Richardson Electronics
POWER & MICROWAVE TECHNOLOGIES

ENABLING THE LOW EARTH ORBIT (LEO) ERA

Silicon Beamforming and PCB Technologies for Advanced LEO Architecture

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1 - LEO at the Edge of SATCOM Innovation

The Challenge: Low Earth Orbit (LEO) constellations push SATCOM to its physical limits. They demand fast beam steering, tight link budgets, and ultra-compact hardware that legacy technology cannot support.

The Solution: Richardson Electronics unifies the essential building blocks for next-generation terminals:

- **Precise Control:** Qorvo (formerly Anokiwave) silicon beamformers for agile X, Ku, and Ka-band management.
- **Signal Integrity:** TTM Technologies, Inc. advanced PCBs and passives (couplers, baluns, terminations) for low-loss, wideband conditioning

2 - Application Domain and Technology Role

Application Domain	LEO Advantage	Technology Role Qorvo (formerly Anokiwave)	Technology Role (TTM)
Military	**Real-time Resilience:** Secure connectivity anywhere globally.	**High-Linearity:** Fast-scan beamforming for secure, jam-resistant links.	**Ruggedization:** Microwave PCB and packaging solutions built for defense payloads
Earth Observation (EO)	**Fast Revisit:** High-resolution imaging with rapid data offload.	**Efficient Steering:** Optimization for X-Band high-throughput downlink channels.	**Precision Materials:** Advanced PCB stacks for sensitive RF sensor modules.
Navigation & Positioning	**High Accuracy:** Enhanced resilience for GNSS positioning.	**Stable Pointing:** Compact phased-array ICs for mobile terminals.	**Low-Loss Stacks:** Multilayer PCBs ensuring signal integrity for front ends.
Communications	**Low Latency:** Continuous, fiber-like global coverage.	**Agile Tracking:** Beamforming ICs enabling seamless Ku/Ka handoffs.	**Thermal Stability:** High-performance RF PCBs managing heat in dense arrays.

3 – Qorvo (formerly Anokiwave)

Qorvo (formerly Anokiwave): The Silicon Edge for LEO

Why it matters: A fully integrated silicon beamforming platform breaks the cost and power barriers for high-volume LEO terminals, delivering the precision of phased arrays with the scalability of CMOS.

The Solution: AWMF-0240 & AWMF-0241 (Silicon Beamformers)

Technical Highlights:

- **Massive Integration:** These ICs pack dual-polarization T/R modules, gain/phase control, and telemetry into a compact **FC-CSP (Flip-Chip)** package, eliminating external LNAs and simplifying thermal management.
- **Smart Efficiency:** Features drastically reduce DC power consumption, critical for mobile and solar-powered LEO terminals.
- **Zero-Touch Precision:** Patented **ZERO-CAL®** technology allows small arrays to self-align, removing the need for expensive factory calibration and speeding up time-to-market.
- **Full Spectrum:** Engineered for **X, Ku, and Ka-band** agility, supporting fast beam steering and wide instantaneous bandwidths required for next-gen constellations.

The Bottom Line: Combining the **AWMF-0240/0241** beamformers and Qorvo's high-efficiency FrontEnd Modules (FEMs), OEMs get a complete, cohesive RF front-end built for the speed and density of the modern space economy.

4 - TTM Technologies, Inc.

TTM Technologies: The LEO SATCOM Backbone

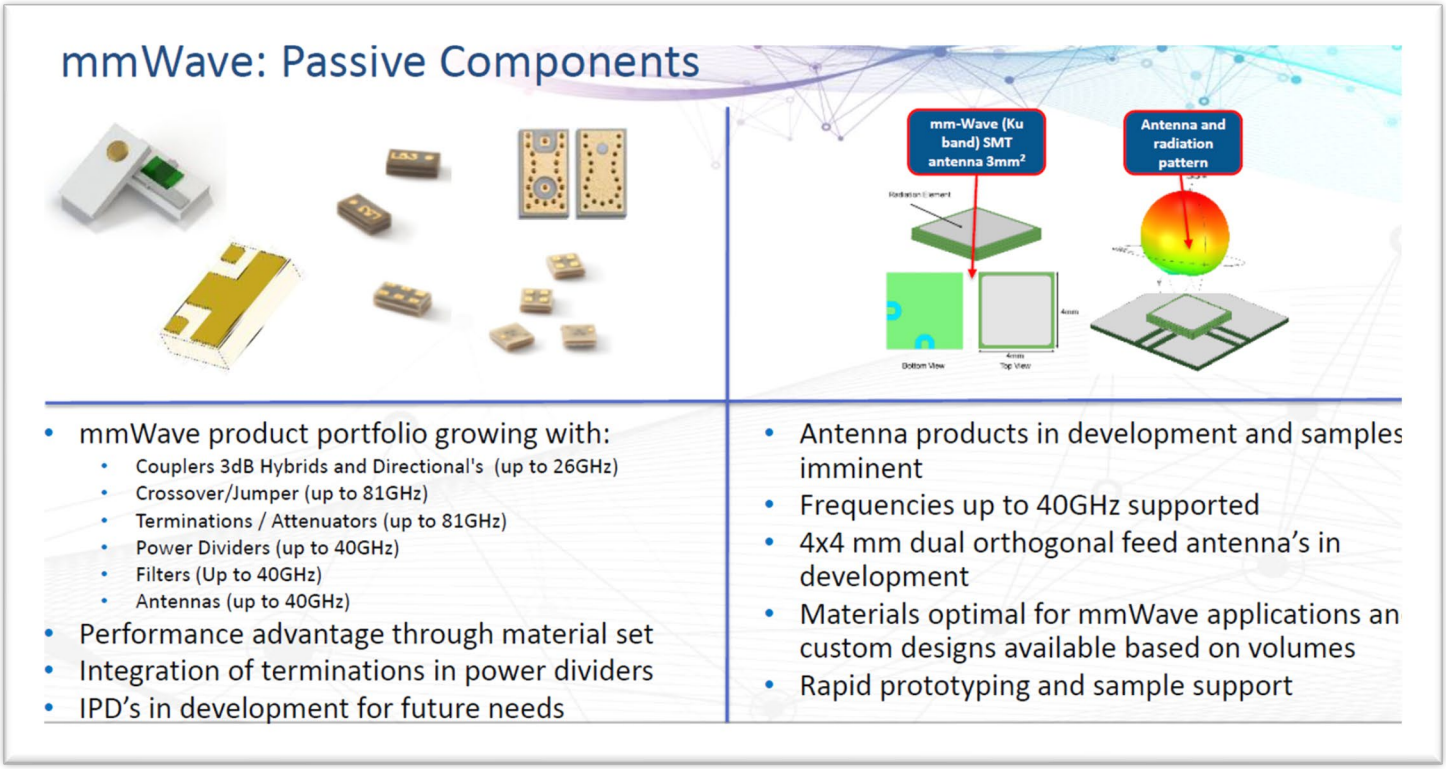
Why it matters: TTM combines U.S.-based advanced PCB fabrication with high-frequency passives to slash Size, Weight, and Power (Swapp) for next-gen constellations like Starlink and Kuiper.

The Big Picture: By vertically integrating multilayer manufacturing with component engineering, TTM delivers a scalable platform for X, Ku, and Ka-band phased arrays.

Technical Highlights:

- **Radical Miniaturization:** The **Mini-Xinger™ Via Jumper** (only **2.28 x 1.27 mm**) enables active ICs to be mounted on the PCB backside. This proprietary interconnect allows for a **single-lamination process**, eliminating complex buried vias and containing signal fields within ground via rings to stop EMI.
- **Extreme Frequency Range:**
  - **Terminations:** DC up to **81 GHz** with Return Loss ~17dB.
  - **Crossovers:** DC to 40 GHz with **>40dB Isolation** and ultra-low insertion loss (<0.8dB @ 40GHz).
  - **Antennas:** 4x4 mm dual orthogonal feed SMT antennas (up to 40 GHz).

- **Constellation Ready:** Proven performance in **Ku-band** (10.7–14.5 GHz) and **Ka-band** (17.7–29.1 GHz) architectures, supporting IF signal conditioning (<6GHz) with hybrid couplers and baluns.



The Bottom Line: TTM delivers the exact PCB backbone and RF precision required for the high-volume, low-latency demands of modern LEO terminals.

5 – Wideband Gap Performance & Comparison

Why it matters: Choosing the right semiconductor material is critical for balancing power, efficiency, and cost in LEO terminals.

Technology	Key Strengths	Limitations	Primary Role in LEO
GaN (on SiC)	-Highest power density -Excellent efficiency -Radiation robustness	-Higher cost per watt -Requires strict thermal design	-High-power uplink PAs and phased array transmit chains

GaAs (pHEMT)	-Ultra–low noise figure -High linearity -Clean RF behavior	-Limited output power -Lower thermal margin	-LNAs, mixers, driver stages in receive paths
Silicon (CMOS Beamforming ICs)	-High channel integration (phase/gain/T/R) -Stable over temp -Low cost & scalable	-Low PA output power -Requires external blocks	-Beamforming cores for AESAs and dense PCB-based arrays

6 – Your SATCOM Bridge to Success

The Reality: Innovation alone doesn't win missions. Execution does. The future of SATCOM won't wait for delays in engineering or logistics.

The Richardson Electronics' Bridge: We transform cutting-edge system architectures into mission-ready solutions. Wherever you operate, our global teams deliver immediate, high-impact support so you can:

- **Access** the world's leading SATCOM technology providers (Qorvo & TTM).
- **Solve** system-level challenges with engineering experts who understand your mission.

Stop planning, Start building: Connect with our team anywhere in the world and explore our line card of technology partners.

MACOM
Designs and manufactures high-performance semiconductor products.

Qorvo
Designs and manufactures RF solutions and core technologies.

Altum RF
Designs and manufactures high-performance RF to millimeter-wave components.

3Rwave
Designs and manufactures RF and microwave solutions.

Aceinna
Designs and manufactures Inertial Navigation Systems.

Amotech
Manufactures and designs Antennas and ceramic capacitors.

TTM
Designs and manufactures custom high-frequency solutions.

DAPU TELECOM
Offers a broad range of timing devices and ICs.

Wakefield
Provides thermal extrusions and heat sinks.

Nxbeam
A fabless manufacturer of mmwave ICs.

LiConn
Designs and manufactures RF & Microwave components.

Masach Tech™
Specializes in board level EMI/RFI shielding design.

Quantum Microwave

Waveguide components, amplifiers, antennas, and mixers for various applications.

Quantic Eulex

High-performance ceramic components for high-frequency microwave applications.

Quantic MWD

Oscillators, amplifiers, frequency converters, and multipliers with a focus on performance.

Quantic UTC

High-reliability multi-layer ceramic chip capacitors for defense and telecom.

WanTcom

RF/microwave low noise amplifiers, power amplifiers, and sub-systems.

Microwave Components, Inc.

Custom miniature electronic air coils since 1978.

TMYTEK

mmWave solutions for 5G/B5G and satellite communication applications.

Junkosha

Ultra high-performance, phase stable cables and cable assemblies.

Maury Microwave

Adapters, cable assemblies, and attenuators for microwave systems.

Signal Microwave

Connector solutions for the Signal Integrity/High Speed Digital market.

Vector Telecom

Microwave waveguide components and assemblies, coaxial cables.

Conduct RF

Solutions for commercial and precision RF applications.

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