VOLTAGES INDUCED IN THE NON-MAGNETIC, METALLIC SHEATHS AND/OR ARMOUR OF SINGLE-CORE CABLES

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SINGLE-CORE aluminium wire armoured cables are often employed in high current industrial applications. Such cables are available in sizes up to 1000 mm^2, whereas it is difficult to obtain multicore steel wire armoured cables in sizes above 400 mm^2. Single-core cables have a smaller bending radius than the equivalent SWA multicore cable and are, in general, easier to handle.

Tables 4D3 and 4E3 in BS 7671 give information on current-carrying capacities and voltage drop for single-core cables with non-magnetic armour.

Note that single-core cables armoured with steel wire or tape must not be used for a.c. circuits. (Regulation 521-02-01 refers).

In any armoured cable system the armour is an exposed-conductive-part and has to be connected to earth as required by Regulation 413-02-06 for TN systems or Regulation 413-02-18 for TT systems. The connection with earth has to be made at a minimum of one point, usually one end.

For a single-core armoured cable, carrying an a.c. load current, a voltage will be induced in the armour. Similarly a voltage will be induced in a metallic screen or sheath of a single-core cable. The magnitude of the induced voltage depends on factors which include the load current, the length of the cable, the armour diameter and the cable spacing. The armour is effectively the secondary of a transformer and the conductor is the primary. See figure 1.

Consider a single-phase circuit formed using two single-core armoured cables, the armours are earthed, generally at the supply end as shown in figure 2. There are two possible configurations for the connection of the armours of the line and neutral conductors at the load end of the circuit:

- Solid bonded system. The armours are interconnected forming a loop (figure 2).
- Single point bonded system. The armours are left unconnected (figure 3).

Note that the same two configurations exist in a 3-phase circuit formed by the use of three (or four) single-core armoured cables.

Solid bonded system

In a solid bonded system the induced voltages drive a circulating current around the armour loop. The current in the armour loop is proportional to the load current, the armour resistance and several other factors. The current in the armour loop is independent of the length of the circuit as both the induced voltage and the resistance of the armour circuit are directly proportional to the length of the cable.

The circulating current in the armour has a heating effect in the cable and hence the current rating of the cable is lower for a solid bonded system than for a single point bonded system. The current ratings given in the Tables in Appendix 4 of BS 7671 are for the solid bonded case and they allow for the heating effect of circulating currents. The effect is usually only significant for larger sizes of cable, hence there is no advantage in single point bonding small cables, less than 50 mm^2.

Solid bonding the armour of single-core cables also allows the armour to be used as a protective conductor.

Single point bonded system

If the armour is only bonded and earthed at one end (figure 3) and not bonded at the other end then the circulating currents will not flow but there will be a standing voltage at the unbonded end. As indicated before the magnitude of the induced voltage will be a function of both the load current and the circuit length.

Safety considerations

Two safety considerations arise depending upon whether solid bonding or single point bonding is used.

i. In a solid bonded system, due to the circulating current, there is a risk of overheating of the gland plates if they are undersized.

ii. In a single point bonded system, there is a risk of electric shock if someone touches the armour or gland at the unbonded end of the circuit. The figure of 25 V is stated in Regulation 523-05-01 (rather than 50 V) because of the possibility of wet conditions or where the cables are installed in a special location. Under fault conditions the current will be higher and hence the induced voltage at the unbonded end will be higher and there is a risk of flashover or breakdown at the glands. Although there is a significantly increased risk of shock under fault conditions the possibility of someone touching the unbonded end of a properly designed system at the exact time of a fault occuring is considered remote.

Also, in a single point bonded circuit, if the cable sheath becomes damaged so that the armour comes into contact with earthed metalwork at some point along the run arcing may occur at this point leading to a cable failure or other damage.

Regulation 523-05-01, quoted in full below, states a preference for solid bonding and requires the installation designer to take account of the circulating currents in a solid bonded system or the induced voltages in a single point bonded system.

523-05-01 The metallic sheaths and/or non-magnetic armour of single-core cables in the same circuit shall normally be bonded together at both ends of their run (solid bonding). Alternatively, the sheaths or armour of such cables having conductors of cross-sectional area exceeding 50 mm^2 and a non-conducting outer sheath may be bonded together at one point in their run (single point bonding) with suitable insulation at the un-bonded ends, in which case the length of the cables from the bonding point shall be limited so that, at full load, voltages from sheaths and/or armour to Earth:

(i) do not exceed 25 volts, and

(ii) do not cause corrosion when the cables are carrying their full load current, and

(iii) do not cause danger or damage to property when the cables are carrying short-circuit current. ■

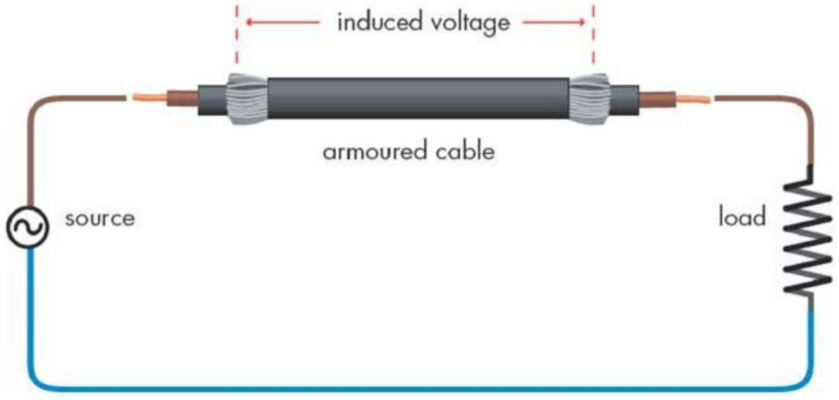

Fig 1: Induced voltage in a cable with a non-magnetic armour

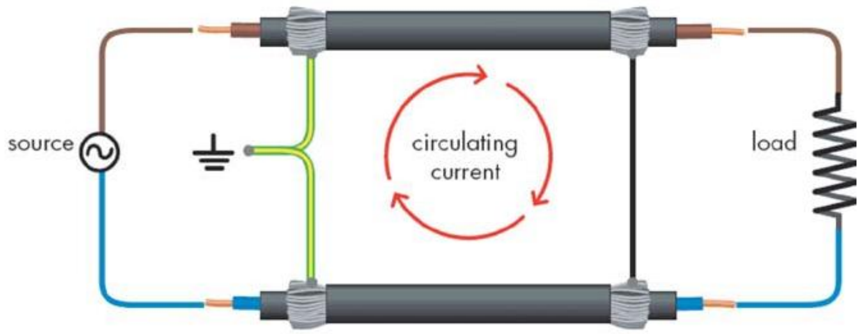

Fig 2: Solid bonded system

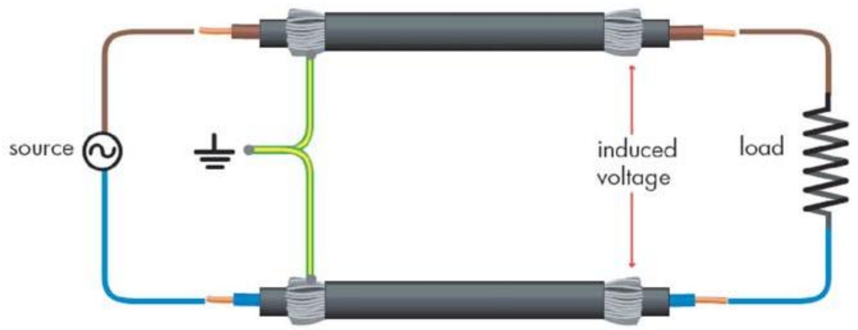

Fig 3: Single-point bonded system