

APPLICATION NOTE

Delivering Efficient RF Connectivity in a 5G World

New Rosenberger EBC® – Efficient Board Connector





RF Board-to-Board Connector Evolution

The original push-on connector sub-miniature connector (SMP) comprised a blind-mate adaptor, or bullet, housed between two PCBs or panel-mounted receptacles. It gave designers what they needed: increased electrical performance, faster installation, and higher density for higher frequency applications.

Crucially, the bullet maintained transmission integrity in the event of any slight axial or radial misalignment. SMP offered designers a hitherto unprecedented level of flexibility for alignment tolerances and simplified the whole production process. Furthermore, it offered a real alternative to the unwieldy mounting hardware used at the time with threaded connectors; allowing higher concentration of simultaneous microwave interconnects per board or panel.

In more recent years, largely driven by the mobile telecom market's need for miniaturization, Board-to-Board and Board-to-Module connections have

become increasingly popular. RF cable assemblies are being replaced by Board-to-Board RF connectors able to handle higher power levels, while saving space, and weight, at lower cost.

Furthermore, with 5G, far more dense deployment of small cell sites is necessary. The Small Cell Forum predicts that the number of small cells deployed globally will rise to 37 million in 2021. This huge growth will in turn create an exponential demand for Remote Radio Head solutions utilizing fit-for-purpose Board-to-Board connection systems.

Out of necessity RF Board-to-Board connector technology has therefore evolved from the early days for accommodating limited misalignment between PCB boards, to offering the widest tolerances available in radial and axial directions for coping with varying spacing between boards. And now, to addressing the specific speeds of 5G to help realize the full potential of the IoT, AI, and other exciting future applications.

Executive Summary

It is almost twenty years since Rosenberger launched the original SMP (sub-miniature push-on) connector series. However, the RF Microwave industry is now entering an equally game changing era in RF connector design. While SMP sparked the ongoing adoption of Board-to-Board and Board-to-Module connection solutions, it is the imminent arrival of 5G which has proven to be the new disruptor in the RF Microwave industry.

This is leading to an exciting new wave of RF connector innovation. Manufacturers are striving to meet the increased performance demands of customers in many market sectors, none more so than those in Mobile Communications where operators are under pressure to deliver widespread roll-out of high-speed 5G from 2020, as quickly as possible, at the lowest possible cost.

Their ubiquitous high speed, low latency networks will be at the very heart of progressing future advances in Artificial Intelligence (AI), The Internet of Things (IoT), Big Data analytics, Machine Learning, Connected Cars, Virtual Reality and much more. In fact, nobody really knows everything that 5G will deliver in the future. Being such a revolutionary technology, it is likely to be used to create services and applications we haven't even imagined.

One thing is for sure, the stakes for more affordable, easy and reliable high speed RF connection systems have never been higher. In response, Rosenberger has developed the EBC® (Efficient Board Connector), a next generation Board-to-Board/Module RF interconnection system. This allows a low cost single design approach for multiple high performance applications and is fully optimized and future-proofed for 5G.



RF Microwave Connectors in a 5G World

As we enter the 5G era many new RF connector design challenges have arisen. Increasing data transmission speeds have necessitated leading RF connector manufacturers to respond but without compromising product performance or design flexibility.

Key requirements include:

- Accommodating space and weight constraints
- Managing 5G ultra-high frequencies
- Providing single miniaturized push-on interconnects for multiple high density PCB applications
- Advanced bullet and receptacle construction to maximize product lifecycle and resilience against RF signal degradation
- Lightweight, rugged design
- Self-aligning blind-mate connectors for enhanced reliability and performance
- Lower cost Board-to-Board/Module stacking connections
- Ensure maximum VSWR

RF Connector Design Challenges

MIMO

Increasingly, active antennas are exploiting massive MIMO (multiple input multiple output). A huge number of Board-to-Board connections are therefore required for connecting active circuitry with the antenna array. Pricing will become much more critical.

In addition, 5G will use very large antenna arrays (up to 64 or 128 elements). Currently, the concepts look like building sandwiches of several boards. For integration, at least one Board-to-Board connection is required for each emitter element of the array.

Space constraints

Complex electronic devices and systems are becoming smaller and smaller which brings challenging size and weight constraints. Designers and OEMs require microwave assemblies that provide higher-speed interfaces and utilize small diameter connectors capable of high mating cycles.

Higher Frequency Demands

With the increasing volume of data being sent and received, especially with 5G, complex device systems will move from traditional single-digit GHz performance levels to frequency requirements above 40 GHz. RF connectors must not only accommodate the size constraints of ever smaller devices for enabling higher-packaging densities, but also maintain superior performance levels.

VSWR and EMC Optimization

Board-to-Board stacking applications inherently have the potential for connector misalignment, especially where legacy technology is involved. This can create an inductive path that negatively impacts VSWR if the characteristic geometry of contact surfaces becomes altered. It requires EMC optimization to be undertaken at the connector design stage, avoiding the potential risk of performance problems or harmful emissions due to charging/discharging when it is in contact with the device.

Universal Board-to-Board Connection

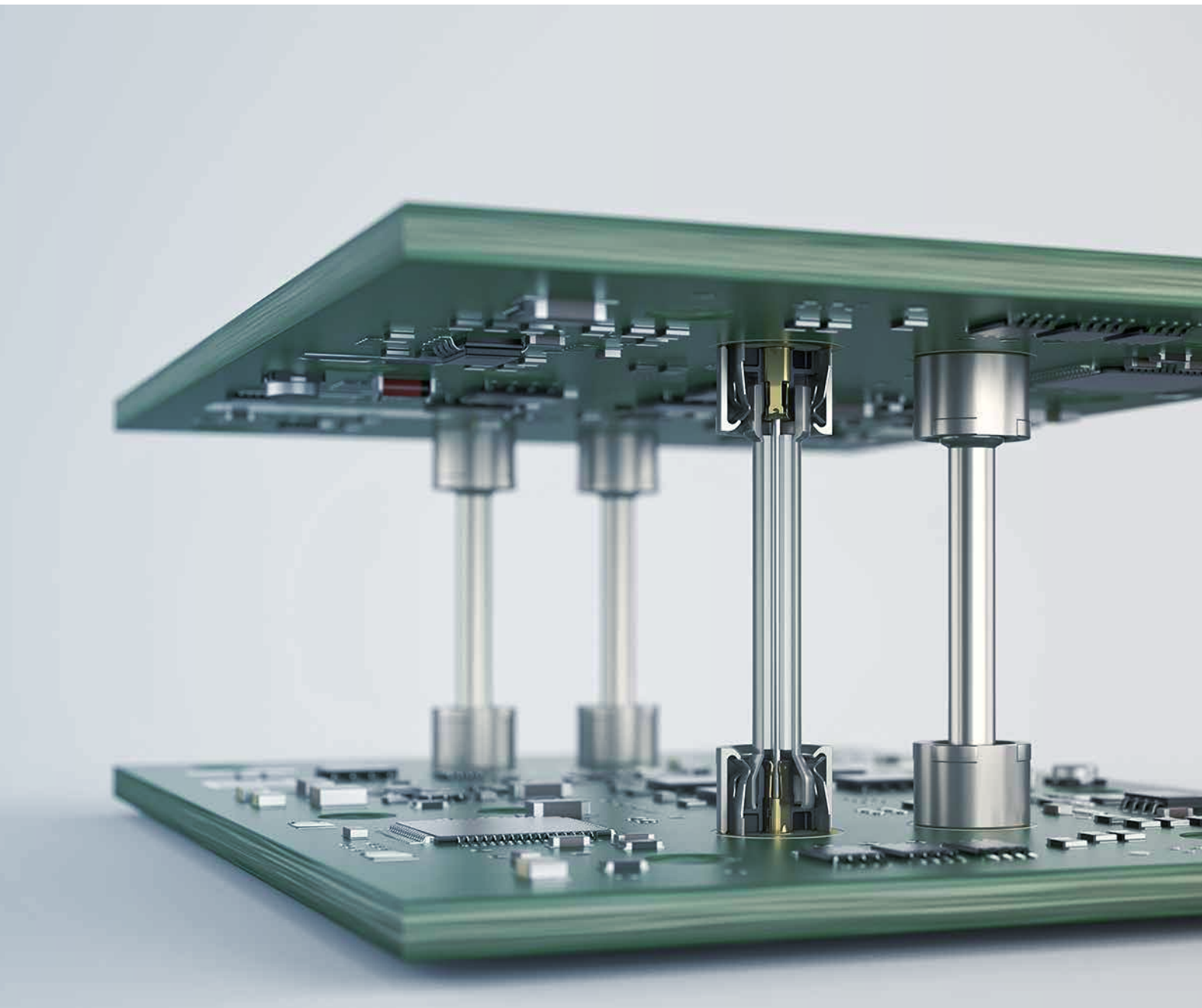
Designers need to more easily solve common, lower frequency, high-density interface challenges, while at the same time ensuring a long-term solution for sophisticated next-generation miniaturized high frequency applications.

Key to this is a bullet interface design which can withstand dimensional changes on misalignment without significantly affecting the character of the transition contact surface, minimizing the effect on signals passing through the connector. This is essential for achieving superior electrical performance of the transmission path between connector and circuit, while accommodating sufficient axial float tolerances but without significantly affecting VSWR.

100 % Design to Cost

All of the above factors clearly present major design engineering challenges to RF solutions manufacturers. At the same time, there is enormous cost pressure on all of the components required, bringing significant financial implications from a production perspective. Furthermore, despite the larger number of elements required for 5G technology, highly competitive market forces dictate that component costs will need to remain the same or even lower.

In order to achieve the necessary cost reduction, new 100 % Design to Cost production methods are necessary which must be implemented at the very outset of all product design and development.



5G RF Connection Design Considerations

- Increasing data transfer rates make reliable connectivity mission critical at cell sites for macro and small cell applications
- As frequency increases, maintaining the impedance becomes more complex
- Even tiny flaws in geometry or materials can be magnified
- RF connectors must be a seamless part of the whole transmission line
- Achieving the minimum of resistance and energy loss are now prerequisites

Rosenberger EBC® Enabling Future Proof 5G Connectivity

As a world-leading RF connector manufacturer, Rosenberger is at the forefront of innovation in the design of new RF connection solutions which are fully optimized and future-proofed for 5G. The company's new low cost, high performance Efficient Board Connector (EBC®) is a clear example.

The EBC® solution enables customers to easily adapt to new critical product design and market challenges being driven by 5G, including:

- The implementation of high-volume manufacturing processes
- The need for the same connector components for both sides of PCBs
- Spring loaded parts on PCBs
- Simpler and lower cost build-up of adaptors
- Shorter life cycle of products
- Competitive marketplace
- Growing pricing pressure

EBC® is a next generation universal RF Board-to-Board/Module adaptor enabling one design solution for many applications. It uniquely integrates both limited detent and smooth bore interfaces in a single bullet, accommodating all of the benefits of the most commonly used Board-to-Board and Board-to-Module HF connections including SMP, LW-SMP, P-SMP.

EBC®'s one size fits all design addresses the mobile industry's urgent requirement for RF connectors to be more easily and readily deployable in the specific configurations desired. With a DC to 8 GHz frequency range, the EBC® system is therefore well-matched for addressing essential 5G high density small cell requirements. This includes largescale integration of Remote Radio Head Units (RHUs). Although the higher bands used by 5G are faster, they don't carry information as far, which will demand the deployment of many more, smaller multiple input and output (MIMO) antennas to boost signals and capacity.

EBC® – Key Features

Essential characteristics of EBC® include the equalization of radial and axial misalignments, different holding forces, minimum PCB board spacing and fast and cost-effective assembly design. A key mechanical design feature is the locating side which is integrated in the bullet. One side has a smooth bore, while the other has a limited-detent design.

EBC® Advantages

Rosenberger's new EBC® series is the ideal 5G Board-to-Board and Board-to-Module RF interconnect solution for sub 6 GHz massive MIMO active antennas and radios.



Its outstanding performance and rigorous design to cost make this solution the ideal choice for 5G radio interconnections.

- Preloaded outer contacts for contact optimization
- One design for many applications
- Self-centering / self-alignment – blind mateability
- Optimized for PCB and filters
- Simple filter connection
- Excellent signal integrity (SI)
- Excellent shielding required for MIMO applications (EMI)
- Designed for mass-volume production
- 100% design to cost; lowest TCO on the market
- Only one PCB coupler design – consistent footprint
- Detent type on the bullet (limited detent – smooth bore)
- Small outline
- Best-in-class axial and radial compensation

Electrical Performance

- Frequency range: DC to 8 GHz
- Power: 100 W
- Return loss: ≥ 20 dB (typ.) depending on axial misalignment
- Screening attenuation: ≥ 50 dB @ DC to 4 GHz
- RF-leakage: ≥ 60 dB @ DC to 4 GHz

Mechanical Performance

- Minimum Board-to-Board distance: 12 mm
- Pitch: > 6.8 mm
- Axial tolerance: ± 0.8 mm
- Radial tolerance: max. 4°

Materials

- Center contact: spring bronze – Aurodur® / silver
- Outer contact: spring bronze – white bronze (e.g. Optalloy®) / flash white bronze over silver (e.g. Optargen®)
- Dielectric: LCP – PTFE / FEP

Summary

5G is expected to be 100 times faster than 4G LTE and will provide a tenfold increase in broadband connection speeds. To achieve this many more Radio Heads for deployment in small cell sites will be necessary making reliable, low cost RF connectivity more mission critical than ever; not least for enabling numerous micro cell applications.

RF Board-to-Board/Module connector systems will play a leading role in 5G device enablement. With this challenge, Rosenberger has taken

Board-to-Board/Module RF interconnection to a whole new level for electrical performance, impedance and ease of installation, while also accommodating the future higher density demands of high frequency 5G applications. This is evidenced by its newly launched, low cost Board-to-Board EBC® connector system. It features a universal bullet design suited to multiple applications, greatly simplifying and reducing the cost of rolling out complex 5G system and device solutions urgently required by mobile operators.

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