



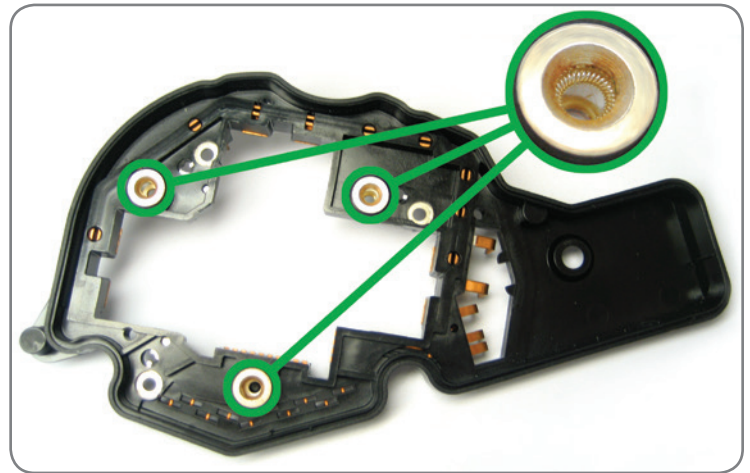
## Connecting, Conducting and EMI/RFI Shielding Solutions for the Motorsports Industry

## A Reputation for Innovation.

When manufacturers of high-performance motorsports vehicles and systems need smart solutions to tough design challenges, they turn to Bal Seal Engineering. Our products are custom-engineered to ensure reliable, consistent fastening, shielding and delivery of current to and from batteries and other systems, and they are already at work in many of today's top-performing vehicles and platforms.

Our Bal Spring™ canted coil springs, with their unique mechanical and electrical properties, allow for the more efficient design of regenerative braking and energy recovery systems (ERS) that can intermittently increase power up to tenfold in high-performance electric and hybrid vehicles. Together with industry design engineers, we're using these springs and other innovative components we make to accelerate advances in racing and EV technology.

We're more than just a problem-solver—we're your innovation partner. With a vast application knowledge base, ISO 9001 and TS 16949 certified processes, and advanced manufacturing capabilities, we can help you develop standard-setting breakthroughs that give you and your team a competitive edge.



*The integration of Bal Spring™ canted coil spring technology into this electronic steering system is just one example of how design engineers have leveraged our products and expertise to improve vehicle reliability and performance.*

## The Bal Spring™: Simple, Efficient & Robust.



The Bal Spring™ canted coil spring is a versatile component that mechanically fastens, conducts electricity, and shields sensitive electronics from the harmful effects of electromagnetic interference (EMI), and radio-frequency interference (RFI). The spring's independent coils, which serve as multiple contact points for optimal current carrying capability in electrical and shielding applications, ensure consistent, reliable connection—even under shock and vibration.

The Bal Spring is robust enough to withstand thousands of insertion and removal cycles, and it can be precisely engineered to meet virtually any connector force requirement. Available in a broad range of wire materials, sizes, and finishes, the spring can be manufactured to inside diameters as small as 0.41 mm (0.016 in.), and can also be easily configured to serve as a "tamper-proof" connection. The spring's compact design and multi-function capabilities help reduce system complexity and weight without compromising performance.

# For Electrical Conducting:

The Bal Spring™ canted coil spring performs extremely well as an electrical contact element, enabling motorsports vehicle and system designers to effectively manage high, medium, and low current in a wide range of vehicle applications.

Each coil of the Bal Spring acts independently across the mating surface interface, compensating for large tolerances and surface irregularities. Figure 1 shows derating curves for

### Bal Spring™ Conducting Applications

- Regenerative braking systems
- Lithium-ion battery pack/harness connections
- Kinetic MGU, heat MGU, energy storage, and control electronics
- Electronic starter controls
- Steering systems

an 8 mm connector using a Bal Spring made from copper alloy. The solid line curves are based on actual test data. Also included are the cross-sectional cable areas in mm<sup>2</sup> for comparison purposes against EU standard cable sizes. The dashed lines represent theoretical derating curves for the same 8 mm connector using 35, 25, and 16 mm<sup>2</sup> EU standard cables.

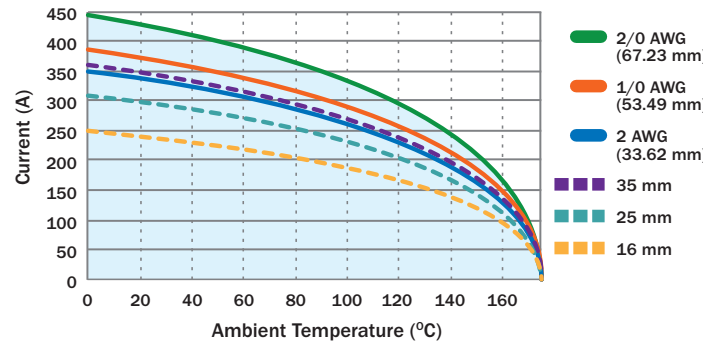


Figure 1. Derating curves for 8 mm Bal Spring canted coil springs in electrical contact element applications. Tests performed to DIN EN 60512-5-2 specifications. Data available upon request for other standard pin sizes.

# For Mechanical Fastening:

Our Bal Spring canted coil springs for latching, locking, and holding applications are available in a variety of materials and surface finishes. In addition to fastening or latching, the spring can be designed to permanently lock two pieces together, or to perform a holding function.

Depending on design requirements, a spring may be engineered to require as much as 900–1000 lb of tension load breakaway force. The spring can also be used to dampen vibration. Its resistance to compression set translates to consistent, repeatable service over thousands of cycles, and its controllable forces make it ideal for quick connect/disconnect applications.

### Bal Spring™ Fastening Applications

- Access panels
- Driver safety systems
- Body assembly

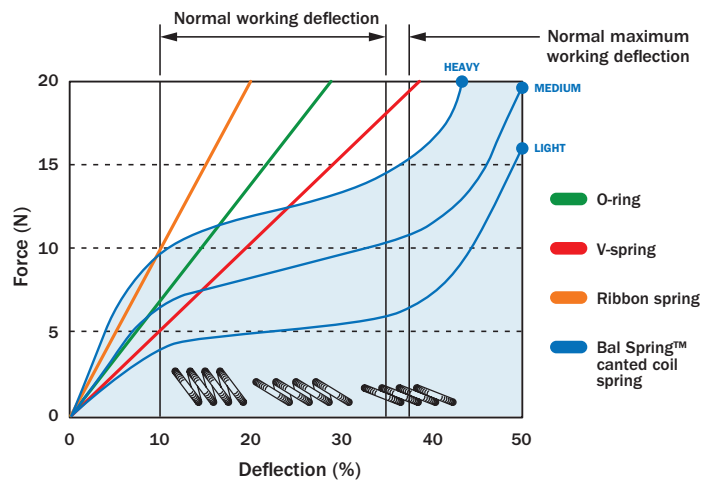


Figure 2. Unlike typical spring technologies, the Bal Spring canted coil spring provides nearly constant force across the working deflection.



# For EMI/RFI Shielding:

## Bal Spring™ Shielding Applications

- Driver information & safety systems
- Radio, telephony & antennae
- Power management (battery packs, power converters & sensors)
- Vehicle performance monitoring

Figure 3 at right indicates the superior shielding effectiveness of the Bal Spring canted coil spring compared with other shielding options. Summary testing data shows that the spring exhibits much lower transfer impedance than finger stock, helical flat springs, or wire mesh over elastomer.

The Bal Spring's highly conductive properties and unique design enable it to provide superior shielding against EMI/RFI, particularly in high-frequency, small-package applications. As an interface shielding component, the spring offers designers a simple, economical means to greatly reduce radiated emissions and conducted interference.

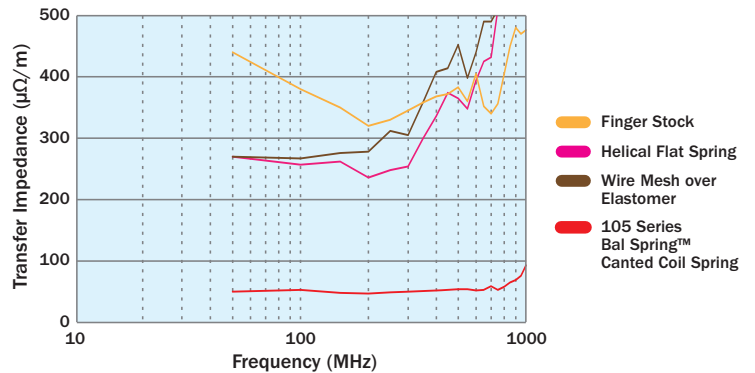


Figure 3. Transfer impedance of Bal Spring canted coil spring vs. other shielding methods.

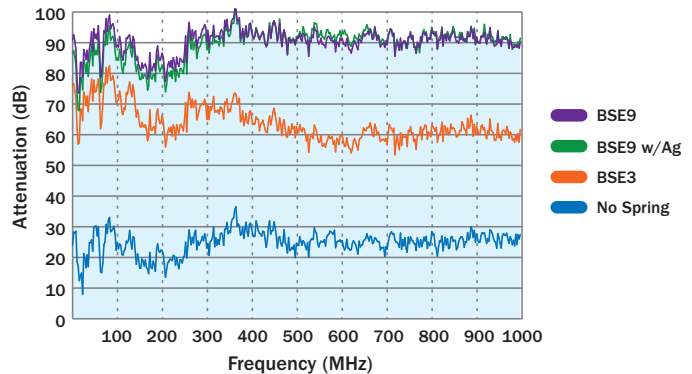


Figure 4. 100 MHz–1 GHz, attenuation vs. frequency.

Figures 4 and 5 at right illustrate the Bal Spring's shielding effectiveness at frequency ranges of 100 MHz–1 GHz and 1–10 GHz. Tests were conducted on a 50-Ω characteristic impedance coaxial connector using a copper alloy Bal Spring with 6-μm silver plating as a shielding element. The spring was shown to provide 60 db of attenuation.

Compared with no spring, material type BSE3 shows greatly improved shielding effectiveness, which may be sufficient for some applications. BSE9, which shows even greater shielding effectiveness, is recommended for high-performance shielding requirements.

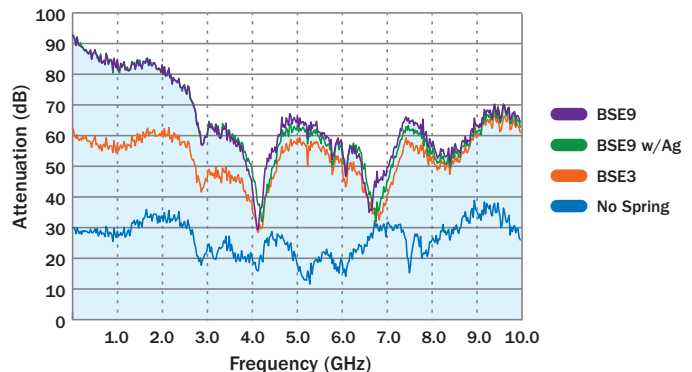


Figure 5. 1–10 GHz, attenuation vs. frequency.

*Note: shielding effectiveness is highly dependent on the connector design and configuration.*

# Typical Bal Spring™ Applications in Formula 1 and Formula E

Designers of F1/FE racing vehicles and systems are leveraging the unique electrical and mechanical capabilities of the Bal Spring canted coil spring to improve performance and safety.

## In radio, telephony & antennae

The Bal Spring shields against EMI/RFI and prevents system "cross-talk."

## In power management systems

The Bal Spring shields against EMI/RFI, ensuring the integrity of signal/data transfer between battery packs, power converters, and sensors.

## In body assembly applications

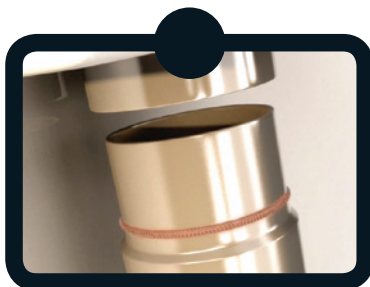
The Bal Spring can be custom-engineered to latch and lock panels and body components for fast removal/replacement.

## In kinetic MGU, heat MGU, energy storage and control electronics

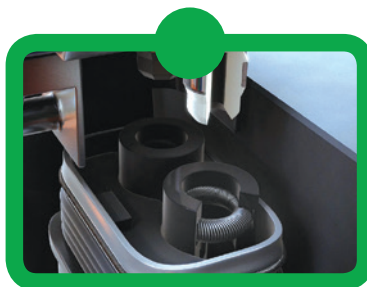
The Bal Spring provides multi-point electrical contact, even in high vibration and shock load environments.

## In regenerative braking systems

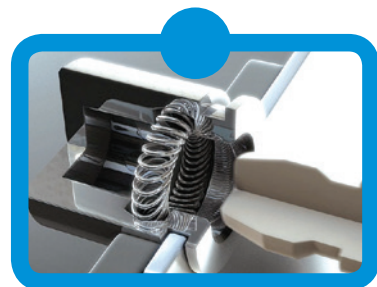
The Bal Spring ensures consistent power transfer to the ERS.



EMI/RFI shielding



Electrical conducting



Mechanical fastening/  
connecting

# Custom components, infinite possibilities.

We are a global provider of custom sealing, connecting, conducting and EMI/RFI shielding solutions. We specialize in applying our advanced designs, unique materials and manufacturing capabilities to meet your most demanding application requirements. Whether you're working on a new product or improving an existing one, we're standing by to help. Call or visit us today.



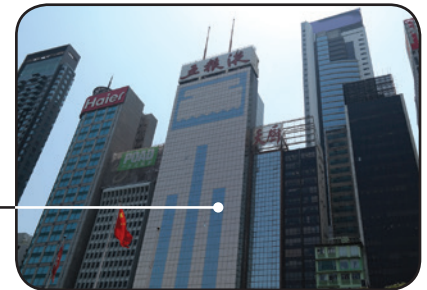
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