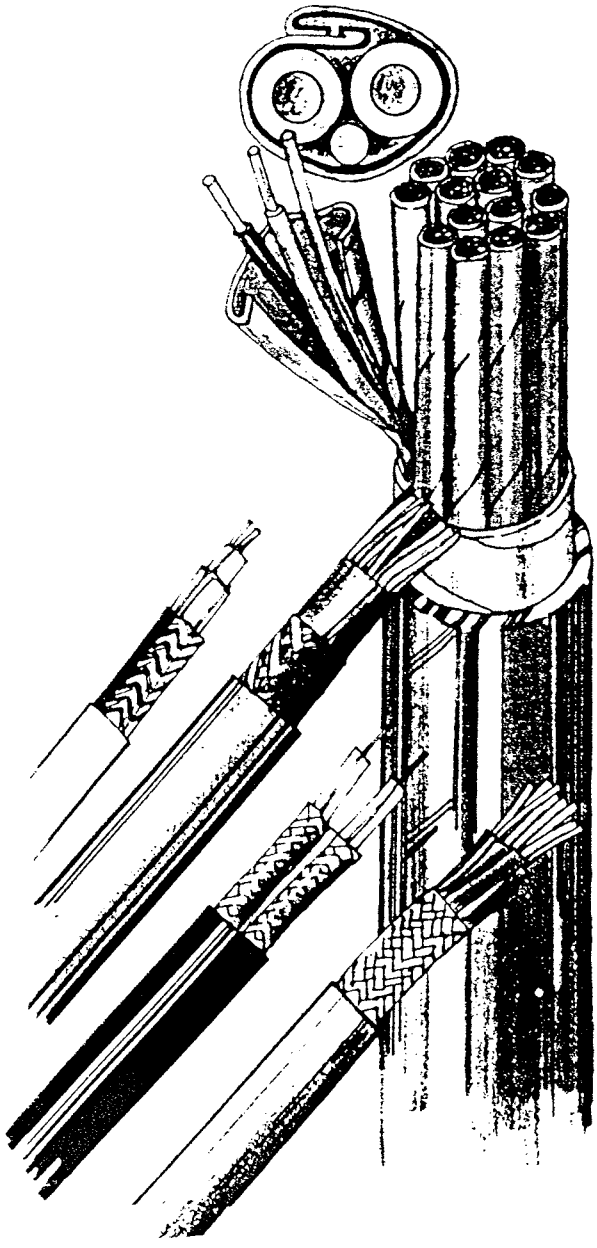
DIRECTOR OF S & T ENGINEERING.
WEST MIDLANDS PROJECTS GROUP.

# *CABLES & TABLES*



## Definitions:-

### CORE

Any single conductor in a group of conductors insulated from all others. Each core being numbered with figures alone or additionally with the core number in words. Number one core is at the centre of the cable.

### END

**"A"** end is the end of the cable at which the numbering of cores increases clockwise from the centre of the cable.

**"Z"** end is the end of the cable at which the numbering of cores increases anti-clockwise from the centre of the cable.

### INSULATION

Non conducting material (rubber & polychloroprene compound) surrounding individual cores.

### RESISTANCE

(a) **Insulation** - resistance preventing leakage of current.

(b) **Line** - resistance of a single core between **"A"** and **"Z"** ends usually quoted in Ohms per km or Ohms per mile.

(c) **Loop** - resistance of two cores, shorted together at "Z" end, measured at "A" end. (ie. line resistance X 2).

### SHEATH

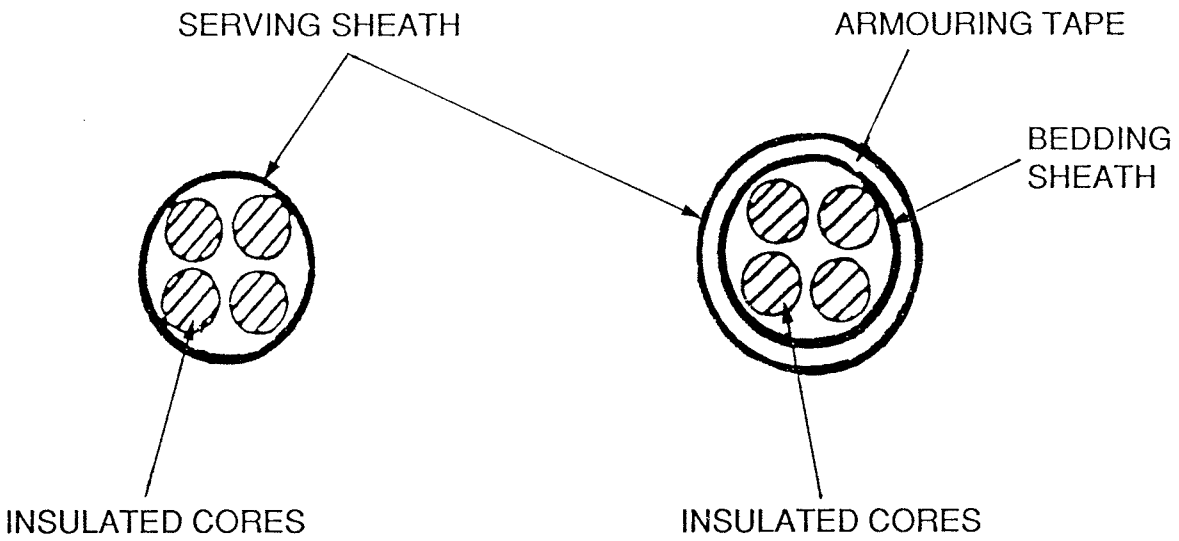
(a) **Bedding** - layer of insulating/protecting material (polychloroprene) surrounding all cores before armouring applied.

(b) **Serving** - outer layer of insulating/protecting material (polychloroprene) applied to the cable.

### ARMOURING

Corrugated steel tape or brass tape to protect cable against mechanical stress.

continued




**Non-armoured** **Armoured**

## Cable Identification

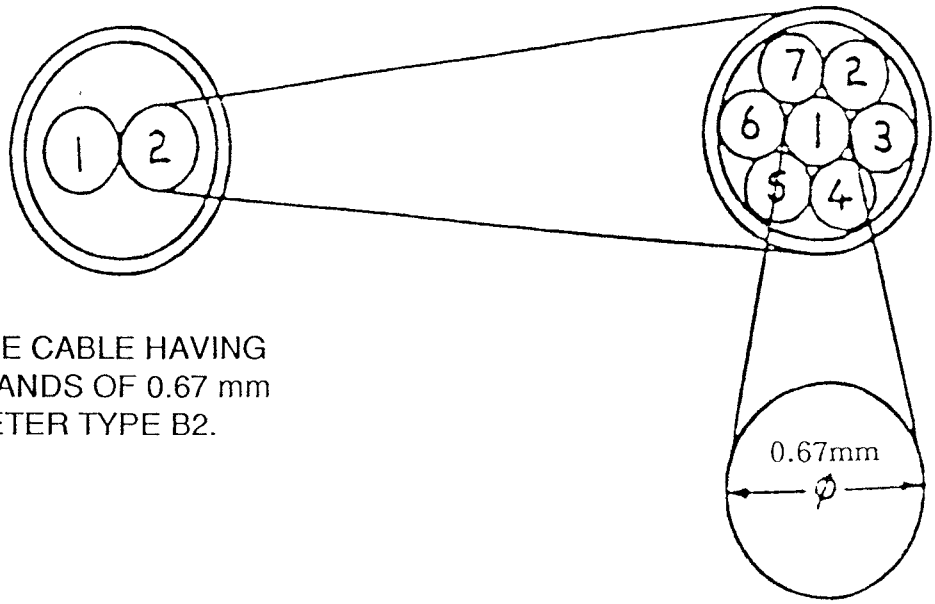
Cables are identified by:-

(a) The number of conductors (cores) in the cable eg. 1c, 7c, 27c etc.

(b) The number of strands per core.

(c) Diameter in milli-metres of each strand (older cables in use today may be quoted in imperial dimensions).

(d) Cable type eg. 7/0.67 mm B2.




2 CORE CABLE HAVING
7 STRANDS OF 0.67 mm
DIAMETER TYPE B2.

continued

Jelly filled cables are identified by pairs, rather than individual cores to indicate their size.

eg. 20 pair 0.9 mm Jelly filled cable.

NB. Jelly filled cables only have one strand per core, so 1/0.9 mm becomes 0.9 mm.

General notes:-

When dealing with twin conductor cables remember to **double the resistance** value to cater for the loop.

Also check that the cable you have specified is designed to be used at the voltage you require and it has the current carrying capacity required.

**Extract from BICC booklet "CABLES & TABLES"**

## Current ratings and associated voltage drop

### Cables installed in air

**PVC insulated, unarmoured cables, with or without sheath, with copper conductors**

**Table 17** **Conduit wire and single core sheathed cables to BS 6004 and 6346**

**Conductor temperature 70°C**

| *Conductor area* | *Bunched and enclosed in conduit or trunking. Bunched and enclosed in underground conduit or ducts** | | | | *Clipped direct to a surface or on a cable tray, bunched and enclosed. Embedded direct in plaster. Suspended in free air.* | | | |
|---|---|---|---|---|---|---|---|---|
| | *Two cables, single phase ac, or dc* | | *Three or four cables, three phase ac* | | *Two cables, single phase ac, or dc* | | *Three or four cables, three phase ac* | |
| | *Current rating* | *Volt drop per amp per metre* | *Current rating* | *Volt drop per amp per metre* | *Current rating* | *Volt drop per amp per metre* | *Current rating* | *Volt drop per amp per metre* |
| *mm²* | *amp* | *mV* | *amp* | *mV* | *amp* | *mV* | *amp* | *mV* |
| 1·0 | 14 | 42 | 12 | 37 | 17 | 42 | 16 | 37 |
| 1·5 | 17 | 28 | 14 | 24 | 21 | 28 | 20 | 24 |
| 2·5 | 24 | 17 | 21 | 15 | 30 | 17 | 26 | 15 |
| 4 | 32 | 11 | 29 | 9·2 | 40 | 11 | 36 | 9·2 |
| 6 | 41 | 7·1 | 37 | 6·2 | 50 | 7·1 | 45 | 6·2 |
| 10 | 55 | 4·2 | 51 | 3·7 | 68 | 4·2 | 61 | 3·7 |
| 16 | 74 | 2·7 | 66 | 2·3 | 90 | 2·7 | 81 | 2·3 |
| 25 | 97 | 1·7 | 87 | 1·5 | 118 | 1·7 | 106 | 1·5 |
| 35 | 119 | 1·3 | 106 | 1·1 | 145 | 1·3 | 130 | 1·1 |
| | | ac dc | | | | ac dc | | |
| 50 | 145 | 0·97 0·91 | 125 | 0·84 | 175 | 0·93 0·91 | 160 | 0·82 |
| 70 | 185 | 0·71 0·63 | 160 | 0·62 | 220 | 0·65 0·63 | 200 | 0·59 |
| 95 | 230 | 0·56 0·45 | 195 | 0·48 | 270 | 0·48 0·45 | 240 | 0·45 |
| 120 | 260 | 0·48 0·36 | 220 | 0·42 | 310 | 0·40 0·36 | 280 | 0·38 |
| 150 | — | — — | — | — | 355 | 0·34 0·29 | 320 | 0·34 |
| 185 | — | — — | — | — | 405 | 0·29 0·24 | 365 | 0·30 |
| 240 | — | — — | — | — | 480 | 0·24 0·18 | 430 | 0·27 |
| 300 | — | — — | — | — | 560 | 0·22 0·14 | 500 | 0·25 |
| 400 | — | — — | — | — | 680 | 0·20 0·12 | 610 | 0·24 |
| 500 | — | — — | — | — | 800 | 0·18 0·086 | 710 | 0·23 |
| 630 | — | — — | — | — | 910 | 0·17 0·068 | 820 | 0·22 |

This table is taken from Table 9D1 of the IEE Regulations, 15th Edition.

*Only applicable up to and including 35 mm²

As you can see from the table cables are described in "cross sectional areas" (csa) ie. $mm^2$.

Therefore you will need to convert your cable into this form to enable you to use the table.

EXAMPLE:- Say we require to know the characteristics of a 7/1.35 mm copper cable.

We know that the cable has 7 conductors wound together and each conductor is 1.35 mm in diameter.

Therefore csa $= \Pi r^2$

$= 3.142 \times 0.675 \times 0.675 \times 7$ (NUMBER OF STRANDS)

$= 10.02\ mm^2$

Use the cable listed as 10 $mm^2$.

continued

## RESISTANCE OF A CONDUCTOR

With reference to the table of cable resistance values on page 07, these values have been calculated for the two conducting materials (copper & aluminium) used in the construction of cables.

The resistance of a conductor depends on several factors.

1. The length ( *l* ) in metres of the conductor.

2. The cross sectional area (a) in metres$^2$ of the conductor.

3. The temperature (°C) of the conductor.

4. The resistivity ($P$ ) in Ω metres of the conducting material.

Resistivity values are well documented in text books generally in the following form.

| MATERIAL | RESISTIVITY AT 0°C | RESISTIVITY AT 20°C |
|---|---|---|
| COPPER | $1.55 \times 10^{-8}$ | $1.73 \times 10^{-8}$ |

Therefore increase in temperature will mean an increase in the resistance of a conductor.

The resistivity constant value is represented by the Greek letter $P$ (RHO).

Using the constant $P$ for the material used and the following formula the resistance (R) of a conductor can be calculated.

$$R = \frac{P\,l}{a}$$

Refer to the following example.

Determine the resistance of a 200 m length of copper wire of diameter 1 mm at a temperature of 20°C

$$R = \frac{P\,l}{a}$$

$$R = \frac{1.73 \times 10^{-8} \times 200}{3.142 \times (0.5 \times 10^{-3}) \times (0.5 \times 10^{-3})}$$

continued

$$R = \frac{346 \times 10^{-8}}{0.7855 \times 10^{-6}}$$

$$R = 440.49 \times 10^{-2}$$

$$R = \frac{440.49}{100} = \underline{\underline{4.4049\ \Omega}}$$

Now that you can calculate the resistance of a conductor check some of the resistance values given in the table on page 07.

The resistance values will be calculated at a temperature of 20°C and also remember to take into account the number of strands per core of cable when calculating the cross sectional area of conductor.

continued

## CABLE RESISTANCE/CURRENT VALUES

| Copper Cables | | | |
|---|---|---|---|
| Conductor Size | Resistance Per Km in Ohms | Resistance Per K yds in Ohms | Current Rating in Amps |
| 9/0.30 mm (A) | 30 | 27.43 | |
| 16/0.30 mm (A) | 17 | 15.54 | |
| 50/0.25 mm (B) | 7.7 | 7.04 | 24 |
| 1/0.85 mm (C) | 30.7 | 28.07 | |
| 1/1.53 mm (C) | 9.76 | 8.92 | |
| 7/0.67 mm (D) | 7.41 | 6.78 | 24 |
| 7/1.35 mm (D) | 1.81 | 1.65 | 42 |
| 19/1.53 mm (D) | 0.52 | 0.47 | 90 |
| 19/2.52 mm (D) | 0.25 | 0.23 | 170 |
| 9/0.012" (A) | 28 | 25.6 | |
| 16/0.012" (A) | 15.8 | 14.45 | |
| 1/0.036" (C) | 26.7 | 25.41 | |
| 1/0.044" (C) | 18 | 16.46 | 11 |
| 1/0.064" (B/C) | 8.5 | 7.77 | |
| 7/0.029" (D) | 5.9 | 5.39 | 26 |
| 7/0.036" (D) | 3.8 | 3.47 | 26 |
| 7/0.044" (D) | 2.56 | 2.34 | 34 |
| 7/0.064" (D) | 1.21 | 1.11 | 56 |
| 19/0.064" (D) | 0.45 | 0.41 | 81 |
| **Aluminium Cables** | | | |
| 16 $mm^2$ (D) | 1.89 | 1.73 | 60 |
| 25 $mm^2$ (D) | 1.20 | 1.10 | 94 |
| 35 $mm^2$ (D) | 0.868 | 0.79 | 115 |
| 50 $mm^2$ (D) | 0.641 | 0.57 | 135 |
| 70 $mm^2$ (D) | 0.443 | 0.41 | 165 |
| 95 $mm^2$ (D) | 0.32 | 0.29 | 200 |

a. Internal wiring in relay rooms/location cupboards, general circuit wiring.

b. Tail cables - from control circuitry to equipment (location - Point machine, location - signalhead, location - track circuit feeds/relays).

c. Multi-core cable, lineside cables, 19c, 27c, 37c & 48c transmission of circuit throughout installation.

d. Power cable - distribution of power to locations etc, single core power cables used in power arrangements circuit wiring (wiring to transformers etc.).

end