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:

1. **Tip**
   - Colour: Red
   - Value: 1

2. **Dot**
   - Colour: Black
   - Value: 0

3. **Tolerance**
   - Colour: Grey
   - Value: 5%

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).

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 |

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

| 1.0 | 1.3 | 1.6 | 2.0 | 2.4 | 3.0 | 3.6 | 4.3 | 5.1 | 6.2 | 7.5 | 9.1 |

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.

CAPACITOR COLOUR CODE

- **Temperature coefficient**
- **First figure**
- **Second figure**
- **47μF 6.3V**

- **Multiplier**
- **Voltage**

| 0.010 | 0.015 | 0.022 | 0.033 | 0.047 | 0.068 | 0.10 | 0.15 | 0.22 | 0.33 | 0.47 | 0.68 | 1.0 | 1.5 | 2.2 | 4.7 |

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:

R = 10000pF 20%
Nom value | Becomes
---|---
15Ω | 15R (multiplier = x1)
33Ω | 330R (multiplier = x1)
5-6kΩ | 5kΩ (multiplier = x1000)
47kΩ | 47kΩ (multiplier = x1000)
1-2MΩ | 1MΩ (multiplier = x1000000)
18MΩ | 18MΩ (multiplier = 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%
- 120kΩJ = 120kΩ 5%
- 156K = 156Ω 10%
- 63M = 6·3Ω 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.

<table>
<thead>
<tr>
<th>Spread</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>10%</td>
<td>9–11</td>
</tr>
<tr>
<td>12%</td>
<td>12–13</td>
</tr>
<tr>
<td>15%</td>
<td>15–16</td>
</tr>
<tr>
<td>18%</td>
<td>18–19</td>
</tr>
<tr>
<td>22%</td>
<td>22–23</td>
</tr>
<tr>
<td>27%</td>
<td>27–29</td>
</tr>
<tr>
<td>33%</td>
<td>33–36</td>
</tr>
<tr>
<td>39%</td>
<td>39–42</td>
</tr>
<tr>
<td>47%</td>
<td>47–51</td>
</tr>
<tr>
<td>56%</td>
<td>56–61</td>
</tr>
<tr>
<td>68%</td>
<td>68–74</td>
</tr>
<tr>
<td>82%</td>
<td>82–90</td>
</tr>
</tbody>
</table>

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 6·2kΩ and 7·4kΩ or a 1·2MΩ of 5% between 1·1MΩ and 1·3MΩ.

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.

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 MICROFarad (μF). 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:

<table>
<thead>
<tr>
<th>Colour</th>
<th>More than 10pF</th>
<th>10pF or less</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black</td>
<td>± 20%</td>
<td>± 0·1pF</td>
</tr>
<tr>
<td>Brown</td>
<td>± 2%</td>
<td>± 0·02pF</td>
</tr>
<tr>
<td>Red</td>
<td>± 5%</td>
<td>± 0·05pF</td>
</tr>
<tr>
<td>Green</td>
<td>± 10%</td>
<td>± 0·1pF</td>
</tr>
<tr>
<td>White</td>
<td>± 10%</td>
<td>± 0·1pF</td>
</tr>
</tbody>
</table>

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:

<table>
<thead>
<tr>
<th>Colour</th>
<th>Voltage rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black</td>
<td>± 20%</td>
</tr>
<tr>
<td>Brown</td>
<td>± 2%</td>
</tr>
<tr>
<td>Red</td>
<td>± 5%</td>
</tr>
<tr>
<td>Green</td>
<td>± 10%</td>
</tr>
<tr>
<td>White</td>
<td>± 10%</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Colour</th>
<th>More than 10pF</th>
<th>10pF or less</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black</td>
<td>± 20%</td>
<td>± 0·1pF</td>
</tr>
<tr>
<td>Brown</td>
<td>± 2%</td>
<td>± 0·02pF</td>
</tr>
<tr>
<td>Red</td>
<td>± 5%</td>
<td>± 0·05pF</td>
</tr>
<tr>
<td>Green</td>
<td>± 10%</td>
<td>± 0·1pF</td>
</tr>
<tr>
<td>White</td>
<td>± 10%</td>
<td>± 0·1pF</td>
</tr>
</tbody>
</table>

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:

<table>
<thead>
<tr>
<th>Colour</th>
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<tbody>
<tr>
<td>Black</td>
<td>± 20%</td>
</tr>
<tr>
<td>Brown</td>
<td>± 2%</td>
</tr>
<tr>
<td>Red</td>
<td>± 5%</td>
</tr>
<tr>
<td>Green</td>
<td>± 10%</td>
</tr>
<tr>
<td>White</td>
<td>± 10%</td>
</tr>
</tbody>
</table>

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
- n = 10⁻⁹
- μ = 10⁻⁶

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

1μF = 10⁶F

Hence 1nF = 1000μF

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

<table>
<thead>
<tr>
<th>Nominal value</th>
<th>Becomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1pF</td>
<td>1pF</td>
</tr>
<tr>
<td>330pF</td>
<td>330pF</td>
</tr>
<tr>
<td>1nF</td>
<td>1nF</td>
</tr>
<tr>
<td>1000pF</td>
<td>1000pF</td>
</tr>
<tr>
<td>4700pF</td>
<td>4700pF</td>
</tr>
<tr>
<td>10000pF</td>
<td>10000pF</td>
</tr>
<tr>
<td>1μF</td>
<td>1μF</td>
</tr>
<tr>
<td>10μF</td>
<td>10μF</td>
</tr>
<tr>
<td>100μF</td>
<td>100μF</td>
</tr>
<tr>
<td>1kF</td>
<td>1kF</td>
</tr>
<tr>
<td>10kF</td>
<td>10kF</td>
</tr>
<tr>
<td>100kF</td>
<td>100kF</td>
</tr>
</tbody>
</table>

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

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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:

**COMMON**

2 & 3

5 & 6

**LEFT CHANNEL**

3

6

**RIGHT CHANNEL**

2

5

Miniature plugs and sockets, frequently found on transistorised radios, are either 2-5 or 3.5mm in diameter.

**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 of voltage or current plotted against the decibel scale (dB). If specific examples need to be worked out the following formula can be used:

\[ dB = 10 \log \left( \frac{P_1}{P_2} \right) \]

where \(P_1\) and \(P_2\) 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 \(P_1\) 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:

\[ dB = 20 \log \left( \frac{V_1}{V_2} \right) \text{ or } \frac{1}{2} \]

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

\[ dB = 20 \log \left( \frac{V_1}{V_2} + 10 \log \frac{Z_1}{Z_2} \right) \]

for voltage gains or losses, or substituting \(1/12\) 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.

**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 amperc 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.

**SOME AUDIO TERMS EXPLAINED**

The specification for the performance of an audio amplifier system will often include terms using decibels above or below (\(\text{dB}\)) 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.

<table>
<thead>
<tr>
<th>Loss (dB)</th>
<th>Power Ratio (approx.)</th>
<th>Voltage Ratio (approx.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1:1</td>
<td>1:1</td>
</tr>
<tr>
<td>1</td>
<td>0.86</td>
<td>0.9</td>
</tr>
<tr>
<td>2</td>
<td>0.62</td>
<td>0.8</td>
</tr>
<tr>
<td>3</td>
<td>0.52</td>
<td>0.7</td>
</tr>
<tr>
<td>4</td>
<td>0.42</td>
<td>0.6</td>
</tr>
<tr>
<td>5</td>
<td>0.33</td>
<td>0.56</td>
</tr>
<tr>
<td>6</td>
<td>0.25</td>
<td>0.5</td>
</tr>
<tr>
<td>7</td>
<td>0.17</td>
<td>0.4</td>
</tr>
<tr>
<td>8</td>
<td>0.12</td>
<td>0.3</td>
</tr>
<tr>
<td>9</td>
<td>0.08</td>
<td>0.2</td>
</tr>
<tr>
<td>10</td>
<td>0.06</td>
<td>0.1</td>
</tr>
<tr>
<td>11</td>
<td>0.05</td>
<td>0.06</td>
</tr>
<tr>
<td>12</td>
<td>0.04</td>
<td>0.04</td>
</tr>
</tbody>
</table>

**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 (8/10ths) of maximum power output at these limits.

**Signal to Noise Ratio:**—Typically stated. 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 50000/10000 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.
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.

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.

\[ I = \frac{E}{R} \]

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.

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

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) = \( 4 \times 20 = 80 \) 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 formula.

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

E = IR = \frac{250}{1000000 \times 10000} = 2.5 (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, \( R_1 + R_2 \) etc., no further explanation is necessary. When the resistors are connected in parallel the formula \( \frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} \) etc. is used. The Calculator on this Datacard gives the resultant value of two resistors in parallel without recourse to a formula.

\[
\begin{align*}
\frac{1}{R} &= \frac{1}{R_1} + \frac{1}{R_2} \\
\text{or} \quad R &= \frac{R_1 R_2}{R_1 + R_2}
\end{align*}
\]

With capacitors in series the same type of formula holds as was used for resistors in parallel, namely \( \frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} \) 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.

\[
\begin{align*}
\frac{1}{C} &= \frac{1}{C_1} + \frac{1}{C_2} \\
\text{or} \quad C &= \frac{C_1 C_2}{C_1 + C_2}
\end{align*}
\]

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 value 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, 180kΩ (180kΩ) and 68kΩ (68kΩ) may be divided by 1000 to give 18 and 6-8 on the scales. The answer from the centre scales is then multiplied by 1000, in this case 4-9 x 1000 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 82000pF 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.

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.

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.

<table>
<thead>
<tr>
<th>BAND</th>
<th>WAVELENGTH</th>
<th>FREQUENCY</th>
<th>DESIGNATION</th>
<th>MODULATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>LW</td>
<td>1875 to 1176m</td>
<td>160 to 255kHz</td>
<td>Low Frequency</td>
<td>Amplitude (AM)</td>
</tr>
<tr>
<td>MW</td>
<td>571 to 187m</td>
<td>525 to 1605kHz</td>
<td>Medium Frequency</td>
<td>Amplitude (AM)</td>
</tr>
<tr>
<td>II</td>
<td>3.4 to 3.1m</td>
<td>88 to 97.6MHz</td>
<td>Very High Frequency</td>
<td>Frequency (FM)</td>
</tr>
</tbody>
</table>

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.

Fig. 3. The other end of the feeder is terminated by a plug to fit the receiver input socket.

Each half 2½ - 6½
1/8" dia. tubing

75 ohm unbalanced

BALUN

Overall length 5'-2½"

Receiver input

Receiver 300 ohms balanced

This aerial, like any other aerial, should be mounted as high up as possible and clear of any buildings, walls or large metal objects or structures. VHF signals will bounce off buildings, hills, gas holders 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.
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.

**DIMENSIONS FOR AERIAL SHOWN IN Fig. 6**

Dimensions assume use of tubing 3/4 in diameter. Director D can be omitted if a 3-element beam is required.

**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.