

Tap Density

Embedded Linux

Raspberry Pi 5

Touchscreen GUI

Hardware Control Backend

Automated Report Generation

Audit & Compliance

CLIENT

A Mumbai-based supplier of precision pharmaceutical and laboratory equipment, serving major pharma companies across India and internationally. They required a complete embedded control and reporting system for their tap density instrument, supplied in two variants: a standard version and an advanced audit-compliant version for regulated environments.

THE PROBLEM

Tapped density is a fundamental characterisation parameter for pharmaceutical powders and granules. It describes how a powder consolidates under mechanical tapping — a graduated cylinder is filled with the sample, tapped a defined number of times, and the volume reduction is used to calculate tapped density along with derived flowability indices: Hausner ratio and Carr's compressibility index. These values tell formulation scientists how a powder will behave during mixing, filling, and compression, and the result needs to be documented as part of the batch record. The client's instrument needed more than a motor that counts taps — it needed to run the test to a defined method, record the readings, derive all calculations automatically, and store every result with full traceability.

WHAT WE BUILT

We built the backend and the frontend for the instrument. The backend drives the tapping mechanism to the exact tap count and rate defined in the method, monitors the run in real time, and signals completion to the application. The frontend runs on a Raspberry Pi 5 with a 7-inch industrial touchscreen and takes the operator from method selection through to a finished, printed test report — with the reporting engine automatically calculating bulk density, tapped density, Hausner ratio, and Carr's index from the operator's initial and final volume readings. Operators save standard test configurations as named methods, so repeat tests on the same powder require no re-entry of parameters. Every test is stored as a searchable record with the operator identity and full timestamp, printable or exportable directly from the instrument without a separate PC. A complete audit trail captures all user actions and system events.

The system was delivered in two versions. The standard version covers the full test, calculation, and reporting workflow. The audit-compliant version adds role-based user access, electronic signatures, and a locked, tamper-evident audit trail — meeting the electronic records requirements of regulated pharmaceutical quality systems without any additional software layer.

WHAT IT DOES

- ✓ Operator loads the sample, selects a method defining tap count, tap rate, and cylinder size, and starts the run from the touchscreen
- ✓ Backend drives the tapping mechanism to the exact parameters, monitoring run progress and signalling completion
- ✓ Tap count and run status displayed live on the touchscreen throughout the test
- ✓ On completion, the system automatically calculates bulk density, tapped density, Hausner ratio, and Carr's compressibility index from the initial and final volume readings
- ✓ Test report generated automatically: method, all calculated values, sample details, operator, and timestamp
- ✓ Reports stored on the instrument, searchable by date, sample, or operator — printable or exportable without leaving the interface
- ✓ Full audit trail logs every user action and system event with a timestamp
- ✓ Audit-compliant version adds role-based access, electronic signatures, and a tamper-evident audit trail for regulated environments
- ✓ Backup and restore protects all saved methods, reports, and settings; user management and system configuration in a separate admin area

OUTCOME

The client received a tap density instrument that runs the complete test, derives all standard flowability parameters automatically, and produces a formatted, traceable report — replacing a manual read-and-record process with one that is consistent, operator-independent, and ready for quality review without any additional steps.