTICAL WIRELESS DATACARD SYSTEM MAR. 1974 8

BBC VHF RADIO STATIONS





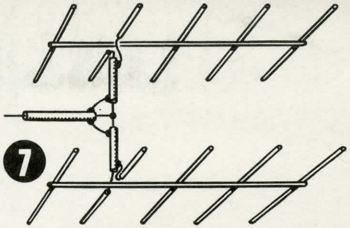
This improved directivity can be obtained by adding reflectors and/or directors to form a beam aerial from the basic dipole, Fig. 6. The increased directivity also increases the strength of signals arriving at the front of the aerial at the expense of unwanted signals from other directions. Such a beam aerial will be required in areas well away from the transmitter where signal strengths are much lower In fringe areas at least a four element beam may be required but hard and fast rules cannot be laid down with so many variables affecting the transmission path of the VHF signal.



It will be noticed that the dipole in Fig. 6 has been modified by folding it into a flat loop and inserting the feeder connections into the centre of one side. This is necessary because the addition of reflectors and directors causes the impedance at the centre of the dipole to be reduced to around 18 ohms. Folding the dipole increases its impedance by about four times, back to about 72 ohms to match the normal coaxial feeder

RECEPTION OF STEREO TRANSMISSIONS

If an FM receiver is fed by an aerial system giving a signal that is only just sufficiently strong to give acceptable reception on mono then that signal will need to be several times as strong to provide equally satisfactory reception if the transmission is in stereo. The increase in signal strength can be obtained by improving the gain of the aerial system by adding more elements to the aerial or by increasing the height of the aerial. In fringe areas it may be necessary to stack two beam aerials, one above the other, connected together by a phasing and matching harness, Fig. 7



The necessity for a stronger signal on stereo arises from the inherently poorer signal-to-noise ratio of stereo transmissions compared to mono. The wider range of audio frequencies transmitted on FM, compared to AM as used on the long and medium wave bands, also increases the noise in the system. Noise, in this context, refers to circuit noise produced in the process of generating the FM signal, whether mono or stereo, and not to man-made or atmospheric electrical noise. FM receivers incorporate amplitude limiting circuits to combat external electrical noise but

Reflector	A	5' 3½"	Separation	E	1"
Dipole	B	4' 10½"	Spacing	F	2' 8"
Director	C	4' 8½"	Spacing	G	1' 7"
Director	D	4' 5½"	Spacing	H	1' 7"

Dimensions assume use of tubing ½" in diameter Director D can be omitted if a 3-element beam is required.

DIMENSIONS FOR AERIAL SHOWN IN FIG. 6

these circuits cannot function properly if the signal presented to the receiver is inadequate. Amplifiers are available, intended to be placed between the aerial system and the receiver input, in order to boost the signal level, but these must be chosen with great care. Although the signal will be increased the amplifier itself may introduce excessive noise thus decreasing the overall signal-to-noise ratio and defeating the original object.

FOR BEST RESULTS

Ensure aerial has adequate gain for the location.

Put aerial at maximum possible height and clear of obstructions, especially those likely to cause spurious reflections.

Ensure elements of aerial are horizontal and that aerial is correctly aligned towards station. This may be done by turning aerial **away** from station for minimum signal and maximum noise or minimum reading on tuning meter. Then turn aerial through 180° from this position. The response at the front of the aerial will be relatively flat.

BBC VHF RADIO TRANSMITTING STATIONS

	ENGLAND	R1/2	R3	R4
	London and South East			
1	Oxford	89·5s	91·7s	93·9s
2	Swingate	90·0s	92·4s	94·4s
3	Wrotham	89·1s	91·3s	93·5s
	Midlands			
4	Sutton Coldfield	88·3s	90·5s	92·7s
a	Churchdown Hill	89·0	91·2	93·4
b	Hereford	89·7	91·9	94·1
c	Northampton	88·9s	91·1s	93·3s
	East Anglia			
5	Peterborough	90·1	92·3	94·5
a	Cambridge	88·9	91·1	93·3
6	Tacolneston	89·7	91·9	94·1
	South			
7	Rowridge	88·5s	90·7s	92·9
a	Brighton	90·1s	92·3s	94·5
b	Ventnor	89·4	91·6	93·8
	West			
8	Wenvoe	89·95	96·8	92·125
a	Bath	88·8	91·0	93·2
	South West			
9	Les Platons	91·1	94·75	97·1
10	North Hessary Tor	88·1	90·3	92·5
a	Barnstaple	88·5	90·7	92·9
b	Okehampton	88·7	90·9	93·1
11	Redruth	89·7	91·9	94·1
a	Isles of Scilly	88·8	91·0	93·2
	North			
12	Belmont	88·8s	90·9s	93·1s
13	Holme Moss	89·3s	91·5s	93·7s
a	Scarborough	89·9s	92·1s	94·3s
b	Sheffield	89·9s	92·1s	94·3s
c	Wensleydale	88·3s	90·5s	92·7s
	North West			
13	Holme Moss	89·3s	91·5s	93·7s
d	Douglas	88·4	90·6	92·8
e	Kendal	88·7	90·9s	93·1s
f	Morecambe Bay	90·0	92·2s	94·4s
g	Windermere	88·6s	90·8s	93·0s
	North East			
14	Pontop Pike	88·5	90·7	92·9
a	Weardale	89·7	91·9	94·1
b	Whitby	89·6	91·8	94·0
15	Sandale	88·1	90·3	94·7

Frequencies (MHz)

	SCOTLAND	R1/2	R3	R4
16	Kirk o'Shotts	89·9	92·1	94·3
a	Ashkirk	89·1	91·3	93·5
	Ayr**	88·7	90·9	93·1
b	Campbeltown	88·2	90·4	92·6
c	Forfar	88·3	90·5	92·7
d	Lochgilphead	88·3	90·5	92·7
	Millburn Muir**	88·8	91·0	93·2
e	Perth	89·3	91·5	93·7
f	Pitlochry	89·2	91·4	93·6
	Rosneath**	89·2	91·4	93·6
g	Toward	88·5	90·7	92·9
17	Meldrum	88·7	90·9	93·1
a	Bressay	88·3	90·5	92·7
b	Grantown	89·8	92·0	94·2
c	Kingussie	89·1	91·3	93·5
d	Orkney	89·3	91·5	93·7
e	Thrumster	90·1	92·3	94·5
18	Rosemarkie	89·6	91·8	94·0
a	Ballachulish	88·1	90·3	92·5
b	Fort William	89·3	91·5	93·7
c	Kinlochleven	89·7	91·9	94·1
d	Melvaig	89·1	91·3	93·5
e	Oban	88·9	91·1	93·3
f	Penifiler	89·5	91·7	93·9
g	Skriaig	88·5	90·7	92·9
15	Sandale	88·1	90·3	92·5

Frequencies (MHz)

	WALES	R1/2	R3	R4
19	Blaenplwyf	88·7	90·9	93·1
a	Dolgellau	90·1	92·3	94·5
b	Ffestiniog	88·1	90·3	92·5
c	Machynlleth	89·4	91·6	93·8
20	Haverfordwest	89·3	91·5	93·7
21	Llanddona	89·6	91·8	94·0
a	Betws-y-Coed	88·2	90·4	92·6
b	Llangollen	88·85	91·05	93·25
8	Wenvoe	89·95	96·8	94·3
b	Brecon	88·9	91·1	93·3
c	Carmarthen	88·5	90·7	92·9
d	Llandrindod Wells	89·1	91·3	93·5
e	Llanidloes	88·1	90·3	92·5

Frequencies (MHz)

	N. IRELAND	R1/2	R3	R4
22	Divis	90·1	92·3	94·5
a	Ballycastle	89·0	91·2	93·4
b	Brougher Mountain	88·9	91·1	93·3
c	Kilkeel	88·8	91·0	93·2
d	Larne	89·1	91·3	93·5
e	Londonderry	88·3	90·55	92·7
f	Maddybenny More	88·7	90·9	93·1
g	Newry	88·6	90·8	93·0

s Carries stereophonic programmes
** Not yet in service

With acknowledgement to the Engineering Information Department of the BBC