



Electrical Performance Advantages of Short, Flat Profile Ground Straps and ESD Bonds Compared to Round Profile Wire Rope Designs

In grounding and bonding applications, the electrical performance of a flat profile flexible braided ground strap is generally superior to that of a round profile wire rope made of the same weight of material. This whitepaper discusses the key factors that contribute to this performance difference.

1. Surface Area:

- **Flat Profile:** A flat braided strap has a larger surface area in contact with the surfaces it is grounding. This increased contact area enhances the conductivity and reduces the resistance of the connection. More surface area allows for better dissipation of heat and current.
- **Round Profile:** A round conductor has a smaller contact area, which can result in higher resistance at the connection points and less efficient current transfer.

2. Skin Effect:

- **Flat Profile:** At higher frequencies, the skin effect causes current to flow primarily on the surface of a conductor. A flat profile, with its greater surface area, accommodates more current flow on its surface, improving performance in high-frequency applications.
- **Round Profile:** The round profile has less surface area available for current flow under the skin effect, potentially limiting its effectiveness at higher frequencies.

3. Flexibility and Mechanical Properties:

- **Flat Profile:** Flat braided straps are more flexible and can conform more easily to irregular surfaces or bends. This flexibility ensures better and more consistent contact, reducing the likelihood of gaps or weak points in the grounding connection.
- **Round Profile:** Round conductors are generally less flexible, making them more challenging to install and maintain consistent contact in applications requiring bending or movement.

4. Heat Dissipation:

- **Flat Profile:** The increased surface area of a flat strap also aids in heat dissipation. Efficient heat dissipation is crucial in maintaining the integrity and performance of the grounding strap under high current loads.
- **Round Profile:** With a smaller surface area, round conductors may retain more heat, potentially leading to thermal stress and reduced performance over time.



5. Inductance:

- **Flat Profile:** Flat straps generally have lower inductance compared to round conductors. Lower inductance is beneficial in grounding applications because it reduces the impedance at high frequencies, ensuring more effective grounding.
- **Round Profile:** Higher inductance in round conductors can result in higher impedance, particularly at higher frequencies, which can degrade the performance of the grounding system.

6. Installation and Connection Points:

- **Flat Profile:** Easier to install and secure using bolts, clamps, or other fasteners, a flat strap can create a more reliable and durable connection. The broad, flat surface provides a stable base for secure connections.
- **Round Profile:** Round conductors may require additional measures to ensure a reliable connection, and the contact area may not be as stable or extensive as that of a flat strap.

Short Versus Long Ground and ESD Bond Straps

Turning the discussion to length, using a shorter length of flat, flexible, braided ground strap is generally preferred over a longer point-to-point strap or any form factor strap with strap with excess length. Here are the key reasons for this preference:

1. Reduced Resistance:

- **Shorter Length:** Electrical resistance in a conductor increases with its length. A shorter strap minimizes the resistance, enhancing the efficiency of the grounding system. This ensures better current flow and more effective grounding.
- **Longer Length:** A longer strap introduces more resistance, which can impede the flow of current and reduce the effectiveness of the grounding system.

2. Minimized Inductance:

- **Shorter Length:** Inductance is proportional to the length of the conductor. A shorter strap has lower inductance, which is crucial for grounding applications, especially at high frequencies. Lower inductance reduces impedance and improves the performance of the grounding system.
- **Longer Length:** A longer strap has higher inductance, which can increase impedance and negatively impact the grounding performance, particularly in applications involving high-frequency signals or transients.



3. Improved Electromagnetic Compatibility (EMC):

- **Shorter Length:** Reducing the length of the grounding strap minimizes its loop area, thereby reducing its susceptibility to electromagnetic interference (EMI). This improves the overall electromagnetic compatibility of the system.
- **Longer Length:** A longer strap with a larger loop area is more prone to picking up EMI, which can cause interference and degrade system performance.

4. Reduced Voltage Drop:

- **Shorter Length:** A shorter grounding strap results in a smaller voltage drop along its length. This ensures that the ground potential remains consistent across different parts of the system, enhancing safety and performance.
- **Longer Length:** A longer strap can cause a significant voltage drop, leading to potential differences within the system and compromising the grounding integrity.

5. Lower Impedance Path:

- **Shorter Length:** A shorter grounding path provides a lower impedance path for fault currents, ensuring rapid and efficient dissipation of excess current. This is critical for safety and protecting equipment from damage.
- **Longer Length:** A longer grounding path presents a higher impedance, which can slow down the dissipation of fault currents and increase the risk of equipment damage or safety hazards.

6. Mechanical Considerations:

- **Shorter Length:** A shorter strap is easier to manage and secure, reducing the risk of movement or disconnection over time. It also reduces the physical space required for installation.
- **Longer Length:** Excess length can lead to mechanical challenges, such as difficulty in securing the strap properly, potential for tangling or snagging, and increased stress on connection points.

7. Aesthetics and Practicality:

- **Shorter Length:** A shorter strap provides a neater and more organized installation. It eliminates unnecessary slack, reducing clutter and potential points of failure.
- **Longer Length:** Excess length can result in a messy installation, with loops or coils that may interfere with other components or systems.



Conclusion

For the above reasons, Glenair recommends that the optimal form factor for a ground strap or Electrostatic Discharge (ESD) bond is the widest and shortest practicable for the applications. Again, here are the key reasons why this form factor is preferred:

1. **Reduced Electrical Resistance:**

- **Wide and Short:** A wider strap increases the cross-sectional area, which reduces the electrical resistance. The shorter the strap, the less material the current has to travel through, further minimizing resistance and ensuring efficient current flow, enhancing the grounding performance.

2. **Lower Inductance:**

- **Wide and Short:** Inductance is lower in shorter conductors. Additionally, a wide strap has a geometry that helps minimize inductance because it reduces the formation of magnetic fields around the conductor.
- Lower inductance is particularly beneficial in high-frequency applications, where it helps maintain effective grounding.

3. **Better Heat Dissipation:**

- **Wide and Short:** A wider strap has more surface area exposed to the environment, improving heat dissipation. This is important in high-current scenarios where excess heat needs to be managed.
- Efficient heat dissipation helps maintain the integrity and performance of the grounding system.

4. **Improved Electromagnetic Compatibility (EMC):**

- **Wide and Short:** This form factor minimizes the loop area, reducing the strap's susceptibility to electromagnetic interference (EMI).
- It helps in maintaining a stable ground potential and reduces noise and interference in sensitive electronic systems.

5. **Enhanced Mechanical Stability:**

- **Wide and Short:** A wider, shorter strap is mechanically more stable and easier to secure. It reduces the risk of movement or disconnection due to vibrations or mechanical stress.



- It also simplifies the installation process, providing a more robust and durable connection.

6. Consistent Ground Potential:

- **Wide and Short:** A short strap ensures minimal voltage drop along its length, maintaining a consistent ground potential across different parts of the system.
- This is crucial for safety and the proper functioning of the entire system, especially in ESD-sensitive environments.

7. Efficient ESD Dissipation:

- **Wide and Short:** In ESD applications, a wide and short strap provides a low-impedance path for electrostatic charges to dissipate quickly and safely.
- This minimizes the risk of electrostatic discharge damaging sensitive electronic components.

In summary, a wide and short ground strap or ESD bond optimizes electrical performance by reducing resistance and inductance, enhancing heat dissipation, improving EMC, providing mechanical stability, ensuring consistent ground potential, and efficiently dissipating electrostatic charges. This form factor is generally the best choice for achieving reliable and effective grounding and bonding in various applications.