

A photograph on the left side of the slide shows a man in a light blue shirt and khaki pants kneeling in front of a server rack. He is pointing at a component within the rack. The rack is filled with various electronic equipment, including what appears to be a power distribution unit with several circuit breakers and cables.

# Grounding

- General
- Protective conductor circuit
- Control circuits
- Lighting circuits

## Protective Conductor Circuit

The protective conductor circuit must consist of:

- separate terminals
- protective conductor and jumpers

Grounding of systems:

- All conductive, exposed, non-current-carrying parts must be grounded
- The grounding conductor must be suitable for the respective mechanical and thermal loads as well as overcurrent


Exception: Small parts, e.g. screws, rivets and rating plates, need not be grounded if energization of these parts is very unlikely

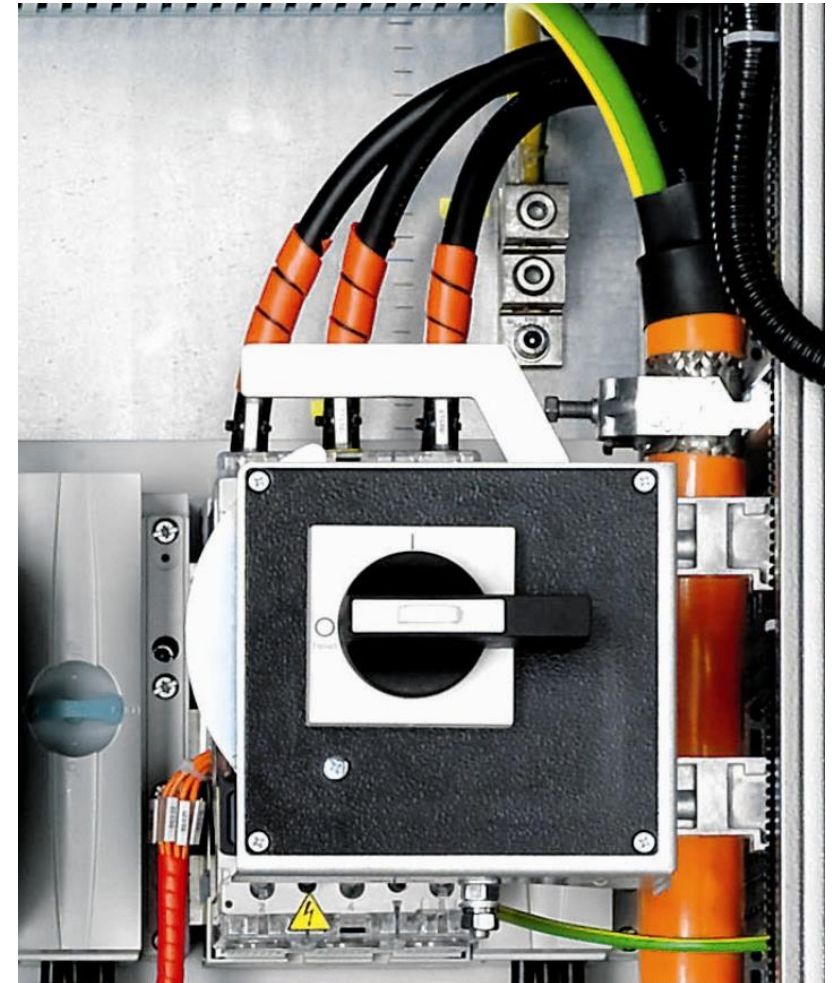
# Protective Conductor Circuit Grounding Terminals

- Every infeed line requires **separate** grounding terminals near the corresponding phase terminals – **grounding point**
- Grounding conductors of additional concrete-footing ground electrodes [auxiliary electrodes] also must be connected to the grounding terminal
- Wires must be made of copper and approved for the application (e.g. finely stranded, flexible, etc.)
- Dimensioning of the conductor cross-section at least according to Table 8.2.2.3

Rated Current (A)	Minimum Cross-section (mm <sup>2</sup> )
16	1.5
20	1.5
25	1.5
32	1.5
40	1.5
50	1.5
63	1.5
80	1.5
100	1.5
125	1.5
160	1.5
200	1.5
250	1.5
320	1.5
400	1.5
500	1.5
630	1.5
800	1.5
1000	1.5
1250	1.5
1600	1.5
2000	1.5
2500	1.5
3200	1.5
4000	1.5
5000	1.5
6300	1.5
8000	1.5
10000	1.5

## Marking

- **"GROUND", "GND", "GRD", "G"** or 
- Protective conductor color for wires / terminals: **green** (or optionally: green/yellow)

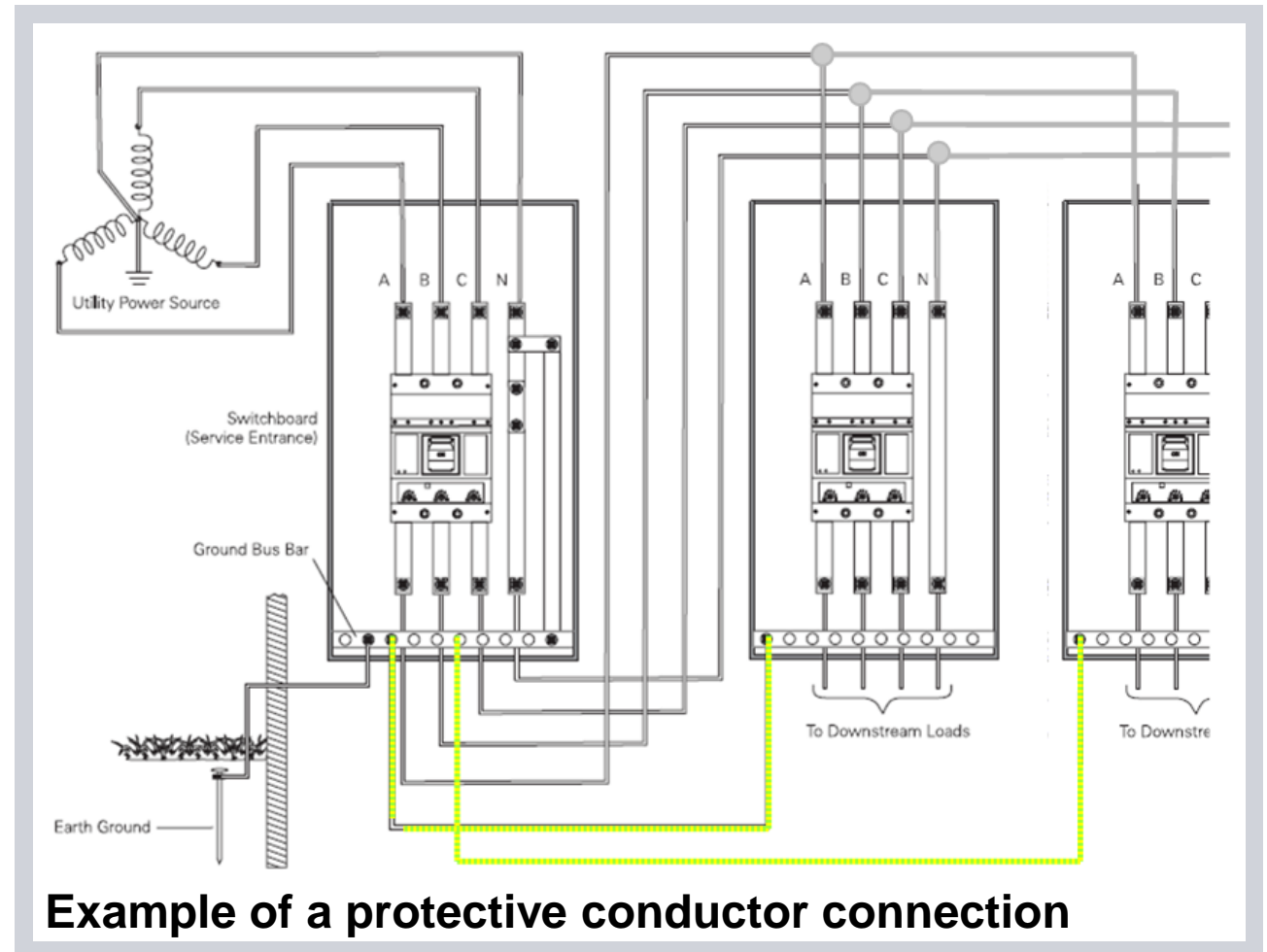


**Table 8.2.2.3 Minimum Size of Equipment Grounding Conductors and Bonding Jumpers**

Rating or Setting of Automatic Overcurrent Device in Circuit Ahead of the Equipment (Not Exceeding Amperes)	Copper Conductor Size (AWG or kcmil)
10	16
15	14
20	12
30	10
40	10
60	10
100	8
200	6
300	4
400	3
500	2
600	1
800	1/0
1000	2/0
1200	3/0
1600	4/0
2000	250
2500	350
3000	400
4000	500
5000	700
6000	800

# Protective Conductor Circuit Continuity

- The protective conductor connection must be continuously available
- Removal of a component must not lead to an interruption (no daisy-chaining – max. ***within*** the industrial control panel)
- Ground studs (e.g. doors, covers) are permitted  
Prerequisite: Effective removal of color and dirt from the contact surface
- Movable machine parts connected by means of metal bearings are considered grounded  
Exception: Movable parts in **non-conductive**, pressurized liquids
- Cable routes and cable ducts made of metal must not be used as protective conductor!



# NFPA 79 Ed. 2012

## Grounding

### NFPA79 Ed. 2007

8.2.3.1 The continuity of the equipment grounding (protective bonding) circuit shall be ensured by effective connections through conductors ***or structural members.***

### NFPA79 Ed. 2012

8.2.3.1 The continuity of the equipment grounding (protective bonding) circuit shall be ensured by effective connections through conductors



## Protective Conductor Circuit

- Doors and covers with mounting parts must be grounded
- If required, covers and doors must be grounded with the enclosure  
e.g. connector, separate PE conductor within the enclosure
- Suspended or movable / spring-loaded operator stations must be grounded *separately*  
Exception: When using multi-core wires, one core (green) may be used as grounding conductor
- Protective conductors leading to doors and covers must be protected against damage

**Caution:** The protective conductor circuit must not be routed through industrial control equipment  
→ **no** disconnection of the protective conductor connection!!!

**Exception:** Disconnectable connections (connectors, receptacles) require a "first make – last break" (leading / lagging contact) connection of the PE conductor

**Note:** If interlocking with connectors / receptacles prevents plug-in *without* protective conductor connection, no "first make – last break" contact is required

### General:

NFPA79 §8.3: Control circuits may be grounded or ungrounded

**With grounded** control circuits, the following conditions apply:

- With AC, the secondary transformer side must be grounded
- With DC, the secondary power supply unit side must be grounded

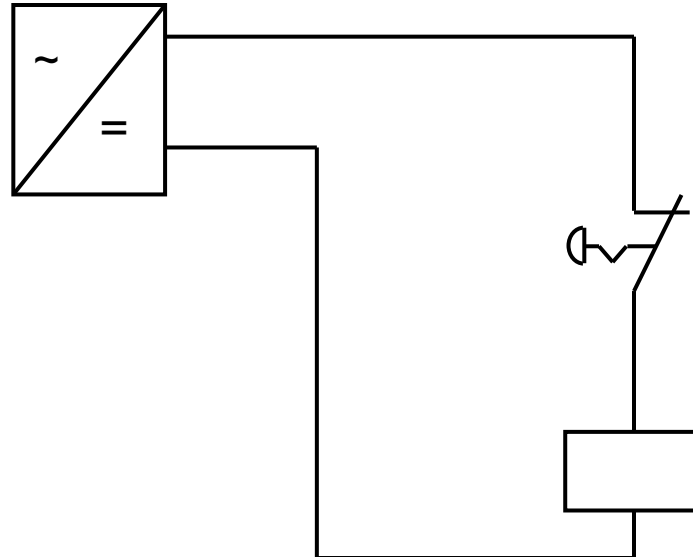
### Exceptions:

1. PELV control circuits must always be grounded
2. Contacts of overload relays may be connected between coils of magnetic devices and the N-conductor when the wire between contact and device is routed within the industrial control panel



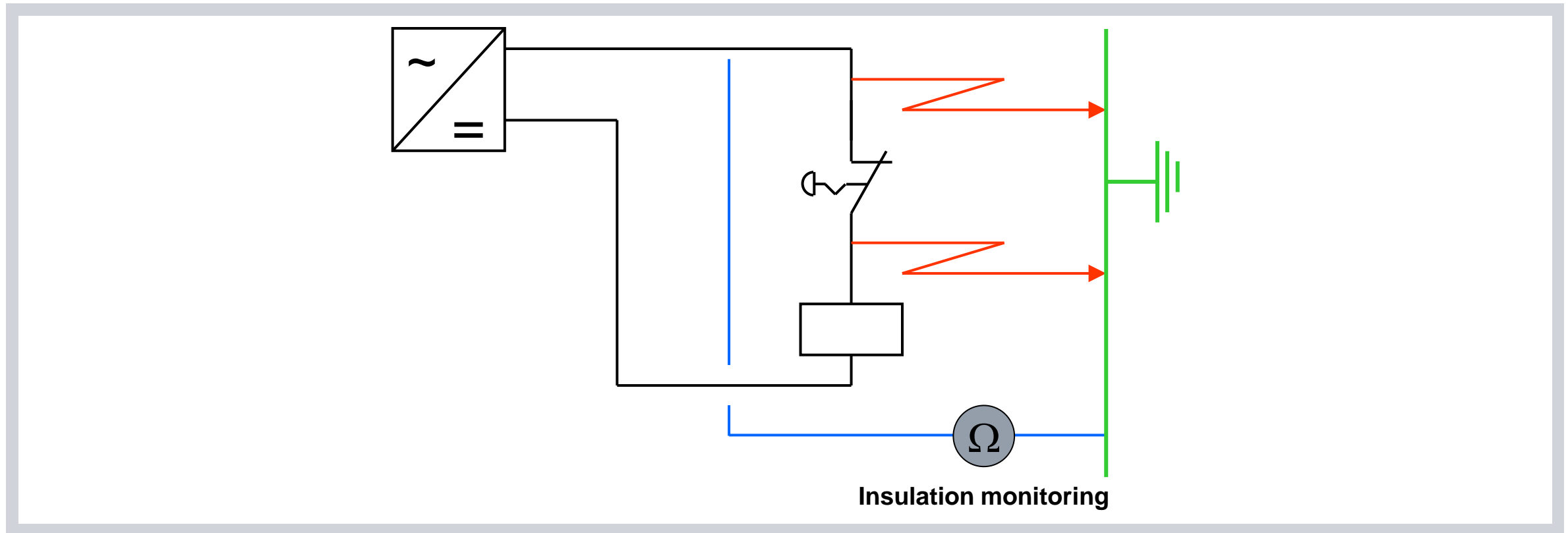
**Ungrounded** control circuits must be equipped with insulation monitoring which:

- indicates ground faults  
faults must be rectified after an **appropriate** period of time → (risk analysis!)  
*or*
- automatically interrupts the circuit



**Exception:** Class 2 control circuits do not require insulation monitoring (§725 NEC)

## Example of Ungrounded Control Circuits



**Note:** Whether ground fault indication is sufficient or immediate interruption is required must be determined within the scope of the risk analysis

## Questions?



### Note / disclaimer

The circuit examples and interpretations of the standard contained in this document shall be non-binding and do not claim to be complete in terms of configuration and equipment or to consider any other contingencies. The information provided herein does not represent any customer-specific solutions, but is merely intended to support the reader with typical tasks.

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