PC57.13.3

IEEE Guide for Grounding of Instrument Transformer Secondary Circuits and Cases

OUTLINE

- Scope
- References
- Need for grounding; Warning
- Definition of Instrument transformers
- Grounding secondary circuits
  - Grounding at a single location
  - Conductor size for connecting to ground

Scope

- The scope of the guide includes the grounding practices presently used and the practices that were not previously reported. Specifically, the issue of the grounding of cases of electronic transducers is addressed.

Covers

- The practices described in this standard apply to all instrument transformers, including capacitive voltage transformers and linear couplers, irrespective of primary voltage or whether the primary windings are connected to, or are in, power circuits or are connected in the secondary circuits of other transformers as auxiliary cts or vts.

Does not cover

- This guide does not discuss the grounding of some applications. For example, grounding of gas insulated substations and metal clad switchgear is not discussed in this guide; the reader will find these topics addressed in reference [9] listed in clause 2. The grounding of circuits of core-balance CTs is also not discussed in this guide. The reader can find this information also in reference [9] listed in clause 2. Another issue that is not discussed in this guide is the practice of using separate safety and control grounds. For discussion on this topic, the reader is directed to reference [12] listed in clause 2.

References

- [1] NFPA 70-2002, National Electricity Code® (NESC®)
- [2] ANSI C2-2002, National Electrical Safety Code® (NESC®)
- [3] C37.103™-2004, IEEE Guide for Differential and Polarizing Relay Circuit Testing
- [4] C57.13.1™-1981 (Reaffirmed 1999), IEEE Guide for Field Testing of Relaying Current Transformers
- [5] C37.92™-2004, IEEE Trial Use Standard for Low Energy Analog Signal Inputs to Protective Relaying

References

- [6] C62.92™-2000, IEEE Guide for the Application of Neutral Grounding in Electrical Utility Systems
- [7] Std. 80™-2000, IEEE Guide for Safety in AC Substation Grounding
- [8] Std. 142™-1991, IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems
- [9] Std. 242™*2001, IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
- [10] Std. 518™-1982 (R1996), IEEE Guide for the Installation of Electrical Equipment to Minimize Electrical Noise Inputs to Controllers from External Sources

References

- [11] Std. 525™-1992, IEEE Guide for the Design and Installation of Cable Systems in Substations
- [12] Std. 665-1995, IEEE Guide for Generating Station Grounding
- [13] Std. 1050-1996, IEEE Guide for Instrumentation and Control Equipment Grounding in Generating Stations
- [14] Std. 1100™-1999, IEEE Recommended Practice for Powering and Grounding Electronic Equipment
- [15] Std. 1143™-1994 (Reaffirmed 1999), IEEE Guide on Shielding Practice for Low Voltage Cables

Need for Grounding Secondary Circuits

- To protect equipment connected to the circuits
- To Protect personnel who might come into contact with the equipment
- How the problem manifests
  - When secondary circuit is not grounded
  - When a case is not grounded
    - Voltage due to charge accumulation on an ungrounded secondary circuit or case

Warning

- Grounding of secondary circuits is an issue of safety of personnel and equipment connected to the secondary circuits. The reader is urged to consider it seriously and follow the stipulations of relevant standards and ensure that the stipulations of the National Electrical Code [1] and the National Electric Safety Code [2] are always adhered to.

Warning

- Article 90.2 (A) of National Electrical Code [1] lists the installations that are covered by the Code [1] and Article 90.2 (B) lists the installations that are not covered by the Code. For immediate reference of the readers, Article 90.2 of National Electrical Code [1] is reproduced in Annex C.

Grounding of Instrument Transformer Secondary Circuits

- Definition of a secondary circuit for the purposes of the guide
- Issues
  - Grounding at a single location
  - Minimum size of the grounding conductor

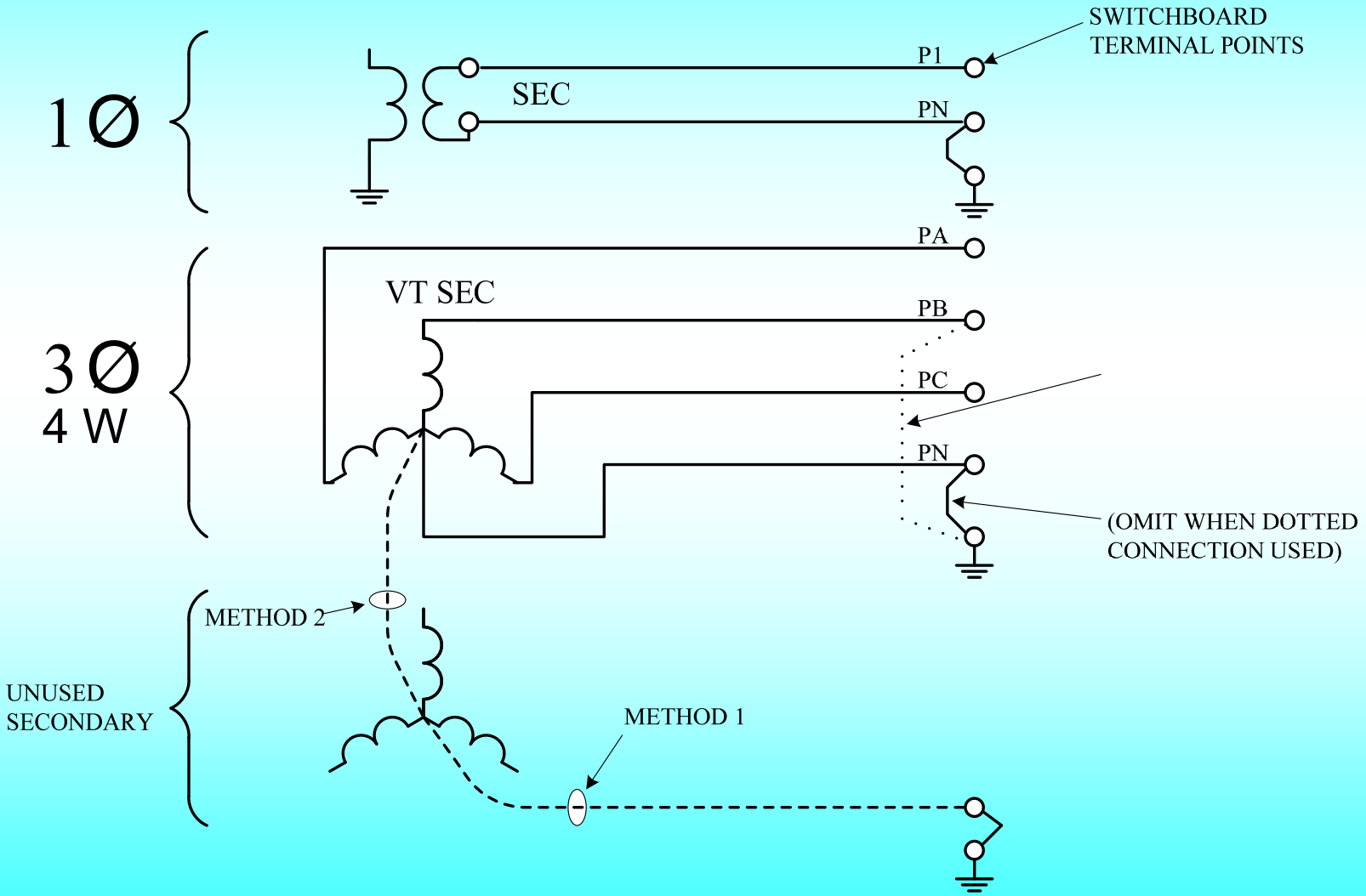
Issues

- Grounding at a single location
  - Voltage at different locations of the physical ground and circuits connected to ground is different when fault currents flow
  - Convenience of testing a secondary circuit
  - Problem with forming a common neutral of more than one instrument transformers and then grounding the neutral bus
    - Isolation of all secondary circuits from ground

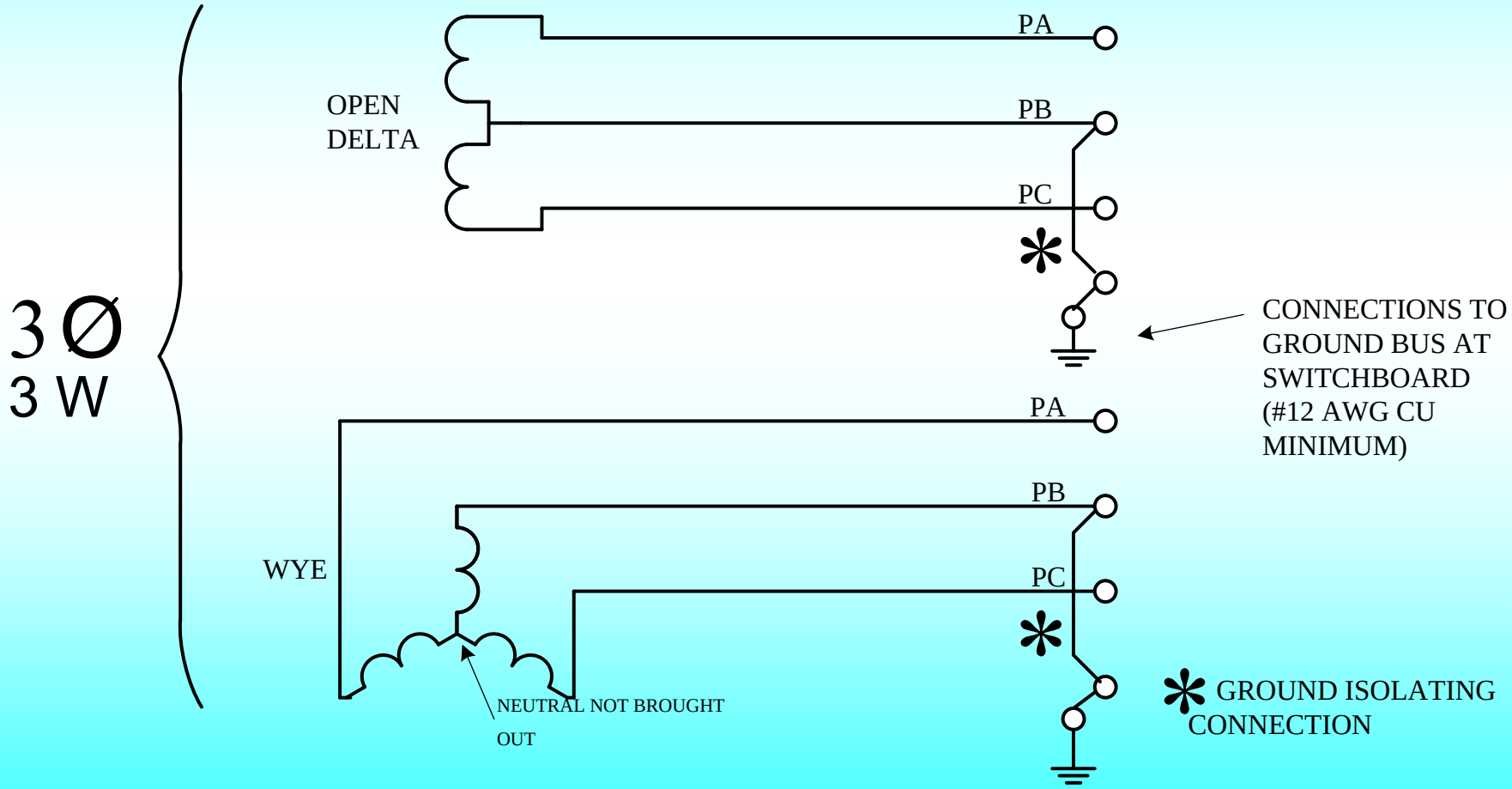
Issues

- Recommended point of grounding
  - switchboard or relay panel
- Grounding unused secondary windings
- Grounding examples

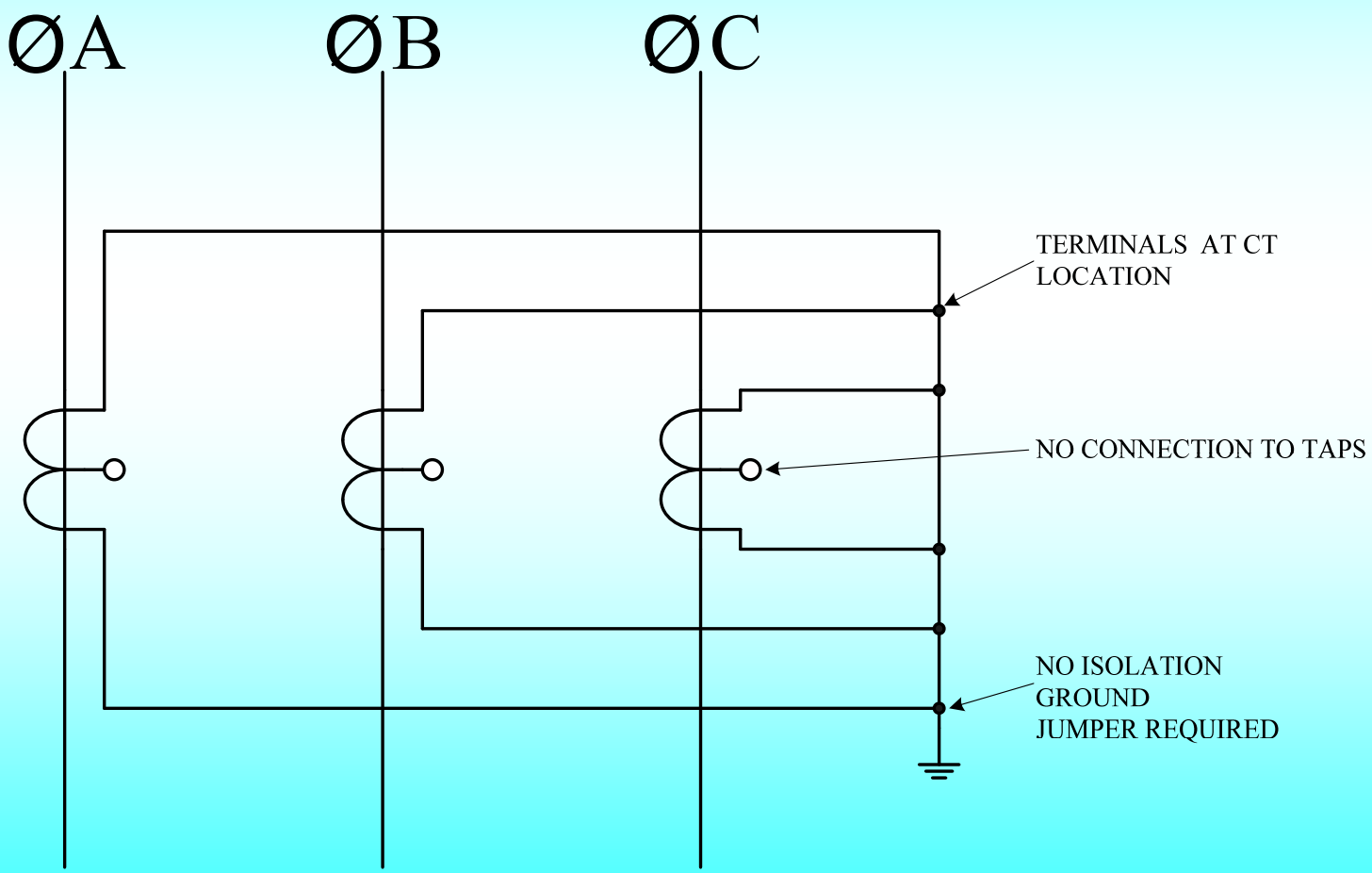
Grounding 3 Φ 4 Wire VT Circuits



Grounding 3 Φ 3 Wire VT Circuits



Grounding unused CTs



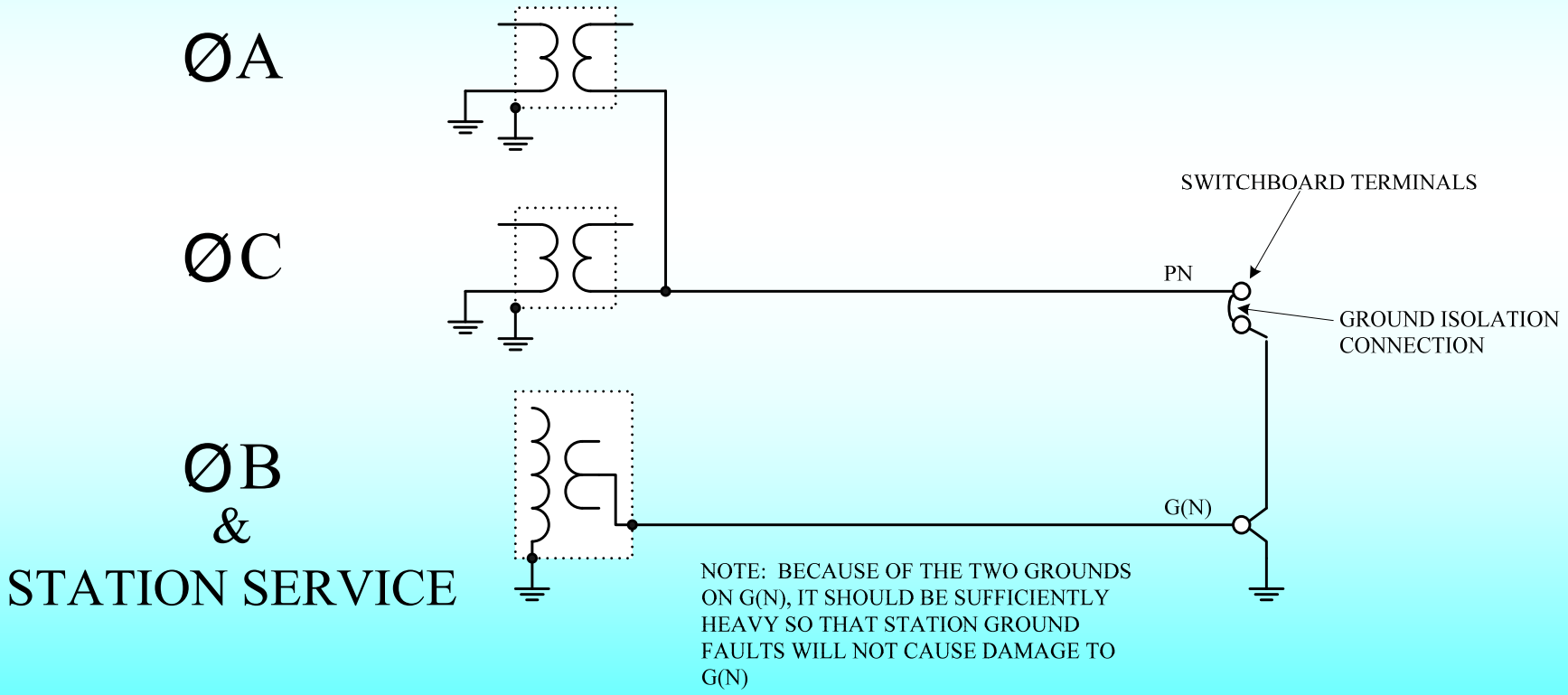
ISSUES

- Minimum size of grounding conductor
  - 12 AWG required by NESC©

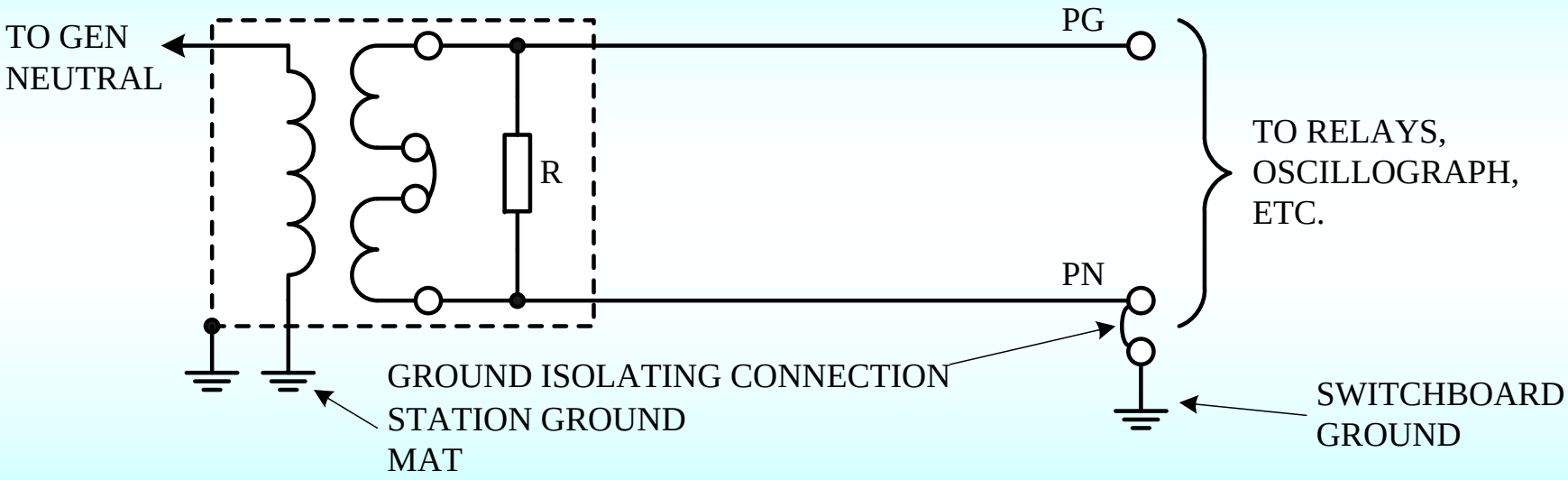
TYPICAL APPLICATIONS

- VT circuits
- Voltage provided from distribution transformers

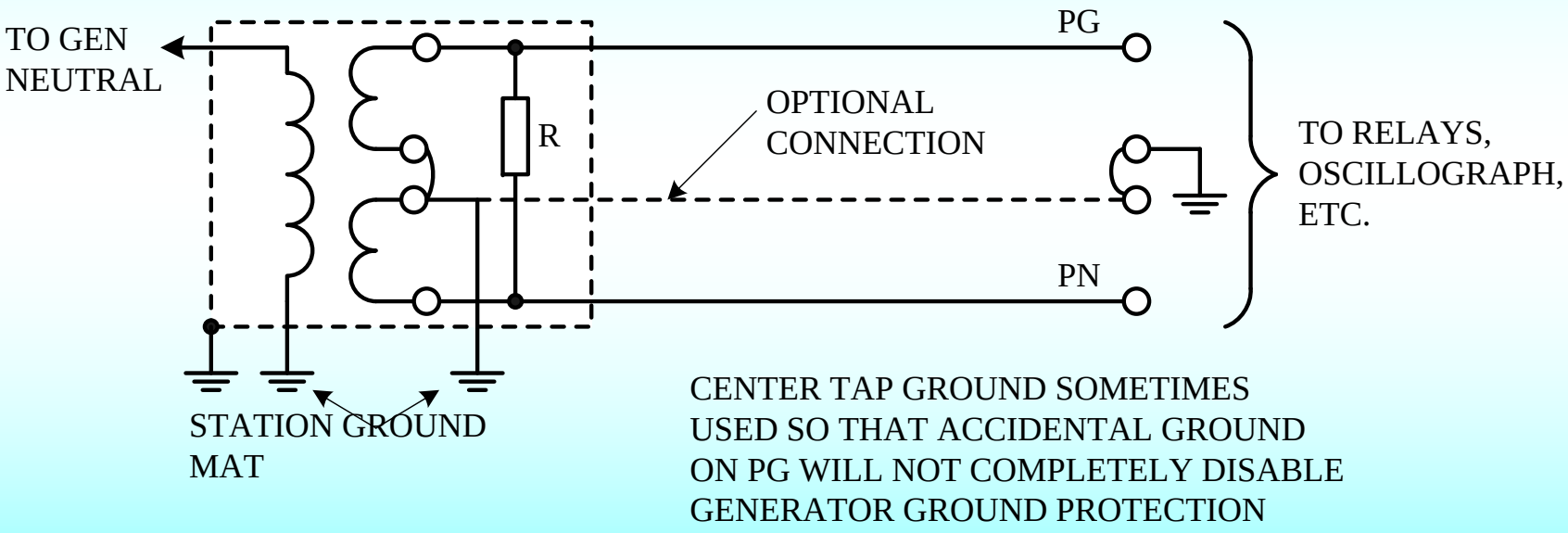
Using Voltage from a Distribution Transformer



Generator Neutral Grounding Transformer

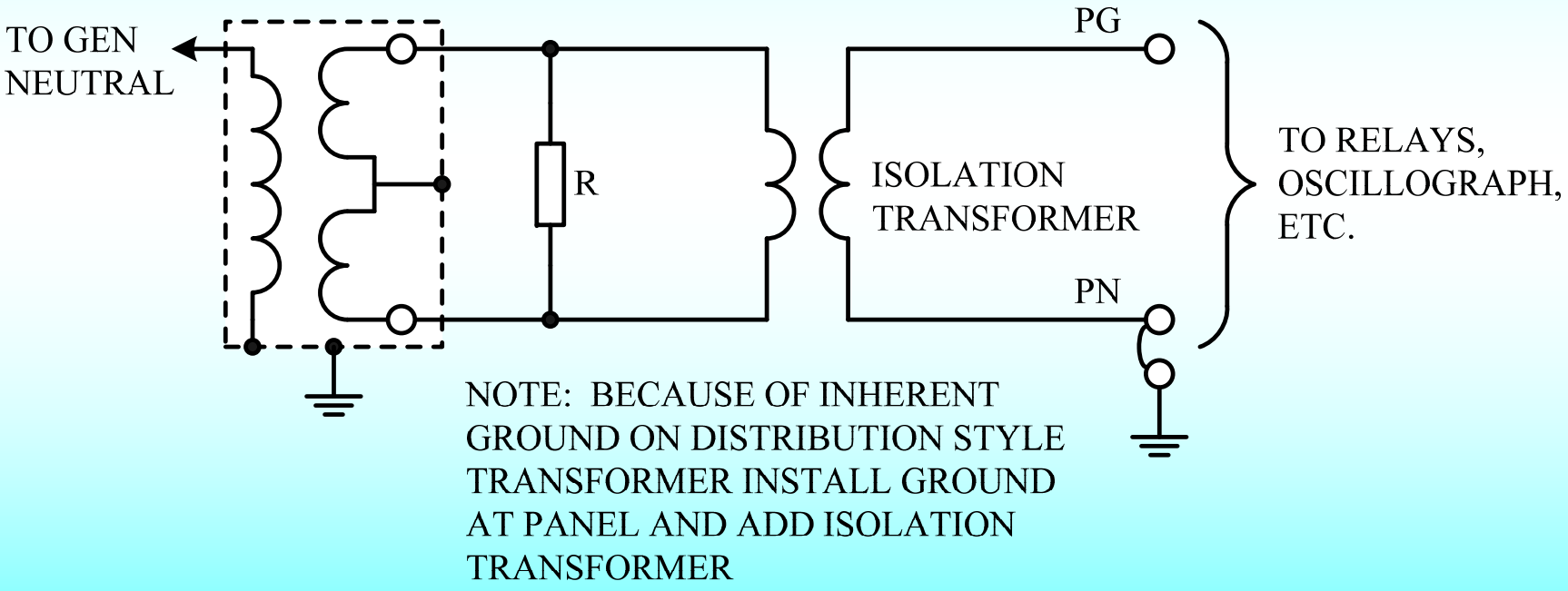


Generator Neutral Grounding Transformer

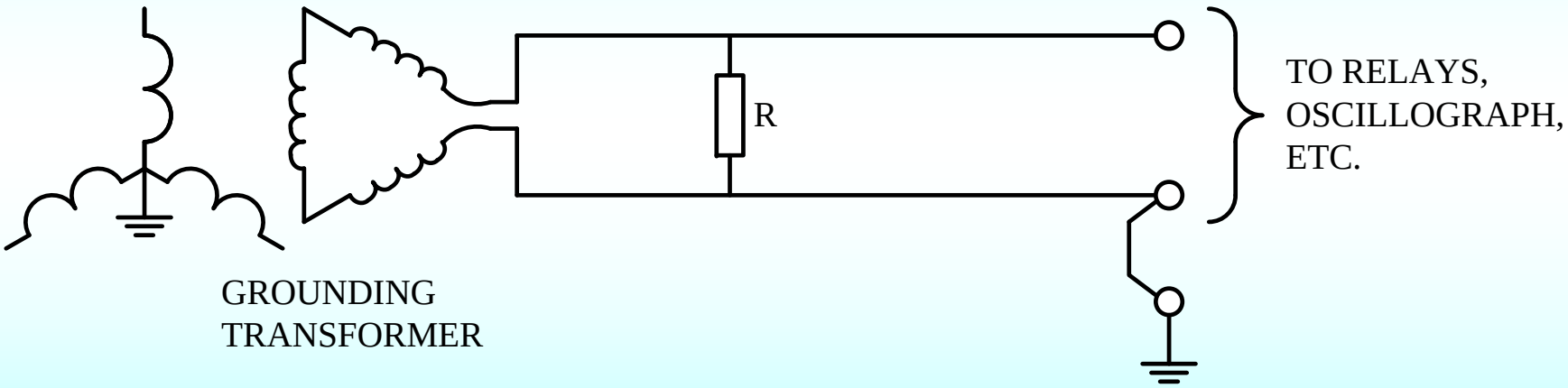


CENTER TAP GROUND SOMETIMES USED SO THAT ACCIDENTAL GROUND ON PG WILL NOT COMPLETELY DISABLE GENERATOR GROUND PROTECTION

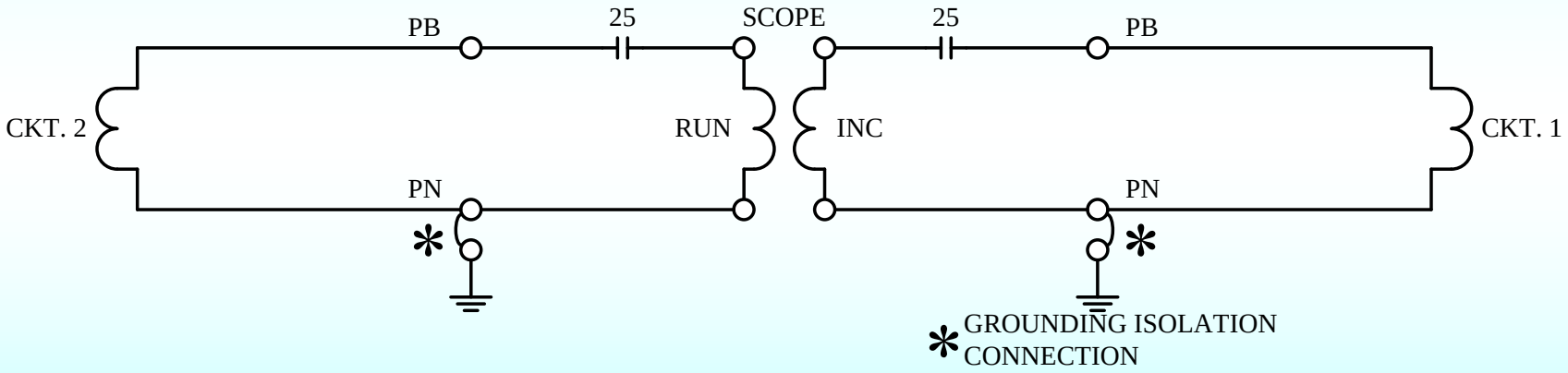
Generator Neutral Grounding Transformer



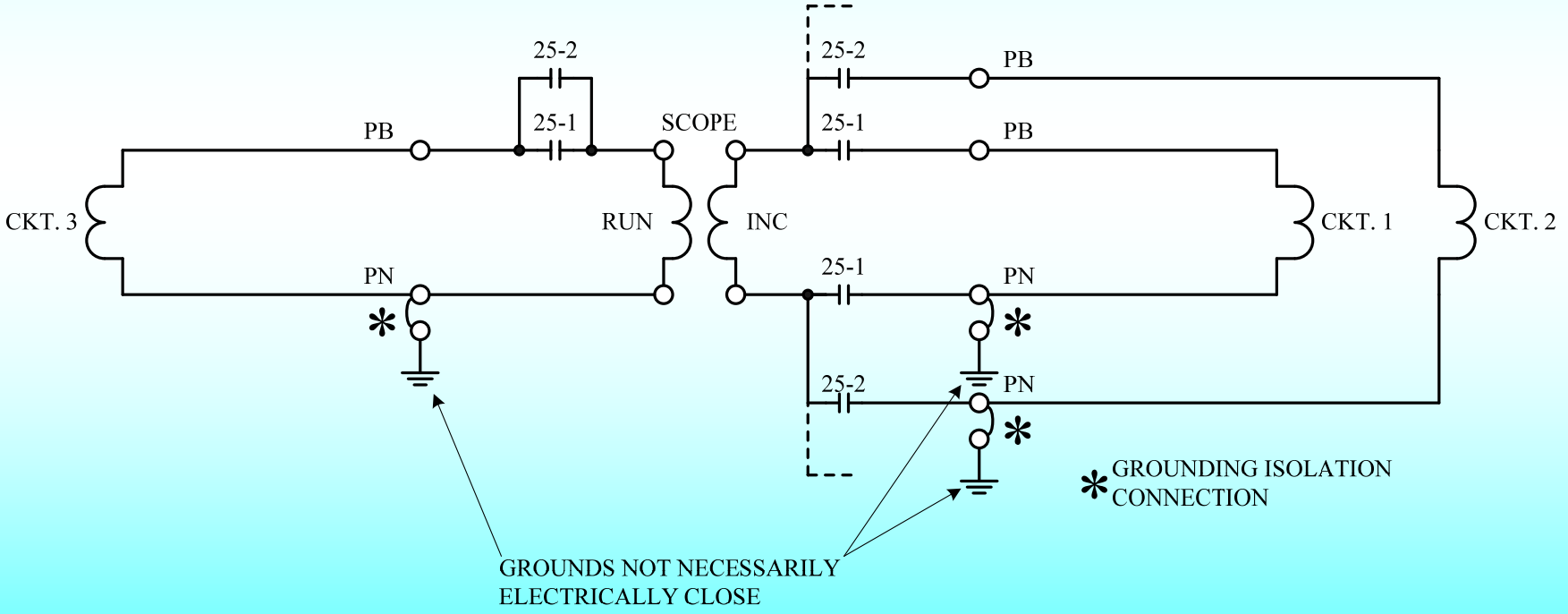
Generator Grounding Transformer



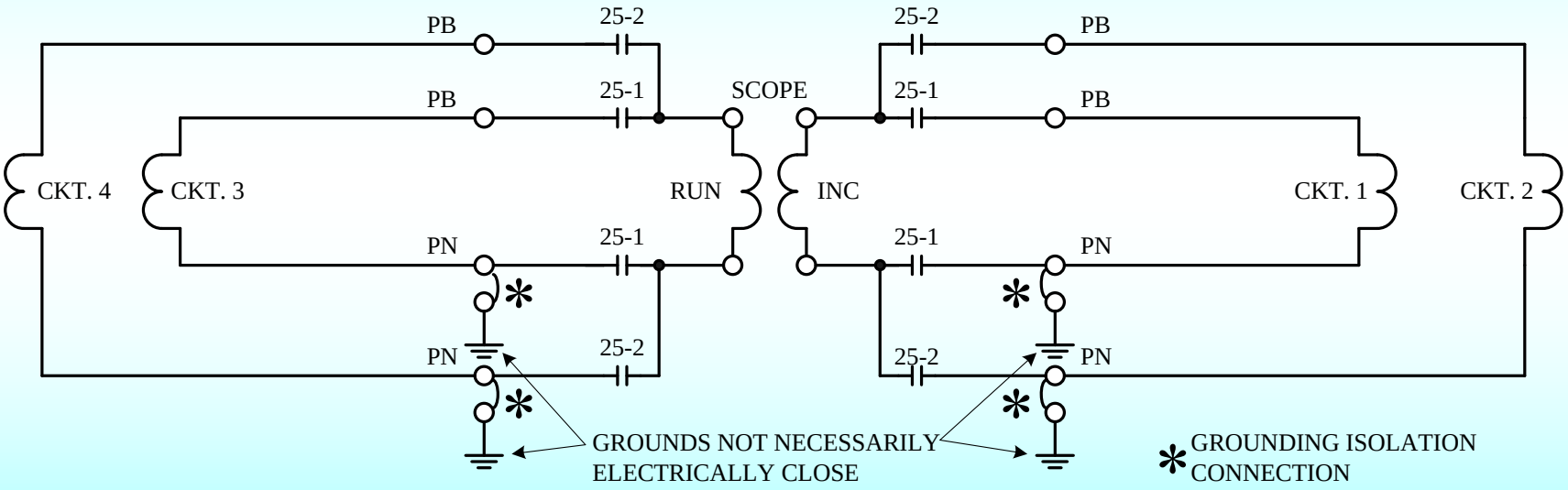
Basic Synchroscope Circuit



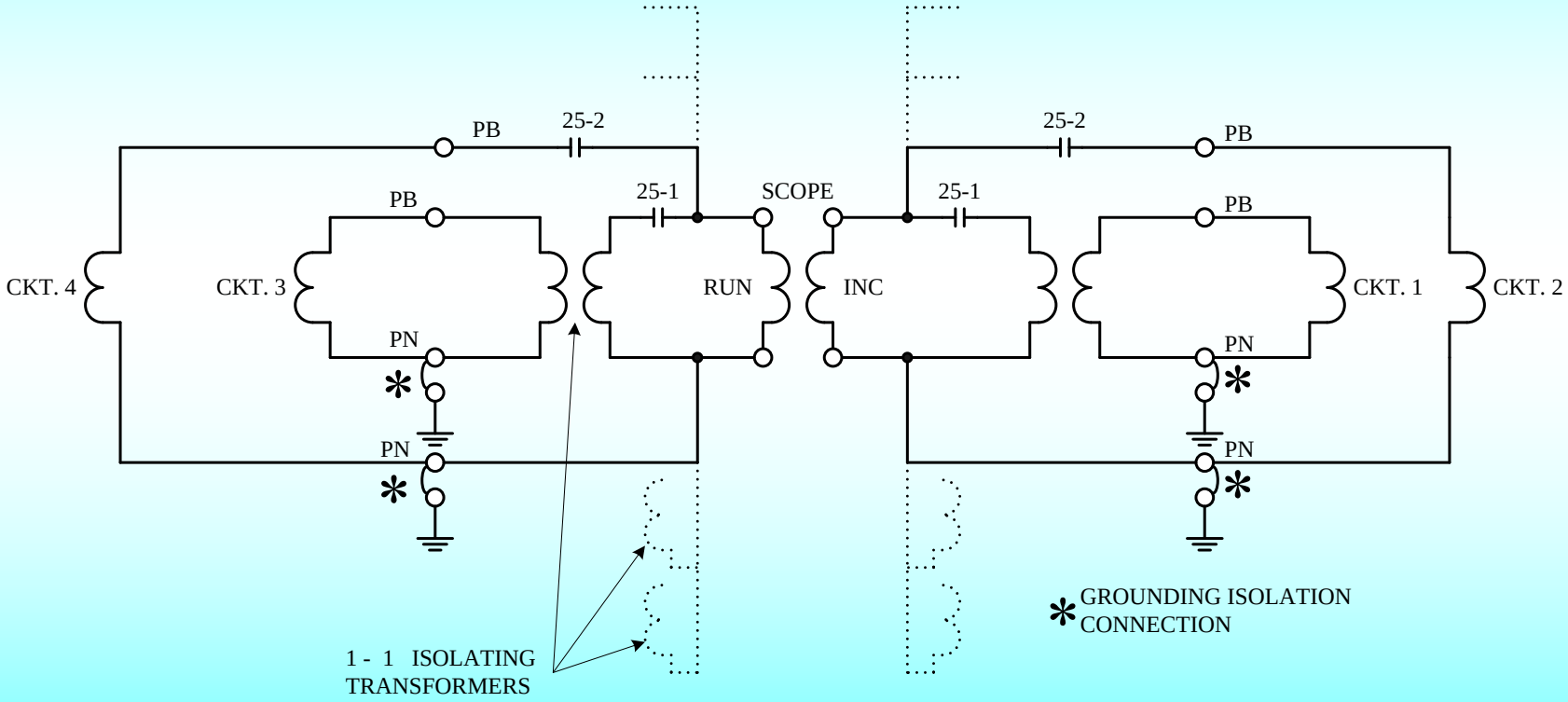
Synchroscope with Multiple Incoming Circuits



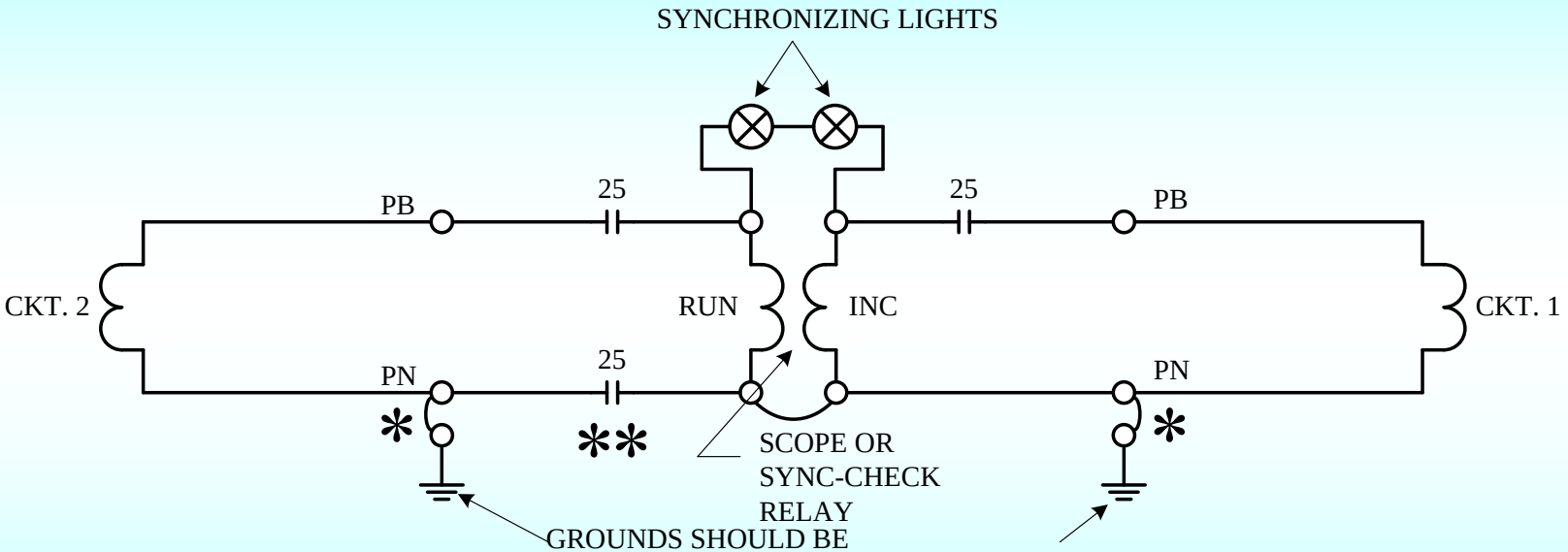
Synchroscope with Multiple Incoming and Running Circuits



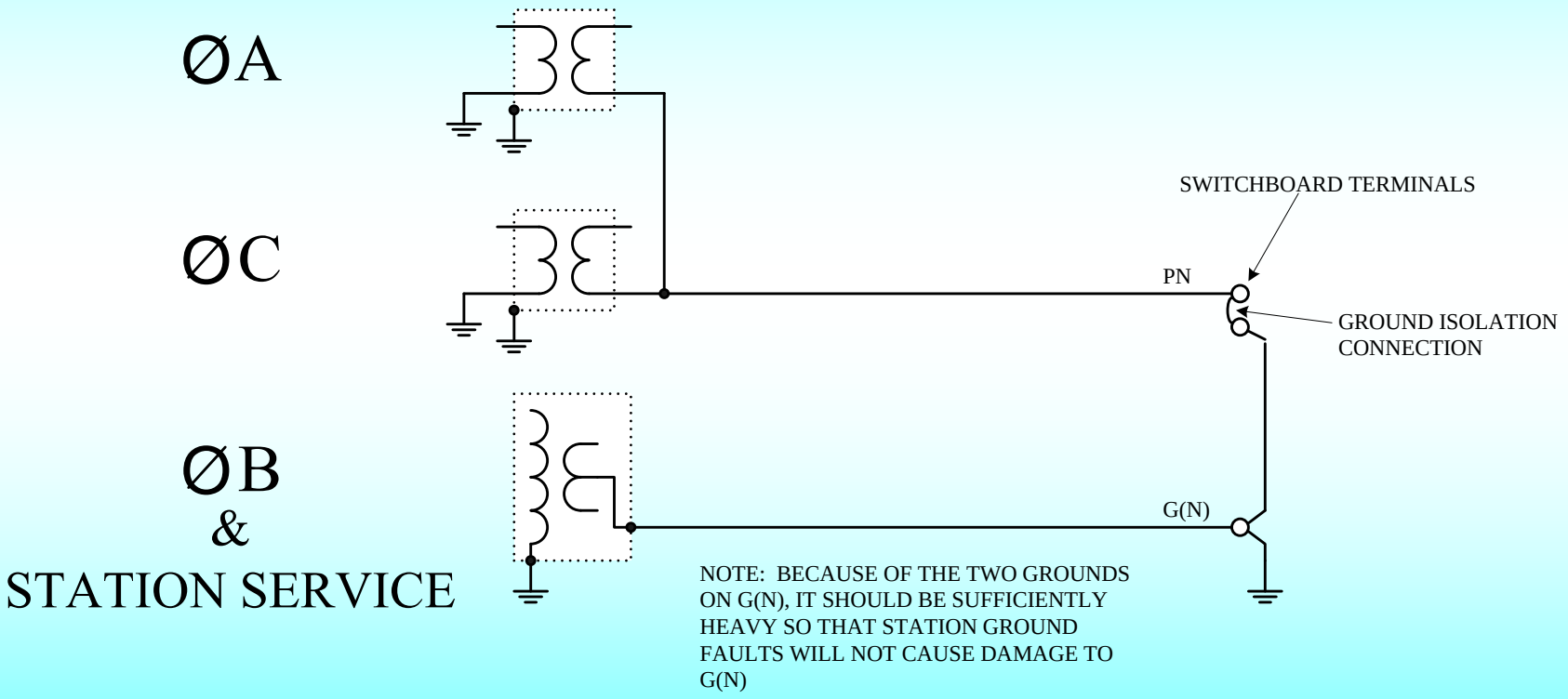
Synchroscope with Multiple Incoming and Running Circuits using Isolating Transformers



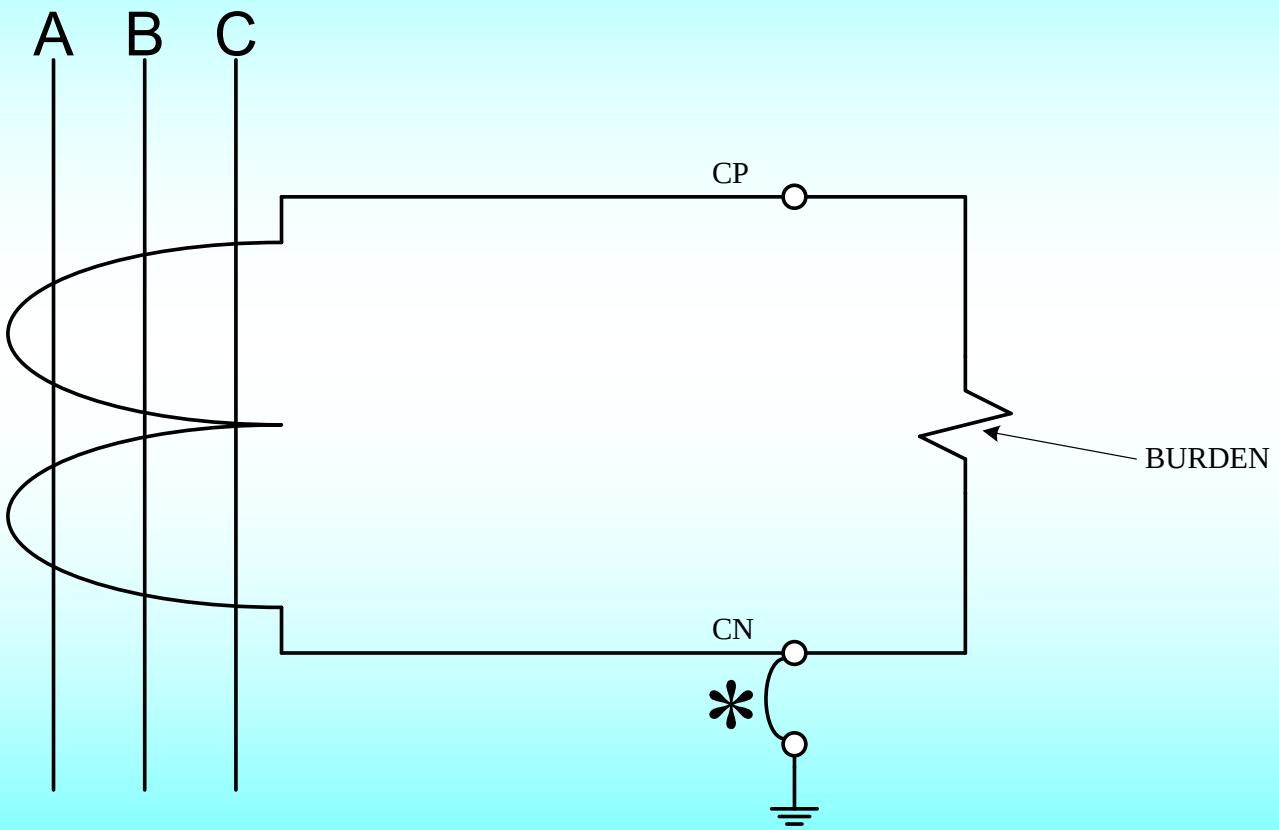
Synchroscope with Synchronizing Lights



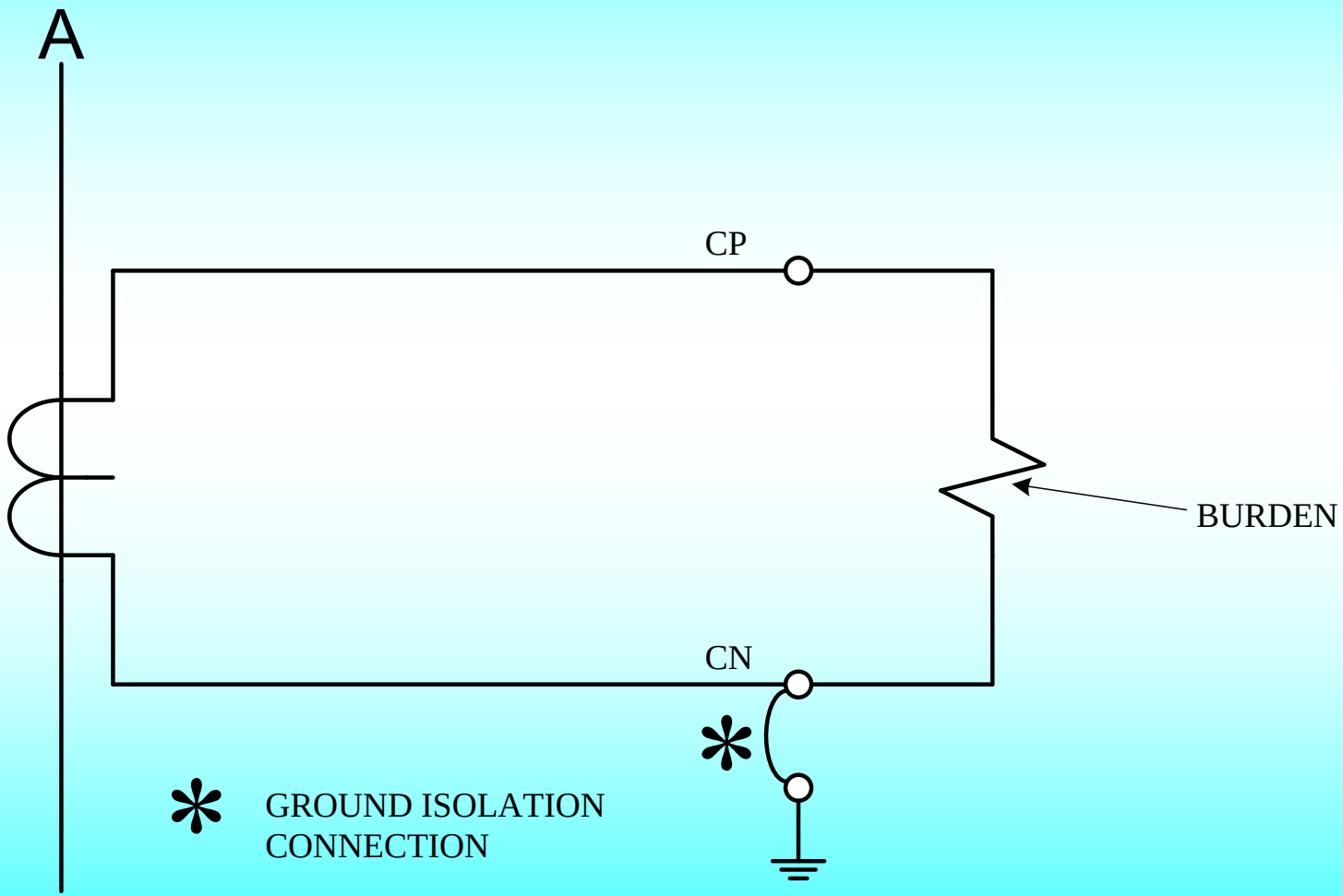
Grounding Distribution Station with one Φ used for Instrumentation



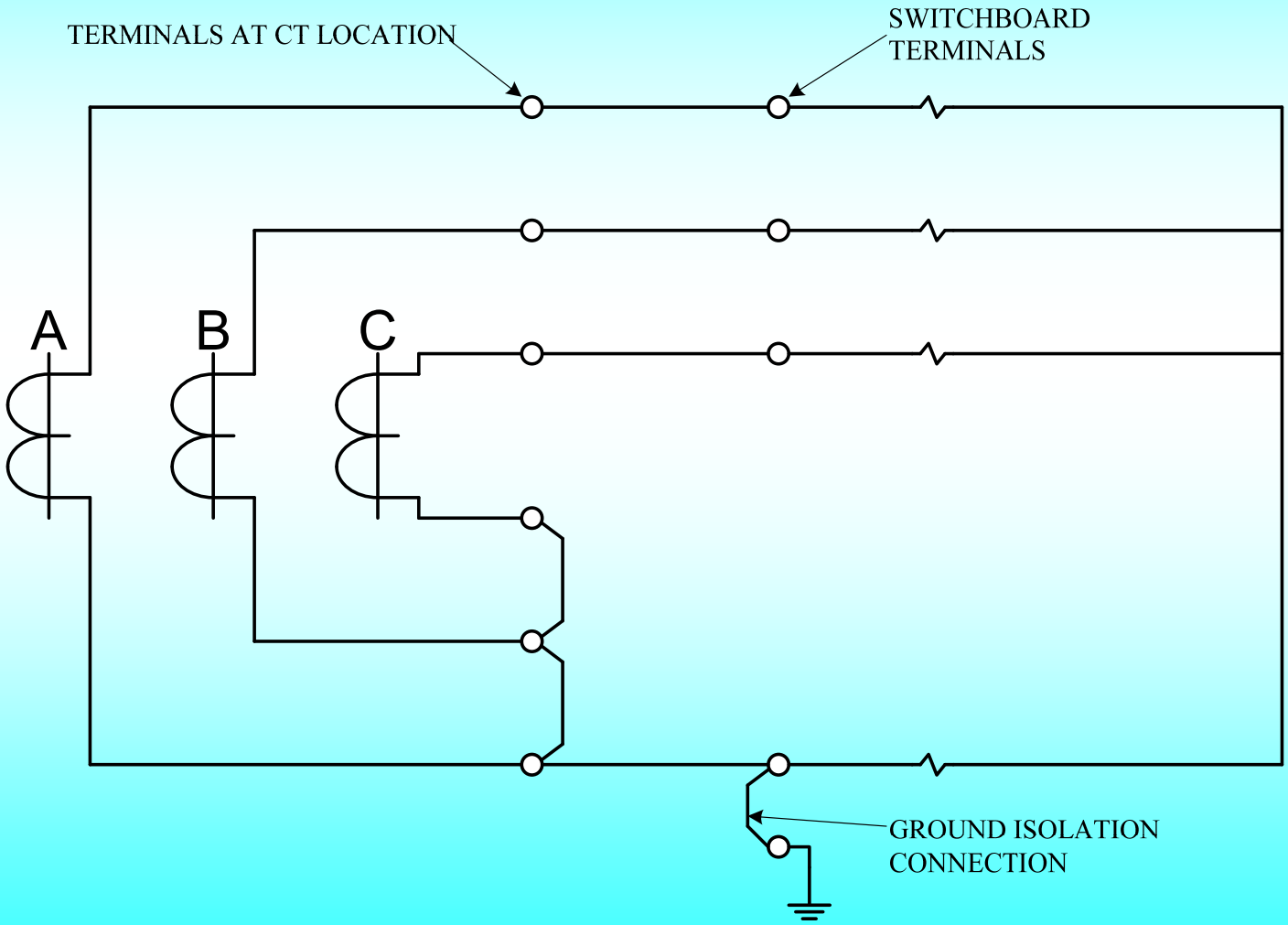
Grounding 1 Φ CT Circuit



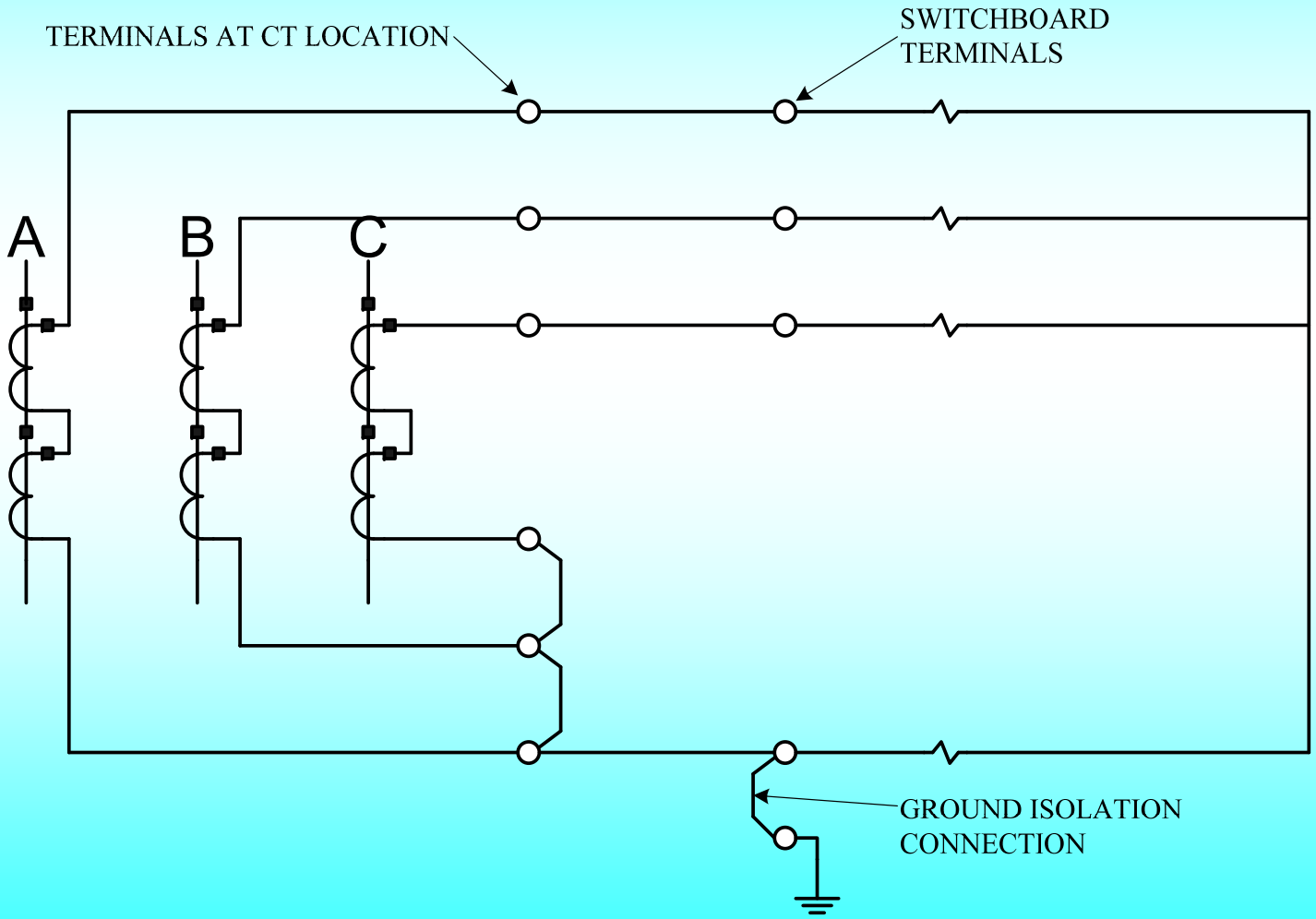
Grounding 1 Φ CT Circuit



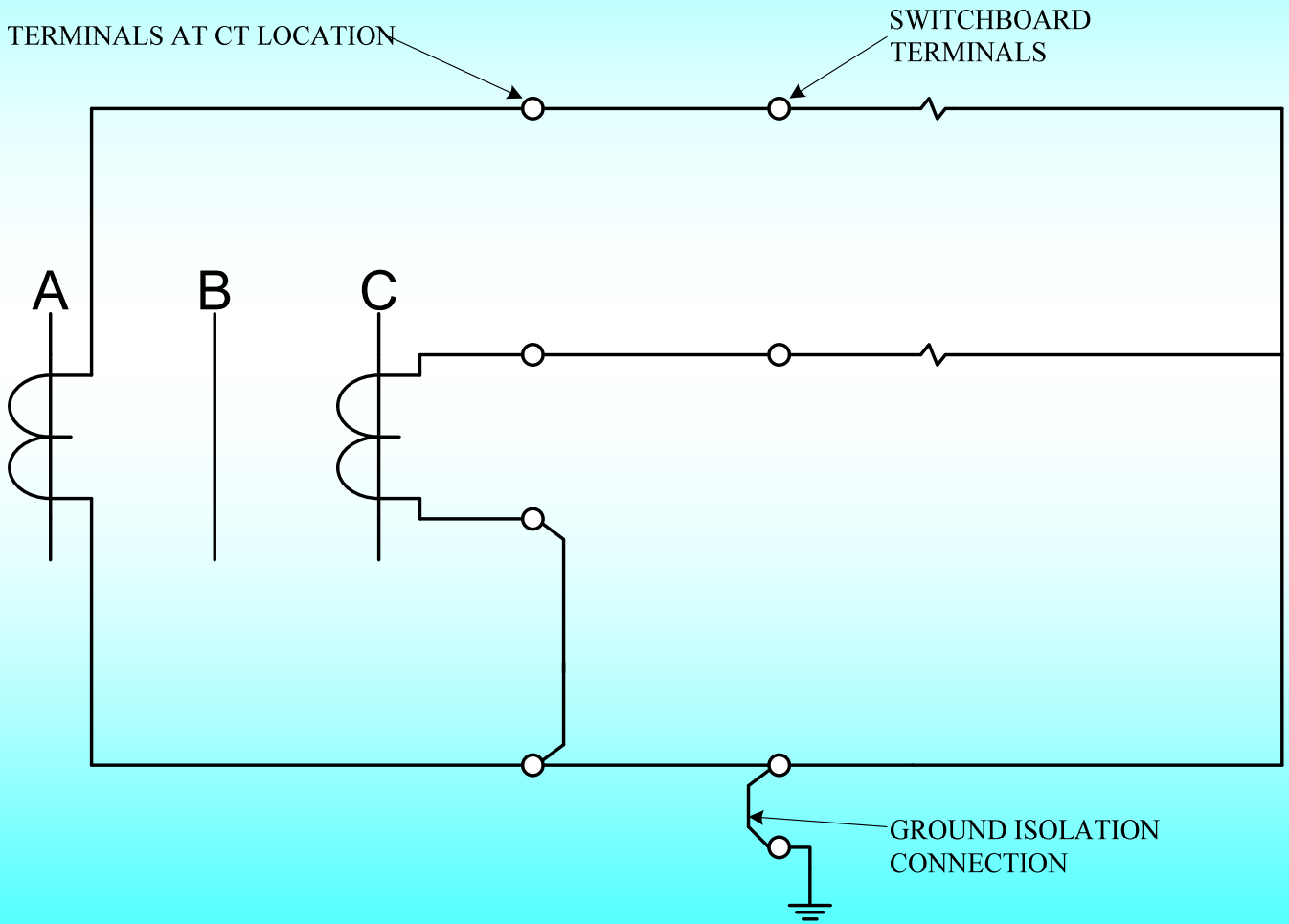
Grounding 3 Φ CT Circuit



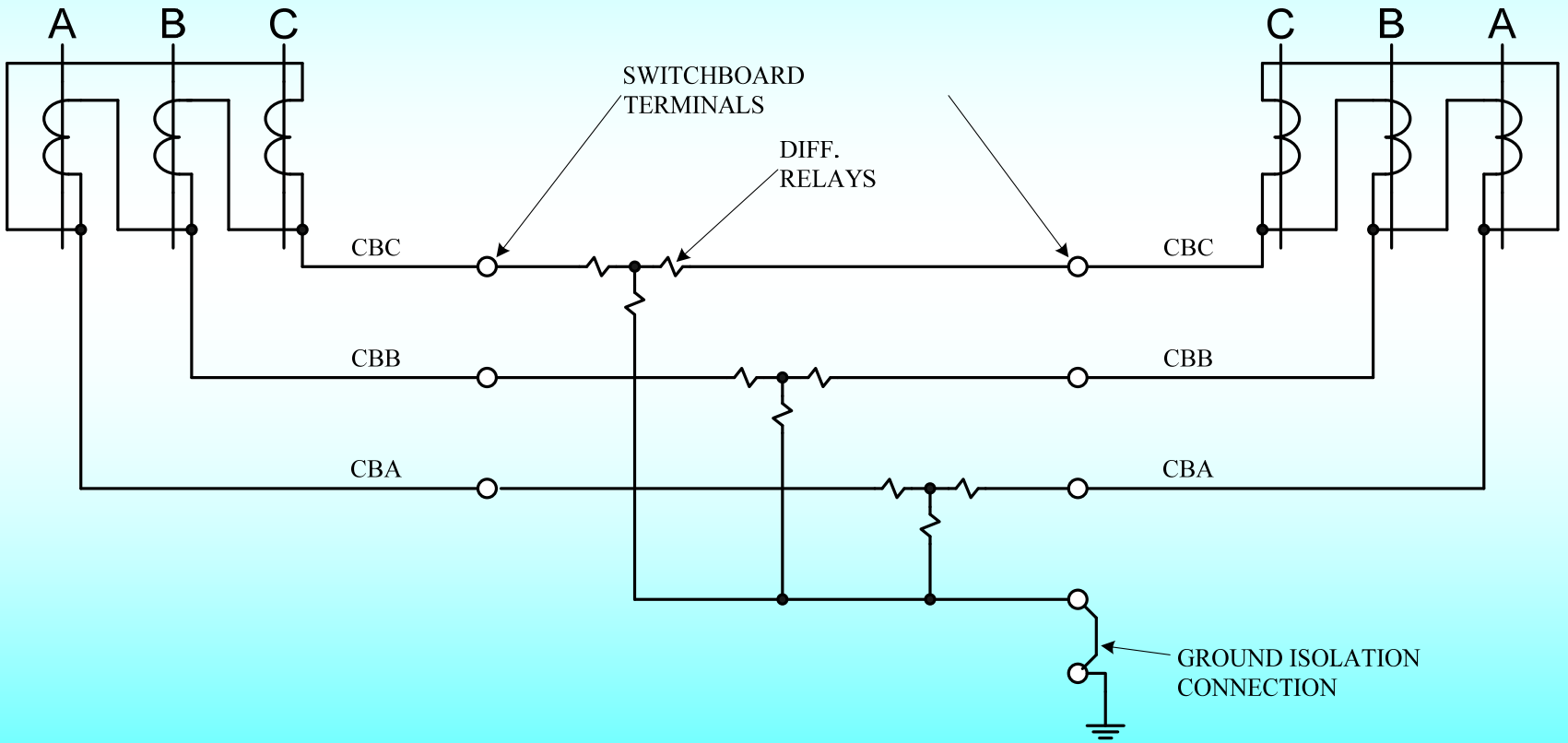
Grounding 3 Φ CT Circuit



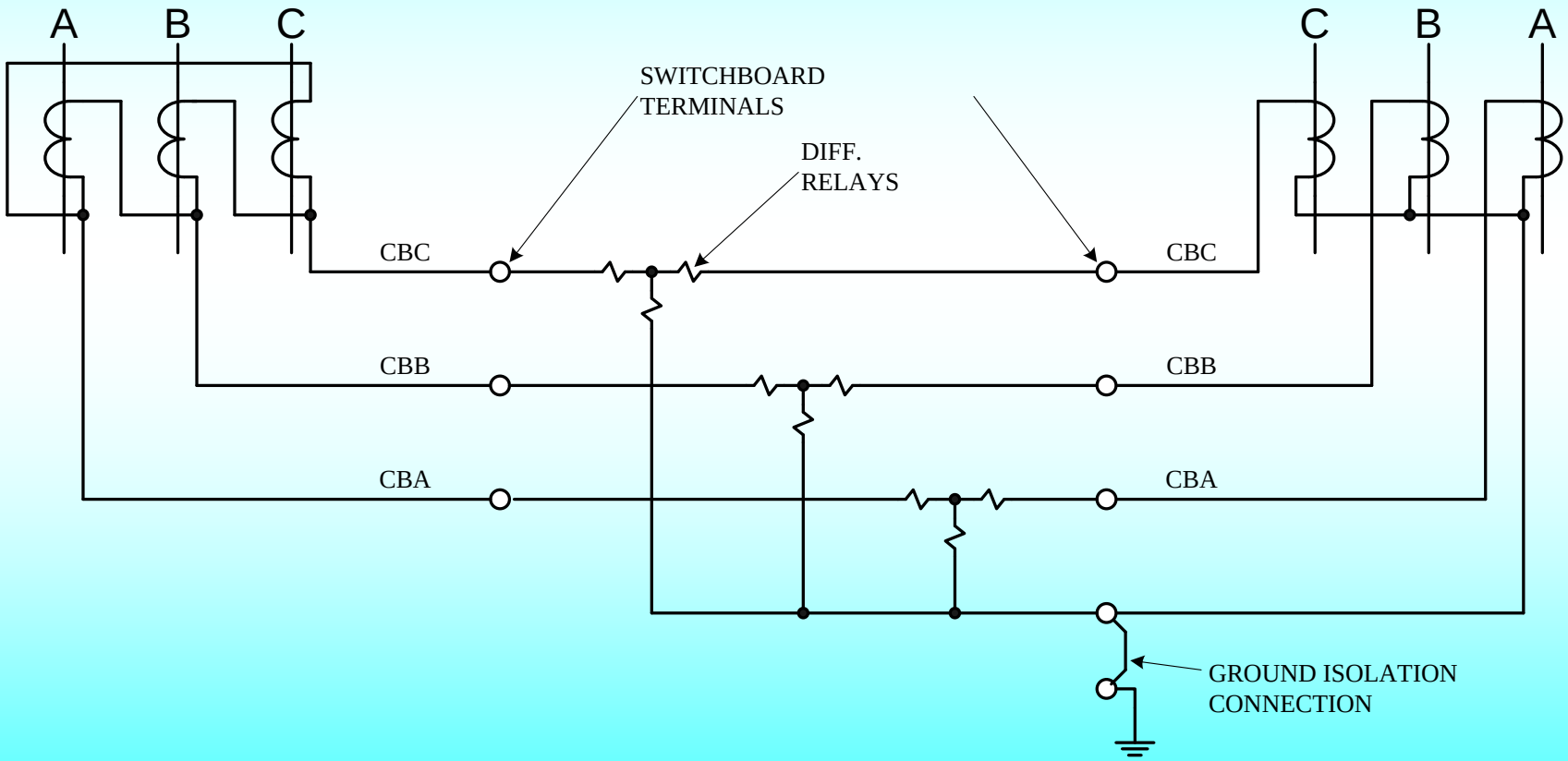
Grounding V Connected CT Circuit



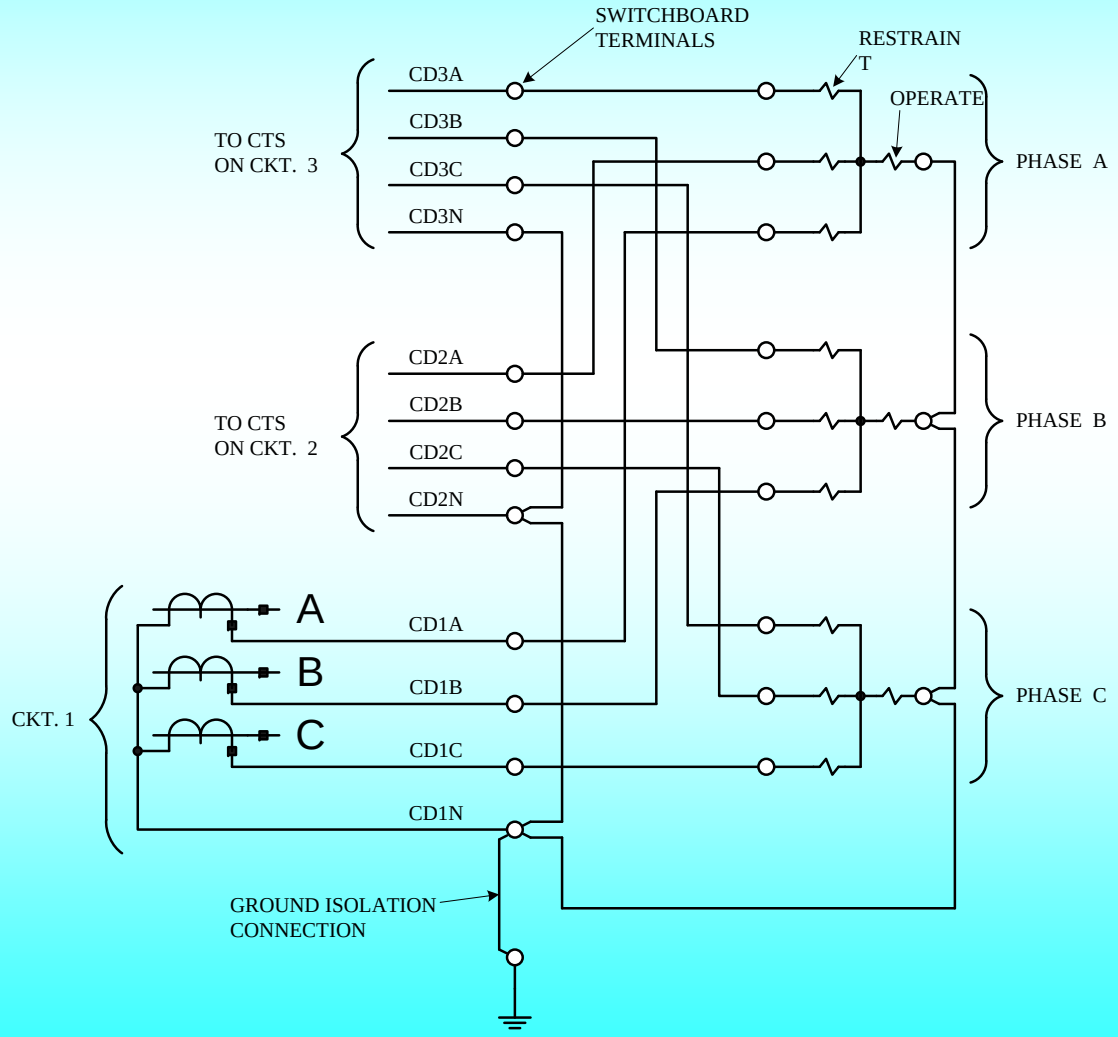
Delta-Delta Connected CTs in a Differential Protection Relay



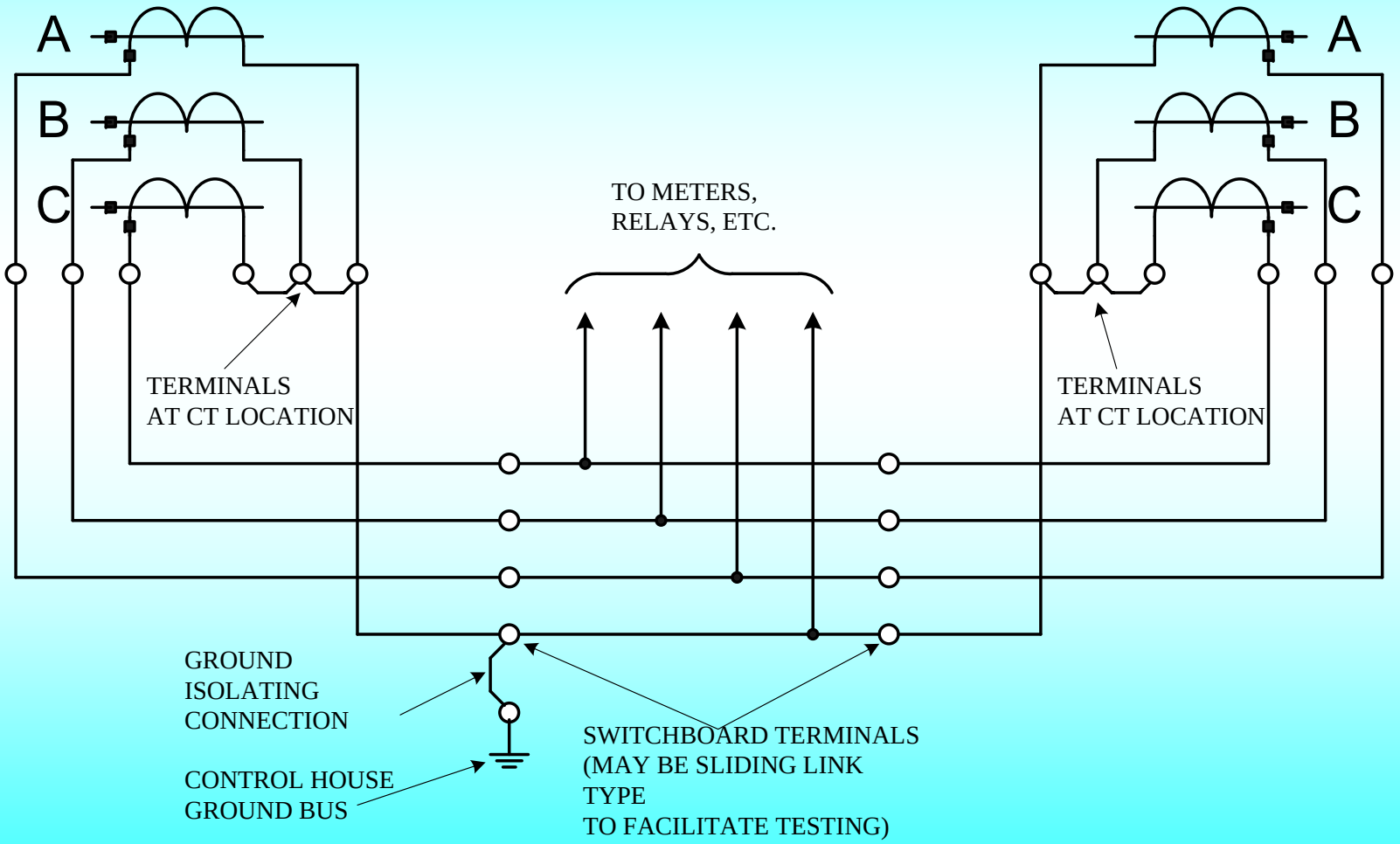
Delta-Wye Connected CTs in a Differential Protection Relay



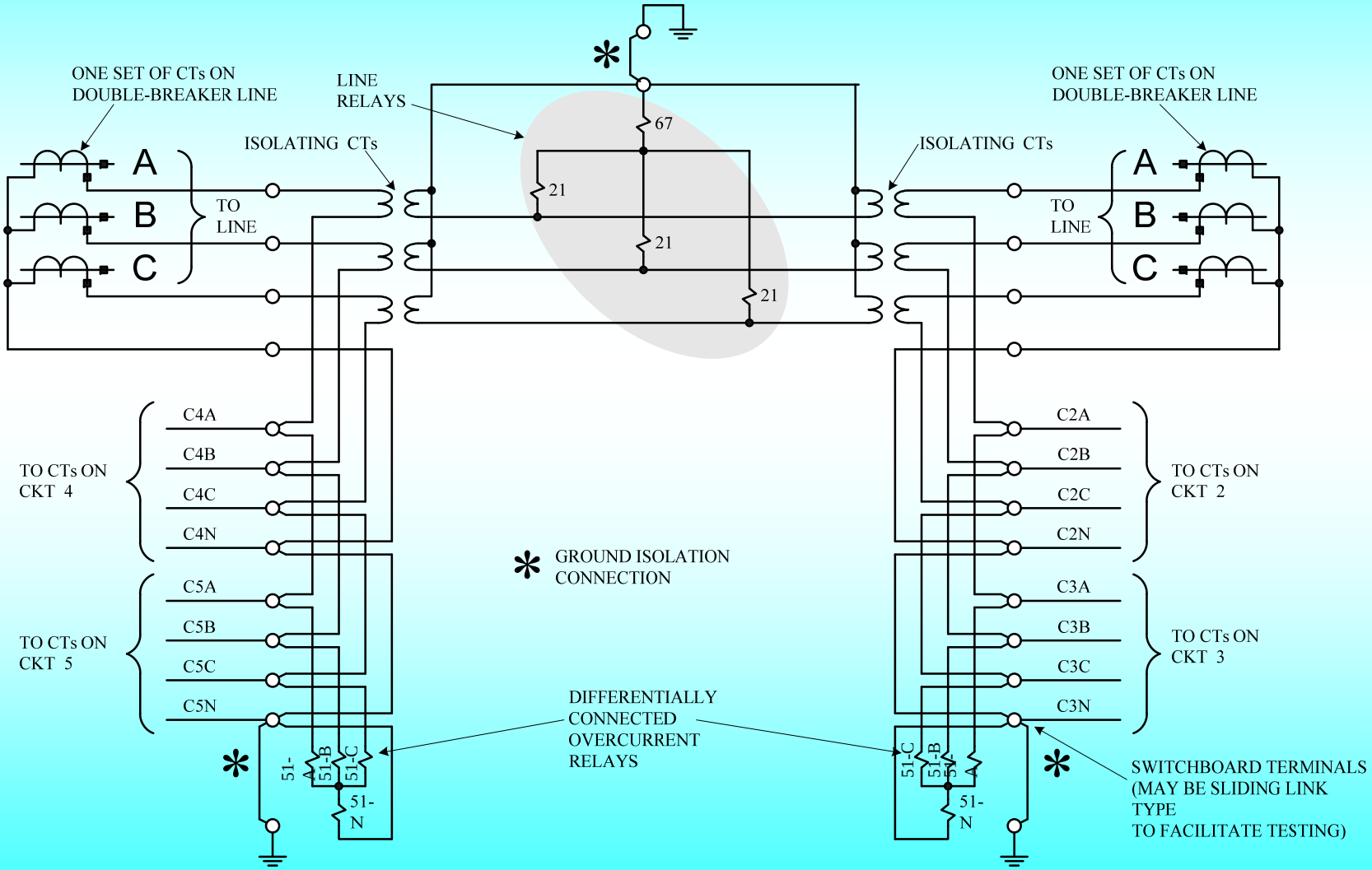
Percentage Bus Differential Scheme



Ring Bus or Breaker and a Half Scheme



Multiple use of CTs



Grounding of Cases

- Grounding metallic conductive cases
- Insulated cases with conductive internal parts
- Ungrounded metallic cases or internal parts
  - Protected by suitable barriers or elevated to prevent contact if operating voltage exceeds 1,000 V

Exceptions to Grounding

- If the primary windings of instrument transformer circuits are connected to circuits of less than 1000 V with no live parts or wiring exposed or accessible to other than qualified persons, the circuits may not be grounded.

Exceptions to Grounding

- For instrument transformer cases, the cases or frames of CTs may not be grounded if the primary windings are not over 150 V to ground and are used exclusively to supply current to meters.

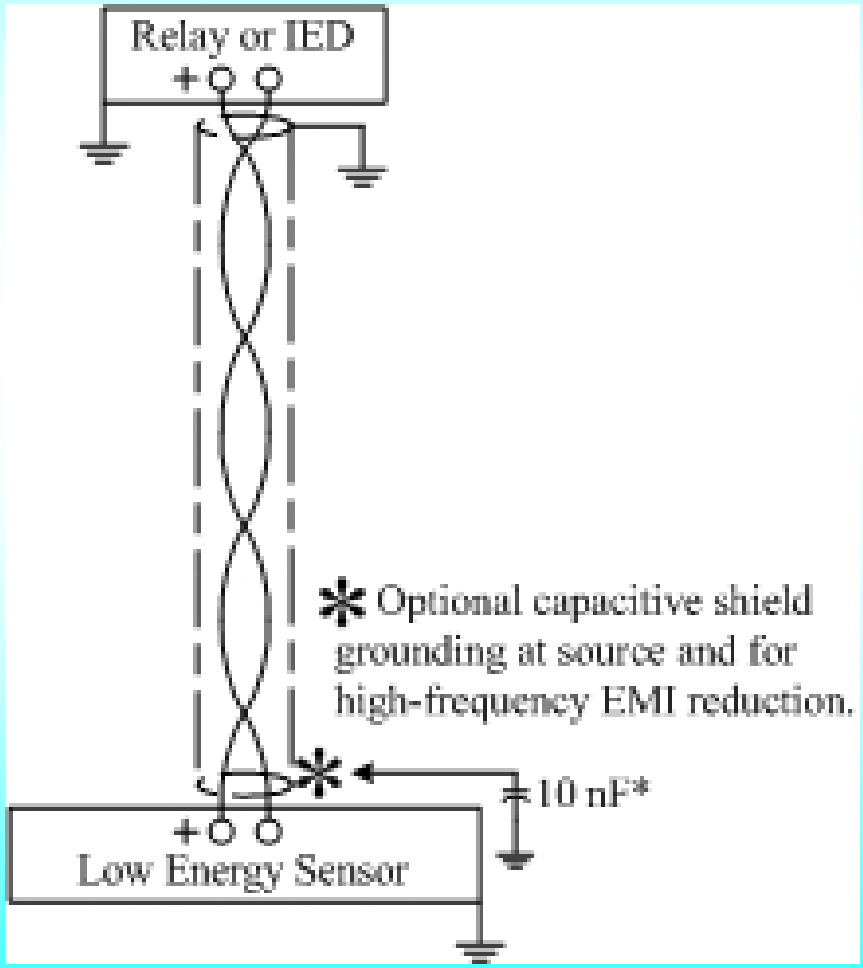
Exceptions to Grounding

- Cases of instruments, meters, and relays operating at less than 1000 V on switchboards having exposed live parts on the front of panels are not usually grounded. Mats of insulating rubber or other suitable floor insulation is provided where the voltage to ground exceeds 150 V.

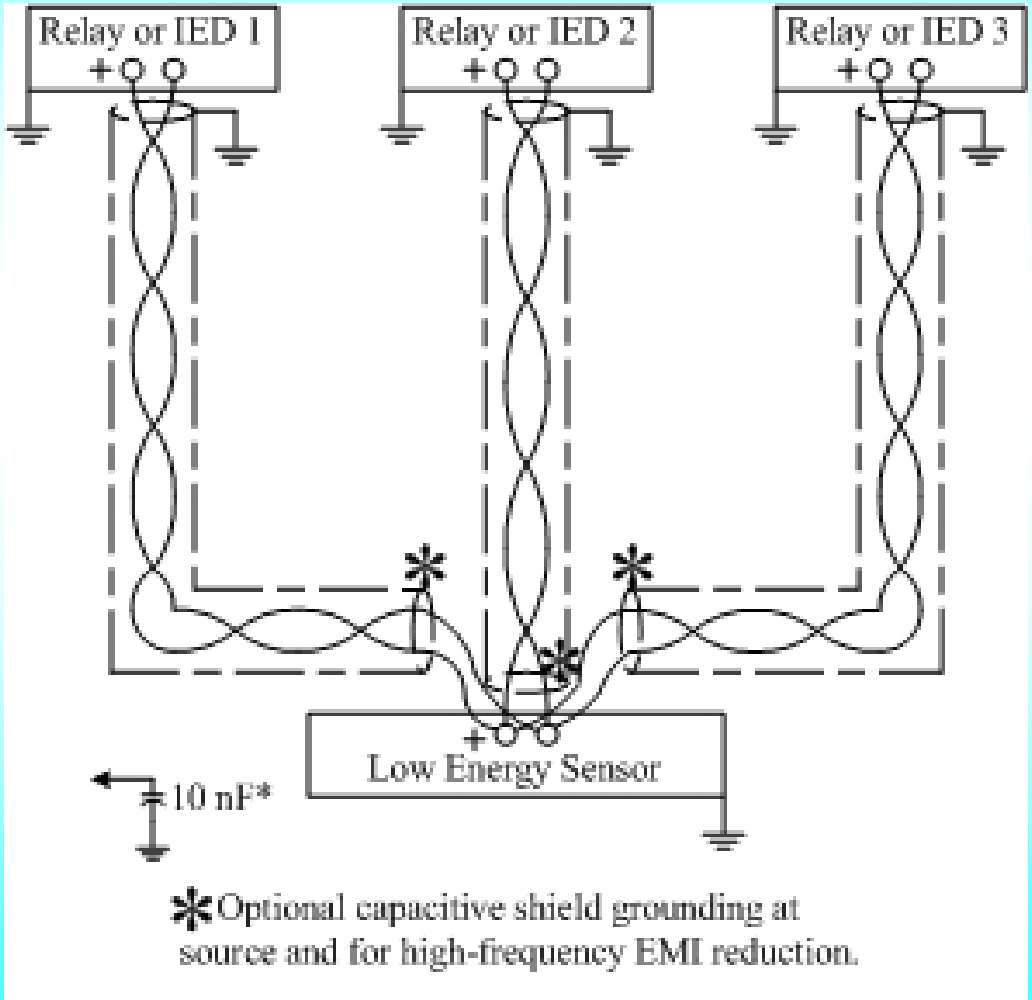
Exceptions to Grounding

- Instruments, meters, and relays, whose current-carrying parts operate at voltages to ground of 1000 V and over, are isolated by elevating them or protecting them by suitable barriers, grounded metal or insulating covers, or guards. In such situations, the cases are not usually grounded.

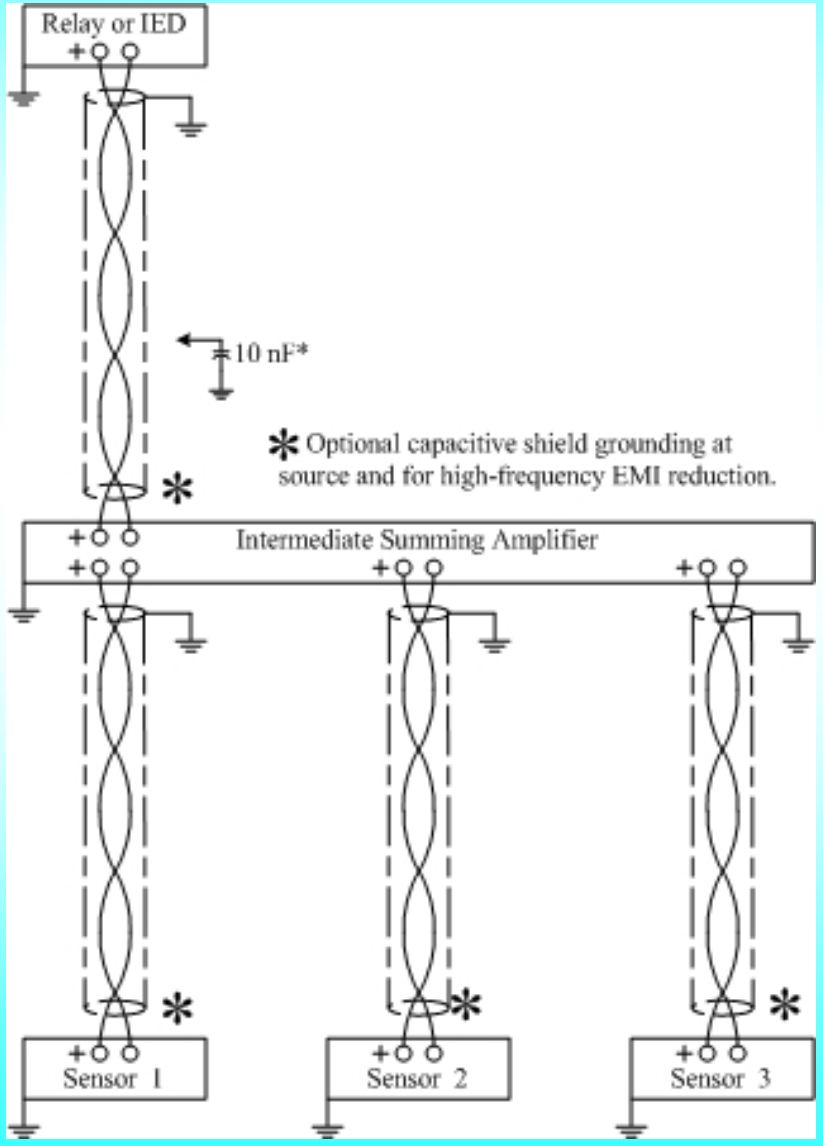
Grounding of Low-Energy Transducers



Grounding of Low-Energy Transducers



Grounding of Low-Energy Transducers

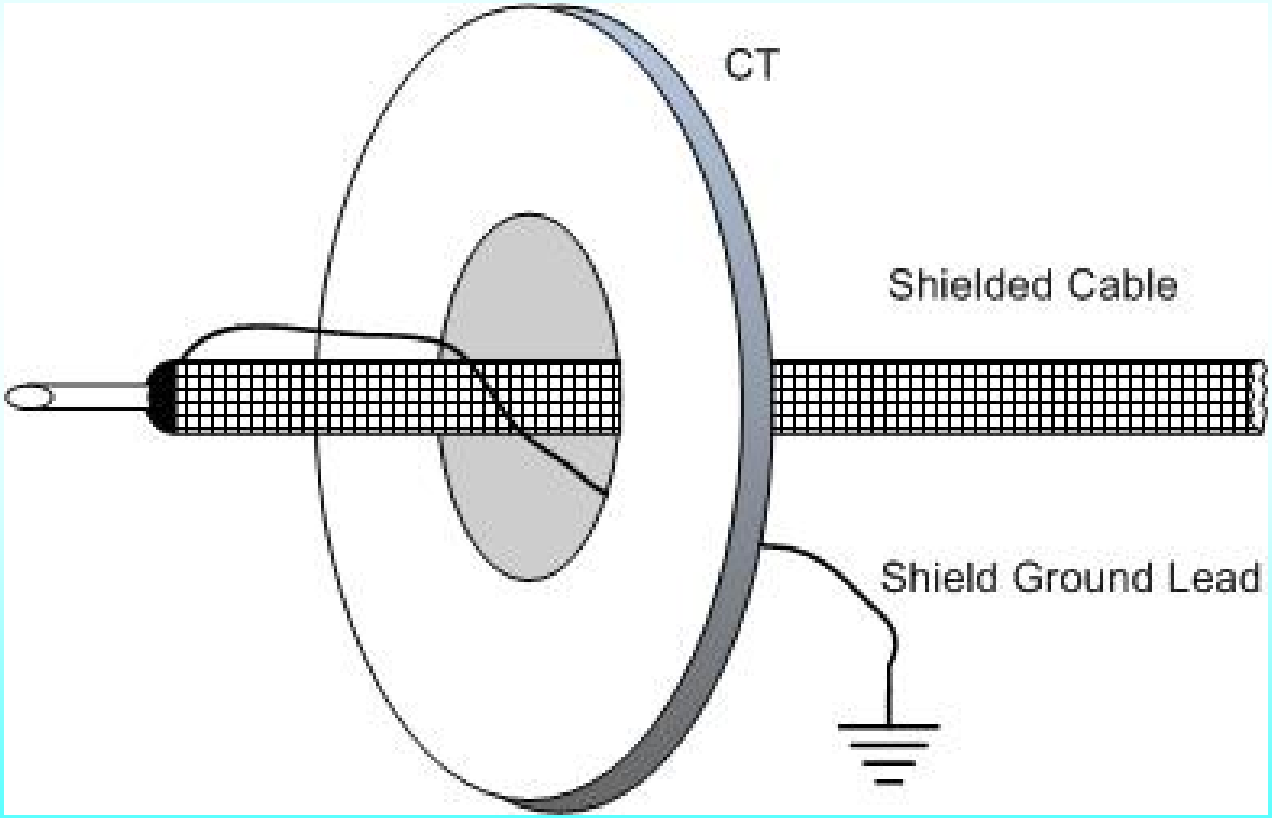


Annex A

- Grounding of shielded cables
  - To consider current carrying capacity of the shield
  - Cables with spiral design shields are grounded at both ends
  - Cables with drain wires are grounded at one end

Annex A

- CTs installed over shielded cables



Annex B

- IEEE Standards reviewed by the WG

Annex C

- Clause 90.2, Scope of National Electricity Code
  - Type of installations covered by the *Code*
  - Type of installations not covered bye the *Code*
  - Special permission

ANNEX D

- Survey of Grounding Practices
  - Approximately one-third of the respondents do not ground voltage transformers “at the first point of use” as described in the Guide. The Working Group is of the opinion that grounding “at the first point of use” is better than grounding at other locations.
  - Almost all respondents indicated that current transformers are grounded “at the first point of use” as described in the Guide.