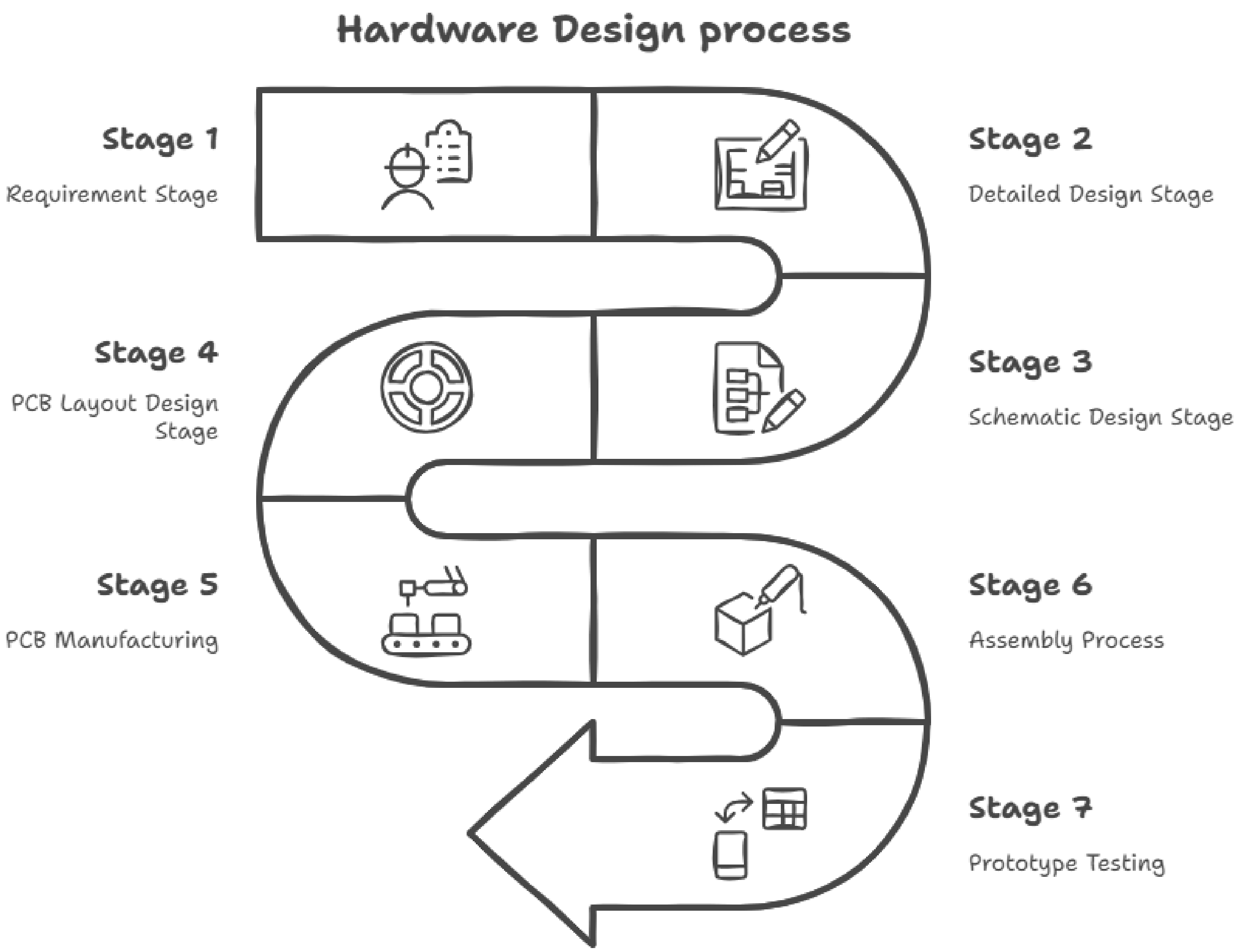
HARDWARE DESIGN PROCESS

By Bargunan Ponnusamy

HARDWARE DESIGN LIFECYCLE

The hardware development process is iterative, multidisciplinary, and documentation-driven. Successful execution depends on aligning requirements, technical design, layout optimization, and production workflows across engineering and manufacturing teams. This guide outlines the complete lifecycle—starting from customer requirements to prototype validation and design revision.



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STAGE 1: REQUIREMENT STAGE

Purpose:

Define the functional, environmental, electrical, and regulatory expectations of the end system.

Key Deliverable:

Hardware Requirements Specification (HRS)

Objectives:

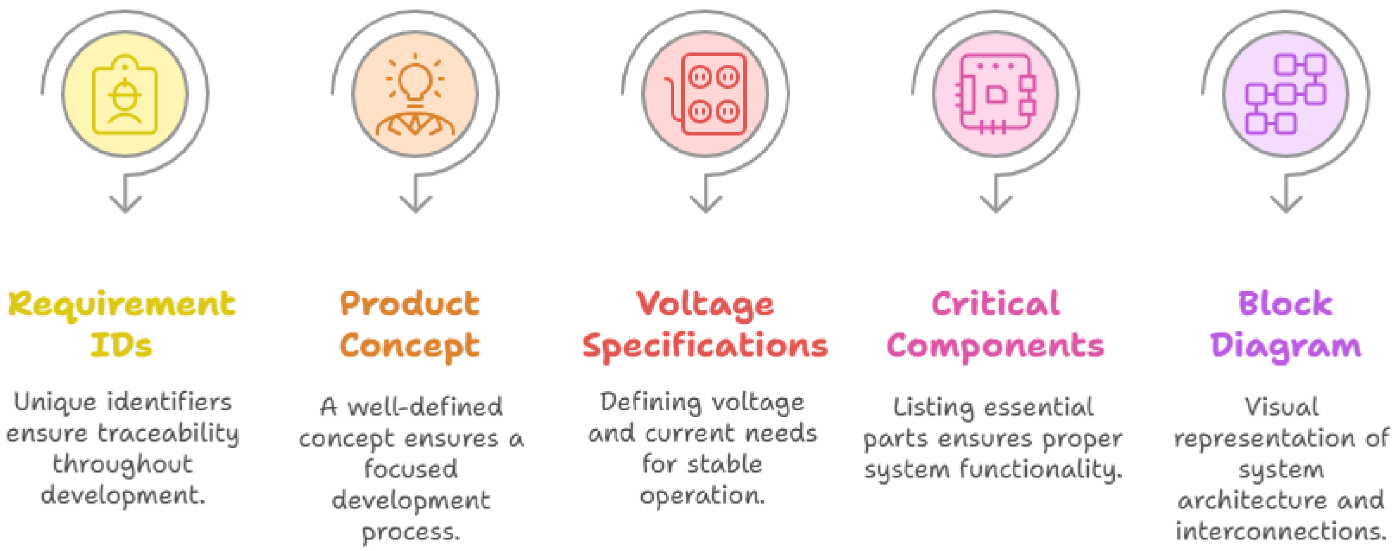
- Formalize client requirements
- Minimize assumptions and verbal dependencies
- Define project boundaries and measurable criteria

What’s Included:

- Unique Requirement IDs for traceability
- Clear product concept and system intent
- Input/output voltage specifications, current consumption
- List of critical components (MCUs, sensors, relays, etc.)
- System-level block diagram

Best Practice:

- Submit the HRS for stakeholder approval before proceeding.



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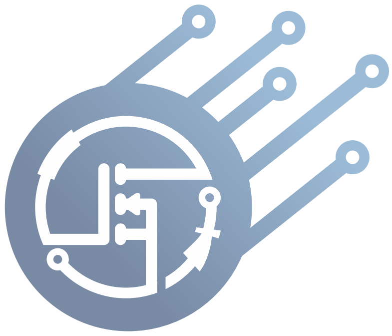
STAGE 2: DETAILED DESIGN

Purpose:

Translate high-level requirements into detailed engineering specifications, enabling robust design execution.

Key Deliverable:

Hardware Detailed Design (HDD) Document

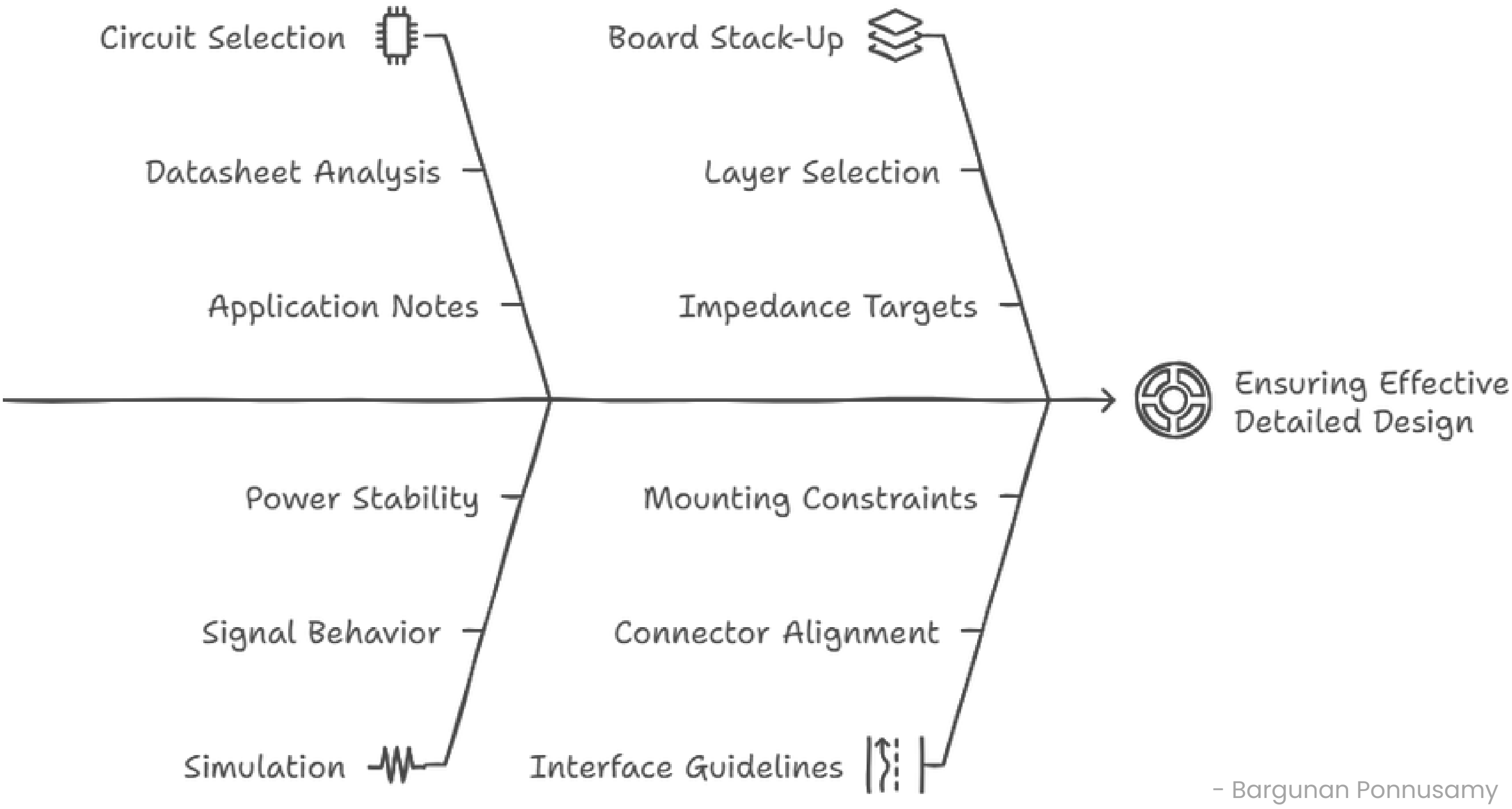


What's Included:

- Critical circuit selection based on datasheets and application notes
- Preliminary simulations for signal behavior and power stability
- Voltage/current distribution diagrams
- Proposed board stack-up (2L/4L/6L), impedance targets
- Mounting constraints and connector alignment
- High-speed interface guidelines (if applicable)

Note:

- HDD serves as the baseline for schematic development and early DFX (Design for eXcellence) planning.



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STAGE 3: SCHEMATIC DESIGN

Purpose:

Define the logical structure of the hardware, interconnects, and component-level behavior using EDA tools.

Key Activities:

Tip:

- Incorporate part availability and alternate vendor data early in the BOM to mitigate supply-chain risks.

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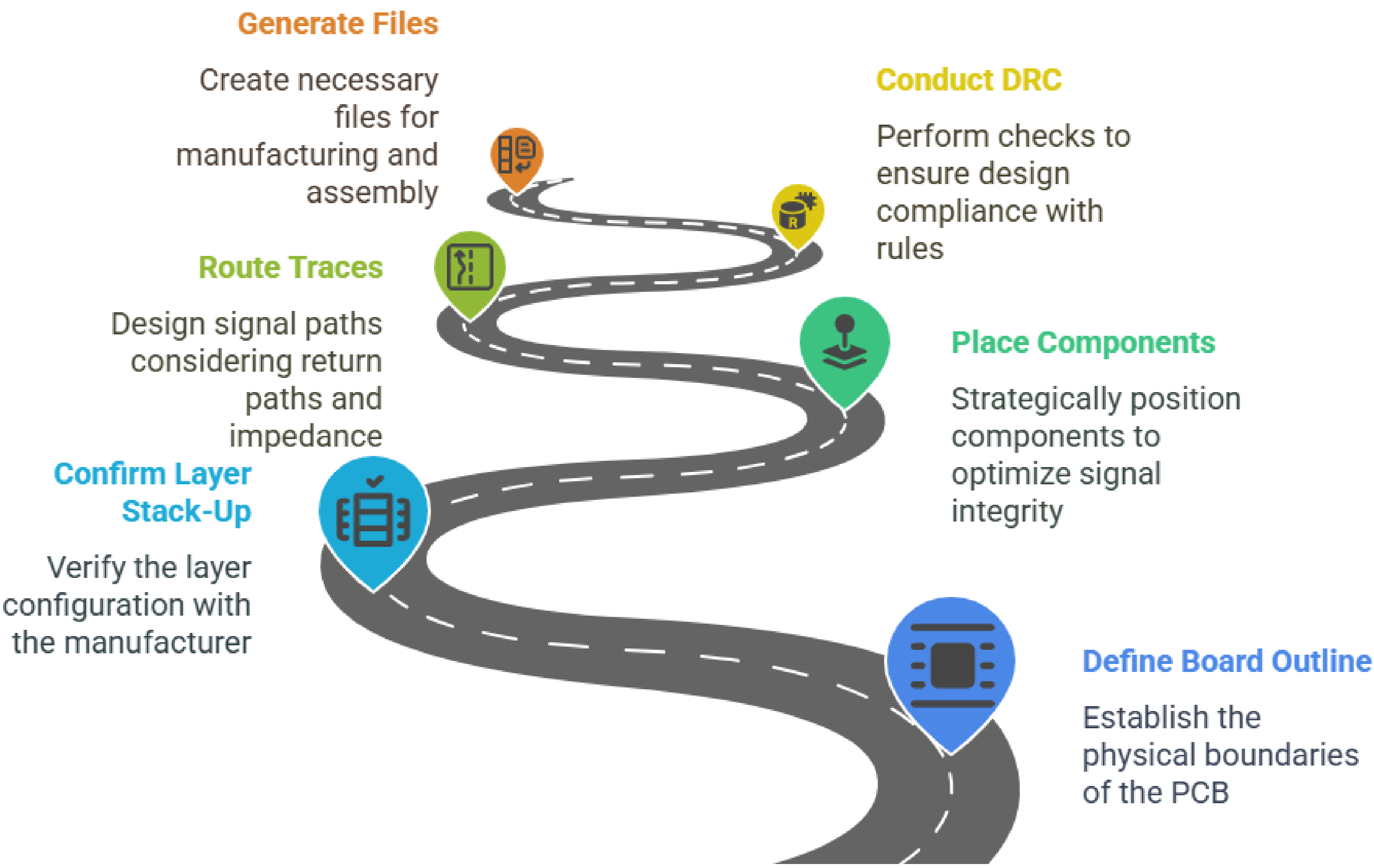
STAGE 4: PCB LAYOUT DESIGN

Purpose:

Convert the schematic into a physical design that meets electrical, mechanical, and manufacturability constraints.

Execution Steps



Professional Guidance

Apply simulation-driven layout (SI/PI/EMC) for high-speed or mixed-signal systems to ensure integrity and reliability.

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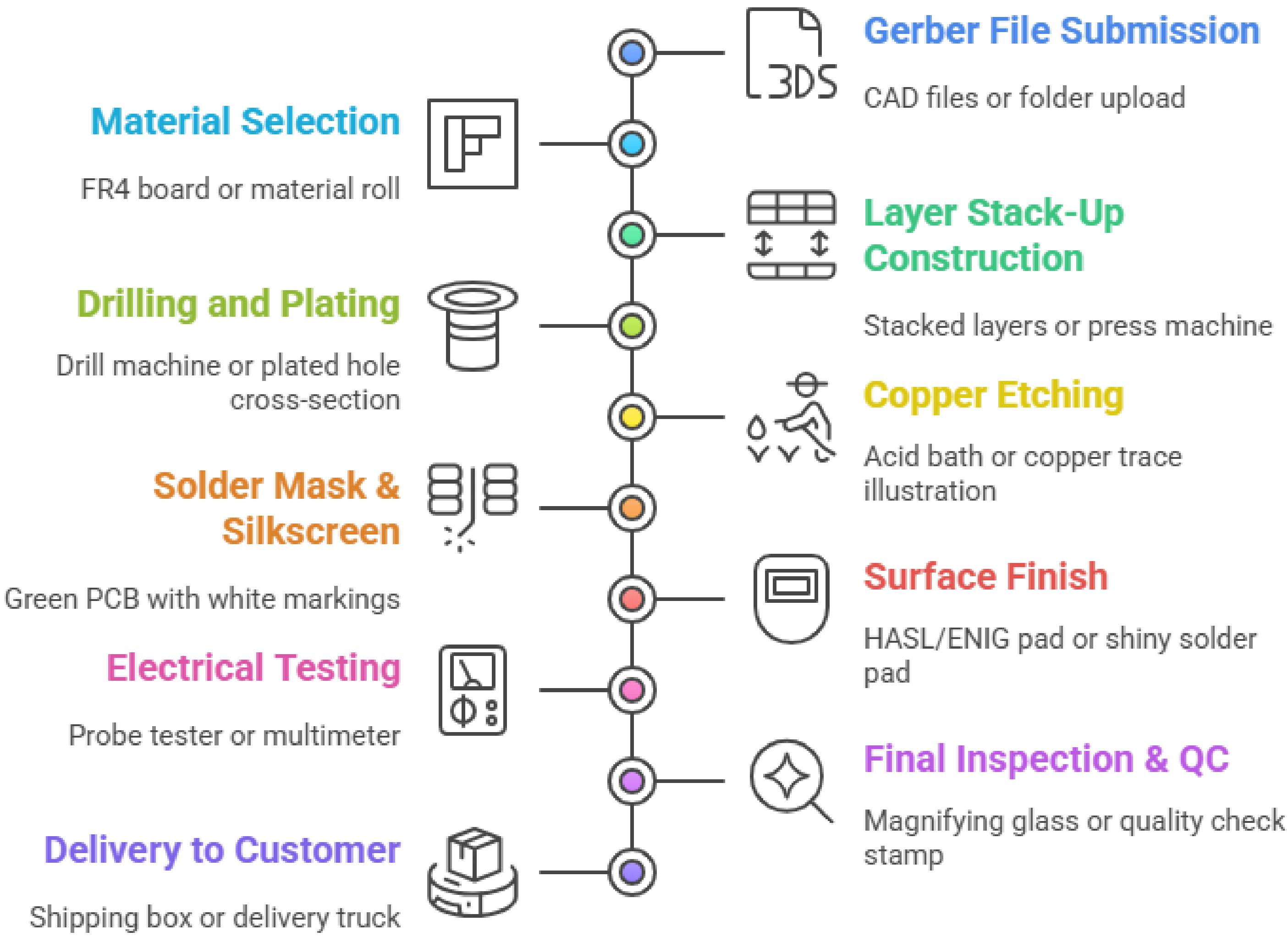
STAGE 5: PCB MANUFACTURING STAGE

Purpose:

Fabricate a physical PCB that matches the design intent with tight tolerance and reliability.

Fabrication Workflow



Quality Assurance:

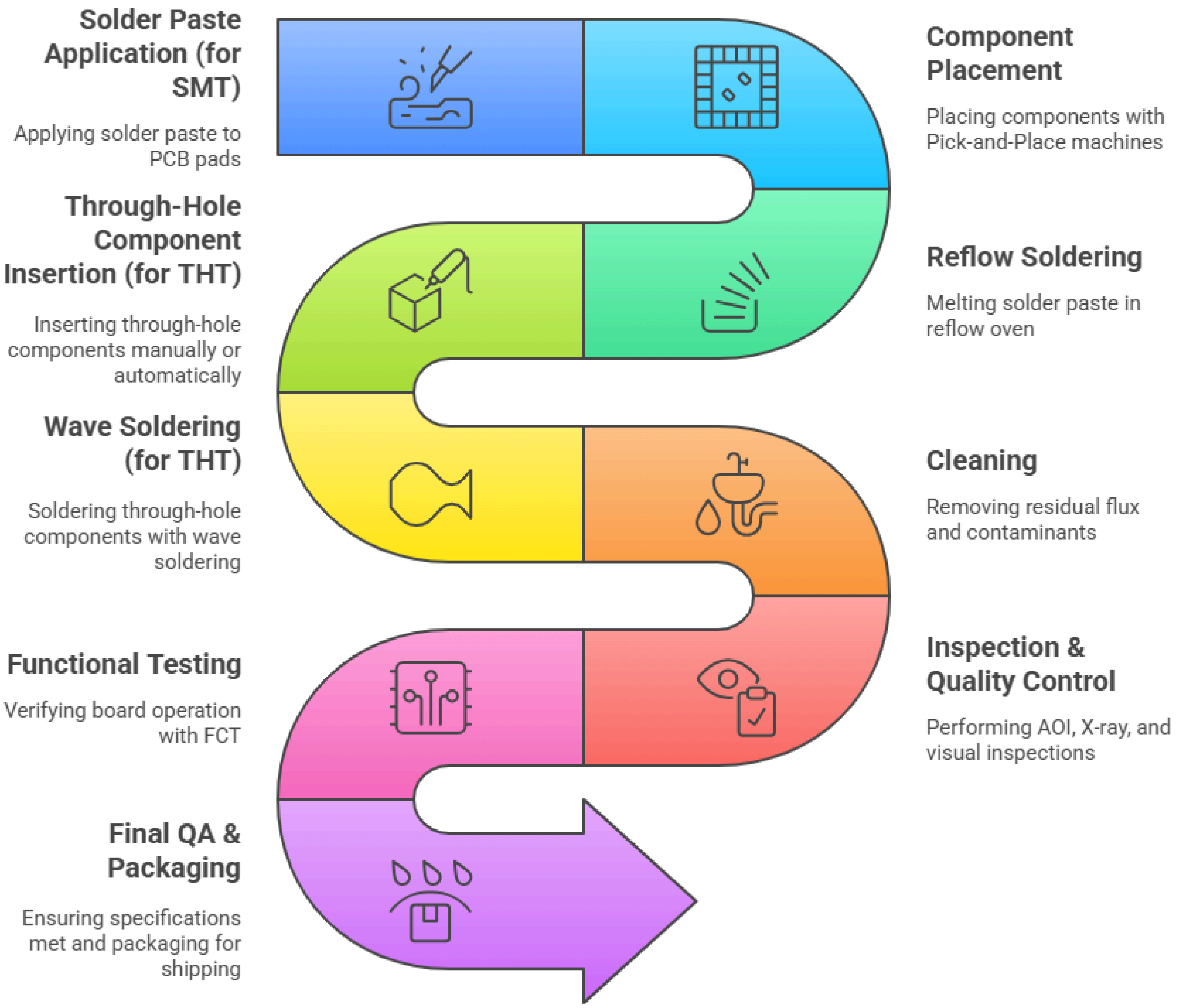
Include panel drawings and soldermask openings in design outputs to avoid manufacturing ambiguity.

STAGE 6: PCB ASSEMBLY STAGE

Purpose:

Assemble electronic components onto the fabricated board using SMT and THT methods.

Key Steps:



Engineering Controls:

Ensure clear communication of DNP (Do Not Populate) components, orientation-sensitive parts, and ESD-safe packaging needs.

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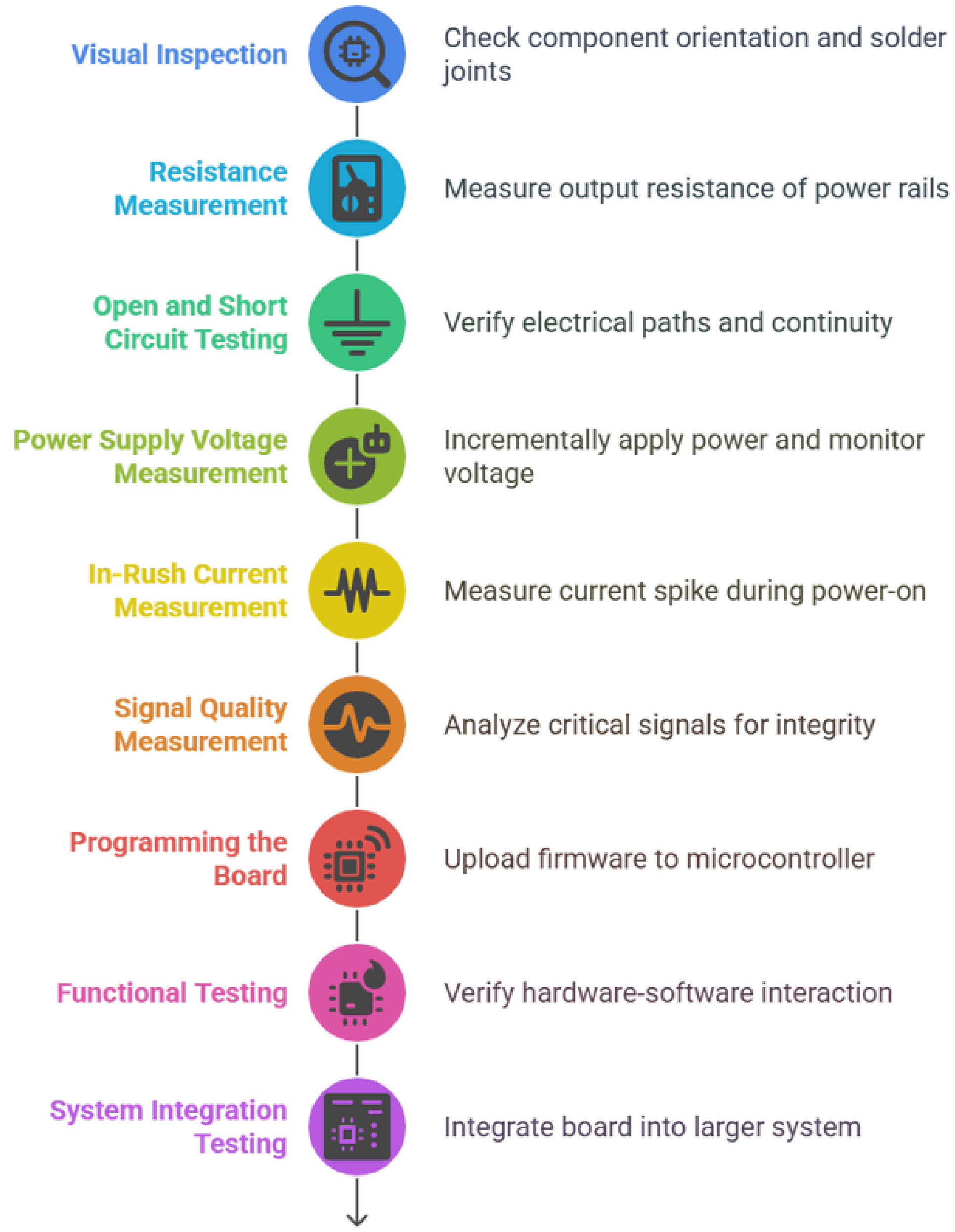
STAGE 7: PROTO TESTING & VALIDATION

Purpose:

Evaluate the first article for electrical functionality, compliance, and system-level integration.

Test Protocols:



Documentation:

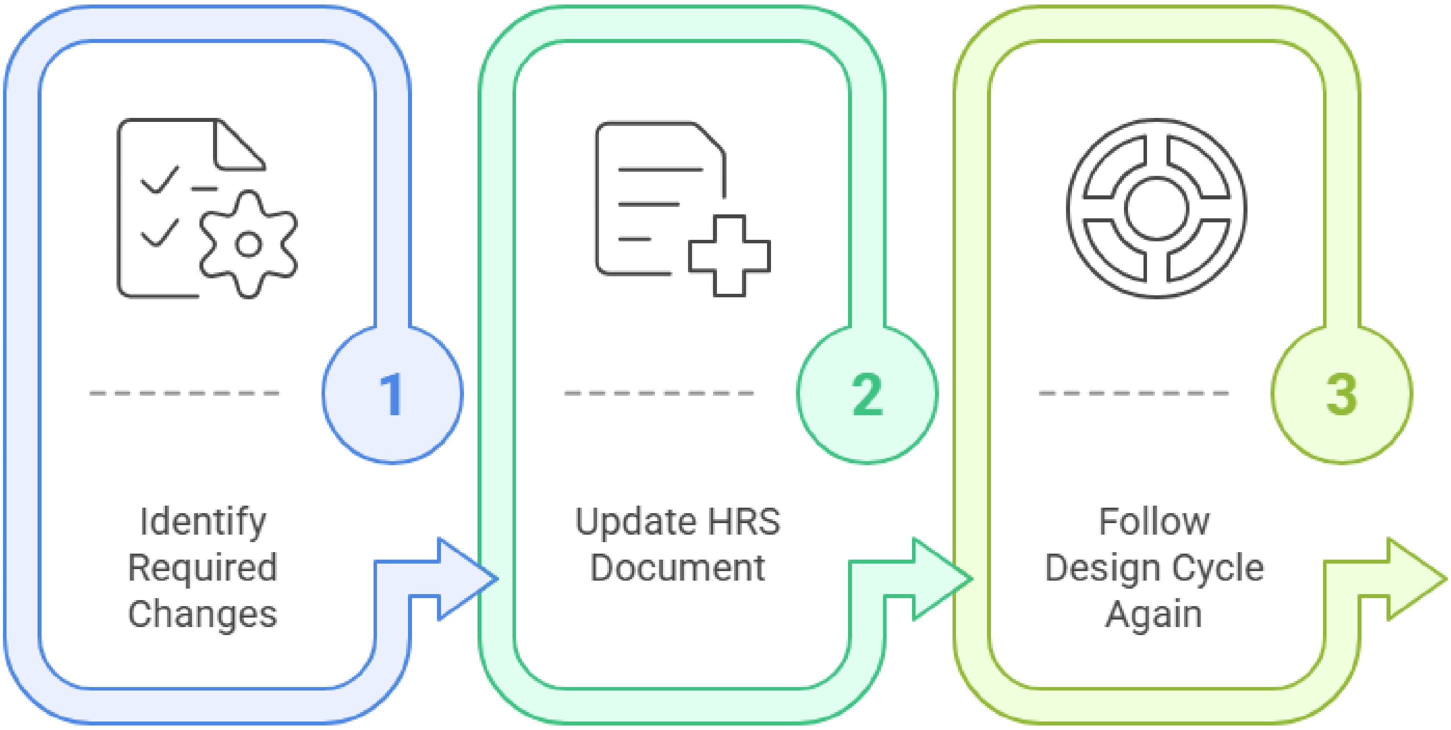
Log all test results in a formal prototype validation report with cross-references to requirement IDs.

STAGE 8: DESIGN REVISION & ITERATION

Purpose:

Refine the design based on field data, internal testing, and client feedback to improve robustness and manufacturability.

Revision Workflow:



Continuous Improvement Model:

Use ECO (Engineering Change Order) processes to manage updates cleanly and maintain traceability in multi-revision environments.

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