Grounding and Wiring of Protection and Control Equipment

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Technical Document

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Contents

1. GENERAL

Switching operations in HV installations generate transient overvoltages in measurement and control cables. Electrostatic or magnetic RF fields either of a latent nature or caused by various operations are also induced in the devices themselves or in the cables connected to them.

Interference of this kind can impair the operation of electronic equipment.

On the other hand, electronic equipment itself can transmit electromagnetic waves that interfere with other electronic equipment.

To keep this interference within acceptable limits, the grounding, wiring and screening of the equipment must fulfil certain minimum standards.

For these precautions to have the desired effect, the station ground must be of good quality.

2. CUBICLE

2.1. Mechanical design

The cubicle must be designed and fitted out such that the impedance for RF interference of the ground path from the electronic device to the cubicle ground terminal is as low as possible.

Metal accessories such as side plates, blanking plates etc., must be effectively connected surface-to-surface to the grounded frame to ensure a low-impedance path to ground for RF interference. The contact surfaces must not only conduct well, they must also be non-corroding.

If the above conditions are not fulfilled, there is a possibility of the cubicle or parts of it forming a resonant circuit at certain frequencies that would amplify the transmission of interference by the devices installed and also reduce their immunity to induced interference.

2.2. Grounding system

2.2.1. Grounding a single cubicle

Movable parts of the cubicle such as doors (front and back) or hinged equipment frames must be effectively grounded to the frame by three braided copper strips (see Fig. 1).

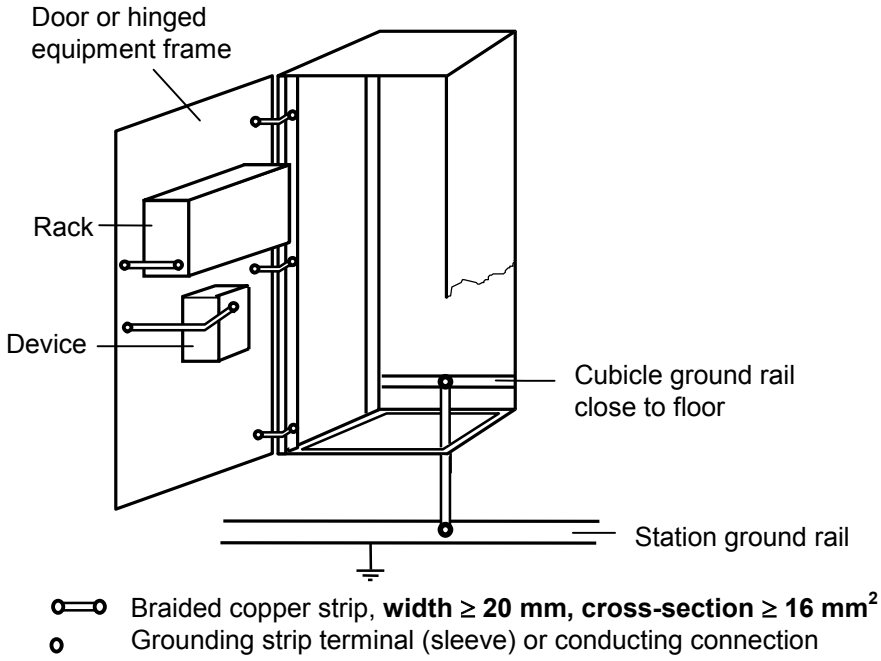

Fig. 1 Cubicle grounding system

The metal parts of the cubicle housing and the ground rail are interconnected electrically conducting and corrosion proof. The contact surfaces shall be as large as possible.

For metallic connections please observe the voltage difference of both materials according to the electrochemical code. The greater the voltage difference, the greater the danger of electrochemical corrosion.

The cubicle ground rail must be effectively connected to the station ground rail by a grounding strip (braided copper, see Section 5.).

Where the two ground rails are more than 5 m apart, two grounding strips must be run parallel and as close as possible to each other.

2.2.2. Grounding system for adjacent cubicles

Where cubicles are placed next to each other (≤ 1 m apart), the requirements of Fig. 2 must be observed in addition to those of Fig. 1.

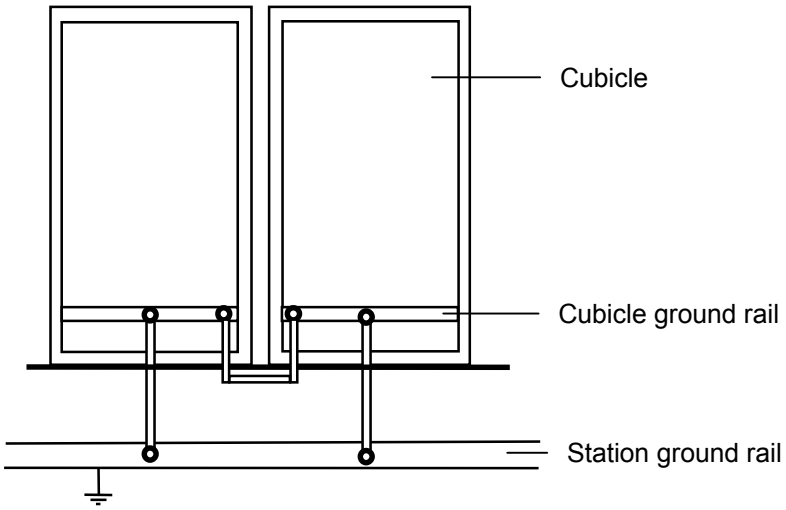

Fig. 2 Cubicle grounding system in the case of several cubicles next to each other

The cubicle ground rails are linked together and each one individually connected to the station ground rail. If the cubicles are further than 1 m apart, they do not have to be interconnected.

In the case of cubicles with several compartments, the ground rails of the compartments are linked together and each one is connected to the station ground rail.

2.2.3. Grounding system for equipment

Grounding strips may be attached to the left (as in Fig. 1) or to the right of racks and devices (see Fig. 3a). Take care that the grounding strip is always as short as possible.

Note the admissible and inadmissible arrangements illustrated in Fig. 3.

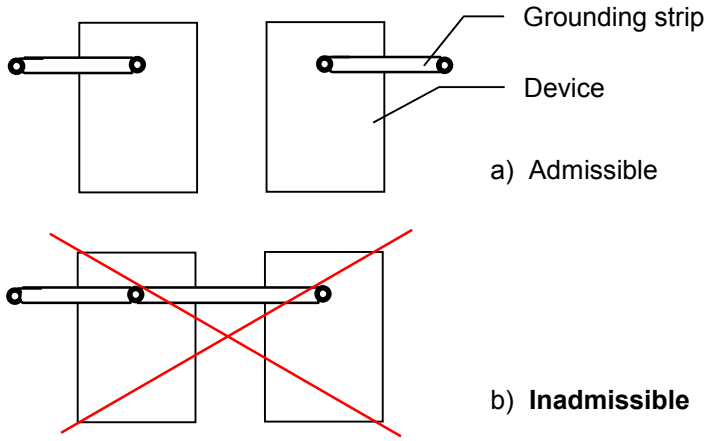

Fig. 3 Grounding system for two devices installed next to each other

If the devices or electrical equipment racks have a tight, extensive corrosion proof and electrically conducting connection to the cubicle metal, there is no need for grounding straps, even if ground connection screws and labels are attached to the device.

3. OPEN EQUIPMENT RACKS

The surface of open equipment rack frames must be electrically conducting and non-corroding and must be effectively connected to the station ground rail (see Fig. 4).

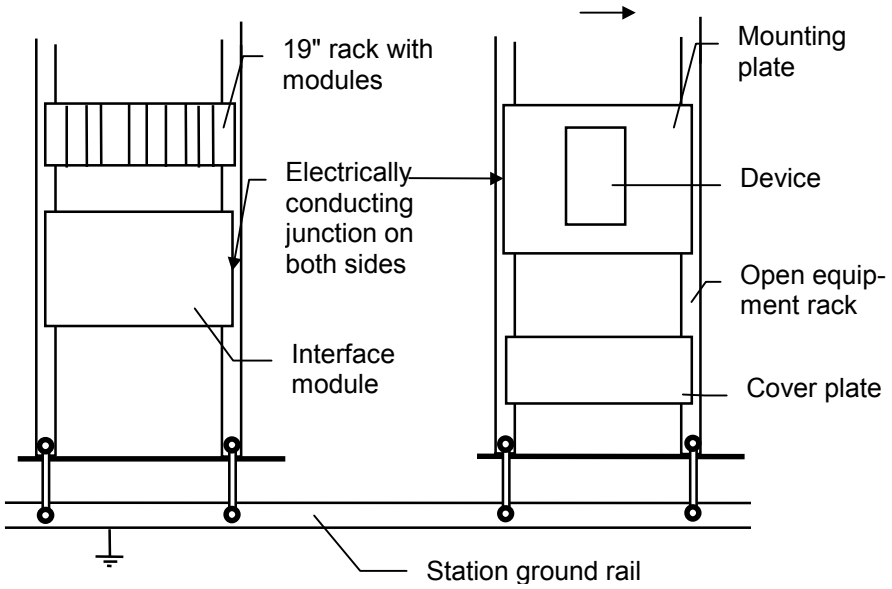

Fig. 4 Grounding system for open equipment racks (front view)

Metal interface modules not having their own grounding strips, mounting plates and all kinds of cover plates must have an electrically conducting connection to the equipment rack, i.e. neither contact surface may be painted and yet must be non-corroding (e.g. galvanised).

Devices and 19" racks must be grounded as shown in Fig. 1. Always take care to keep the grounding strips as short as possible.

As stipulated in Section 2.2.1, a second grounding strip must be run parallel and as close as possible to the first, if the station ground rail is more than 5 m away.

4. SCS CONSOLE

Basically, an SCS console is mechanically the same as a cubicle (see Section 2.1).

The console housing must be electrically connected to the station ground rail by a braided copper strip (see Section 5) as shown in Fig. 5 (insertion from below).

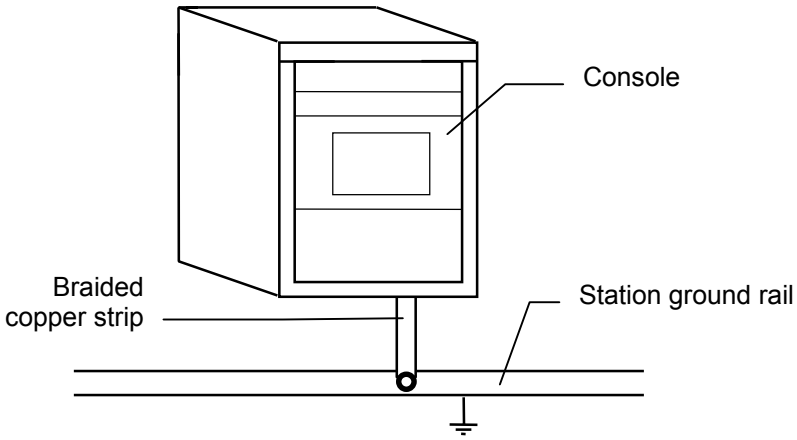

Fig. 5 Grounding system for an SCS console

The grounding strip is bolted to the inside of the console housing immediately adjacent to the inlet gland (electrically conducting surface-to-surface, see Fig. 6).

As stipulated in Section 2.2.1, a second grounding strip must be run parallel and as close as possible to the first, if the station ground rail is more than 5 m away.

All the devices installed in the console must be connected by grounding strips to the console housing. Always take care that the grounding strip is as short as possible.

5. GROUNDING STRIPS (braided copper) AND THEIR INSTALLATION

High frequency currents are produced by interference in the ground connections and because of skin effect at these frequencies, only the surface region of the grounding strips is of consequence.

The grounding strips must therefore be of (preferably tinned) braided copper and not round copper conductors, as the cross-section of round copper would have to be too large.

Data of braided copper strip: Width ≥ 20 mm,
Cross-section ≥ 16 mm^2
(protection ground)

Proper terminations must be fitted to both ends (press/pinch fit and tinned) with a hole for bolting them firmly to the items to be connected.

The surfaces to which the grounding strips are bolted must be electrically conducting and non-corroding.

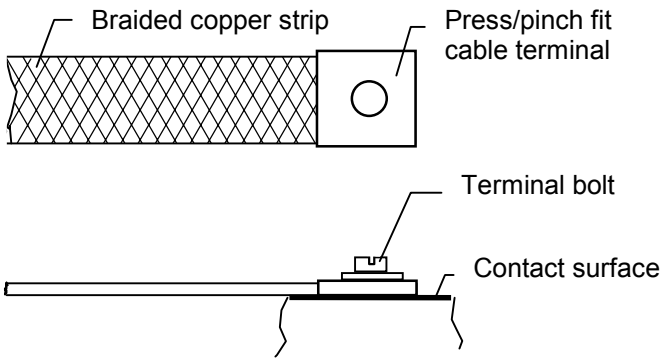

Fig. 6 Ground strip and termination

If the contact surface is aluminium, a *cupal* (copper plated aluminium) washer must be inserted between the grounding strip and the aluminium to prevent electrochemical corrosion (the voltage difference of Cu – Al amounts to approximately 2 V).

6. WIRING

6.1. External wiring

The external wiring includes all the connections from the primary plant to the cubicle or open equipment rack terminals or directly to the device terminals.

This cables are preferably run in metal ducts that are connected to the station ground at several places.

The external wiring is of the following types:

- instrument transformer leads
- auxiliary supply cables
- binary inputs and outputs.

Since experience has shown that the main source of interference is the c.t. and v.t. leads, these should be run in different cable ducts separately from the other cables.

C.t. and v.t. leads and leads conducting binary signals are recommended to be shielded (see Section 7.)**.**

6.2. Internal wiring

The internal wiring includes all the connections from the cubicle or equipment rack terminals to the device terminals. In the case of open equipment racks, these connections should be kept as short as possible.

As mentioned in Section 6.1. above, it is an advantage for the c.t. and v.t. leads to be run separately from the other cables, i.e. they should not be run in the same cable duct or in the same cable loom. Mutual coupling can be avoided by crossing cables of different types perpendicularly and not running them parallel (see Fig. 7).

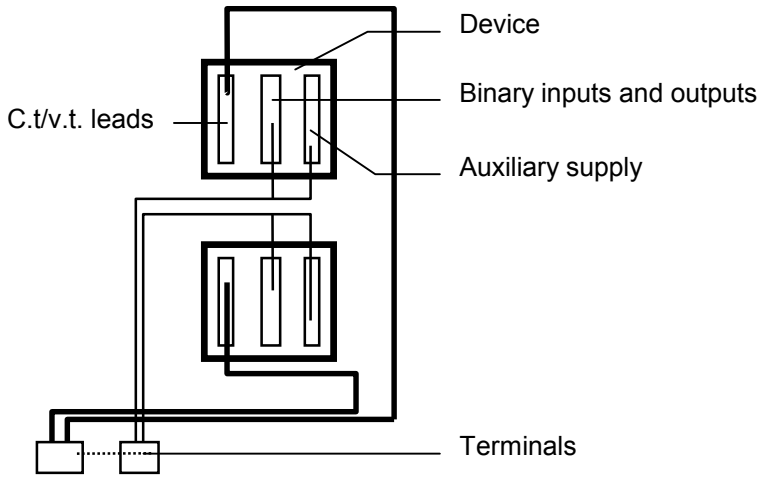

Fig. 7 Example of crossing c.t./v.t. leads and supply/ signal cables perpendicularly

6.3. Communication cables

No precautions have to be taken in the case of optical fibre cables.

Conventional copper communication cables must be screened (see Section 7.). The cable shield must be effectively connected to ground in the cubicles at both ends immediately adjacent to the cable inlet (see Section 7.2.).

With the cable shields grounded at both ends, any potential differences between the cubicles will cause balancing currents to flow in the shields that can induce interference in the cables. This can interfere with the function of a device at cable lengths of 10 m and more.

A possible solution is to run the cables along ground rails of the meshed ground system of the station building and grounding the shields at intervals of 5 to 10 m.

For this purpose, a suitable length of insulation is stripped from the shield and the exposed shield connected by a cable cleat to a grounded metal surface (Fig. 9). Both the cleat and the contact surface must be electrically conducting and non-corroding.

An alternative is to run a low-impedance ground connection parallel to the screened cables to “bypass” the balancing currents (Fig. 8).

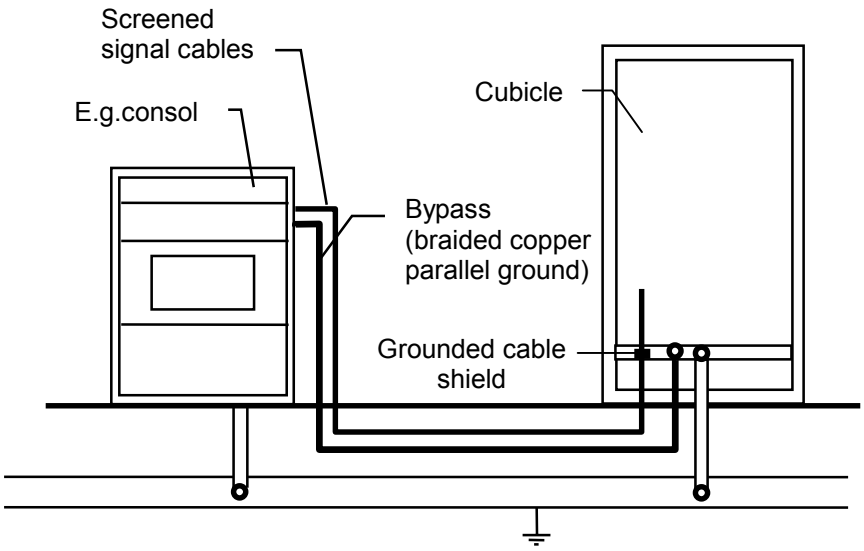

Fig. 8 Low-impedance parallel ground connection

Fig. 8 shows a parallel ground connection between an SCS console and a cubicle. The same arrangement applies in the case of two cubicles.

The parallel ground is of braided copper (see Section 5.). It should be kept parallel to the signal cable. This reduces the PLC impedance of the connection between the container and the cubicle. In order to guarantee paralleling, the braided copper band and the signal line may be loosely strapped together at intervals.

Cables conducting analogue (LF) signals must have twisted cores. Multi-core cables must have twisted pairs.

7. SCREENING

7.1. Cable shields

The cable shields shall be braided and have a cover factor of at least 80 %.

7.2. Grounding the ends of cable shields

The ground connection to a cable shield must extend around the entire circumference.

Grounding a shield by soldering a wire to it achieves only an inadequate screening effect in industrial installations.

Cable shields must be grounded at both ends.

The best screening effect is achieved when the cable would enter the cubicle via a screwed cable gland. If a cable gland of this type is not provided, the cable must be grounded as shown in

Fig. 9 and Fig. 10 on the inside of the cubicle ***immediately adjacent to the cable inlet***.

To ground the cable, remove a suitable length of the insulation and push the braiding of the shield back over the end of the insulation. Secure the end of the cable to the grounded surface by means of a metal cleat (Fig. 9). The cleat and the contact surface must be electrically conducting and non-corroding.

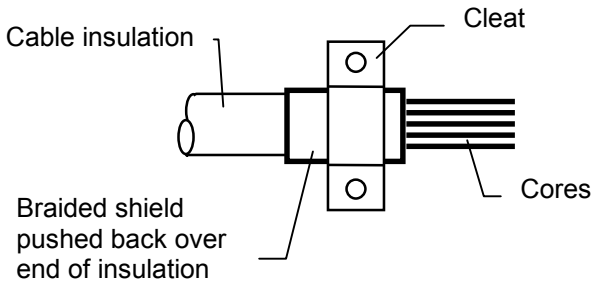

Fig. 9 All-round grounding of the end of the cable shield

The shield must be pushed back over the insulation to prevent it from fraying with time and the quality of the ground contact di

minishing. It also reduces the risk of pinching the shield and the cores.

Choose a cleat that holds the shield firmly but does not pinch the shield or the cores.

The grounding system in the case of open equipment racks is executed as shown in Fig. 9 and Fig. 10.

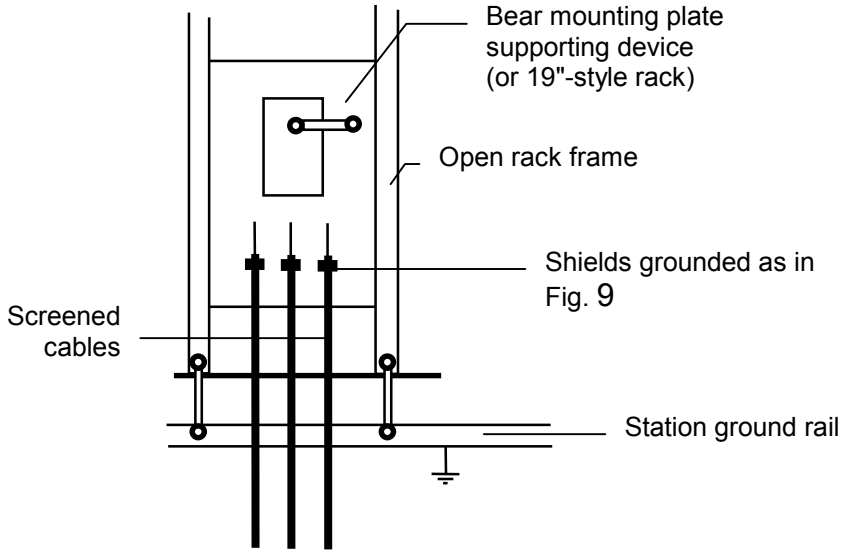

Fig. 10 Grounding cable shields in the case of an open equipment rack (rear view)

The rear of the mounting plate must not be painted and the surface must be a good conductor and non-corroding.

As explained in Section 5 and shown in Fig. 4, the mounting plate must be in good electrical contact with the frame of the open rack.

The unscreened ends from the point of grounding to the device terminals must be kept as short as possible. Certain groups of cables must also be run separately as explained in Section 6.2.

7.3. Grounding the shields of interface cables

Connector housings must be either of metal or metal-coated plastic and be equipped with an effective strain relief that is electrically connected to the housing.

The insulation is stripped and the shield pushed back as described in Section 7.2. The cable strain relief must ground the shield around the entire circumference in the same way as the cleat in the preceding cases.

The screws securing the connector in place after it has been inserted must be firmly tightened to establish a reliable ground connection.

Many signal cables still ground the cable shield via a pin on the connector (mostly plastic connector housings). The screening effect achieved in such cases is inadequate in industrial installations.

The same applies when the shield is grounded via a wire coming out of the connector housing and connected to an external ground terminal.

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