2. System Overview

Hardware manual

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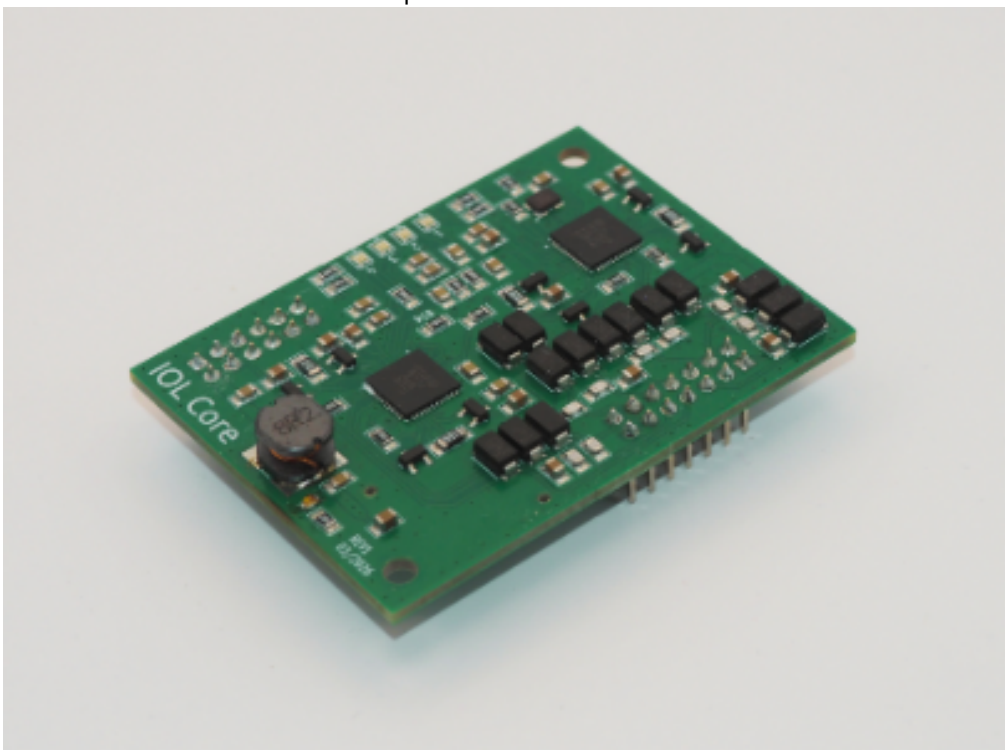


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2. System Overview

2.1 What is OEE?

OEE (Overall Equipment Effectiveness) is the industry-standard metric for how effectively a production line is used. It is the product of three factors:

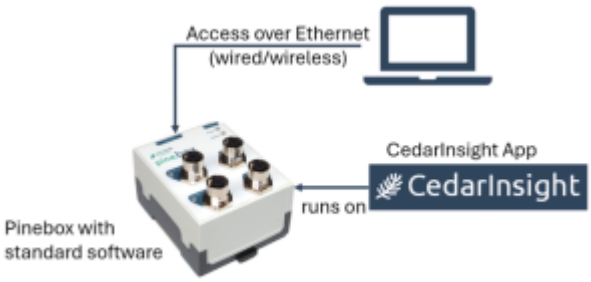
Factor	Question answered	Losses captured
Availability	Did the line run when it should have?	Unplanned downtime (breakdowns, faults)
Performance	Did it run at full speed?	Slow cycles, minor stops
Quality	Did it produce good parts?	Scrap, rejects

```
OEE = Availability × Performance × Quality
```

An OEE of 100% means: producing only good parts, at maximum speed, with no unplanned stops. World-class discrete manufacturing is typically considered to be around 85%.

Pinetek Insight computes these factors automatically from the counter signals of your line; the exact formulas are documented in chapter 10. OEE Calculation Reference.

2.2 System architecture at a glance



2.2.1 Pinetek Insight application

Pinetek Insight runs as an app on the Pinebox. It consists of:

- a backend (data acquisition, state machine, database, report generation), and
- a web interface served on port `8000`. No client installation is needed; any modern browser on connected network can access it at http://<device-ip>:8000. See the connection option in the Pinebox manual: Pinebox Manual, Configuration Update [PBX].

Production data is stored in a MariaDB database on the device itself. Normal operation has no cloud dependency. Data leaves the device only where explicitly configured: backups (chapter 9.3), e-mailed reports (chapter 8) and the AI Assistant (chapter 6.5).

2.2.2 Pinebox as data source [PBX]

The Pinebox standard software (running in parallel to the **Pinetek Insight** app) is the field-level data acquisition source. It connects to the IO-Link machine sensors and makes the acquired signals available to **Pinetek Insight** in two ways:

- **Polled services**: the Pinebox exposes counters, timers and cycles as simple network services; **Pinetek Insight** reads them cyclically.

- **Pushed values**: process sensor values are sent *by* the Pinebox side *to* **Pinetek Insight**'s data interface.

Signal	Interface	Used by Pinetek Insight for
Piece counters	polled from Pinebox `/counter/values`	Production quantities, state detection, throughput per stage
Takt timers	polled from Pinebox `/timer/values`	Takt/cycle-time monitoring
Machine cycles (energy-based)	polled from Pinebox `/cycles`	Cycle stations: cycle duration, energy, stall detection
Process sensors	pushed to the **Pinetek Insight** API	Additional analogue/process values (temperature, pressure, speed, ...)



Using more than 4 sensor inputs In the standard single-device installation the Pinebox services run on the same host as **Pinetek Insight** and are reached at `localhost:18080`; a Pinebox can equally be addressed by its IP on the plant network. Multiple Pinebox devices can be used; each counter, takt source and cycle station stores its own host/port. The “external” Pineboxes are standard devices without the **Pinetek Insight** app running.

The details for integrating additional Pinebox devices are described in chapter 11.

How the signals are wired and configured on the device side is described in the Pinebox Manual [PBX]. Chapter 11 of this manual describes exactly which Pinebox services **Pinetek Insight** consumes.

2.2.3 Data flow

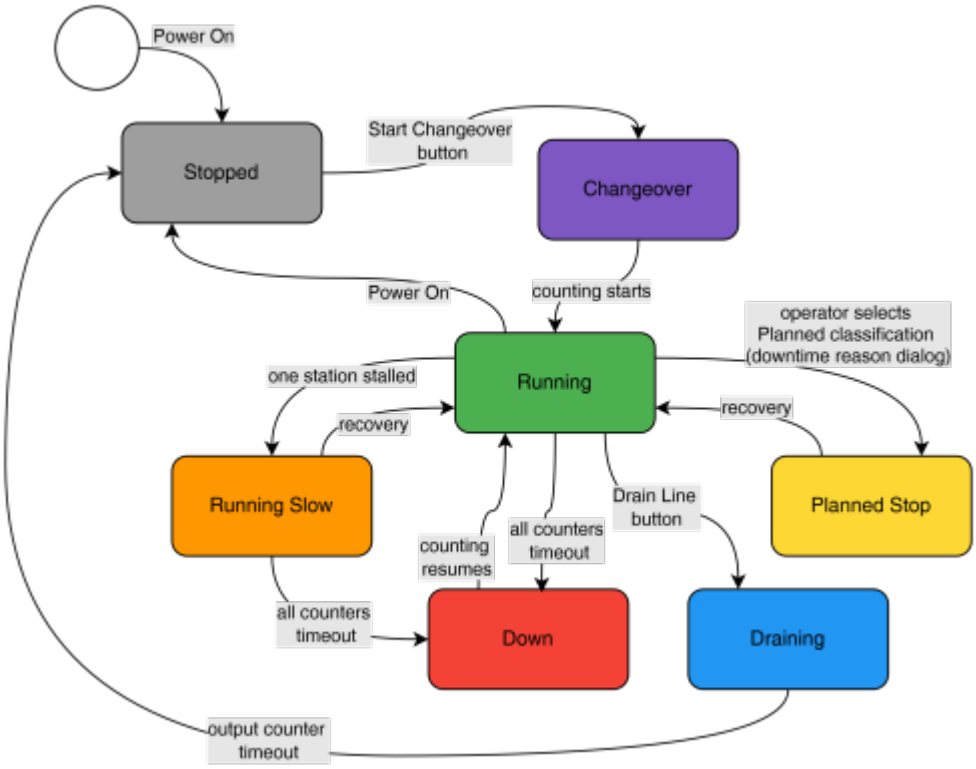
1. The Pinebox counts parts at each process stage and measures timers/cycles. [PBX]
2. **Pinetek Insight** polls the counter values cyclically (see chapter 11).
3. The state machine compares current with previous values, detects activity and timeouts, and derives the production state.
4. Every state change is written to the database as a state event; counter readings are stored as time series.
5. When a production run ends, **Pinetek Insight** computes and stores the run's OEE figures.
6. The analysis views, the AI Assistant and the report engine all read from this database.

2.3 The production state model

2.3.1 States

The line is always in exactly one of seven states:

State	Meaning
Stopped	No production run active
Changeover	Product change / setup in progress; run is prepared
Running	Production run active, counters advancing normally
Running Slow	Run active, but throughput below expectation
Down	Unplanned stop; counters stopped unexpectedly
Planned Stop	Deliberate pause (break, planned maintenance)
Draining	Input stopped, line runs empty before the run ends (no bottleneck detection)



2.3.2 How counter signals drive state transitions

Pinetek Insight derives states from the movement of the stage counters [PBX]:

- **Changeover → Running**: production starts when a product is selected and counting begins.
- **Running → Down**: a stage counter stops advancing for longer than its configured **timeout** (see *Line Config → Program → Stages*, chapter 7.1) → planned/unplanned stop. The state is set by the operator. When counting resumes, the state returns to **Running** automatically.
- **Running → Running Slow**: throughput falls below the expected rate without stopping completely (one station stalls minimum)
- **Running → Draining**: triggered manually; the input stage is expected to stop while the rest of the line runs empty. When the output counter times out, the run ends and the state becomes **Stopped**.
- **Stopped**: ending the run (manually or after draining) always returns to Stopped.

Every period spent in **Down** must be justified with a downtime reason (chapter 5.4). Time in **Planned Stop** counts as planned downtime and does not reduce Availability.

2.3.3 State events

Each contiguous period in a state is stored as one state event with start, end and duration. State events are the basis for the shift timeline (chapter 5.2), the state distribution and downtime analyses (chapter 6) and the Availability calculation (chapter 10).

2.4 Key concepts and terms

Term	Meaning
Program	A line configuration: the set of process stages, their counters, sensors, takt sources and detection parameters. Typically one program per line layout or product family.
Product	An article produced with a program. Carries part number and ideal cycle time. Several products can share one program.

Term	Meaning
Production run	One continuous production of one product: from changeover/start to run end. OEE is calculated per run.
Process stage	One counting point in the line (e.g. filler, capper, packer). Each stage has a role: *Input*, *Output*, *Defect/Reject* or *Intermediate*.
Counter	A piece counter acquired by the Pinebox and mapped to a stage. [PBX]
Takt	Cycle-time measurement from a Pinebox timer. [PBX]
Cycle station	A machine monitored via energy-based cycle detection (power rise/fall), e.g. a press or moulding machine. [PBX]
Sensor	A process value (temperature, pressure, …) pushed into **Pinetek Insight**. [PBX]
Downtime reason	Category + reason assigned to a Down period, from the catalogue configured in chapter 7.7.
Units in / Units out	Parts entering the line (input stage) / good parts leaving the line (output stage).
Target quantity	The planned quantity for a run, entered at changeover.

A full glossary is provided in Appendix A.