TINEL-LOCK BACKSHELLS: ADVANCED MILITARY/DEFENSE PERFORMANCE

Tinel-Lock backshell technology offers a unique balance of properties for terminating a braided cable shield for robust, cost-effective performance.

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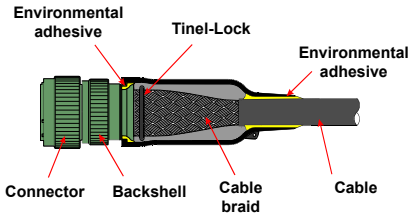
Electronic systems in military vehicles and aircraft are exposed to extreme shock, vibration, temperature cycling, and electromagnetic interference (EMI). These stresses particularly affect cable harnesses — especially the area between the cable and the connector's backshell that provides a mechanical attachment point for shielding and/or sealing systems. A variety of technologies can be used to trap the metallic cable braid to the backshell. The challenge for designers is to select the appropriate mechanism in terms of cost, ease of installation, and robustness suitable to the specific ground-vehicle or aviation application. TE Connectivity (TE) developed Tinel-Lock technology along with TXR Series backshells to offer a unique balance of properties for terminating a braided cable shield for robust, cost-effective performance.

Designed to Meet Termination Challenges

Backshells serve several functions: They enable harness routing management by delivering protection from wire chafing. They also include features to accommodate heat-shrink memory boots for sealing, and attachment points for harness braiding or shielding to provide a measure of EMI screening. Conductive shielding around cables is used to take electrical and magnetic field voltages to ground. Otherwise, cables can act as antennas — picking up EMI, transmitting noise, and even radiating energy from other cables in the form of "crosstalk." Properly trapping the metallic braid of the cable shield to the backshell is vital to screen EMI. Selecting the optimum trapping method also ensures electrical continuity in the form of low DC resistance, provides strong physical attachment, and allows the accommodation of a heat-shrink boot when cable strain relief and an environmentally sealed solution are desired.

A typical Tinel-Lock termination system includes the connector, backshell, an optional heat-shrink memory boot with environmental adhesive, the cable, the cable braid, and the Tinel-Lock ring used to trap the braid on the landing area of the backshell (Figure 1).

Tinel-Lock technology is a shape memory metal ring that, after heating, shrinks to terminate the braid for a uniform, 360º circular



[Figure 1 | A termination system using a Tinel-Lock ring and an optional heat-shrink boot]

connection. The resulting cable termination withstands severe shock and temperature cycling ranging from -65°C to 200°C, while also providing excellent electrical continuity, vibration resistance, and corrosion resistance. Tinel-Lock backshells can be used to terminate nickel, silver, and tin-plated cable braids.

Compared to the other cable termination methods discussed later, the Tinel-Lock solution offers several installation advantages.

Reduced craft sensitivity for the installer

With its pre-shaped, one-piece metal construction, the Tinel-Lock ring retains a memory of its circular shape. After installation, the Tinel-Lock ring recovers its original diameter while exhibiting fractional shrinkage that uniformly secures the ring around the braid.

The TE AD-5000 Tinel-Lock assembly tool is a manually operated resistance heating device specifically designed to install the Tinel-Lock (Figure 2).

[Figure 2 | The TE AD-5000 installation tool is used to correctly install the Tinel-Lock for screened terminations]

With braided cable, installation begins by slipping the Tinel-Lock ring over the cable. Then the braid is opened to fit over the backshell entry's profile. The braid/shield material is pushed up until it fully covers the landing area and

butts against the backshell's shoulder. The installer then slides the Tinel-Lock along the cable, positioning it perpendicularly to the cable, stopping short of the backshell's shoulder and three millimeters away from the entry.

The installer powers on the AD-5000 installation tool and uses the tool's notched electrodes to grip the Tinel-Lock without contacting the backshell. The installer presses a foot pedal to supply power to the electrodes, which immediately heat the Tinel-Lock ring.

Visible indicator of proper installation

A dot of thermochromic paint on the outside surface of the Tinel-Lock ring changes color when the appropriate installation temperature is reached. As soon as the paint turns black, the installer releases the foot switch and removes the electrodes. The Tinel-Lock cools in seconds, slightly shrinking from its original circular shape to firmly lock the braid into place with uniform 360° pressure.

Available in easy-to-install, side-entry design

A side-entry Tinel-Lock is available to join a cable or harness shield to a user-built connector backshell assembly or other cable termination device without prepositioning the ring on the harness. The low-profile, buckle-free, side-entry design features an opening with interlocking ends (Figure 3). This feature allows easy removal of the Tinel-Lock for access to the termination without depinning the connector if detachment or repair to a connector or cable is ever needed. During installation, the opening of the side-entry Tinel-Lock ring is simply pushed over the shielding. Next, a resistance heater or simple heat gun is used to heat the ring. Thermochromic paint applied to the ring changes color to indicate when the ring has been heated to its final recovery shape.

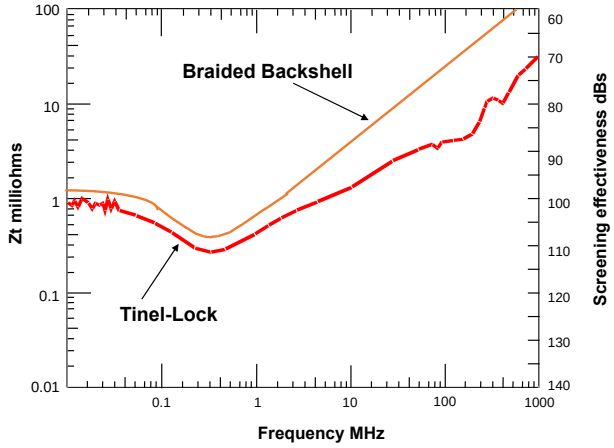
[Figure 3 | Side-entry Tinel-Lock rings]

Performance Advantages

For any harness system, EMI protection is only as strong as its weakest link. Shields are not perfect conductors, and any aperture in the shielding system can allow external magnetic and electric fields to penetrate the cable. In other words, EVERY CONNECTION COUNTS when designing a harness.

The selection of screen termination is determined by the specific cable braid type and the required screening performance across the expected frequency range.

EMI shielding performance varies significantly between different screened military backshell types. Shielding effectiveness is measured in terms of electromagnetic field screening (higher dB is better) and electrical resistance (lower milliohms is better) at a given frequency (MHz). Figure 4 compares Tinel-Lock rings with another type of backshell:



[Figure 4 | Comparison of EMI effectiveness for two different termination types]

- **Standard banding backshells** can have the cable shield terminated with either a band strap or a magneform crimp ring. The band strap starts as a flat piece of metal that must be formed into a circle. The installer uses a tool to carefully draw the band down tightly in a uniform circular shape. Band straps are a popular solution, but installers can experience problems if uneven tension is applied and the band hits break strength, requiring reapplication of a new band. As an alternative to band straps, the backshell can be supplied with a braid that's attached with a magneform ring. Braids are typically available in 6-, 12-, or 18-inch lengths. The installer has the flexibility to join the braided backshell to an existing cable, which still necessitates another technique when joining the pre-supplied braid of the backshell to the braid of the harness or cable. Although braided backshells are economical, their EMI screening effectiveness can be compromised if braid apertures are altered during final installation.
- **Tinel-Lock TXR Series backshells** employing Tinel-Lock ring technology strike a balance between cost and screening effectiveness across the electromagnetic spectrum from 1 MHz to 1,000 MHz. Screening effectiveness is consistent whether TXR Series backshells are used in harnesses exiting straight from the equipment or used with heat-shrink boots. When an angled exit is needed, straight TXR Series backshells can be used with molded heat-shrink boots that recover to 45° or 90° angles after heating.

Environmental and Application Considerations

As shaped memory metal rings that, after heating, shrink uniformly and securely around braiding, Tinel-Lock backshells have inherent resistance to severe shock, vibration, and temperature cycling. Thermally, the Tinel-Lock is a very stable material that traps the braid securely over a -50°C to 200°C temperature range. A Tinel-Lock assembly can be complemented by the addition of a heat-shrinkable molded boot with adhesive. This configuration environmentally seals and strengthens the cable strain relief between the backshell and the cable jacket, thereby reducing stress and strain on wiring. Tinel-Lock technology is available in TXR Series screened backshells suitable for MIL-DTL 5015, MIL-DTL-26482 and MIL-DTL-38999 Series connectors, and other MIL-STD-compliant products.

Backshell Materials

- **Aluminum** is a strong, lightweight, and cost-effective material that is selected for many applications.
- **Nickel aluminum bronze** is preferred for use in harsh saltwater/marine environments.
- **Stainless steel** 303, 304, and 316 grades are corrosion-resistant steels (CRES) that feature excellent corrosion and chemical resistance, provide greater strength than aluminum, and can be surface treated to meet customer application requirements.

Examples of Surface Treatment Options

- **Cadmium,** the historical standard finish for military and industrial connectors and backshells, offers excellent salt-spray corrosion resistance.
- **Electroless nickel** is commonly used in industrial and high-temperature applications where a nonreflective finish and high corrosion resistance are not essential.
- **Hard anodized coatings** are used where surface hardness and abrasion resistance are the main criteria. The buildup for hard-coat anodizing is much thicker than standard anodizing.
- **Zinc cobalt** is an enhanced corrosion-resistant plating compared to traditional zinc plating of the same thickness. By electroplating zinc and cobalt to the particular metal, the end result is a uniform ductility that offers up to six times the corrosion resistance of conventional zinc plating.
- **Shot blast** is used for a nonreflective finish on nickel aluminum bronze and stainless steel materials.
- **Black zinc nickel** is the latest Restriction of Hazardous Substances (RoHS) compliant solution for environmental plating of connectors and backshells. It is also highly compatible with other plating materials.

Capabilities for Backshells — and Beyond

When today's designers of military electronic systems and harnesses select backshells, they need to find a balance among economy, ease of installation, physical robustness, material suitability, and electrical performance. To help designers make the optimum choice, TE offers a wide range of Tinel-Lock backshells, connectors, cables, tooling, and full harnessing capabilities to handle many application challenges. Count on our expertise — from design support to testing to prototyping to tooling to manufacturing at scale — to help meet your specific objectives for electronic systems facing demanding conditions on the ground or in the air.

Key Takeaways

- TE developed Tinel-Lock technology along with TXR Series backshells to offer a unique balance of properties for terminating a braided cable shield for robust, cost-effective performance..
- Connectors using Tinel-Lock backshells have inherent resistance to severe shock, vibration, and temperature cycling — all common challenges with electronic systems in military vehicles and aircraft.
- Tinel-Lock technology is a shape memory metal ring that, after heating, shrinks to terminate the braid for a uniform, 360º circular connection.
- Compared to the other cable termination methods, the Tinel-Lock solution offers several installation advantages including reduced craft sensitivity for the installer, a visible indicator of proper installation, and an available easy-to-install, side-entry design.

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