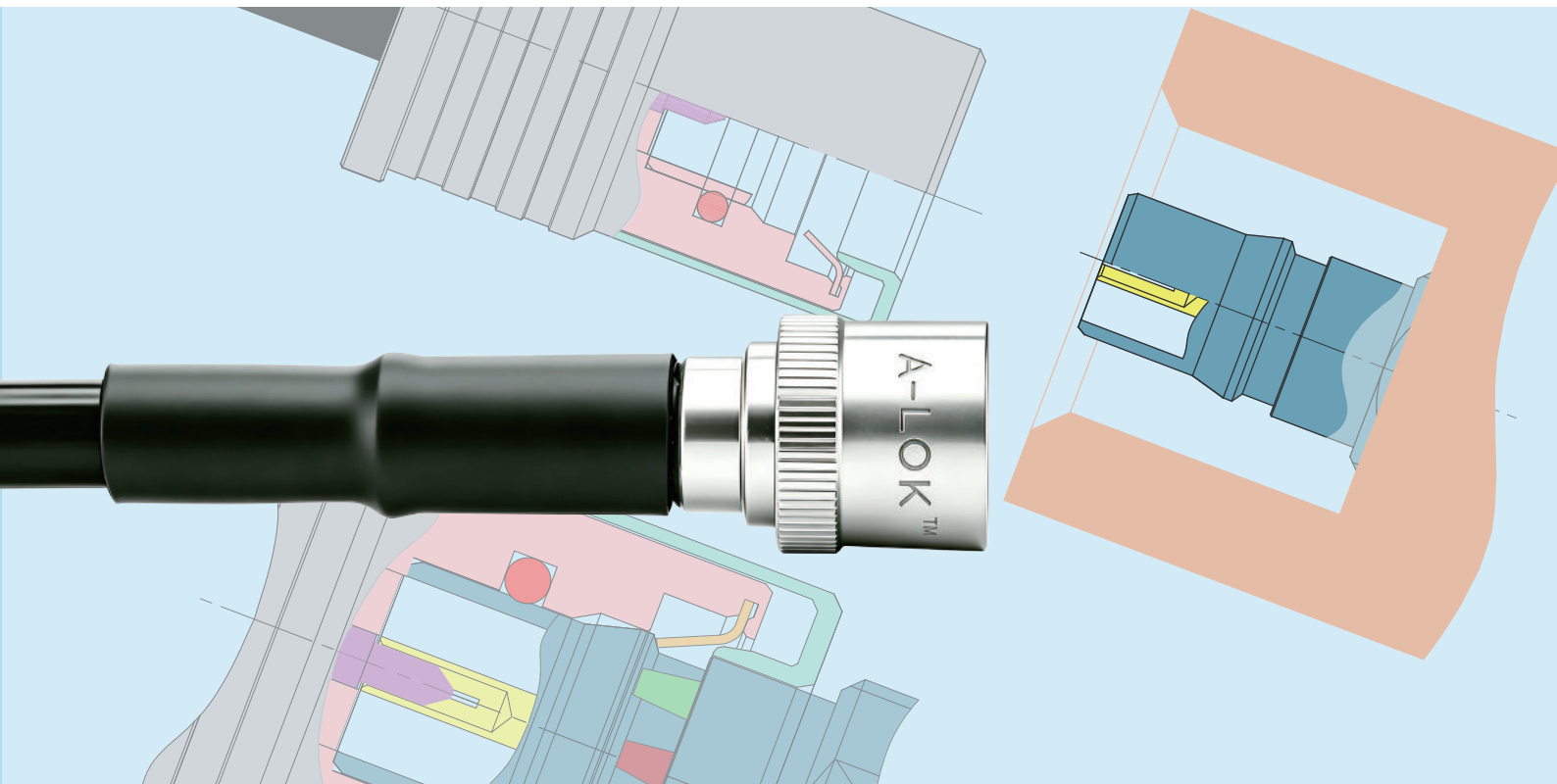


A-LOK™ Connectors: Shifting from Elastic to Rigid Self-Locking Mechanics



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01 Structural Generations of RF Quick-Lock Interfaces

In high-frequency coaxial interconnects, the standard SMA interface remains the absolute main-stream benchmark due to its optimized trade-off among microwave performance, mechanical ruggedness, and supply-chain maturity. However, as applications trend toward automated test equipment (ATE), high-density modular packaging, and rapid deployment, the legacy threaded alignment of SMAs reveals practical constraints in operational efficiency and assembly speed.

To achieve rapid blind-mating and high throughput without compromising RF performance, quick-lock interconnects have emerged as a vital alternative. Balancing operational efficiency, mechanical retention, and high-frequency performance within a constrained physical footprint has driven three generations of structural evolution and technical compromises:

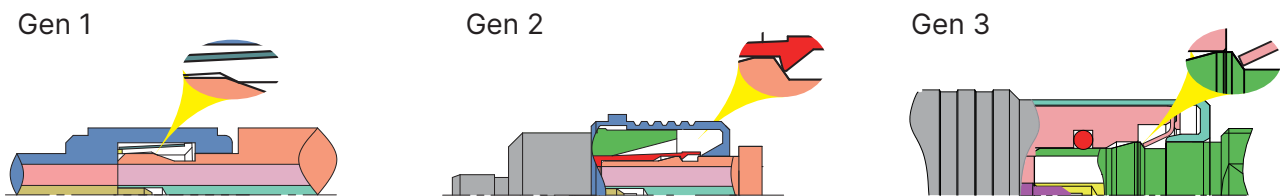


Fig 1 Structural Generations of RF Quick-Lock Interfaces

- **Generation 1: Slotted Receptacle & Friction-Sleeve Mechanics (*Gen1 in Fig 1*)**
 - **Mating Architecture:** Typified by legacy POB variants, this configuration relies on a slotted brass spring ring compressed into a shallow receptacle groove via the radial tension of an external stainless-steel snap ring. The outermost sleeve serves strictly as a rigid shroud with no integrated un-mating kinematics.
 - **Mechanical Limitations:** Lacking an integrated release mechanism, de-mating requires brute axial pulling. Under continuous duty cycles, this stress accelerates material fatigue and plastic deformation in both the brass substrate and the snap ring, degrading retention forces and introducing micro-gaps.
- **Generation 2: Independent Cantilevered Fingers (Industry-Standard QMA) (*Gen2 in Fig 1*):**
 - **Mating Architecture:** Exemplified by the standard QMA interface, this generation introduced an outer sliding sleeve to minimize extraction force. It utilizes the elastic deflection of beryllium-copper (BeCu) cantilevered fingers to seat past a steeper receptacle ridge, maintaining pre-load through spring tension.
 - **Mechanical Limitations:** The underlying physics remains a passive elastic retention system. Because the independent cantilever fingers require mechanical clearance to expand, dynamic vibration or side-loading moments easily force the fingers outward. This drives micro-scale axial slippage, triggering false-lock conditions, intermittent connections, or signal reflection at high frequencies (*see Fig 2*).

■ Generation 3: A-LOK™ Axial Geometric Rigid Interlocking Mechanism (*Gen3 in Fig 1*):

- **Structural Topology:** Engineered to be 100% retro-compatible with standard QMA receptacles, the A-LOK™ platform completely abandons the passive reliance on elastic material deformation to resist tensile loads. Upon lockout, the center-symmetric structural teeth act as rigid struts. This mechanism strategically leverages the exceptional in-plane compressive rigidity of the stamped BeCu sheet material, converting external axial tensile loads entirely into column compressive stress along the teeth. This triggers a directive Door-Bolt Effect that physically eliminates any radial expansion or slip vectors (*see Fig 3*).
- **Key Advantage:** This interlocking mechanics preserves the absolute physical certainty of the electrical reference plane over its operational lifecycle. Coupled with the vernier-patterned tolerance adaptation mechanism, it permanently eliminates connector axial tilt and micro-gaps, preventing signal anomalies and impedance discontinuities induced

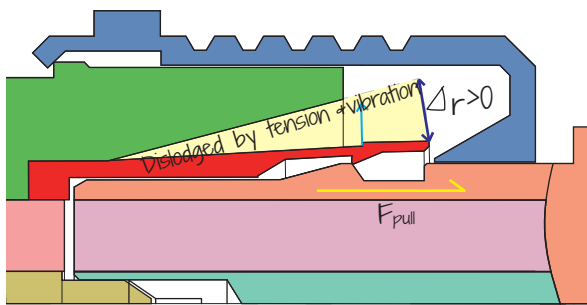


Fig 2 Mechanical Limitations of Gen 2

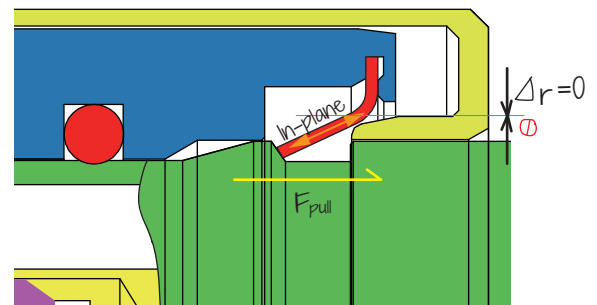


Fig 3 Structural Topology of A-LOK

02 Three-State Kinematics & Load Distribution

The A-LOK™ 18 platform optimizes precision load distribution by alternating the BeCu interlocking teeth between elastic compliance and rigid constraints across three distinct functional states. This completely eliminates the technical bottleneck in standard QMA interfaces, where installation forces must be inflated to gain external retention at the expense of core reference-plane axial pre-load:

■ State 1: Low-Stress Insertion (6 N Compliant Engagement)

Mechanism: In the initial mating phase, the interlocking teeth are oriented to face away from the receptacle interface. As insertion progresses, the teeth slide smoothly along the inner wall with minimal elastic deflection, maintaining a stable axial insertion force of 6N (versus 25N for legacy QMA)—eliminating residual axial stress applied to PCB pads and contact pins during integration.

■ State 2: High-Retention Interlocking (110 N Rigid Interlocking)

Mechanism: Upon full engagement under reverse axial tension, the geometry instantly triggers a true "Door-Bolt Effect". The tensile load is precisely directed along the in-plane dimension of the interlocking teeth, leveraging their extreme structural rigidity against compressive buckling. This forces the external load to convert entirely into column compressive stress along the teeth, ensuring a self-tightening mechanical lock with an axial retention force of 110N min. across 2,000 cycles while permanently securing the reference-plane axial pre-load. (see Fig 3)

■ State 3: Zero-Damage Disengagement (10 N Low Release Force)

Mechanism: In the locked state, the outer sleeve remains static and isolated from dynamic loads. Upon manual retraction, internal micro-ramps smoothly cam the interlocking teeth outward from the inside (see Fig 4). This kinematic linkage instantly unlocks the geometric constraint, expanding the teeth radially with just 10N of release force (half that of a standard QMA)—permanently safeguarding cable assemblies and ATE test matrices from abrupt mechanical shocks.

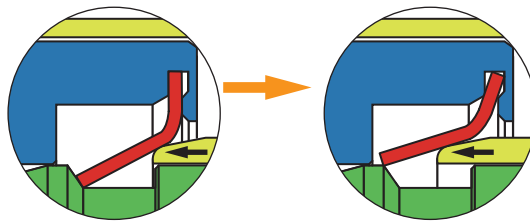


Fig 4 Zero-Damage Disengagement

03

Failure Analysis: False-Lock Mechanisms & Tolerance Adaptation

- Standard QMA interfaces rely strictly on an auditory click for mating confirmation. Due to manufacturing tolerance stack-up, this acoustic feedback merely indicates that the locking fingers have cleared the peak of the receptacle ridge. This signal can be deceptive, driving two critical false-lock failure modes that lead to intermittent connections in the field:

- **Incomplete Seating / Partial Engagement:**

The click occurs as fingers pass the ridge peak, but manufacturing interferences prevent them from fully settling into the root of the retention groove. Under structural vibration or tension, these partially engaged fingers easily slip, causing mechanical unseating. (Fig 2)

- **Residual Air Gaps / No Reference Contact:**

The click confirms ridge clearance, but due to tolerance stack-up, the core electrical reference planes fail to achieve true face-to-face compression. A micron-scale air gap remains, driving impedance discontinuities and vibration-induced signal dropouts.

- **Vernier-Patterned Locking Teeth for Tolerance Adaptation**

In CNC machining, micron-level manufacturing tolerances are inevitable, and conventional, uniform-length locking fingers are highly susceptible to tolerance stack-up. The A-LOK™ 18

utilizes a staggered, center-symmetric configuration featuring 9 internal teeth divided into 3 sets (3 teeth per set), spaced 120 ° apart. Within each set, the teeth feature micron-level length differentials—forming a physical vernier pattern:

- **Dynamic Tolerance Compensation:** Upon mating, the staggered teeth engage the receptacle slope progressively, behaving like a vernier scale. Within designed tolerance limits, at least one optimal 3-tooth set is guaranteed to secure onto the slope with perfect 120° symmetry (see Fig 5).
- **Eliminating Axial Tilt:** Guided by the 3-point planar constraint, radial forces are perfectly balanced at the center axis. This physically prevents connector tilt and delivers a true zero-gap reference interface under all tolerance conditions.

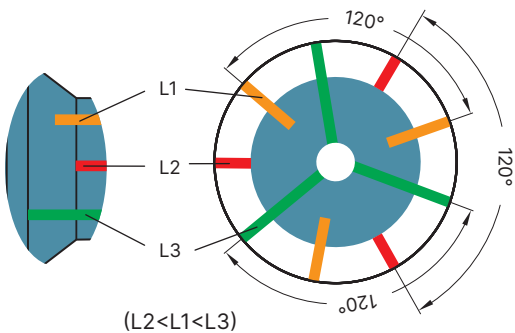


Fig 5 Vernier-Patterned locking teeth for tolerance adaptation

■ Twist Verification

Kinematic analysis shows the acoustic "click" merely indicates ridge clearance, not a zero-gap interface. Because the A-LOK™ 18 teeth achieve side-load-free engagement, manual rotation becomes the definitive method to verify plane adaptation: this uniform, solid drag is entirely isolated from side-wall interference and originates exclusively from the compressed reference planes under axial pre-load (interfacial tactile friction). Conversely, standard QMA interfaces generate massive radial tension; their rotation resistance is dominated by parasitic side-wall galling, which masks the reference plane contact and leaves false-lock risks undetected.

04 Technical Specifications Benchmark

Parameter	Standard QMA	A-LOK™ 18	Mechanical & Engineering Value
Locking Mechanism	Open cantilever beam	Rigid teeth (Door-Bolt effect)	Eliminates axial micro-slippage under vibration
Insertion Force (TYP.)	25 N	6 N	For high-density blind-mating; protects pads and pins
Axial Retention Force (min.)	60 N	110 N	Delivers exceptional safety margin for high-retention lock
Interface Material & Life	Gold-plated brass (Wear-prone)	Hardened Stainless Steel (2,000+ cycles rated, 5,000 lab-tested)	Near-zero degradation for extended service
Extraction Force	20 N	10 N	For high-cycle ATE matrices; protects cable assemblies
Cable Protection	High unlock force (risk)	13 N light release	Protects micro-coax & PCB lands

05 Typical Industry Applications and Technical Roadmap

Based on its rigid axial locking structure, the A-LOK™ platform is designed for advanced industrial and commercial systems with stringent requirements for mating constraint, service lifecycle, and signal stability.

- **Commercial Satellites & Airborne Sensing Systems:** The door-bolt mechanism eliminates transient axial displacement driven by external resonance, ensuring phase and impedance stability for multi-channel commercial communication, satellite interconnects, and airborne sensing systems under vibration.
- **High-Density ATE Automated Test Lines:** While maintaining high axial retention, A-LOK™ 18 reduces the extraction force required for high-cycle mating profiles in test matrices, lowering the wear rate of micro-coaxial cables and test ports.
- **Industrial AR & Smart Headsets:** Within compact blind-mate layouts, the ultra-low insertion and extraction forces, coupled with the interfacial friction verification, permanently eliminate interface micro-slippage—preventing signal anomalies, impedance discontinuities, and potential contact dropouts in high-vibration or Power-over-Coax (PoC) configurations.

■ Millimeter-Wave Roadmap Extension

The A-LOK™ axial rigid interlocking mechanics and vernier matrix offer exceptional scalability. To address next-generation high-frequency requirements, Anoison has initiated the platform extension:

- **A-LOK™ 40 (Precision 2.92mm Dedicated Quick-Lock System):** Featuring an independent, dedicated interface, this configuration inherits the identical interlocking architecture and vernier matrix from A-LOK™ 18. The RF path matches standard 2.92mm air-line cavity dimensions, supporting operation up to 40 GHz for high-frequency ATE lines and high-performance microwave modules.

— *An exceptional quick-lock connector must deliver a smooth engagement and a rigid lock. That uniform, solid friction you feel upon manual rotation is the physical certainty delivered by Anoison.*

Technical Questions & Support: tech@anoison.com or [[Online Contact](#)]