PRODUCTION · RAMP · PILOT · MP · REFERENCE DOCUMENT · PUBLIC

Production ramp-up plan

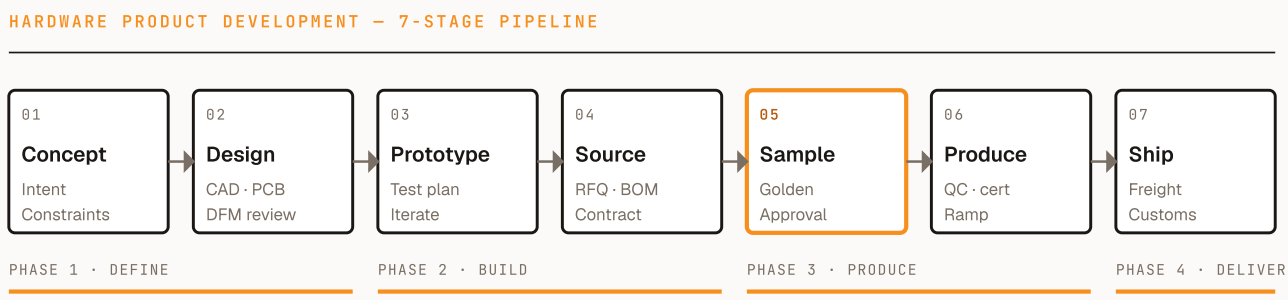
Reference for transitioning from pilot to mass production — yield ramp curves, gate criteria, operator training, capacity planning, and the milestones that signal readiness for full-volume production.

REVISION	ISSUED	OWNER	COMPANION
1.0	May 2026	Ideambox engineering	PDF reference

ABSTRACT

Production ramp-up is the planned transition from low-volume pilot (50–500 units) to mass production (10 000+ units). Done well, yield ramps from 70 % to 95 % over 4–8 weeks, defect rates drop, and unit cost stabilises. Done poorly, yield stays low, schedule slips, and the first 3–6 months of production lose money.

Section 1 covers pilot-to-MP gate criteria. Section 2 covers yield ramp targets. Section 3 covers operator training and line balancing. Section 4 covers capacity planning. Section 5 covers production process documentation. Section 6 covers risk management during ramp.



THE RAMP-UP SITS BETWEEN PHASE 3 (SAMPLE / PILOT) AND PHASE 4 (PRODUCTION). GET IT RIGHT AND YIELD RAMPS CLEANLY; GET IT WRONG AND THE FIRST 3 MONTHS OF PRODUCTION ARE UNPROFITABLE.

CONTENTS

1. Pilot-to-MP gate criteria

Before scaling production from 100 to 10 000 units/week, the project must meet specific gate criteria. Below these thresholds, the line is not ready for MP.

1.1 Gate criteria checklist

- **[ ] First-pass yield ≥ 90 % in pilot run.**
- **[ ] All critical dimensions at Cp/Cpk ≥ 1.33 on production samples.**
- **[ ] All known defects catalogued in QC plan with severity classification.**
- **[ ] Standard Operating Procedures (SOPs) written for every station.**
- **[ ] Operators trained and qualified for their assigned stations.**
- **[ ] Production test fixtures validated**
  same fixture catches same defects across batches.
- **[ ] BoM and Spec sheet revisions locked at production version.**
- **[ ] All compliance certificates issued (CE, FCC, etc.).**
- **[ ] Material allocation secured**
  Critical components have safety stock + lead-time visibility.
- **[ ] Logistics + customs plan confirmed.**
- **[ ] Rework path defined for each defect type.**
- **[ ] End-of-line audit process in place (FQC).**
- **[ ] First-pass-yield (FPY) target agreed with supplier as contract metric.**

1.2 Pilot production batch sizes

STAGE	QUANTITY	PURPOSE
Engineering Sample (ES)	5–10	Process feasibility check
Pre-Production Sample (PPS)	20–50	Full process verification
Pre-Production Run (PPR)	100–500	Yield + cycle time baseline
Pilot production	500–2 000	Operator training, fixture validation
Ramp 1 (initial MP)	2 000–5 000	First commercial batch
Ramp 2 (steady-state MP)	5 000+ per week	Full production volume

1.3 Risk-based gate exceptions

Some products may pass MP gate with first-pass yield <90 %, if:

- **Defects are recoverable at rework station with known fix time.**
- **Yield improvement plan in writing**
  Specific actions + timeline to reach 90 %.
- **Buyer accepts the risk financially**
  Higher unit cost during ramp.

This must be a deliberate choice, not a default.

2. Yield ramp curve

First-pass yield improves predictably as the line stabilises. Track and forecast it explicitly.

2.1 Typical yield ramp (consumer hardware)

PRODUCTION BATCH	CUMULATIVE UNITS	FIRST-PASS YIELD	DEFECT RATE
1 (pilot)	0–500	65–75 %	25–35 %
2–3 (early ramp)	500–5k	75–85 %	15–25 %
4–8 (mid ramp)	5k–20k	85–92 %	8–15 %
9–15 (late ramp)	20k–50k	92–96 %	4–8 %
16+ (steady state)	50k+	95–98 %	2–5 %

2.2 Yield improvement levers

LEVER	TYPICAL GAIN	TIME TO APPLY
Operator skill (per shift)	+2–5 %	1 week
Fixture refinement	+3–7 %	2–3 weeks
Process parameter tuning	+2–4 %	1–2 weeks
Component variability reduction	+1–3 %	2–4 weeks
Tooling refinement	+2–8 %	4–8 weeks
Design change (ECN)	+5–15 %	6–12 weeks
Material substitution	+1–5 %	2–6 weeks

2.3 Common yield killers

DEFECT	CAUSE	FIX
Solder bridges (PCBA)	Stencil aperture too large	Reduce paste volume; adjust aperture
Tombstoning	Reflow profile asymmetry	Adjust profile; balance pad design
Component misalignment	Pick-and-place feeder issues	Adjust feeder positioning; clean nozzle
Surface defects (plastic)	Mold contamination; wear	Clean mold; refurbish
Mis-aligned screws	Torque setting; tool wear	Re-calibrate; replace driver
Connector damage	Operator force; tool fit	Adjust insertion path; train operator
Foreign material in pack	Loose particles in line	Improve cleanliness protocol

3. Operator training + line balance

The production line is human + machine. Training and balance determine throughput.

3.1 Operator skill curve

First-week operators perform at 40–60 % of experienced operator productivity. Productivity reaches 90 %+ at 2–3 weeks. Don't ramp on first-week operators.

3.2 Training stages

STAGE	DURATION	ACTIVITIES
Familiarisation	1 day	Walk through line; understand the product
Single-station training	2–3 days	Master one station
Quality awareness	1 day	Defect identification, SOP compliance
Cross-station rotation	3–5 days	Learn 2–3 adjacent stations
Certification	1 day	Demonstrate proficiency to QA lead
Continuous improvement	Ongoing	Kaizen suggestions, defect feedback

3.3 Line balancing

Each station's cycle time should be close to the line's bottleneck. If station A takes 60 s and station B takes 30 s, B is starved 50 % of the time.

CYCLE TIME ISSUE	SYMPTOM	FIX
Bottleneck at one station	Other stations idle	Add operator, automate, simplify
Cycle time imbalance	Throughput < capacity	Rebalance, redistribute tasks
WIP buildup	Inventory between stations	Pull system, takt-time discipline
Operator fatigue	Late-shift quality drop	Job rotation, breaks, shorter shifts

3.4 Cycle time + takt time

- **Cycle time**
  Time for one operator to complete their station task.
- **Takt time**
  Customer demand interval (working hours / units required).
- **Goal**
  Each station's cycle time ≤ takt time.

Example: 50 units/hour demand → takt time = 72 s. Each station must complete in ≤ 72 s.

3.5 Standard Operating Procedure (SOP)

One SOP per station. Includes:

- **Task description**
  What to do, in plain language.
- **Tools used**
  List of tools per task.

- **Visual aids**
  Photos at each step.
- **Quality check**
  What to verify before moving to next station.
- **Quality issues**
  Common defects, how to recognise.
- **Cycle time target**
  Expected duration per task.
- **Sign-off block**
  Operator and QA lead initial when complete.

4. Capacity planning

How fast can the line scale? What's the volume ramp from week 1 to week 12?

4.1 Line capacity formula

``` Daily capacity = Working hours × shifts × stations × units/station-hour ÷ (1 + reject rate) × OEE (Overall Equipment Effectiveness, typically 0.75-0.90)

Weekly capacity = Daily capacity × working days (typically 5-6) ```

Example: 1 line, 1 shift × 8 hours, 10 stations × 30 units/hour, 5 % reject, 0.85 OEE:

- **Hourly: 300 units / 1.05 × 0.85 = 243 units**
- **Daily: 1 944 units**
- **Weekly: 9 720 units**

## 4.2 Capacity ramp

| WEEK | HOURS/DAY | SHIFTS | LINES | ESTIMATED WEEKLY CAPACITY |
|---|---|---|---|---|
| **1 (pilot)** | 4 | 1 | 1 | 2 000 |
| **2** | 6 | 1 | 1 | 4 000 |
| **3-4** | 8 | 1 | 1 | 8 000 |
| **5-8** | 8 | 1 | 2 | 16 000 |
| **9-12 (steady)** | 8 | 2 | 2 | 30 000 |

Plan ramp on the supplier side. Capacity is often the bottleneck during early production.

## 4.3 Component supply during ramp

Material supply must lead production by safety stock buffer + lead time:

- **Week 1 production**
  Materials ordered 8–12 weeks earlier.
- **Re-order point**
  Materials triggered when stock falls below (weekly demand × supplier lead time × 1.5 safety factor).
- **Critical components**
  Higher safety stock (4–8 weeks) for single-source items.
```

5. Production process documentation

The line generates documentation; the documentation supports the line.

5.1 Documents on the production floor

- **SOPs per station**
  Visible at workstation; updated when process changes.
- **Quality plan**
  AQL, inspection points, defect catalogue with photos.
- **Bill of materials**
  Posted at each station for verification.
- **Defect log**
  Per-shift, per-station defect counts.
- **Visual standards**
  Boards showing good/bad examples at cosmetic stations.
- **First-article inspection report**
  One unit per shift start, verified against spec.

5.2 Trend monitoring

- **Daily yield reports**
  First-pass yield + reject rate + defect breakdown.
- **Weekly trend**
  Yield trajectory, recurring defects, process drift signals.
- **Cp/Cpk tracking**
  Critical dimensions trended over time.
- **Operator performance**
  Per-operator productivity + defect attribution.

5.3 Process change control

CHANGE TYPE	OWNER	APPROVAL
Tooling adjustment (within spec)	Production supervisor	Floor approval
Process parameter change	Process engineer	QA + Engineering
Material substitution	Engineering	ECN + sign-off
Design change	Engineering	Full ECN process
SOP revision	Production supervisor	QA review

6. Risk management during ramp

The first 4–8 weeks of production carry the highest risk. Plan for surprises.

6.1 Common ramp risks

Supply-side

- **Component shortage (allocation)**
- **Quality drift in materials**
- **Tooling failure or wear**
- **Supplier scheduling conflicts**
- **Currency / cost fluctuation**

Production-side

- **Operator skill gap**
- **Fixture wear or failure**
- **Process parameter drift**
- **Defect identification gaps**
- **Capacity bottleneck unforeseen**

6.2 Risk mitigation tactics

RISK	MITIGATION
Component shortage	Safety stock 4–8 weeks, dual-source critical parts
Tooling failure	Spare tooling on standby; refurbishment plan
Operator turnover	Cross-training; documented SOPs
Quality drift	Daily Cp/Cpk monitoring; intervention triggers
Capacity shortfall	Second shift availability; outsourcing backup
Customs / shipping delay	Buffer stock at destination; alternative ports

6.3 Daily standup during ramp

A short morning meeting catches problems before they propagate:

- **Yesterday's actual production vs. target**
- **Defect breakdown by station and type**
- **Open issues from production floor**
- **Risk indicators (material levels, fixture status, operator gaps)**
- **Today's plan + adjustments**

6.4 Escalation criteria

Issues that warrant immediate escalation:

- **First-pass yield drops below 75 %**
- **Single defect type accounts for >50 % of defects**
- **Critical component shortage (less than 2 weeks of supply)**
- **Tooling damage requiring repair**
- **Compliance-relevant defect (mis-marked, mis-labelled)**

> FINAL NOTE. production ramp-up is the discipline of converting a known-working prototype into a known-working production batch. The first batch of any new product is the hardest; subsequent batches benefit from accumulated learning. Document everything, observe trends, and intervene early. Yield ramps on engineering discipline, not on hope.