Ultra-Low Loss and Precision Passive Components for Quantum Computing: Market Opportunities and Technology Requirements 2025-2030

Dennis M. Zogbi
Paumanok Publications, Inc.
dennis@paumanokgroup.com

SLIDE OUTLINE

- Title Slide
- About Paumanok Publications
- The Quantum Computing Revolution
- Why Traditional Components Fail in Quantum Systems
- Quantum System Architecture Overview
- Ultra-Low Loss Capacitors for Quantum Systems
- Precision Resistors for Quantum Computing
- High-Q Inductors and Emerging Magnetic Technologies
- Market Size and Growth Projections
- Regional Market Investments
- Applications in Subassemblies
- Competitive Landscape
- Technology Gaps and Unmet Needs
- Emerging Materials and Future Technologies
- Questions and Contact Information

INSTRUCTOR BIO

DENNIS M. ZOGBI

EXECUTIVE SUMMARY

Dennis M. Zogbi is the founder and CEO of Paumanok Publications, Inc. (operating as Paumanok Industrial Market Research), and stands as the world's preeminent authority on passive electronic components. With 37 years of continuous market research (1988-2026) and authorship of more than 260 specialized reports, Zogbi has established himself as the electronics industry's most trusted voice on capacitors, resistors, inductors, circuit protection components, and their associated raw materials supply chains.

Recognized globally for his technical-economic analysis methodology and deep vertical market research approach, Zogbi serves as a regular contributor to TTI, Inc.'s MarketEYE resource center and holds the distinction of being majority owner of Passive Component Industry Magazine LLC—the only publication dedicated exclusively to capacitors, resistors, and inductors.

EARLY CAREER & FOUNDING OF PAUMANOK (1988)

Dennis M. Zogbi was born on February 27, 1965. The Paumanok brand was developed in 1988 when Zogbi was at University in New York and received his first contract from a highly respected manufacturer of value-added and application specific ceramic components located in the Carolinas of the United States.

The First Project: Varistor Market Research (1988)

His initial assignment was to study the global market for a type of non-linear resistor known as a "varistor," which is used for overvoltage protection in electrical and electronic circuits, and to determine whether a new style of small case size, ultra-small multilayered stacked varistor would work well in the emerging electronics industry. This pioneering work examined zinc oxide-based components capable of withstanding touch-activated electrostatic discharge (15kV), a critical capability for the emerging surface mount technology era.

Expansion Into Core Passive Components

Following the success of the varistor study, Zogbi's client base rapidly expanded. The company that encouraged this process in 1988 encouraged him to study the multilayered ceramic capacitor industry soon after, as well as the plastic film capacitor industry and the aluminum electrolytic capacitor industry. Other vendors in resistors and inductors encouraged him to expand his offerings in market research data into the thick and thin film resistor markets and into the magnetic components space.

This early client encouragement shaped what would become Zogbi's signature comprehensive coverage of the entire passive component ecosystem—an approach that remains unique in the industry nearly four decades later.

RESEARCH METHODOLOGY & INNOVATION

The Vertical Research Model

Zogbi pioneered what he terms a "ground-up vertical approach" to market research. As he describes his methodology: the focus is vertical research whereby he studies mining, materials processing, component production, component distribution, and component consumption across end-use markets including wireless handsets, computers, televisions, automotive, defense, medical, mining, hybrid electric vehicles, undersea cable, renewable energy, and power systems—analyzed by key country worldwide.

This comprehensive supply chain analysis—from ore extraction through end-use application—distinguishes Paumanok's research from competitors who typically focus on isolated segments of the value chain.

Longitudinal Data Sets: The 37-Year Advantage

One unique aspect of the Paumanok business model is that for years Zogbi developed rich datasets on the same specific industry, tracking the same specific line items, and eventually achieved month-to-month reporting capabilities on 60 individual sub-categories of passive components and their respective materials supply chains.

This continuous data collection from 1988 through 2026 creates an irreplaceable historical archive that enables:

- Long-term trend analysis and pattern recognition
- Accurate forecasting based on historical cycles
- Industry consolidation tracking (documenting over $6.1 billion in capacitor industry M&A transactions since 1990)
- Raw materials price indexing spanning multiple economic cycles
- Technology evolution mapping across nearly four decades

The Mosaic Research Technique

Zogbi has briefed the U.S. Government on his proprietary "Mosaic Technique" for private intelligence gathering through open source materials. This methodology integrates:

- Secondary research from government statistics (UN Comtrade, customs data)
- Company financial filings and disclosures
- Primary research through executive interviews
- Supplier and distributor surveys
- Field research including factory visits
- Trade show intelligence gathering
- Patent analysis for technology trend identification
- Cross-validation across multiple independent data sources

The Passive Component Raw Material Index

Zogbi developed and maintains the proprietary Passive Component Raw Material Index, which tracks pricing and availability for nine critical feedstocks: tantalum, ceramics, aluminum, plastics, palladium, ruthenium, nickel, copper, barium, titanium, and activated carbon. This unique market intelligence tool provides early warning signals for supply chain disruptions and component pricing trends.

AREAS OF SPECIALIZATION

Core Component Expertise

Capacitors:

- Ceramic capacitors (MLCC, disc, leaded)
- Aluminum electrolytic capacitors (standard, polymer, hybrid)
- Tantalum capacitors (solid, wet, polymer)
- Plastic film capacitors (polypropylene, polyester, polyphenylene sulfide)
- Supercapacitors and carbon-based energy storage
- High-voltage capacitors across all dielectrics
- Specialized capacitors (mica, glass, paper, diamond-like carbon)

Resistors:

- Thick film chip resistors
- Thin film precision resistors
- Wirewound resistors
- Carbon composition resistors
- Metal oxide and metal film resistors

- Resistor networks and arrays
- Current sense and power resistors

Inductors & Magnetic Components:

- Discrete inductors
- Ferrite beads
- Transformers
- Common mode chokes
- Power inductors for DC-DC conversion
- RF inductors and specialty magnetics

Circuit Protection:

- Varistors (metal oxide, silicon carbide)
- Electrostatic discharge (ESD) suppressors
- Fuses (electrical and electronic)
- Thermistors (NTC, PTC)
- Thyristor-based protection devices
- Transient voltage suppressors

Raw Materials & Supply Chain Intelligence

Zogbi is particularly recognized for his expertise in electronic materials, including:

- **Tantalum:** Mining, processing, powder production, conflict minerals compliance, and market dynamics
- **Ceramics:** Barium titanate formulations, dielectric materials, ferrites
- **Aluminum:** Etched foils for electrolytic capacitors, high-purity grades
- **Plastics:** Dielectric films (BOPP, PET, PPS, PEN), metallization processes
- **Conductive Polymers:** PEDOT formulations and ecosystem analysis
- **Precious Metals:** Palladium, ruthenium, and platinum group metals in electronics
- **Base Metals:** Nickel, copper, tin, and their alloys
- **Specialty Materials:** Activated carbon for supercapacitors, rare earth elements

Emerging Technology Markets

Zogbi has positioned himself at the forefront of emerging applications requiring advanced passive components:

- **AI Infrastructure:** Bypass, decoupling, and filtering capacitors for GPUs and AI chipsets
- **Quantum Computing:** Ultra-low loss components for cryogenic applications

- **Electric Vehicles:** High-voltage (800V+), high-temperature components for propulsion systems
- **Renewable Energy:** HVDC transmission capacitors, grid-scale energy storage
- **5G/6G Communications:** RF components and next-generation filtering
- **Medical Technology:** Implantable and diagnostic equipment components
- **Defense & Aerospace:** High-reliability, mission-critical components

End-Use Market Analysis

Zogbi provides comprehensive end-use market intelligence across:

- Automotive electronics (conventional, hybrid, battery electric)
- Consumer electronics (smartphones, computers, home entertainment)
- Industrial electronics (factory automation, robotics, process control)
- Telecommunications infrastructure
- Medical and healthcare technology
- Defense, military, and aerospace systems
- Oil & gas electronics (downhole logging, pump monitoring)
- Mining and heavy equipment
- Renewable energy systems (solar, wind, battery storage)
- Power supplies and conversion equipment

PUBLISHED WORKS & INTELLECTUAL OUTPUT

Market Research Reports (260+ Titles)

Zogbi has authored and published more than 260 syndicated market research reports since 1988, covering:

Annual Flagship Publications:

- Passive Electronic Components: World Market Outlook (37 consecutive annual editions: 1988-2026)
- Capacitors: World Markets, Technologies and Opportunities
- Resistors: World Markets, Technologies & Opportunities
- Individual deep-dive studies on ceramic, aluminum, tantalum, film, and specialty capacitors

Specialized Technology Studies:

- Ultra-Low Loss and Precision Components for Quantum Systems
- Capacitors for AI Infrastructure
- High Voltage Capacitors: World Markets and Technologies

- Supercapacitors: Technologies and Opportunities
- Conductive Polymer Capacitors: Ecosystem Analysis
- Value-Added and Application Specific Components

Materials-Focused Research:

- Capacitor Films: Plastic Dielectric Film Markets
- Capacitor Foils: Etched Anode and Cathode Dielectrics
- Tantalum Raw Materials and Processing
- Ceramic Dielectric Materials
- Conductive Polymer Ecosystems

End-Use Market Studies:

- Passive Components for Medical Technology
- Automotive Electronics Components
- Industrial Electronics Components
- Defense and Aerospace High-Reliability Components
- Oil & Gas Electronics Markets
- Renewable Energy System Components

Passive Component Industry Magazine

As majority owner and publisher of Passive Component Industry Magazine LLC, Zogbi produces the only periodical dedicated exclusively to capacitors, resistors, and inductors. Specialized editions include:

- The Medical Issue
- The Raw Materials Issue
- The ESD Issue
- The Tantalum Issue
- The Aluminum Electrolytic Issue
- The Plastic Film Issue
- The Ceramic and Tantalum Issue

White Papers & Industry Insights

Zogbi regularly publishes focused white papers on emerging trends, including:

- X & Y Capacitors in Battery Electric Vehicle Propulsion
- Polypropylene Capacitors for HVDC Power Transmission
- Global Electrical and Electronic Fuse Market Reviews
- Medical Electronic Component Supply Chain Analysis
- Predictive Analytical Tools for Passive Component Trends

- Class II and III Medical Electronic Component Supply Chain Analysis

TTI MarketEYE Contributions

As a featured contributor to TTI, Inc.'s MarketEYE resource center, Zogbi publishes monthly (and increasingly bi-weekly) technical-economic analyses on passive component markets. Recent articles include:

- Passive Component Raw Material Index quarterly updates
- Global Market Updates for Inductors, Beads and Cores
- Technical-Economic Research: Annual Year in Review
- Vertical Integration of Materials Technology in the Capacitor Industry
- High-Reliability Passive Electronic Components analysis
- Mapping Complex Ecosystems (magnetic components, conductive polymers, plastic films)

INDUSTRY RECOGNITION & SPEAKING ENGAGEMENTS

Keynote Addresses & Conference Presentations

Zogbi has delivered more than 28 keynote speeches across 14 countries worldwide at premier industry conferences:

Major Conference Presentations:

- **CARTS (Capacitor and Resistor Technology Symposium):** Multiple keynote addresses including panel participation on conflict minerals (Santa Clara, CA, March 2014) and the historic CARTS 2000 Brussels presentation on industry snapshot and market forecasting
- **Tantalum-Niobium International Conference:** Invited speaker on "State of The Tantalum Industry" (York, UK, October 2013; Vancouver BC, Canada, 2018), including presentations for the 75th HC Starck Anniversary on future tantalum requirements
- **Capacitor and Resistor Marketing Symposium:** 28 presentations across global venues
- **TAITRONICS (Taiwan):** "China's Growth In Passives: 20 Year Assessment"
- **ECA Summer Seminar:** Keynote speaker on "Future Outlook of Passives in Consumer Electronics"
- **Kemet Executive Leadership Programs:** Guest speaker in Dijon, France

Specialized Technical Presentations:

- Supercapacitors: World Markets, Technologies & Opportunities
- Conductive Polymer Capacitors market analysis
- Capacitors for Renewable Energy Systems and Power Factor Correction

- Passives in Automotive Electronics (Murata Manufacturing guest speaker)
- Value-Added Resistor Industry analysis (TT Electronics PLC)
- Mergers & Acquisitions in Passive Components and Industry Cycles (2019)

Government & Institutional Briefings:

- U.S. Government: Rare Earths Used in Electronic Components
- U.S. Government: Mosaic Technique and Private Intelligence Gathering Through Open Source Materials
- Battelle Memorial Institute: The Relationship Between Unit Price and Harmonized Tariff Schedule Classification

Industry Endorsements

Zogbi's expertise has earned recognition from industry leadership:

John Denslinger, ECIA President and CEO: "Dennis has a pulse on passive components, raw materials, applications, markets, and advanced technology like no one else. In a world dotted by specialists and dominated by volume manufacturers, Dennis is the industry's resident expert on sourcing, production and use of passive technology."

Walter Tobin, ERA CEO: "Dennis is a widely published and trusted resource in our industry."

BUSINESS LEADERSHIP & ENTREPRENEURSHIP

Paumanok Publications, Inc.

Founded: 1988
Structure: Wholly-owned private company
Headquarters: Cary, North Carolina, USA
Role: Founder, CEO, and Principal Research Director

Under Zogbi's leadership, Paumanok Publications has evolved from a one-person consultancy to a recognized global brand in industrial market research. The company operates with a distinctive business model:

Service Offerings:

- Syndicated off-the-shelf market research reports
- Single-client proprietary consulting engagements
- On-site executive presentations and briefings
- Due diligence support for mergers and acquisitions
- AI-powered market intelligence agents (launched 2025-2026)

Client Base:

- Component manufacturers (capacitor, resistor, inductor producers)
- Private equity and investment firms
- Electronic component distributors
- OEMs and EMS providers
- Raw materials suppliers (mining companies, chemical processors)
- Trade associations and government agencies

Passive Component Industry Magazine LLC

Role: Majority Owner and Publisher
Distinction: The only magazine dedicated exclusively to passive electronic components

This publication serves as both a revenue stream and a brand-building platform, reinforcing Paumanok's position as the industry's thought leader.

Innovation: AI-Powered Market Intelligence

In 2025-2026, Zogbi launched a new product line of AI-powered market intelligence agents, leveraging 37 years of proprietary data:

- Capacitor AI Superagent ($30,000/year)
- Resistor AI Superagent ($20,000/year)
- Magnetics AI Superagent ($15,000/year)
- Component-specific agents for tantalum, MLCC, aluminum electrolytic, and other categories ($7,500/year each)

This innovation represents a significant strategic evolution, adding recurring subscription revenue to the traditional one-time report sales model.

ANALYTICAL FRAMEWORKS & CONTRIBUTIONS TO INDUSTRY KNOWLEDGE

Technical-Economic Analysis Integration

Zogbi pioneered the integration of technical specifications with economic analysis in passive component research. His reports uniquely combine:

- Engineering performance parameters (voltage, capacitance, temperature ratings, ESR, Q-factor)
- Manufacturing cost structures and gross profit analysis
- Raw material pricing and availability trends
- Technology roadmaps and R&D trajectories

- Competitive landscape and market share data
- End-use application requirements and specifications

Industry Consolidation Tracking

Zogbi maintains comprehensive databases on industry consolidation, documenting mergers, acquisitions, and divestitures. His research has tracked over $6.1 billion in capacitor industry M&A transactions since 1990, providing invaluable intelligence for:

- Private equity firms evaluating investments
- Strategic buyers assessing acquisition targets
- Component manufacturers analyzing competitive dynamics
- Industry observers understanding market evolution

Cyclical Market Dynamics

Drawing on 37 years of continuous observation, Zogbi has developed sophisticated models for understanding passive component industry cycles:

- **Supply-Demand Imbalances:** Analyzing the frenzied upcycles and parts shortages that periodically disrupt mass-produced components
- **Profitability Erosion:** Documenting the decline in industry gross margins from approximately 25% in 2007 to ~17% in recent years
- **Technology Transitions:** Tracking miniaturization trends, voltage rating increases, and capacitance density improvements
- **Geographic Shifts:** Mapping manufacturing migration patterns from Japan/USA to Korea/Taiwan/China

High-Reliability Component Segmentation

Zogbi developed frameworks for understanding the high-reliability passive component market, identifying five key subcategories:

1. **Defense & Aerospace:** Mission-critical, harsh environment applications
2. **Medical Technology:** Implantable and diagnostic equipment
3. **Industrial Electronics:** Long-life, high-temperature applications
4. **Automotive Electronics:** Reliability and temperature requirements
5. **Telecommunications Infrastructure:** 24/7 operation and minimal downtime tolerance

His research demonstrates that while high-reliability components represent lower volumes, they command significantly higher prices and operating margins (up to 75% in medical and defense applications versus 17% industry average).

Raw Materials Impact Analysis

Zogbi's unique focus on raw materials provides early-warning intelligence on:

- **Conflict Minerals Compliance:** Tantalum sourcing, certification, and regulatory impacts
- **Supply Chain Vulnerabilities:** Single-source dependencies, geopolitical risks
- **Price Volatility:** Precious metal price fluctuations affecting component costs
- **Technology Constraints:** Material availability limiting component performance advancements
- **Sustainability Considerations:** Recycling, circular economy opportunities

---

CURRENT FOCUS AREAS (2025-2026)

AI Infrastructure Components

Zogbi has positioned himself as the leading authority on passive components for artificial intelligence systems, analyzing:

- Bypass and decoupling capacitors for GPU and AI accelerator chips
- Power delivery networks for high-current, low-voltage AI processors
- Thermal management requirements driving component specifications
- Data center infrastructure buildout implications for component demand

Quantum Computing Components

Pioneering research into ultra-low loss components for quantum systems:

- Cryogenic temperature operation requirements
- Ultra-low dissipation factor capacitors and inductors
- Precision resistors for quantum control systems
- Materials science challenges in quantum electronics

Electric Vehicle Propulsion Systems

Comprehensive analysis of passive components in advanced EV architectures:

- 800V+ high-voltage bus capacitors
- Silicon carbide (SiC) and gallium nitride (GaN) power electronics support components
- Battery management system (BMS) components
- Ultra-fast charging infrastructure requirements
- X and Y safety capacitors for propulsion inverters

Supply Chain Resilience & Geopolitical Analysis

Post-pandemic and amid geopolitical tensions, Zogbi provides critical intelligence on:

- Component availability and lead time trends
- Manufacturing capacity shifts and nearshoring initiatives
- China-U.S. trade dynamics and tariff impacts
- Export controls on semiconductor equipment affecting passive component demand
- Alternative sourcing strategies and supply chain diversification

---

PERSONAL BACKGROUND

Born: February 27, 1965 (age 60)
Current Residence: Cary, North Carolina, USA
Previous Locations: Morrisville, NC; Durham, NC
Education: Associate degree; attended university in New York (1988)
Family: Married to Jane Zogbi; has children including Daniel Zogbi

---

PROFESSIONAL PHILOSOPHY & APPROACH

Commitment to Long-Term Perspective

Zogbi's 37-year continuous research commitment represents an extraordinary dedication to building institutional knowledge. In an era of quarterly earnings focus and short-term analysis, his multi-decade datasets provide unique historical context that cannot be replicated.

Technical Integrity

Zogbi maintains rigorous research standards, cross-validating data across multiple independent sources and grounding analysis in both engineering fundamentals and economic realities. His work combines deep technical understanding with practical business intelligence.

Industry Service

Beyond commercial research, Zogbi has contributed to industry knowledge through:

- Regular thought leadership articles accessible to the broader electronics community
- Speaking engagements that educate rather than simply promote
- Government briefings on industry dynamics and supply chain issues
- Academic pricing for universities, supporting next-generation researchers

Adaptability & Innovation

While maintaining core research continuity, Zogbi has demonstrated remarkable adaptability:

- Expanding coverage into emerging technologies (AI, quantum, advanced EVs)

- Adopting new digital platforms (Gumroad for e-commerce)
- Developing AI-powered intelligence products
- Evolving from pure research into consulting and advisory services

---

INDUSTRY IMPACT & LEGACY

Shaping Industry Understanding

For 37 years, Zogbi has defined how the passive component industry understands itself. His frameworks, terminology, and analytical approaches have become industry standards. Concepts like the Passive Component Raw Material Index, technical-economic analysis, and vertical supply chain research are now widely adopted because of his pioneering work.

Supporting Investment Decisions

Zogbi's research has informed billions of dollars in investment decisions:

- Private equity acquisitions of component manufacturers
- Strategic M&A transactions
- Manufacturing capacity expansion decisions
- Technology development investments
- Supply chain strategy formulation

Documenting Industry Evolution

Through 260+ published reports spanning nearly four decades, Zogbi has created an unparalleled historical archive documenting:

- The shift from through-hole to surface mount technology
- The rise of Asian manufacturing dominance
- The miniaturization revolution in passive components
- The emergence of new materials (conductive polymers, advanced ceramics)
- The evolution of end-use markets from mainframe computers to AI infrastructure

Influencing Technology Development

By identifying market gaps and technology opportunities, Zogbi's research has influenced:

- Component manufacturers' R&D priorities
- Materials suppliers' product development roadmaps
- Industry consolidation patterns
- Standards development and qualification requirements

FUTURE VISION

As Zogbi approaches the 40th anniversary of Paumanok Publications (2028), he continues to expand his research empire while building toward sustainable institutional longevity. Current strategic initiatives include:

Platform Expansion:

- Scaling AI-powered intelligence agents
- Building research team capabilities
- International market development (Asia, Europe)
- Enhanced digital delivery and customer engagement platforms

Coverage Expansion:

- Deepening analysis of emerging technologies
- Expanding into adjacent component categories
- Strengthening raw materials intelligence
- Developing circular economy and sustainability research

Thought Leadership:

- Increasing publication frequency
- Launching multimedia platforms (podcasts, video)
- Writing comprehensive industry history
- Mentoring next-generation researchers

Succession Planning:

- Documenting proprietary methodologies
- Building institutional knowledge base
- Developing research team capabilities
- Considering strategic partnership opportunities

CONTACT INFORMATION

Professional Affiliations:

- Founder & CEO, Paumanok Publications, Inc.
- Majority Owner, Passive Component Industry Magazine LLC
- Contributing Expert, TTI, Inc. MarketEYE

Digital Presence:

- Website: www.paumanokgroup.com
- LinkedIn: linkedin.com/in/passiveelectroniccomponents
- TTI MarketEYE: Regular contributor
- Gumroad: Paumanok IMR

DEFINING QUOTE

As summarized in his TTI MarketEYE biography: "Dennis M. Zogbi is the author of more than 260 market research reports on the worldwide electronic components industry. Specializing in capacitors, resistors, inductors and circuit protection component markets, technologies and opportunities; electronic materials including tantalum, ceramics, aluminum, plastics; palladium, ruthenium, nickel, copper, barium, titanium, activated carbon, and conductive polymers. Zogbi produces off-the-shelf market research reports through his wholly owned company, Paumanok Publications, Inc, as well as single client consulting, on-site presentations, due diligence for mergers and acquisitions, and he is the majority owner of Passive Component Industry Magazine LLC."

Biography Version: 2.0
Last Updated: January 2026
Word Count: ~5,500 words

Dennis M. Zogbi represents a singular figure in industrial market research—combining nearly four decades of continuous research, unmatched technical-economic expertise, and an irreplaceable archive of longitudinal data that makes him the definitive voice on the global passive electronic components industry.