Separately Derived SourcesApplication Note - AN-1

The ***Separately Derived Source*** (SDS) is one of the most cost-effective power quality measures that can be implemented for a sensitive load. Installation of a properly grounded, bonded, and located SDS can provide complete immunity from common-mode and grounding problems. However, improper installation of an SDS can result in a degraded level of protection or even contribute to power quality problems.

What is a Separately Derived Source?

The most common type of Separately Derived Source is a common insulating transformer. Such a device, often used to adapt voltages from a higher level (480 VAC) to a lower level (208Y/120 VAC), provides an excellent opportunity to derive a new system ground. This type of transformer can be small single phase devices, suitable for powering a single piece of equipment, or large three phase devices that can be used to supply power to an entire installation.

Other types of Separately Derived Sources may include: shielded isolation transformers, power conditioners, voltage regulators, UPS systems, rotary power conditioners, and motor generators. However, not all of these devices qualify as separately derived sources.

The National Electric Code (NEC) Article 100 defines an SDS as having *"...no direct electrical connection, including a solidly connected grounded circuit conductor, to supply conductors originating in another system."* If in doubt, contact the device manufacturer to determine if a particular device can be considered a separately derived source.

Location of a Separately Derived Source

For power quality purposes, the best place to install a separately derived source is physically close to the sensitive load (within 10-25 feet). The benefit of this type of location is that the neutral and ground conductor impedances are kept as low as possible. This minimizes the possibility of load generated common-mode problems, and ensures that the sensitive load is kept to the same ground potential as the surrounding environment.

The National Electric Code

The NEC provides some specific instructions with regard to installing and grounding Separately Derived Sources. These can be found in Article 250 - Grounding.

Article 250-20 contains a detailed list of the types of electrical systems that must be grounded. By "grounded", the code means "Connected to earth or to some conducting body that serves in place of the earth" *(Definition - Article 100).* A grounded electrical system or source is one in which a conductor (often called a "neutral") is connected to ground.

The following types of AC electrical systems (50 - 1000 Volts) must be grounded:

- Where the system can be grounded so that the maximum voltage to ground on the ungrounded conductors does not exceed 150 volts
- Three phase, 4 Wire Wye systems where the neutral is used as a circuit conductor
- Three phase, 4 Wire delta systems where the mid-point of one phase winding is used as a circuit conductor
- Separately Derived Sources that meet the above requirements

NEC 250-30 provides specific guidelines for the techniques and connections required to safely ground a separately derived source. This NEC passage will be addressed in detail through the rest of this application note.

Grounding Connections

A properly grounded and bonded Separately Derived Source includes five main ground bonds or connection points. All of these must be present to ensure safety and effectiveness.

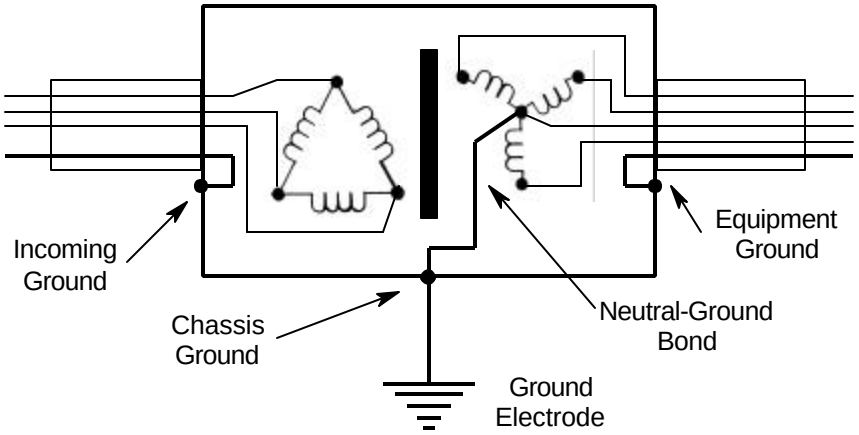
Incoming ground: this ground conductor is supplied with the primary transformer feed. It may be undersized (smaller than phase conductors) as permitted in the NEC without adversely affecting power quality

Chassis connection: this ensures that the transformer chassis itself is safely grounded in case of electrical fault

Ground electrode connection: this connection ensures that the derived source (secondary) is effectively referenced to the local building ground. It is important that this electrode be physically close to the Separately Derived Source.

Output neutral: The output neutral (if present) is a current carrying, grounded conductor. It should never be reduced in size or derated for sensitive electronic loads

Equipment / Output ground: the output ground is a safety and reference conductor. It should never be reduced in size or derated for sensitive electronic loads.

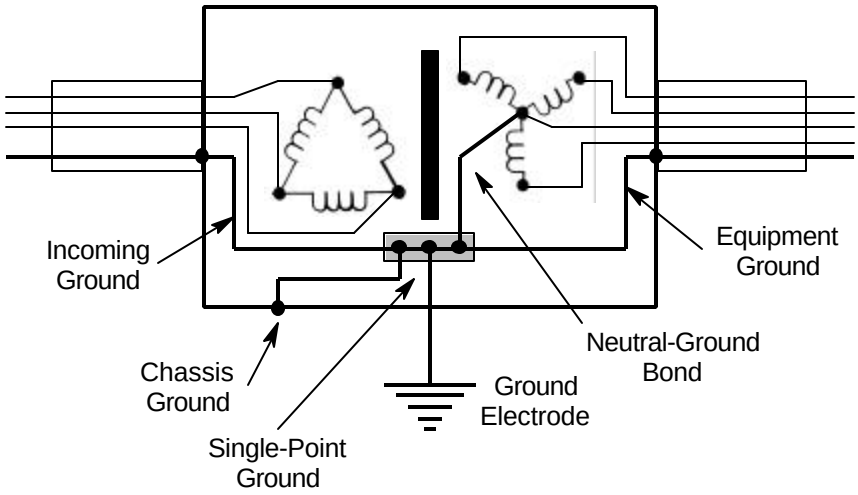


Minimum Grounding to Meet NEC Requirements

The NEC considers simple bonding to the chassis or enclosure of the SDS to be acceptable grounding. However, this type of connection may deteriorate over time due to resistance of paint or the enclosure finish, mechanical connection failure, corrosion, or accidental disconnection.

Preferred Grounding to Ensure Power Quality

It is highly recommended to exceed the NEC requirements with regard to grounding. Use of a "single point" ground terminal block within the SDS will provide a convenient place to interconnect all required grounds, and ensure that low impedance, reliable grounding can be maintained over the life of the equipment.



Common Grounding Problems and Questions

It is very common for Separately Derived Sources to be grounded incorrectly or in a less than ideal way. The results are often an unacceptable level of ground voltage and common-mode problems.

Incoming Neutral

In a true SDS, the incoming neutral should never be connected to the grounds or chassis of the device. Doing so is a violation of the NEC and will result in ground currents that can cause equipment problems. If a neutral is supplied to a Separately Derived Source, it should be taped off and not connected. The only exception is a UPS or other device where a mechanical Bypass switch might require an Input neutral in order to bypass the Separately Derived Source.

Ground Electrode

The ground electrode is a common place for grounding problems. Many SDS are not connected to a ground electrode, resulting in no local ground reference. In other cases, the ground electrode is located far from the separately derived source. Finally, some SDS are grounded only to the electrode (not to the chassis, or input and output grounds) in hopes of obtaining a "clean" ground. All of these practices violate the NEC and may create safety hazards and performance problems.

Incoming Ground

In general, the incoming ground does not need to be fully sized, but can be sized in accordance with the NEC. However, in cases where the ground electrode is not installed or is distant from the Separately Derived Source, a full sized incoming ground conductor will improve the system grounding.

Floating Output Secondary

One misconception surrounding "Isolation" Transformers (a common type of Separately Derived Source) is that the output should be "Isolated", that is, not connected to ground. In most cases, such isolation is a violation of the NEC. Except in very special cases as permitted in the code, the secondary of a SDS must be grounded by bonding the output neutral to ground. Failure to make this connection will result in an ungrounded output.

Teal Electronics *produces power conditioners that are Separately Derived Sources. Proper installation and grounding of TEAL conditioners ensures the best possible grounding for your sensitive systems.*

