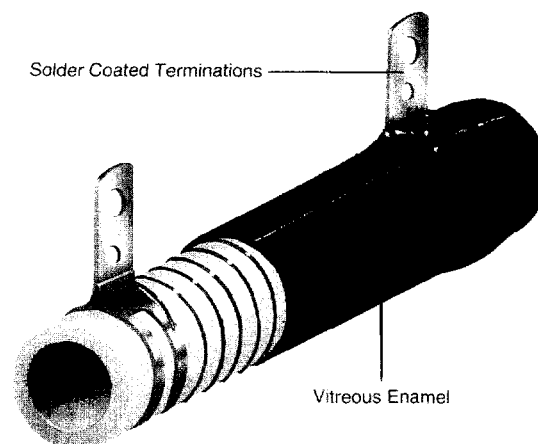


# Tubular Vitreous Enamelled Wirewound Resistors

1600/1900 Series

- Impervious lead free vitreous enamel coating
- High purity ceramic substrate
- Based on thirteen tube sizes
- Can be supplied with fixed, adjustable, tapped or low inductance winding.
- Seven termination styles with choice of mounting arrangements
- All welded/brazed construction



## GENERAL INFORMATION

Vitreous enamelled wirewound resistors are capable of withstanding a higher dissipation, size for size, than any other protected type; this is attributable to the higher operating temperature which the wire and enamel can withstand. Vitreous enamel provides exceptionally good protection to the wire element and is essentially impervious to moisture. The resistors can safely be used in harsh environmental conditions.

The Welwyn range is based on thirteen sizes of tube, each of which has a recommended maximum dissipation which limits operating surface temperature to a maximum of 375°C

The stability and high reliability of Welwyn tubular vitreous resistors is a direct result of the best quality materials being used in their construction.

High purity ceramic tubes have been matched with nickel chromium resistance alloy wires and specially formulated enamel to ensure that the resistors can withstand repeated heat cycling without damage.

Connections between the resistance element and end terminations are welded; other connections are brazed.

Mounting devices are available which permit resistors to be mounted by both ends or by one end. Single ended mounting is recommended for applications which do not subject the resistor to shock or vibration. Ferrules and the F type mounting plug are anchored into the tubes with high temperature adhesive.

**Special requirements, for types or styles not described in this brochure, will be considered for economic quantities.**

## ELECTRICAL DATA

|                             |        | 1601  | 1905 | 1600 | 1602 | 1906 | 1603 | 1604 |
|-----------------------------|--------|---|------|------|------|------|------|------|
| Power rating at 70°C        | Watts  | 11  | 16   | 16.5 | 17   | 22   | 25   | 35   |
| Resistance range            | Ohms   | See Table 1   |      |      |      |      |      |      |
| Limiting element voltage    | Volts  | See Table 1   |      |      |      |      |      |      |
| TCR (-55° to + 200°C)       | ppm/°C | Typically <+75                      Maximum + 200                   |      |      |      |      |      |      |
| Resistance tolerance        | %      | 1, 2, 5, 10                      See table 1 for value restrictions |      |      |      |      |      |      |
| Values                      |        | Any value within the specified resistance range                     |      |      |      |      |      |      |
| Thermal impedance           | % Watt | See fig .1  |      |      |      |      |      |      |
| Operating temperature range | °C     | -55 to +375   |      |      |      |      |      |      |

## ELECTRICAL DATA

|                             |          | 1605  | 1908 | 1607 | 1606 | 1608 | 1609 |
|-----------------------------|----------|---|------|------|------|------|------|
| Power rating at 70°C        | Watts    | 47  | 54   | 76   | 91   | 115  | 165  |
| Resistance range            | Ohms     | See Table 1   |      |      |      |      |      |
| Limiting element voltage    | Volts    | See Table 1   |      |      |      |      |      |
| TCR (-55°C + 200°C)         | ppm/°C   | Typically <+75                      Maximum + 150                   |      |      |      |      |      |
| Resistance tolerance        | %        | 1, 2, 5, 10                      See table 1 for value restrictions |      |      |      |      |      |
| Values                      |          | Any value within the specified resistance range                     |      |      |      |      |      |
| Thermal impedance           | °C/Watts | See fig .1  |      |      |      |      |      |
| Operating temperature range | °C       | -55 to +375   |      |      |      |      |      |

**Note** See Figure 1 for curves of temperature rise / watts dissipation.

ELECTRICAL DATA (Continued)

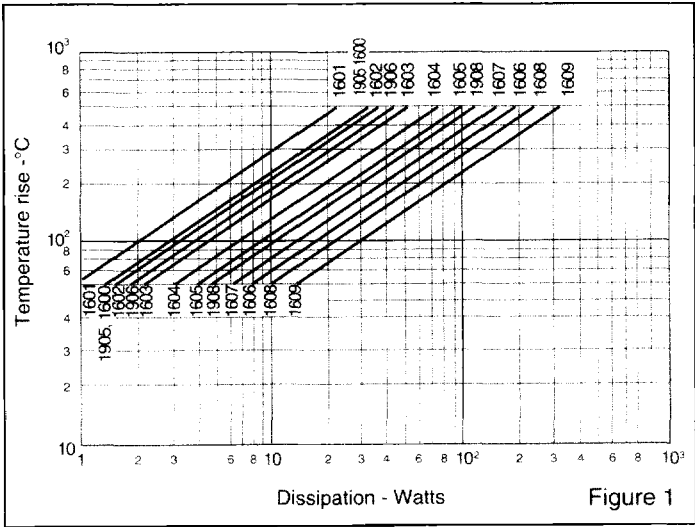
TABLE 1

| *Dissipation (watts) to produce operating hotspot temperature (°C) of: |                |      |     |               | Resistance range (ohms) |     |     |                       | Limiting element voltage |            | Low inductance winding resistance range (ohms) |     |                          |
|--|----------------|------|-----|---------------|-------------------------|-----|-----|-----------------------|--------------------------|------------|--|-----|--------------------------|
| Type   | Ambient = 20°C |      |     | Ambient =70°C | Minimum resistance at   |     |     | Max. at any tolerance | Termination style        |            | Min. res. at                                   |     | Max. at either tolerance |
|  | 200            | 300  | 375 |               | ±5%                     | ±2% | ±1% |                       | C                        | All others | ±10%   | ±5% |                          |
| 1601   | 5              | 10   | 14  | 11            | 1                       | 15  | 25  | 15k                   | 250                      | 150        | 10   | 50  | 1.3k                     |
| 1905   | 7              | 14.5 | 20  | 16            | 1                       | 15  | 30  | 30k                   | —                        | 450        | 10   | 50  | 3.5k                     |
| 1600   | 7.5            | 15   | 21  | 16.5          | 1                       | 15  | 30  | 56k                   | —                        | 600        | 10   | 50  | 5.0k                     |
| 1602   | 8              | 15.5 | 22  | 17            | 1                       | 20  | 25  | 43k                   | 500                      | 350        | 10   | 50  | 4.0k                     |
| 1906   | 9.5            | 19   | 28  | 22            | 1                       | 20  | 30  | 50k                   | 700                      | 550        | 10   | 50  | 5.5k                     |
| 1603   | 11             | 22   | 32  | 25            | 1                       | 20  | 30  | 83k                   | 850                      | 750        | 10   | 50  | 7.5k                     |
| 1604   | 15.5           | 31   | 45  | 35            | 1                       | 20  | 60  | 100k                  | 1300                     | 1000       | 15   | 50  | 11.5k                    |
| 1605   | 21             | 41   | 59  | 47            | 1                       | 30  | 40  | 100k                  | 1100                     | 900        | 15   | 50  | 14k                      |
| 1908   | 24             | 47   | 68  | 54            | 1                       | 30  | 40  | 100k                  | 1200                     | 1000       | 10   | 50  | 16k                      |
| 1607   | 34             | 66   | 95  | 76            | 1                       | 30  | 50  | 100k                  | 1300                     | 900        | 15   | 50  | 22k                      |
| 1606   | 41             | 80   | 115 | 91            | 1                       | 30  | 40  | 160k                  | 2100                     | 1900       | 15   | 50  | 32k                      |
| 1608   | 52             | 101  | 145 | 115           | 1                       | 30  | 50  | 180k                  | 2100                     | 1800       | 20   | 50  | 38k                      |
| 1609   | 74             | 145  | 208 | 165           | 1                       | 35  | 50  | 250k                  | 3000                     | 2500       | 30   | 100 | 58k                      |

\*The stated dissipation applies to resistors mounted horizontally with unobstructed bore.

PERFORMANCE DATA

|  |      | MAX  | TYP  |
|--|------|------|------|
| Load : 1000 hours at 70°C                  | ΔR % | 5.0  | 3.5  |
| Shelf life : 12 months at room temperature | ΔR % | 1.0  | 0.1  |
| Climatic                                   | ΔR % | 0.5  | 0.35 |
| Long term damp heat                        | ΔR % | 0.2  | 0.05 |
| Bump and vibration                         | ΔR % | 00.1 | 0.02 |
| Noise ( in a decade of frequency)          | μV/V | zero | zero |



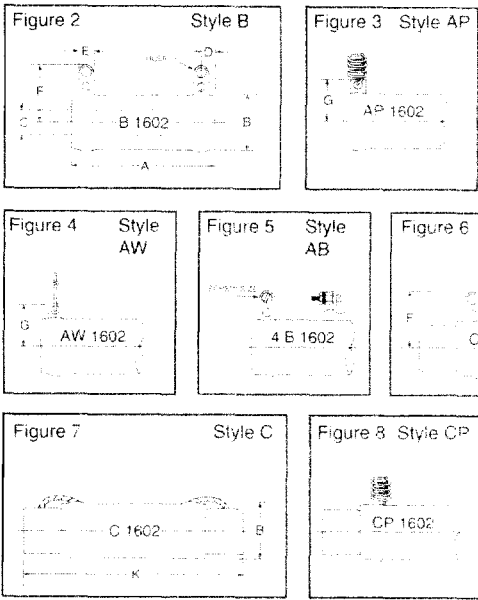
**PHYSICAL DATA**

**Table 2 Dimensions in millimetres. See fig 2-8 for styles**

| TYPE | A<br>max | B<br>max | C<br>max | D<br>nom | E<br>max | F<br>max | G<br>nom | H<br>±.25 | J  | K<br>max |
|------|----------|----------|----------|----------|----------|----------|----------|-----------|----|----------|
| 1601 | 33.0     | 17.5     | 8.2      | 4.5      | 5.0      | 19.5     | 15       | 3.0       | M3 | 59       |
| 1905 | 56.1     | 14.5     | 6.55     | 4.5      | 5.0      | 17.5     | 10       | 3.0       | M3 | —        |
| 1600 | 61.5     | 14.5     | 6.55     | 4.5      | 5.0      | 17.5     | 10       | 3.0       | M3 | —        |
| 1602 | 51.0     | 17.5     | 8.2      | 4.5      | 5.0      | 19.5     | 15       | 3.0       | M3 | 77       |
| 1906 | 64.3     | 17.5     | 8.2      | 4.5      | 5.0      | 19.5     | 15       | 3.0       | M3 | 90       |
| 1603 | 74.5     | 17.5     | 8.2      | 4.5      | 5.0      | 19.5     | 15       | 3.0       | M3 | 101      |
| 1604 | 102      | 17.5     | 8.2      | 4.5      | 5.0      | 19.5     | 15       | 3.0       | M3 | 128      |
| 1605 | 89.5     | 24.0     | 13.2     | 5.7      | 6.8      | 26.5     | 17       | 4.0       | M4 | 122      |
| 1908 | 102      | 24.0     | 13.2     | 5.7      | 6.8      | 26.5     | 17       | 4.0       | M4 | 134      |
| 1607 | 102      | 32.0     | 19.2     | 7.0      | 9.8      | 32.0     | 22       | 6.4       | M6 | 134      |
| 1606 | 166      | 24.0     | 13.2     | 5.7      | 6.8      | 26.5     | 17       | 4.0       | M4 | 198      |
| 1608 | 152      | 32.0     | 19.2     | 7.0      | 9.8      | 32.0     | 22       | 6.4       | M6 | 184      |
| 1609 | 216      | 32.0     | 19.2     | 7.0      | 9.8      | 32.0     | 22       | 6.4       | M6 | 248      |

**TERMINATIONS**

Styles B, 4B, AP and AW are available in all 13 tube sizes.  
 Styles C, CB and CP are available in sizes 1601 to 1609 inclusive, 1906 and 1908  
**Lugs (Figure 2):** 60/40 solder coated nickel iron. Denoted by prefix B to size reference, thus B1602  
**Pigtails (Figure 3):** 14/.193 mm copper, 150 mm minimum length. Denoted by prefix AP, thus: AP1602  
**Rigid wires (Figure 4):** 1.2 mm diameter tinned copper, 32 mm minimum length.. Denoted by prefix AW, thus: AW1602  
**Lugs with screws, nuts and washers (Figure 5):** Nickel plated brass screws and nuts. Denoted by prefix 4B, thus: 4B1602  
**Ferrule, electrically isolated (Figure 6):** Connection to resistor via 60/40 solder coated nickel iron lugs. Denoted by prefix CB, thus: CB1602  
**Ferrule electrically live (Figure 7):** Nickel plated brass. Denoted by prefix C, thus: C1602  
**Ferrule, electrically isolated (Figure 8):** Connection to resistor via pigtails of 14/.193 mm copper, 150mm minimum length. Denoted by prefix CP thus: CP1602



**MARKING** The resistors are legend marked with type reference, resistance value tolerance and manufacturing date code. Value marking conforms to IEC 62

**SOLVENT RESISTANCE:** The vitreous coating and marking are resistant to all accepted industrial cleaning fluids.

**ORDERING PROCEDURE**  
 Specify type reference etc. as indicated  
 in this example of C1602 10Ω 5%

Type C1602 10R J  
 Value (use IEC62 code) \_\_\_\_\_  
 Tolerance (use IEC62 code) \_\_\_\_\_

Send your order direct to Welywn Components

**ADJUSTABLE RESISTORS** (See Figure 9)

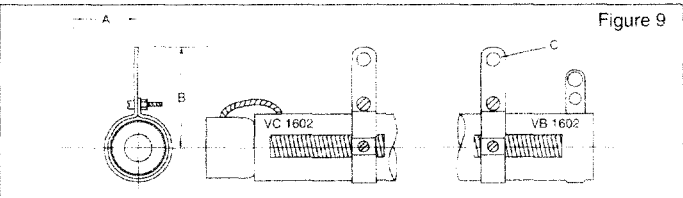
Adjustable resistors use the same basic construction as fixed resistors already described, and have a window in the vitreous enamel through which contact is made to the resistive element by a sliding contact band. The band is fitted with a clamping screw and nut to retain it firmly in position.  
 The adjustable winding style has a maximum permissible hot spot temperature of 300°C and the maximum dissipation, for an ambient temperature of 20°C, is specified in Table 4. The partial open winding necessitates a reduced maximum resistance, when compared with fixed resistors, and the resistance range is also defined in Table 4.  
 More than one adjusting band can be fitted, up to the maximum number specified in Table 3.  
 Adjustable resistors are available in termination styles B, 4B, AP, C, CB and CP, in sizes 1602 to 1609 inclusive and 1906 and 190

**TABLE 4**

| Type | Max dissipation in 20°C ambient (watts) |                | Resistance range (ohms) |                           |                     |
|------|---|----------------|-------------------------|---------------------------|---------------------|
|      | 200°C hot spot                          | 300°C hot spot | Min. for styles VC, VCP | Min. for all other styles | Max. for all styles |
| 1602 | 8                                       | 15.5           | 4                       | 3                         | 1.6k                |
| 1906 | 9.5                                     | 19             | 4                       | 3                         | 2.5k                |
| 1603 | 11                                      | 22             | 5                       | 6                         | 3.0k                |
| 1604 | 16                                      | 31             | 8                       | 8                         | 5.3k                |
| 1605 | 21                                      | 41             | 6                       | 6                         | 4.5k                |
| 1905 | 24                                      | 47             | 11                      | 10                        | 7.5k                |
| 1607 | 34                                      | 66             | 11                      | 9                         | 8.1k                |
| 1606 | 41                                      | 80             | 14                      | 13                        | 13.2k               |
| 1608 | 52                                      | 101            | 17                      | 16                        | 15.4k               |
| 1609 | 74                                      | 145            | 25                      | 24                        | 24.5k               |

**TABLE 3**

| Tube size        | A mm max | B mm max. | Hole C dia. mm. | Max. no. of adjusting bands |
|------------------|----------|-----------|-----------------|-----------------------------|
| 1602, 1603, 1906 | 20       | 27        | 3.2             | 1                           |
| 1604             | 20       | 27        | 3.2             | 3                           |
| 1605, 1908       | 25       | 32        | 3.7             | 2                           |
| 1606             | 25       | 32        | 3.7             | 4                           |
| 1607             | 30       | 38        | 3.7             | 2                           |
| 1608             | 30       | 38        | 3.7             | 3                           |
| 1609             | 30       | 38        | 3.7             | 5                           |



**MANUFACTURED VALUES**  
 Available in any value within the specified resistance range. Requirements for resistance values outside the stated limits will be examined by our engineers and a quotation given, if production is practicable

**STANDARD SELECTION TOLERANCE ±10%**  
 All other details (details) of the electrical and environmental performance of adjustable resistors are the same as for fixed resistors.

**ORDERING PROCEDURE**  
 Specify type reference etc. as indicated in this example of adjustable VCP 1602 60 ohms 10%

Adjustable V CP1602 60R K  
 Type \_\_\_\_\_  
 Value (Use IEC62 Code) \_\_\_\_\_  
 Tolerance (Use IEC62 Code) \_\_\_\_\_

Send your direct order to Welywn Components

## TAPPED RESISTORS See Figure 10

Fixed resistors can be supplied with taps to special order. Because of the reduced winding length, the total resistance of a tapped resistor will be less than can be offered on a fixed resistor of the same size. The reduction is proportional to the number of taps and Table 5 is intended as a guide.

The minimum resistance per section on all sizes is 1Ω and the standard selection tolerance for any section is ±10%.

### ORDERING PROCEDURE

Enquiries for tapped resistors must state the following details:

Resistance per section

Maximum dissipation per section

Maximum operating ambient temperature

Maximum permissible dimensions if important.

Type of terminations required. (See 'Terminations', page 3)

Resistor style or proposed method of mounting.

| TABLE 5 |  |   |                      |
|---------|--|---|----------------------|
| Type    | *Maximum total dissipation in 20°C ambient (watts) with single tap | *Max. total resistance with single tap (ohms) | *Max. number of taps |
| 1905    | 14.5   | 9k  | 1                    |
| 1600    | 15.0   | 12k   | 1                    |
| 1602    | 15.5   | 9K  | 1                    |
| 1906    | 19.0   | 13k   | 1                    |
| 1603    | 22   | 18k   | 1                    |
| 1604    | 31   | 29k   | 2                    |
| 1605    | 41   | 34k   | 2                    |
| 1908    | 47   | 38k   | 2                    |
| 1607    | 66   | 53k   | 2                    |
| 1606    | 80   | 78k   | 4                    |
| 1608    | 101  | 93k   | 4                    |
| 1609    | 145  | 140k  | 4                    |

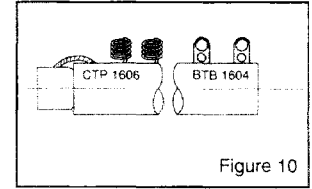


Figure 10

\*Maximum total dissipation assumes that this will be evenly spread over the total element length.

## LOW INDUCTANCE RESISTORS

Ayrton-Perry wound elements are supplied for low inductance applications. This winding style has a maximum permissible hot spot temperature of 300°C. The maximum dissipation is defined in Table 1 under the heading *Operating hot spot temperature of 300°C*, and resistance ranges are defined in the three right-hand columns of this table.

### ORDERING PROCEDURE

Specify the full type reference, resistance value and tolerance, using IEC 62 code references. The addition of L to the prefix describing terminal configuration indicates Ayrton-Perry winding. Eg BL 1602/50R ±5%

## APPLICATION NOTES

When cold, vitreous enamel has excellent insulation resistance. In common with all insulants the specific resistance of the enamel decreases with increased temperature; therefore, if operated at any temperature approaching the maximum, the resistor cannot be classed as an insulated type and should not be used in contact with any conducting materials.

The recommended dissipations for each of the resistor hot spot temperatures applies to resistors mounted horizontally. If the bore is completely blocked a 15% derating is recommended. However, wherever possible, resistors should be mounted vertically with unobstructed bore.

This makes best use of the chimney effect of the heated tube and will encourage a cooling stream of air through the bore.

Allowances must be made, when tubular resistors are mounted in banks, for the effects produced by radiation between tubes.

Appreciable reduction of hot spot temperature can be achieved by arranging that resistors are subjected to some measure of forced draught. In general, it is most efficient to extract air from the resistor enclosure and arrange that an air inlet is adjacent to the bottom of the tubes.

If soft soldered connections are used the resistors should be derated where applicable to limit the hot spot temperature to 300°C.

# Mounting devices for 1600/1900 series

**Table 6** Mounting clip dimensions (mm) See Fig.11

| Clip ref.  | Type | A nom. | B max. | C nom. | D max. | E max. | F max. | G $\pm 0.2$ | H dia. | J dia. | K nom. | Auxiliary locking Spring ref. |
|------------|------|--------|--------|--------|--------|--------|--------|-------------|--------|--------|--------|-------------------------------|
| MD1<br>MD4 | 1601 | 52     | 68     |        |        |        |        |             |        |        |        | MD16                          |
|            | 1602 | 70     | 86     |        |        |        |        |             |        |        |        |                               |
|            | 1603 | 90     | 106    | 29     | 19     | 17.5   | 14.5   | 4.8         | 4.0    | 3.9    | 7.2    |                               |
|            | 1604 | 121    | 137    |        |        |        |        |             |        |        |        |                               |
|            | 1906 | 83     | 99     |        |        |        |        |             |        |        |        |                               |
| MD2<br>MD5 | 1605 | 108    | 128    |        |        |        |        |             |        |        |        | MD17                          |
|            | 1908 | 187    | 207    | 35     | 22     | 25.5   | 17.5   | 5.6         | 4.0    | 4.7    | 8.7    |                               |
| MD3<br>MD6 | 1607 | 125    | 146    |        |        |        |        |             |        |        |        | MD18                          |
|            | 1608 | 176    | 197    | 49     | 33     | 32.0   | 19.0   | 6.4         | 4.0    | 6.3    | 9.5    |                               |
|            | 1609 | 240    | 261    |        |        |        |        |             |        |        |        |                               |

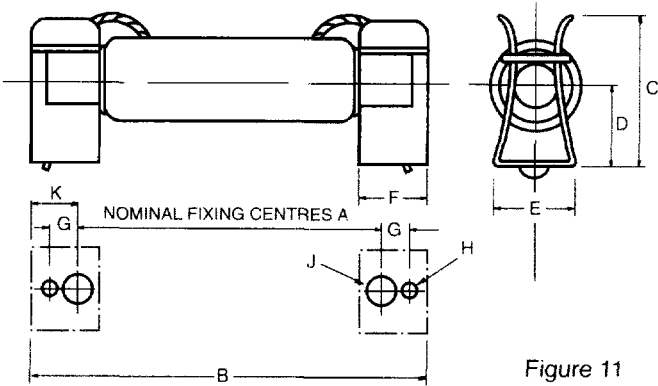


Figure 11

These mounting clips are suitable for termination styles C, CB and CP. MD4,5 and 6 have an ear formed in the bottom surface of the bracket to prevent rotation of the mounting plate. The auxiliary locking springs ensure positive retention of the tube under severe mechanical shock conditions. See Figure 11.

**ORDERING PROCEDURE**  
Mounting clips (and auxiliary locking springs when required) should be ordered in units and specify the type reference.

**Table 7** Mounting brackets dimensions (mm). See Fig. 12.

| Bracket ref. | Type | A nom | B nom | C nom | D nom | E nom |
|--------------|------|-------|-------|-------|-------|-------|
| MD40         | 1600 | 78    | 92    | 10    | 20    | 4.2   |
|              | 1905 | 73    | 87    |       |       |       |
| MD41         | 1601 | 50    | 64    |       |       |       |
|              | 1602 | 68    | 82    |       |       |       |
|              | 1603 | 91    | 105   | 13    | 20    | 4.2   |
|              | 1604 | 119   | 133   |       |       |       |
|              | 1906 | 81    | 95    |       |       |       |
| MD42         | 1605 | 106   | 120   |       |       |       |
|              | 1606 | 183   | 197   | 20    | 25    | 5.2   |
|              | 1908 | 119   | 133   |       |       |       |
| MD43         | 1607 | 121   | 143   |       |       |       |
|              | 1608 | 171   | 193   | 28    | 30    | 5.2   |
|              | 1609 | 235   | 257   |       |       |       |

These brackets are suitable for termination styles B, 4B, AP & AW

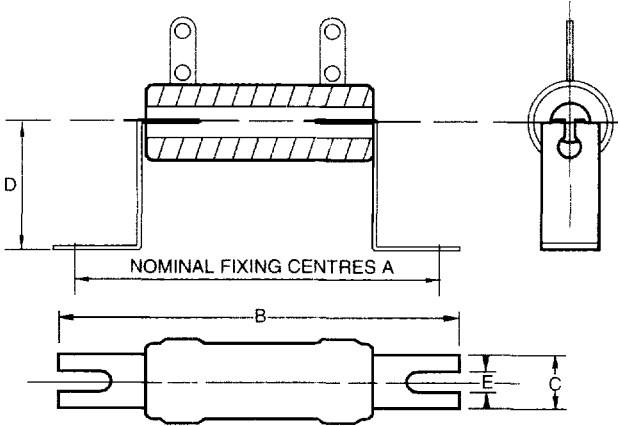


Figure 12

**ORDERING PROCEDURE**  
Mounting brackets should be ordered in units and specify the type reference.

**TABLE 8** Mounting plug dimensions (mm) See Fig. 13.

| Type                                 | A   | Min. | Max. | C  |
|--------------------------------------|-----|------|------|----|
| 1601<br>1602<br>1603<br>1604<br>1906 | 1.6 | 3.7  | 5.3  | M4 |
| 1605<br>1606<br>1908                 | 1.6 | 3.7  | 5.3  | M5 |
| 1607<br>1608<br>1609                 | 3.2 | 5.2  | 6.8  | M6 |

F type bushes are suitable for termination styles B, 4B, AP and AW

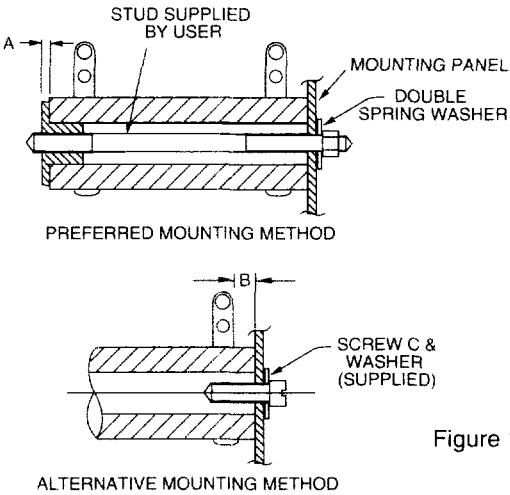


Figure 13

**ORDERING PROCEDURE**  
Mounting plugs are denoted by the prefix 'F' added to the size reference; e.g. BF1602 and APIF1602.