The New Standard For Microwave Amplifiers In New Space: Agility Without Compromising The Mission

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Introduction

1.The Low Orbit Revolution and the Agility Imperative

The aerospace industry is undergoing a structural metamorphosis that redefines not only business models but the fundamental principles of space systems engineering. Historically, access to space was reserved for government agencies and large telecommunications operators, whose assets in geostationary orbit (GEO) represented massive capital investments designed to operate for decades. In this paradigm, retrospectively termed "Old Space" or "Traditional Space," risk aversion was the supreme dictate. Every component, from the most complex transponder to the simplest resistor, had to undergo exhaustive qualification processes that often consumed years of development and generated volumes of technical documentation outweighing the flight hardware itself.

However, the emergence of "New Space" has irrevocably altered this equation. Driven by the miniaturization of electronics, reduced launch costs, and the insatiable demand for global connectivity and real-time Earth observation, the focus has shifted toward constellations in Low Earth Orbit (LEO). These new distributed architectures rely not on the invulnerability of a single monolithic satellite, but on the resilience of a network composed of hundreds or thousands of smaller, more economical nodes with reduced lifespans.

This paradigm shift poses a critical dilemma for Radio Frequency (RF) engineers and program managers: the need to balance operational reliability with deployment speed. Traditional qualification methodologies, designed for 15-year missions in severe radiation environments, are economically unfeasible and temporally incompatible with a typical 18-month development cycles characterizing New Space. Conversely, the indiscriminate use of Commercial Off-The-Shelf (COTS) components without modifications exposes missions to unacceptable risks of catastrophic failure due to the inherent reality of the space environment.

In this context, this technical brief comprehensively analyzes ERZIA's proposed solution: the **-NS (New Space)** line of RF & Microwave amplifiers. Through a detailed breakdown of technical specifications, design philosophy, and test protocols, we examine how this new hardware category fills the gap between traditional space-grade modules (Class V/K) and standard industrial components. It is argued that integrating specific risk mitigation strategies—such as radiation tolerance, multipaction management, outgassing compliance, and thermal and mechanical robustness, allows satellite operators to deploy high-performance payloads with immediate lead times, without sacrificing mission integrity.

The analysis is structured to guide the reader from the macroeconomic and physical problems of the space environment to the specific engineering solution, culminating in a review of the flight heritage that validates this approach. This document serves as a decision-making tool for systems engineers seeking to optimize the value chain of their RF & microwave payloads.

2. The New Space Context: Speed, Cost, and Orbital Physics

2.1 The Economics of Planned Obsolescence in Orbit

To understand the need for a new class of amplifiers, we must first dissect the economic reality of LEO missions. Unlike a GEO satellite that must amortize its $500+ million cost over 15 or 20 years, a typical LEO satellite in a mega-constellation has a design life of 3 to 5 years. This reduced lifespan is not just a consequence of orbital decay due to atmospheric drag, but a strategic decision: it allows operators to update their technology and distributes the risk over hundreds of satellites.

In this scenario, 20-year reliability ceases to be an asset and becomes a financial liability. Paying a 500% premium for an amplifier qualified for two decades of operation on a satellite that will disintegrate in the atmosphere in five years is an inefficiency that New Space business models cannot tolerate. Venture capital investors and commercial operators demand an accelerated Return on Investment (ROI), which puts downward pressure on CAPEX (capital expenditure) and, crucially, Time-to-Market.

2.2 The Time-to-Market Imperative

Speed is the new currency. In the satellite telecommunications sector, the race to occupy orbits and frequencies assigned by the ITU is fierce. A six-month delay in the delivery of High Power Amplifiers (HPA) for the payload can mean losing spectrum priority or ceding market share to a competitor.

The traditional methodology for acquiring space hardware is linear and slow. It involves specification definition, custom design, procurement of specific semiconductor wafers, hermetic packaging, and destructive qualification campaigns that can last months. ERZIA has identified that this flow is incompatible with the agile New Space methodology, where hardware is often developed in parallel with software and where the ability to iterate quickly is vital. Immediate availability, or "off-the-shelf," becomes a technical requirement as strict as noise figure or saturated output power.

2.3 The Risk Profile: From "Fail-Safe" to "Fail-Operational"

The shift toward distributed constellations also alters risk management philosophy. In single-satellite architecture, a failure in the main amplifier is catastrophic. In a constellation of 500 satellites, the loss of one unit degrades system capacity by 0.2%, which is manageable via software and dynamic routing.

This does not imply that hardware can be low quality; launch costs remain significant (thousands of dollars per kilogram). Rather, it implies that the "safety margin" can be adjusted. Instead of designing for theoretical worst cases with 100% margins, designs target nominal cases with robust but efficient statistical margins. ERZIA addresses this new risk profile through a "reliable enough" approach, which does not mean low quality, but quality optimized for the specific mission.

3. Why Traditional Methodology Fails in the New Paradigm

The persistence of traditional methodologies in a radically changed market creates operational and financial friction. Analyzing why they fail is essential to appreciating the proposed alternative.

3.1 The Documentation and NRE Barrier

In the traditional model governed by standards like MIL-PRF-38535 or ECSS-Q-ST-60, documentation is the primary product. Engineers must generate Parts, Materials, and Processes (PM&P) analyses, Radiation Hardness Assurance (RHA) reports, and absolute traceability down to the wafer diffusion lot. This process incurs massive Non-Recurring Engineering (NRE) costs. For a New Space startup or university lab, paying hundreds of thousands in NRE before receiving the first screw is unfeasible.

ERZIA highlights that New Space clients seek functionality and certainty, not bureaucracy. The excess documentation of traditional methodology slows decision-making and consumes valuable engineering resources on reviewing paperwork rather than system integration.

3.2 Supply Chain Inertia

Traditional High-Reliability (Hi-Rel) components suffer from extreme lead times, often exceeding 50 weeks. This is because they are manufactured to order and require dedicated test campaigns for each lot. If an engineer discovers a design issue in the transceiver six months before launch and needs to change the amplifier, traditional methodology offers no reaction capability. The project stops or launches with degraded capabilities.

3.3 Over-Engineering and Over-Cost

Designing an LNA to withstand 100 krad of accumulated radiation (typical of a 15-year GEO mission or a Jupiter mission) when the LEO mission will only experience 10 krad in its lifetime is a waste of resources. "Rad-Hard" components use exotic process technologies (like Silicon on Sapphire or Tantalum shielding) that multiply cost and restrict availability. Traditional methodology lacks the granularity to offer intermediate solutions; it is a binary "all or nothing" system that leaves the mid-market segment unattended.

4. The New Space Context: Speed, Cost, and Orbital Physics

To propose a credible alternative to the traditional model, a manufacturer must demonstrate a deep understanding of the rules it attempts to rewrite. ERZIA is not a consumer electronics startup trying to enter the space sector, but an established firm with flight heritage proven in the solar system's most extreme conditions.

4.1 Uninterrupted Traditional Space Heritage Since 2005

The company has been participating uninterruptedly in traditional space projects since 2005. During these two decades, ERZIA has provided critical hardware for flagship European Space Agency (ESA) missions, including the LISA Pathfinder, ExoMars (specifically for the NOMAD instrument), and Altius.

Furthermore, their technological footprint extends to deep space and lunar exploration, having supplied amplifiers for lunar missions, establishing a continuous presence on the lunar surface and in orbit. Beyond government agency science missions, ERZIA maintains a strong track record supplying high-reliability amplifiers for private clients operating commercial telecommunications payloads in Geostationary Orbit (GEO).

This experience provides the empirical data and experience needed to precisely calibrate safety margins in their COTS products for New Space. It is not theory; it is hardware proven.

4.2 Fusion of Worlds: COTS and Hi-Rel

ERZIA's strategy is based on its dual nature. On one hand, it maintains the design and production capability traditional space. On the other, it possesses a catalog of over 300 high-performance COTS products and strong activity on the design and production of RF & Microwave amplifiers and Integrated Microwave Assemblies for Aerospace and Defense markets.

The company management team have articulated a vision where the expertise of high-reliability processes (soldering, inspection, thermal management) is applied to COTS designs. This allows for the "productization" of space technology. Instead of designing a new amplifier for every client (Custom), they take a mature, proven COTS design and apply the necessary modifications to survive space. This eliminates NRE and reduces technical risk, as the base RF design has already been validated in hundreds of terrestrial units.

5. The New Concept -NS: Redefining COTS for Space

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5.1 Calculated Reliability: The 30 krad Standard (TID)

Radiation is the silent enemy of electronics in space. There are two main types of effects: Total Ionizing Dose (TID), which degrades components over time (threshold voltage shifts, leakage currents), and Single Event Effects (SEE), caused by the impact of a single energetic particle that can cause logical or destructive failures (Latch-up).

ERZIA has standardized its -NS line to withstand a TID of 30 krad (Si). This value is not arbitrary:

- **LEO Environment Analysis**: In a typical low orbit (500-800 km, polar or equatorial inclination), the annual dose behind standard aluminum shielding (2-3 mm) ranges between 1 and 5 krad per year.

- **Safety Margin:** For a 5-year mission, the accumulated dose would be 5 to 25 krad. By guaranteeing 30 krad, ERZIA offers a sufficient safety margin to cover solar activity variability and different orbits, without incurring the extreme costs of the 100 krad or 300 krad components needed for long term GEO or Jupiter missions.

Additionally, the circuitry is prepared to resist single events up to 32 MeV·cm²/mg. This is achieved by selecting intrinsically robust semiconductor technologies and designing circuits which mitigate the effects of Single Events.

5.2 Vacuum Management: Multipactor and Venting

The vacuum of space presents mechanical and electromagnetic challenges that terrestrial components ignore.

- **Venting (Decompression):** A hermetic terrestrial module could explode or deform in space due to internal pressure of 1 atmosphere against the external vacuum. -NS modules incorporate venting structures calculated to allow air to escape at a safe rate during launch vehicle ascent, preventing structural damage.

- **Multipaction Effect:** In vacuum conditions, high-power electric fields in an amplifier can accelerate free electrons. If these electrons strike device walls with sufficient energy, they release secondary electrons, creating a resonant avalanche that can destroy the device or generate unacceptable noise. This phenomenon does not occur atmospheric pressure. ERZIA designs the internal geometry of its -NS modules, a critical consideration for its High Power Amplifiers (HPA).

5.3 Pure Tin" Mitigation and Tin Whiskers

In the commercial electronics industry, the use of pure tin finishes is standard practice to comply with RoHS (Restriction of Hazardous Substances) regulations, which mandate lead-free alternatives. However, in the vacuum of space, pure tin presents a critical hazard due to the spontaneous growth of "tin whiskers"—

In the commercial electronics industry, the use of pure tin finishes is standard practice to comply with RoHS (Restriction of Hazardous Substances) regulations, which mandate lead-free alternatives. However, in the vacuum of space, pure tin presents a critical hazard due to the spontaneous growth of "tin whiskers"—microscopic, highly conductive hair-like filaments that can grow millimeters in length. If these whiskers bridge the gap between adjacent component terminals or ground planes, they can cause catastrophic short circuits.

To mitigate this risk, ERZIA strictly avoids the use of pure tin solder in the assembly of its -NS line. Furthermore, because many high-performance COTS components are originally manufactured with pure tin finishes to meet commercial standards, ERZIA applies a rigorous mitigation strategy that neutralizes the whisker threat while preserving the performance and availability advantages of the COTS components.

5.4 Materials and Outgassing

Molecular contamination is a critical threat to optical sensors and solar panels. In a vacuum, materials such as adhesives, plastics, and epoxies release volatile organic compounds (Outgassing). These gases can condense on cold surfaces, obscuring lenses and reducing solar cell efficiency.

The -NS line exclusively uses materials compliant with ASTM E595 and NASA requirements (TML $< 1.0\%$ and CVCM $< 0.1\%$). This drastically differentiates an ERZIA -NS amplifier from a generic industrial amplifier, whose use of standard adhesives could ruin a Earth observation payload.

5.5 Automotive Grade Components (AEC-Q)

One of ERZIA's key innovations to reduce costs without sacrificing robustness is the incorporation of automotive-grade passive components (resistors, capacitors). The automotive industry demands extremely high-quality standards (AEC-Q100/200) to withstand vibrations, thermal shock, and prolonged operation, very similar to launch and LEO operation requirements. By using these components, ERZIA leverages the automotive industry's economy of scale to offer superior-to-commercial reliability at a fraction of the cost of "Space Grade" components.

5.6 Fast Delivery and Stock Models

Perhaps the most disruptive feature of the -NS concept is logistics. By relying on standardized designs and available COTS, ERZIA can maintain stock of units or assemble them in lead times of a few weeks. This contrasts with the typical 26-50 weeks in the sector. For a satellite integrator, this means the ability to order a flight amplifier near the end of the design cycle, reducing the risk of specification changes, and receive batches in quantities which can satisfy the exigent launch schedules of New Space.

6. Technical Analysis of the -NS Portfolio: Comprehensive Tx/Rx Solutions

By offering both Solid State Power Amplifiers (SSPAs/HPAs) for the transmission downlink and Low Noise Amplifiers (LNAs) for the reception uplink, ERZIA enables payload engineers to source fully compatible, space-ready COTS components across the entire spectrum. This comprehensive portfolio drastically reduces integration risks and supply chain complexities.

6.1 Key Specifications Table (Representative Selection)

The following table highlights a strategic selection of both HPA and LNA models from the -NS line, illustrating the wide frequency coverage and complementary performance available for immediate integration:

6.2 Analysis by Band and Payload Arquitecture

6.2.1 UHF, L, and S Bands: Robust Telemetry and IoT Constellations

For critical Command and Control (TT&C) or IoT data collection, the RF link must be infallible. On the receive side, the ERZ-LNA-0070-0300-20-0.7-NS provides excellent noise figure performance across 0.7 to 3 GHz, allowing the satellite to "hear" faint signals from low-power ground terminals. On the transmit side, operators can pair this with the highly versatile ERZ-HPA-0002-0600-42-NS. Covering 20 MHz to 6 GHz with 42 dBm of output, this combination is the ultimate RF engine for Software-Defined Radios (SDRs) that require dynamic frequency hopping across multiple lower bands.

6.2.2 C, X, and Ku Bands: Earth Observation and High-Speed Data

Earth Observation (EO) satellites and Synthetic Aperture Radars (SAR) demand high peak power to penetrate the atmosphere and sensitive receivers to capture the returning echo or ground station uplinks. The ERZ-LNA-0700-1300-51-1-NS offers a massive 51 dB of gain for X and Ku-band reception, ensuring that even the most attenuated signals are recovered. Conversely, pushing gigabytes of imaging data down to Earth requires raw power; the ERZ-HPA-0800-1100-43-NS delivers 43.5 dBm in the X-band, overcoming atmospheric losses and maximizing the data throughput during short orbital passes.

6.2.3 K, Ka, and Q Bands: The High-Throughput Broadband Frontier

Mega-constellations providing global internet access rely on the K, Ka, and Q bands to achieve massive bandwidth. However, these millimeter-wave frequencies suffer from severe atmospheric attenuation. The ERZ-LNA-2500-4300-33-2-NS provides crucial low-noise amplification across

Part Number	Type	Freq Range (GHz)	Gain (dB)	Pout / (dBm) / NF (dB)	Key Capability	Primary Application
ERZ-HPA-0002-0600-42-NS	HPA	0.02 - 6	50	42	Ultra-wideband transmission	Multi-mission SDR, Broadband Telemetry
ERZ-LNA-0070-0300-20-0.7-NS	LNA	0.7 - 3	20	NF of 0.7 dB	High sensitivity in L/S bands	TT&C Uplink, IoT Data Collection
ERZ-HPA-0800-1100-43-NS	HPA	8 - 11	42	43.5	X-band high power (20W+)	Earth Observation Downlink, SAR
ERZ-LNA-0700-1300-51-1-NS	LNA	7 - 13	51	NF of 1 dB	Extremely high gain reception	Sensitive X/Ku band sensor arrays
ERZ-HPA-1730-2120-44-NS	HPA	17.3 - 21.2	50	43.5	Outstanding power density	K-band Satcom Downlink
ERZ-HPA-2000-4000-39-NS	HPA	20 - 40	52	39	Broad Ka-band, high linearity	HTS (High Throughput Satellites)
ERZ-LNA-2500-4300-33-2-NS	LNA	25 - 43	28	NF of 2 dB	Ultra-wide mmWave reception	Ka/Q-band Gateways, ISL Receivers
ERZ-HPA-3750-4250-39-NS	HPA	37.5 - 42.5	49	39	High frequency, reliable output	Q-band Gateways, Inter-satellite Links

a massive 25 to 43 GHz sweep, capturing highly attenuated Ka/Q-band uplink signals. To complete the circuit, HPAs like the ERZ-HPA-2000-4000-39-NS (Ka-band) and ERZ-HPA-3750-4250-39-NS (Q-band) provide high-gain, linear power necessary for high-order modulation schemes.

7. Quality Protocols and Testing: Validating the Promise Solutions

By offering both Solid State Power Amplifiers (SSPAs/HPAs) for the transmission downlink and Low Noise Amplifiers (LNAs) for the reception uplink, ERZIA enables payload engineers to source fully compatible, space-ready COTS components across the entire spectrum. This comprehensive portfolio drastically reduces integration risks and supply chain complexities.

7.1 Manufacturing Standards

All modules in the -NS line are manufactured in cleanrooms within facilities certified under ISO 9001 and EN 9100 (Aerospace Quality Management). The baseline manufacturing process utilizes ERZIA's proven best practices, executed by IPC-certified operators to guarantee a high-quality and reliable soldering standard for New Space COTS products.

However, for clients whose missions demand an even higher level of scrutiny and who are willing to accommodate it in their budget, ERZIA offers the option to solder according to the IPC J-STD-001 Space Addendum as a paid upgrade. The Space Addendum imposes stricter requirements on solder joint metallurgy, flux residue cleaning, and visual inspection. By making the Space Addendum an on-demand option rather than the default, ERZIA successfully maintains the cost-efficiency and agility of the -NS line while still providing a clear, customized path for programs that require traditional space-grade soldering verification.

7.2 Comprehensive Acceptance Test Reports (ATR)

Each -NS amplifier is delivered with a full Acceptance Test Report (ATR) with electrical tests performed at three temperatures (cold, ambient, and hot) by default. All the relevant

information is presented to completely characterize the amplifiers. In addition, extra electrical tests can be accommodated, normally at the same price, or with a small delta when needed.

7.3 Additional Screening a la Carte

For missions with requirements beyond standard LEO (e.g., MEO, GEO or longer duration missions), ERZIA offers the flexibility to perform additional tests on flight units or internal components. This can include random vibration testing, shock testing or dedicated thermal vacuum (TVAC) cycles as well as burn-ins or screening at component or module level. Even extra radiation tests are possible if needed. This flexibility allows customers to pay only for the level of assurance their mission justifies, maintaining the cost-efficiency philosophy of New Space.

8. Management Perspectives: The Vision Behind the TechnologySolutions

The -NS line strategy is not accidental but the result of deep market analysis by ERZIA's leadership.

Luis García, CEO, reflects on the profound transformation the sector is experiencing:

"The space industry is undergoing a paradigm shift. New Space programs move incredibly fast, and the pressure to reduce costs while deploying large constellations is intense. The traditional model of decade-long developments is no longer the only path. We created this product line to give commercial satellite builders immediate access to flight-ready RF hardware that has been engineered from the ground up to meet these new orbital demands."

This statement underscores that the goal is not to compete with "Old Space" components in billion-dollar scientific missions, but to enable the mass commercialization of space through agile, flight-ready solutions.

David Díez, Managing Director, explains why ERZIA is the ideal partner to cover this specific market niche. He highlights that ERZIA's unique position is built upon two fundamental pillars:

1. **Over 20 Years of Traditional Space Heritage:** A deep, uninterrupted track record since 2005 supplying highly reliable hardware for flagship government missions (ESA, NASA, CNSA) and private GEO clients.

2. **Commercial Production Expertise:** Extensive experience managing a broad catalog of commercial amplifiers that perfectly balance rapid production timelines with technical excellence and robust reliability.

"By bringing together these two worlds—our traditional space heritage and our agile COTS manufacturing capabilities—we have created the New Space line," notes Díez. "The result is a unique solution meticulously optimized for this niche, offering the best of both paradigms: the peace of mind of space-grade engineering with the speed and efficiency of the commercial sector."

9. Conclusion: The Third Way for Space RF Engineering

The dichotomy between "cheap and risky" (pure COTS) and "expensive and slow" (Traditional Space) has been a brake on innovation in the satellite industry. The ERZIA -NS amplifier line breaks this false dilemma by offering a "third way": COTS hardware optimized for the orbital environment.

The analysis presented in this Tech Brief demonstrates that:

1. **Physics Rules:** You cannot "cheat" space. Radiation, vacuum, outgassing and other parameters are real. The -NS line addresses these physical factors with specific engineering solutions (venting, materials, semiconductor selection, etc...) rather than ignoring or over-analyzing them.

2. **Economics Matter:** By eliminating NRE and reducing lead times from months to weeks, ERZIA aligns the RF supply chain with the financial and development cycles of New Space.

3. **Quality is a Baseline:** By default, all ERZIA products (both standard COTS and -NS models) are manufactured in cleanrooms under strict ISO 9001 and EN 9100 standards, maintaining ruggedness against extreme vibration, acceleration, shock, and temperature. Customers are then given the flexibility to verify this inherent robustness by selecting only the specific tests their mission requires, including the optional IPC Space Addendum, avoiding unnecessary bureaucratic paralysis while maintaining total confidence.

For engineers and program managers building the next generation of space infrastructure, the -NS line represents a strategic tool: the ability to deploy advanced RF capabilities today, with the reliability needed to accomplish the mission tomorrow.

10. Next Steps

To integrate these solutions into your next mission, the following concrete actions are recommended:

1. **Datasheet Review:** Download the full datasheets for -NS models relevant to your frequency band (S, C, Ku, Ka, Q/V) and verify compatibility with your application.

2. **Contact ERZIA**: We are willing to talk with you. Our sales and engineering teams can give you any additional detail about our -NS products, and offer customization options that would make these products adapted to your needs.

Additional Resources:
New Space | ERZIA
Space | ERZIA

David Díez is Managing Director at ERZIA and focused on Business Development and R&D.