HOW TO MANAGE MANUFACTURING DEVIATIONS.

IDENTIFY • CONTAIN • ASSESS • AUTHORIZE • VERIFY ///

Control the change before the change controls the product.

BASELINE (RELEASED)



RELEASED PCB BASELINE
Approved design, BOM, process requirements and drawings.

NO SILENT CHANGES

PROPOSED / ACTUAL DEPARTURE



Change to design, process, material or specification.

MANUFACTURING DEVIATION

A controlled departure from a product, process or procurement requirement for a defined scope.

WHY FORMAL CONTROL MATTERS

1. **PROTECTS CONFIGURATION BASELINE**
   Maintains a trusted reference for what was approved.
2. **PREVENTS UNAPPROVED CAM, MATERIAL OR PROCESS CHANGES**
   Ensures changes follow the right path and approvals.
3. **ASSESSES RISK BEFORE SHIPMENT**
   Quality, reliability, schedule and cost impacts understood before decisions.
4. **PRESERVES WHAT WAS ACTUALLY BUILT**
   Accurate records enable traceability and learning.
5. **PREVENTS TEMPORARY EXCEPTIONS BECOMING PERMANENT**
   Time-box, review and re-validate or revert to baseline.
6. **SUPPORTS AUDITS, INVESTIGATIONS AND CORRECTIVE ACTION**
   Evidence-based decisions that drive improvement.

TERMINOLOGY AT A GLANCE

DEVIATION	NCR	CONCESSION	REWORK	REPAIR	USE-AS-IS	SCRAP	ENGINEERING CHANGE
Authorized departure from a requirement for a defined scope.	Requirement not fulfilled.	Authorized use of nonconforming product.	Returns product to full conformity to all original requirements.	Makes product usable but may not restore original conformity.	Accepts known condition with defined impact and controls.	Prevents unintended use of nonconforming product.	Formally revises the baseline (released data, documents).

THREE SITUATIONS, THREE DIFFERENT CONTROLS

1 NORMAL PROCESS ADJUSTMENT

Small, routine adjustments within approved limits.

- Within process window
- No impact on fit, form, function
- Managed by standard work/instructions

DOCUMENT AND MONITOR.

2 SUPPLIER-PROPOSED DFM CHANGE

Change to released data or process to improve manufacturability.

- Must be proposed and documented
- Requires formal evaluation
- Approval before implementation

DO NOT IMPLEMENT WITHOUT APPROVAL.

3 ACTUAL NONCONFORMANCE

Product already fails a requirement.

- Stop, contain and evaluate
- Record facts and impact
- Disposition with authorization

CONTROL AND CLOSE THE LOOP.

NO DEVIATION IS IMPLEMENTED MERELY BECAUSE THE SUPPLIER BELIEVES IT IS HARMLESS.

CONTAIN, DEFINE AND ASSESS.

STOP WORK • IDENTIFY SCOPE • COLLECT EVIDENCE • REVIEW RISK

1. **IDENTIFY** deviation/ proposed change
2. **STOP** affected work
3. **CONTAIN** boards, panels, lots
4. **CITE** exact requirement
5. **QUANTIFY** actual condition
6. **COLLECT** objective evidence
7. **ASSESS** technical and quality risk
8. **IDENTIFY** approval authority
9. **SELECT** disposition
10. **OBTAIN** written approval
11. **IMPLEMENT** exactly
12. **INSPECT / TEST**
13. **UPDATE** CoC / NCR / traveler
14. **CLOSE** corrective action and trend

IMMEDIATE CONTAINMENT

- **STOP SHIPMENT.** Do not release or ship any affected product.
- **SEGREGATE PHYSICAL PRODUCT.** Clearly label and segregate all affected boards, panels, and lots.
- **IDENTIFY WORK ORDERS / LOTS.** Record WO, lot number, quantity, location, process step, and operator.
- **ASSESS EARLIER SHIPMENTS.** Identify customer shipments and quantities already delivered.
- **FREEZE PROCESSING.** Hold at current step; do not continue processing or rework.
- **PRESERVE COUPONS / DATA.** Retain panels, coupons, photos, and process data for analysis.
- **NOTIFY ENGINEERING / QUALITY.** Escalate immediately per procedure.
- **BLOCK ERP / MES RELEASE.** Place holds to prevent movement or further processing.
- **RECORD TIME / PERSON.** Document when, by whom, and what was contained.

REQUIREMENT (THE STANDARD)

- **DRAWING & REVISION.** Refer to the latest released drawing and revision.
- **FABRICATION NOTE.** Applicable fabrication note and revision.
- **MANUFACTURING DATASET REVISION.** CAM, drill, etch, route files and revision level.
- **STACK-UP.** Layer build-up, material and thickness requirements.
- **PO CLAUSE.** Purchase order clause or special requirements.
- **IPC STANDARD / REVISION / CLASS / PARAGRAPH.** Exact IPC requirement and section.
- **CUSTOMER QUALITY SPECIFICATION.** Customer specification and revision.
- **APPROVED DFM & SUPPLIER QUALIFICATION CONDITION.** DFM guidelines and supplier qualification status at time of order.

ACTUAL CONDITION (THE FACTS)

- **SPECIFIED vs MEASURED VALUE.** Exact requirement compared to actual measurement.
- **AFFECTED QUANTITY.** How many boards/panels/lots are affected.
- **LOT / WORK ORDER / DATE CODE.** Traceability identifiers.
- **LAYER / FEATURE / LOCATION.** Where on the board and in which layer/feature.
- **PHOTOS / MICROGRAPHS.** High-resolution, scaled, and documented.
- **MICROSECTION.** Cross-section with measurements and callouts.
- **ET / IMPEDANCE / MATERIAL / PROCESS RECORDS.** Test data and process parameters.
- **ISOLATED OR SYSTEMIC.** Single event or recurring pattern.

RISK ASSESSMENT (CONSIDER ALL IMPACTS)



- **ELECTRICAL** Function, impedance, isolation, crosstalk
- **THERMAL** Heat dissipation, Tg, CTE mismatch
- **MATERIAL** Laminate, copper, resin, finish
- **COMPLIANCE** Regulatory, safety, environmental
- **MECHANICAL** Strength, stress, vibration, handling
- **RELIABILITY** Life, failure modes, field performance
- **MANUFACTURING MARGIN** Process capability, variation sensitivity
- **CONFIGURATION** Design intent, fit, form, function
- **TRACEABILITY** Data integrity, end-to-end trace
- **PROGRAMME / QUALIFICATION** Customer programme, qualification status

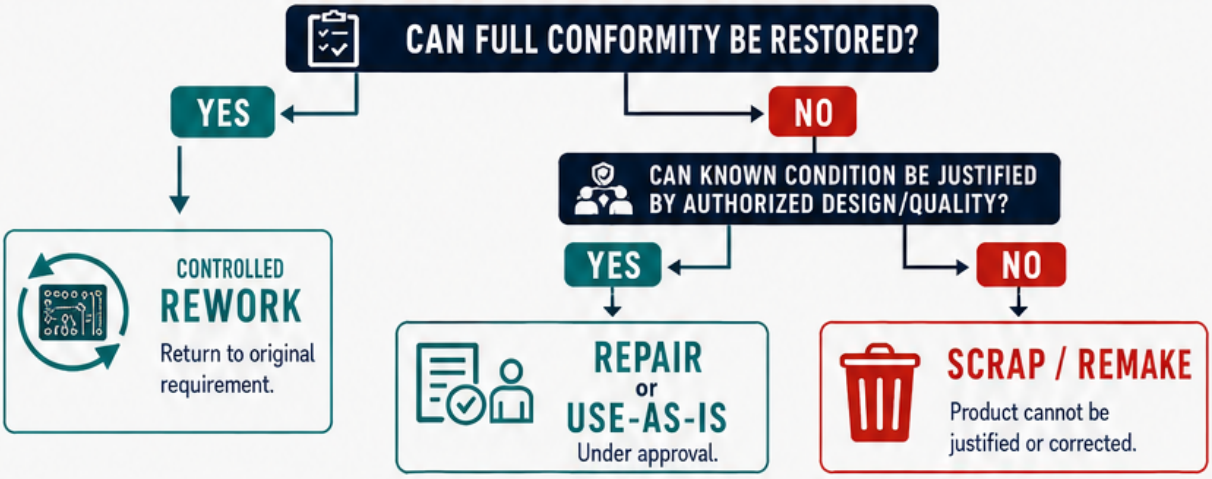
"THE BOARD STILL WORKS" IS NOT A HIGH-RELIABILITY RISK ASSESSMENT.

CONTAIN FIRST, DEBATE SECOND.

FACTS BEFORE OPINIONS.
DOCUMENT BEFORE DECISIONS.

CHOOSE THE CORRECT DISPOSITION.

REWORK • REPAIR • USE-AS-IS • SCRAP • REMAKE



REWORK

RETURNS TO ORIGINAL REQUIREMENT.

- Approved instruction or process.
- Extra exposure or intervention assessed for side effects.
- Reinspect/retest 100% as required by plan.
- Traceability and acceptance recorded.

REPAIR

MAKES PRODUCT USABLE BUT NOT NECESSARILY FULLY CONFORMING.

- Approved repair method.
- Evaluated for reliability impact.
- Customer or design authority where required.
- Post-repair evidence and disclosure.

USE-AS-IS / CONCESSION

REQUIREMENT REMAINS UNMET.

- Exact condition and rationale documented.
- Limited to specific lot/quantity.
- Usage restrictions and limitations defined.
- Authorized approval obtained.
- Referenced in shipment records.
- Does not change future drawing automatically.

SCRAP / REMAKE

WHEN RISK CANNOT BE JUSTIFIED OR CONFORMITY RESTORED.

- Physically control scrap to prevent unintended use.
- Preserve analysis samples as required.
- Correct process before remake.

APPROVAL AUTHORITY MATRIX – WHO CAN AUTHORIZE?

SITUATION	EXAMPLES	TYPICAL AUTHORITY
PROCESS SETTING WITHIN APPROVED WINDOW	Laminate cycle time, drill speed, plating current within limits	SUPPLIER MANUFACTURING / QUALITY
NONCRITICAL DFM FEATURE	Nonfunctional copper balancing, fiducial count, tooling marks	PCB / DESIGN ENGINEERING
IMPEDANCE / GEOMETRY FEATURE	Trace width/spacing within impedance tolerance, length match	PCB + SI / DESIGN AUTHORITY
MATERIAL SUBSTITUTION	Laminate, prepreg, copper foil substitution	MATERIALS / PCB ENGINEERING + CUSTOMER QUALITY (AS REQUIRED)
IPC ACCEPTANCE DEPARTURE, REPAIR OR USE-AS-IS	IPC-6012 / 6013 acceptance, use-as-is concession	AUTHORIZED MRB / DESIGN / CUSTOMER AUTHORITY
SITE / SOURCE CHANGE	New supplier, alternate site, new equipment line	SUPPLY CHAIN + QUALITY + ENGINEERING / REQUALIFICATION

DISPOSITION = WHAT HAPPENS TO THIS PRODUCT.

≠

CORRECTIVE ACTION = WHY IT HAPPENED AND HOW RECURRENCE IS PREVENTED.

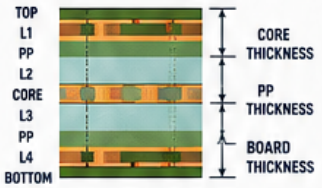
SCHEDULE PRESSURE NEVER JUSTIFIES AN UNSAFE DISPOSITION.

ASSESS PCB-SPECIFIC DEVIATIONS.

STACK-UP • MATERIAL • IMPEDANCE • VIAS • FINISH

Every deviation must be reviewed, measured, and approved.

1 STACK-UP CHANGE



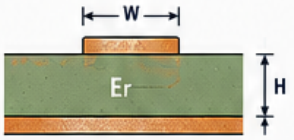
- Core / prepreg thickness
- Board thickness (finished)
- Glass style / material family
- Dk / Df at frequency
- Impedance recalculation
- Resin fill content
- Aspect ratio (lamination)
- Dielectric spacing
- Sequential lamination impact
- Approved revision level

2 MATERIAL SUBSTITUTION



- Exact manufacturer / grade
- Tg (DSC) / Td
- Z-axis CTE
- Dk / Df at frequency
- Moisture absorption
- CAF resistance
- UL recognition
- Reflow compatibility
- Matching prepregs / cores
- Prior qualification data
- Impact on signal loss

3 CONTROLLED IMPEDANCE



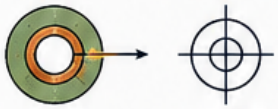
- Required value / tolerance
- Original geometry (W/H)
- Proposed geometry (W/H)
- Actual dielectric (Er)
- Model used & assumptions
- Coupon correlation data
- Production measurement
- SI / crosstalk review
- Design approval before copper change

4 HOLE / VIA



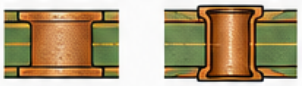
- Finished hole vs production drill
- Aspect ratio (depth / dia.)
- Plating allowance
- Annular ring (min / target)
- Press-fit / interference
- Backdrill (depth / method)
- Current / thermal rating
- Microsection verification
- Assembly fit (connectors, pins)
- Impact to IPC Class 3 product

5 ANNULAR RING / REGISTRATION



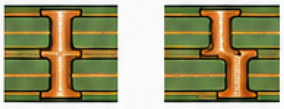
- Layer / feature location
- Remaining land / breakout
- Acceptance criteria (min / target)
- Drill-to-copper and layer trend
- Isolated vs systemic issue
- Plating connection integrity
- Process capability / margin

6 COPPER THICKNESS / PLATING



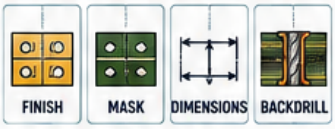
- Base copper (weight / thickness)
- Finished copper PTH (min / target)
- Finished copper surface (min / target)
- Local vs average thickness
- HAR distribution & uniformity
- Current capacity & reliability impact
- Representative microsection
- Plating bath control records

7 MICROVIAS



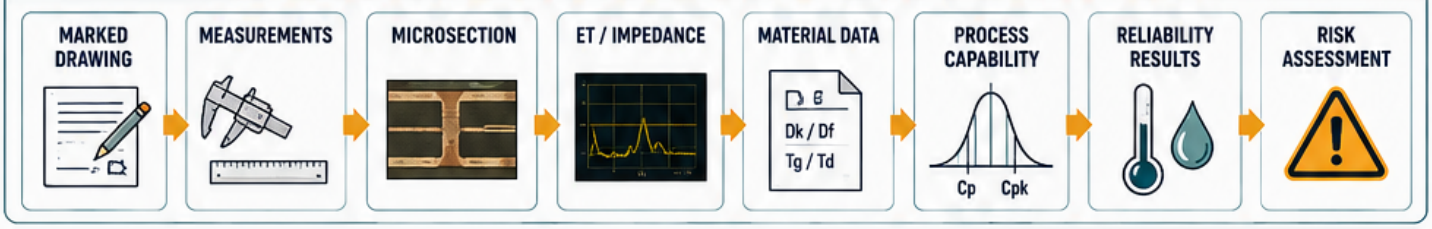
- Diameter / depth (target / capture)
- Stacked vs staggered
- Target / capture geometry
- Via fill (filled / capped / tented)
- Interface plating integrity
- Lamination cycle compatibility
- Microsection verification
- Thermal / reliability evidence
- Qualified HDI process scope

8 SURFACE FINISH / MASK / DIMENSIONS / BACKDRILL



- Finish type / thickness and functional interface
- Mask registration / web / creepage
- Board thickness / profile / slots / bow
- Target layer for backdrill
- Residual stub (min / target)
- Backdrill depth tolerance
- Registration checks
- SI verification after backdrill

EVIDENCE REQUIREMENTS — COLLECT AND REVIEW BEFORE APPROVAL.



"EQUIVALENT" MATERIAL OR "STANDARD FACTORY CHANGE" IS NOT TECHNICAL APPROVAL.

CONTROL THE RECORD AND PREVENT RECURRENCE.

APPROVAL • CONFIGURATION • COC • CORRECTIVE ACTION • TRENDING

EXPLICIT APPROVAL RECORD

- **DEVIATION ID** — Unique identifier for traceability.
- **PART / REVISION** — Exact part number and revision.
- **PO / LOT / QUANTITY** — Purchase order, lot number and quantity impacted.
- **EXACT REQUIREMENT** — Cited drawing, specification or standard.
- **ACTUAL CONDITION** — Observed condition and measured results.
- **SUPPORTING EVIDENCE** — Photos, reports, measurements, test data.
- **DISPOSITION** — Use as-is, rework, sort, scrap or other.
- **LIMITATIONS / CONDITIONS** — How and where the product may be used.
- **ONE-TIME OR PERMANENT** — Indicate one-time concession or permanent change.
- **REQUIRED INSPECTION / TEST** — Additional inspection, testing or 100% screen as required.
- **APPROVER NAME / FUNCTION / DATE** — Qualified approver with role and date.
- **DOCUMENT CHANGES** — All document or record updates required.

TEMPORARY DEVIATION

- Defined lot, quantity and time scope.
- Requirement remains unchanged.
- Future lots must revert to requirement.
- Exception record with explicit approval.

VS

PERMANENT ENGINEERING CHANGE

- Changes the product definition.
- New revision baseline established.
- Future lots follow ECN / ECO.
- Controlled design update.

CONFIGURATION CONTROL FLOW

TEMPORARY (ONE-TIME) DEPARTURE PATH

RELEASED BASELINE (Requirement) → APPROVED LOT-SPECIFIC DEPARTURE (Concession) → AS-BUILT RECORD / CoC (Disposition, Evidence, Limits, Tests) → ONE TIME ONLY — Future lots revert to baseline requirement.

PERMANENT CHANGE PATH

RELEASED BASELINE (Requirement) → ECN / ECO (Change Control Process) → NEW RELEASED BASELINE (New Revision) → PERMANENT CHANGE — Future lots follow new revision.

CERTIFICATE OF CONFORMANCE (CoC) MUST

- State exact part number, revision and lot.
- Include concession ID where required.
- Include statement consistent with disposition.
- Reference all applicable NCRs (retrievable).
- Confirm no carryover to future lots.
- Disclose repair or rework where required.

CORRECTIVE ACTION FLOW

CONTAIN → DEFINE → OCCURRENCE ROOT CAUSE → ESCAPE ROOT CAUSE → SYSTEMIC CONTRIBUTORS → ACTION → VERIFY EFFECTIVENESS → REVIEW SIMILAR PRODUCTS

WEAK VS STRONG RESPONSE

WEAK (SYMPTOM ONLY)
Operator error / retrained.
No objective evidence of effectiveness.

STRONG (SYSTEM SOLUTION)
- ✓ System change prevents recurrence.
- ✓ Objective effectiveness evidence provided (data, metrics, audit).

DEVIATION LOG FIELDS

SUPPLIER	Supplier name and location.
CATEGORY	Plating, drilling, lamination, finish, etc.
REPEATED PART FAMILY	Part family / platform identified.
UNAUTHORIZED VS APPROVED-BEFORE-BUILD	Unauthorized deviation or approved concession before build.
MATERIAL SUBSTITUTIONS	Material changes, supplier, grade.
IMPEDANCE / PLATING / REGISTRATION	Technical performance categories.
CUSTOMER ESCAPES	Escaped to customer (Yes/No, details).
APPROVAL TURNAROUND	Time from submission to approval.
RECURRENCE INDICATOR	Repeat deviation (Yes/No, count).

TREND DASHBOARD (WHAT TO WATCH)

- TOTAL DEVIATIONS (# per period) — ↓
- REPEAT DEVIATIONS (% of total) — ↑
- CUSTOMER ESCAPES (# per period) — ↑
- MATERIAL SUBSTITUTIONS (% of total) — –
- APPROVAL TURNAROUND (Avg days) — –
- RECURRENCE RATE (% within 90 days) — ↑

SUPPLIER-STATUS IMPACT LADDER

1. **MONITOR** — Meets expectations. Continue standard oversight.
2. **CAPABILITY-MARGIN REVIEW** — Minor issues or tight margins. Review capability and plans.
3. **CORRECTIVE ACTION / INCREASED INSPECTION** — Issues identified. CAPA required. Increase oversight and inspection.
4. **RESTRICT** — Performance not acceptable. Restrict new business / volume.
5. **SUSPEND / REQUALIFY** — Severe or repeated issues. Suspend until requalified.

A ONE-LOT CONCESSION MUST NEVER BECOME THE SUPPLIER'S NEW STANDARD PROCESS.

CONTROL EVERY DEPARTURE BEFORE RELEASE.

MANAGED WORKFLOW • REVIEW CHECKLIST • RED FLAGS • FINAL CONTROL

THE NOVATRONIC MANAGED DEVIATION CONTROL MODEL

1. **MANUFACTURER** — raises DFM/ deviation before implementation.
2. **NOVATRONIC** — checks completeness and evidence.
3. **CLASSIFY** — process-only / DFM change / nonconformance / supplier change.
4. **PCB MANUFACTURING RISK REVIEW** — assess impact to function, yield, reliability, cost and schedule.
5. **CUSTOMER / DESIGN AUTHORITY** — receives focused decision package with facts and recommendation.
6. **APPROVE / REJECT** — decision and conditions are documented.
7. **MANUFACTURER** — implements exact disposition as authorized.
8. **EVIDENCE VERIFIED** — before shipment or release.
9. **LINK TO CoC AND LOT** — deviation linked to Certificate of Conformance and lot record.
10. **SUPPLIER HISTORY** — add event to supplier history. Recurring events trigger CAR or qualification review.

DEVIATION REVIEW CHECKLIST

1	Deviation ID / Reference	☐
2	Supplier / Site	☐
3	Part Number / Revision Level	☐
4	Purchase Order / Lot / Quantity	☐
5	Exact Requirement (spec, drawing, IPC, contract)	☐
6	Actual Condition (quantified)	☐
7	Evidence Attached (photos, reports, data)	☐
8	Scope Contained (lot, panels, areas)	☐
9	Previous Shipments Assessed (same condition? impact?)	☐
10	Impact Assessment Completed Electrical ☐ Mechanical ☐ Reliability ☐ Material ☐ Compliance ☐ Configuration ☐ Qualification ☐	
11	Proposed Disposition (rework, use-as-is, concession, scrap)	☐
12	Decision Authority (name / role / company)	☐
13	Customer / Design Authority Approval	☐
14	Controlled Rework / Repair Instructions (if any)	☐
15	Verification / Test Plan and Results	☐
16	Certificate of Conformance Updated	☐
17	Corrective Action Required (CAR / Preventive Action)	☐
18	Deviation Logged (system / log) and AVL / Scorecard Updated	☐
	Retention Period Confirmed	☐

No deviation is complete without documented approval, verification, linkage to the lot and retention.

RED FLAGS — DO NOT ACCEPT

1. Already changed because "it is our factory standard."
2. "Equivalent" material used — no approval needed.
3. Automatic impedance / trace adjustment without notification.
4. Electrical test used to dismiss a plating / finish issue.
5. "We will update the drawing after shipment."
6. Cosmetic claim without evidence or quantified impact.
7. "Class 3 allows it" — requirement not verified.
8. No lot / quantity identified or scope not defined.
9. Blanket permanent approval after only one production run.
10. Repeated concessions on the same requirement.
11. NCR issued without root cause or corrective action.
12. Certificate of Conformance that hides a known exception.

INCOMING INSPECTION AFTER APPROVED DEVIATION

- ✓ Lot and quantity match the approved deviation.
- ✓ Required rework / test complete and recorded.
- ✓ Board markings / date code verified.
- ✓ CoC reference and deviation ID present.
- ✓ Affected characteristic inspected or tested per approval.
- ✓ No additional, unapproved departures.
- ✓ Deviation record archived with receiving record.

THE FINAL CONTROL PRINCIPLE — FIVE PARTS, ONE STANDARD

1. **IDENTIFY EXACTLY** — Define the exact requirement and the actual condition. No assumptions.
2. **CONTAIN COMPLETELY** — Limit scope to what is affected. Stop spread. Protect the customer and the process.
3. **ASSESS OBJECTIVELY** — Evaluate risk to function, yield, reliability, cost and delivery.
4. **AUTHORIZE CORRECTLY** — Obtain the right authority. Document the decision and any conditions clearly.
5. **VERIFY AND RETAIN** — Verify results. Link to CoC and lot. Retain records for the required period.

NO SILENT CHANGES — EVERY CONTROLLED DEPARTURE IS TRACEABLE TO AUTHORITY, LOT AND EVIDENCE.