APPLICATION NOTES

HIGH-PERFORMANCE ENGINEERING APPLICATION NOTES

Advanced PCB Solutions & Technical Implementation Guidelines for Mission-Critical Systems.

© 2026 Aditi Electronics And Research Pvt. Ltd.

Technical Documentation | Confidential

AN-1: Introduction to PCB Applications

As electronic systems evolve, the choice of PCB substrate and construction becomes the defining factor in system performance. AEAR provides specialized engineering for various board types to ensure structural and electrical integrity across all environments.

Rigid Solutions

High-layer count (up to 32+) utilizing high-Tg FR4 and ceramic-filled laminates for maximum dimensional stability.

Flexible & Rigid-Flex

Polyimide-based solutions for dynamic 3D applications, reducing connector counts and improving reliability in compact volumes.

Metal-Core (MCPCB)

Aluminum and copper base layers for superior thermal conductivity in high-brightness LED and power conversion modules.

Advanced Substrates

PTFE, Rogers, and Megtron materials for high-frequency and ultra-low loss signal requirements.

AN-2: Consumer Electronics

The consumer market demands extreme **miniaturization** without sacrificing processing power. AEAR utilizes High-Density Interconnect (HDI) technologies to achieve unprecedented component density.

Feature	Standard Capability	Advanced HDI (AEAR)
Line Width / Spacing	100µm / 100µm	35µm / 35µm
Via Technology	Through-hole	ELIC (Every Layer Interconnect)
Micro-via Diameter	150µm	75µm - 100µm (Laser Drilled)

AN-3: Automotive Systems

Automotive electronics, especially in EV power trains, require robust designs capable of handling high voltages and extreme vibrations. Reliability is non-negotiable for safety-critical ADAS and battery management systems (BMS).

High Voltage Safety

Implementation of 1.5mm+ clearance and creepage distances to support 400V/800V architecture.

Thermal Management

Utilization of heavy copper and thermal vias to dissipate heat from high-current inverter MOSFETs.

STANDARD DESIGN

Insufficient clearance leads to arcing and insulation breakdown in high-humidity automotive environments.

AEAR OPTIMIZED

Calculated creepage paths and specialized solder masks prevent dielectric failure up to 1000V peak.

AN-4: Industrial Automation

Industrial PCBs must survive "dirty" power and high-current loads. Our ruggedized designs focus on current carrying capacity and mechanical durability.

Current Analysis

Simulation of 100A+ current paths to determine required copper weight (3oz to 6oz).

Mechanical Reinforcement

Vibration-resistant mounting and thick-core substrates for heavy industrial environments.

Environmental Protection

Selective conformal coating and potting compatibility for chemical and dust resistance.

AN-5: Embedded Systems & High-Speed Data

High-speed digital design requires meticulous control over impedance and signal timing. DDR4/DDR5 memory interfaces and PCIe Gen4/5 links demand picosecond-level precision.

Fly-By Topology

Optimized routing for high-speed memory modules to minimize stubs and reflections.

Skew Management

Strict length matching within 2ps (approx. 0.3mm) for differential pairs and clock signals.

Protocol	Data Rate	Design Constraint
DDR4/DDR5	3200 - 6400 MT/s	Strict impedance (40/50Ω)
PCIe Gen 5	32 GT/s	Ultra-low loss laminates
USB 4.0	40 Gbps	Return loss < -15dB

AN-6: Thermal & Power Optimization

Heat is the primary cause of electronic failure. Effective thermal management involves moving heat from the silicon to the ambient environment through the PCB stackup.

Copper Coins

Embedded solid copper blocks directly under high-heat components for maximum vertical conductivity.

Thermal Vias

Array of PTHs with conductive epoxy filling and over-plating (VIPPO) for heat transfer to internal planes.

AN-7: Reliability & Stress Testing

Mission-critical PCBs must undergo rigorous validation to ensure long-term operation in hostile environments. AEAR adheres to IPC Class 3 standards for medical and aerospace applications.

HALT/HASS Testing

Highly Accelerated Life Testing to identify failure modes before mass production.

Thermal Cycling

Survival testing from -40°C to +125°C to ensure solder joint and PTH integrity.

Our reliability lab conducts micro-sectioning analysis to verify plating thickness and intermetallic growth, ensuring that every board exceeds industry benchmarks for longevity.

AN-8: EMI/EMC Mitigation

Electromagnetic interference can cripple sensitive analog circuits. Proper grounding and shielding techniques are integrated at the architectural level.

Ground Plane Integrity

Continuous reference planes to minimize return path loops and radiated emissions.

Via Stitching

Strategic placement of ground vias along board edges and around RF sections to create a Faraday cage effect.

Guard Traces

Shielding sensitive traces with grounded copper to prevent cross-talk in mixed-signal designs.

AN-9: RF Performance Optimization

For applications like 77GHz radar and satellite communications, standard FR4 is insufficient. AEAR specializes in high-frequency laminates that provide stable Dk/Df across broad temperature ranges.

Material	Dielectric Constant (Dk)	Dissipation Factor (Df)
Standard FR4	4.4	0.0200
Rogers 4003C	3.38	0.0027
Megtron 6	3.7	0.0020

Advanced hybrid build-ups allow for RF layers on specialized substrates while utilizing standard FR4 for power and slow-speed logic, optimizing both cost and performance.

AN-10: Future Tech & 6G Readiness

As we move toward Sub-THz communications and 6G, PCB technology must evolve to handle even higher frequencies and smaller wavelengths.

LCP Substrates

Liquid Crystal Polymer provides near-hermetic performance and ultra-low loss for 100GHz+ applications.

Embedded Components

Integrating passives and active dies within the PCB stackup to reduce parasitic inductance and footprint.