TECHNICAL DATASHEET · SOFTWARE

MPC Position Control

PYTHON CLI EDITION · NO MATLAB · CARIMO DCMK KIT

A pure-Python CLI pipeline for **Model Predictive Control** of the CARIMO DC Motor Kit, position (angle) loop. A real constrained quadratic program (OSQP) plans every move to hit a target angle inside hard limits, and **cracks the stiction wall** that breaks textbook linear MPC. One terminal command per experiment opens a live plot and auto-saves a CSV + PNG. **Twelve textbook chapters** walk students through every MPC knob. No MATLAB, no toolbox licence.

Every MPC knob is a dial

Prediction horizon N	10–30 ticks
Control horizon M	1–24 ticks
Output weight Q	0.1–10
Integrator weight Q_e	100–2000
Input weight R	1e-4 to 1e-2
Input-rate weight R_du	0–10
Hard input bounds u	±3000 to ±65535
Hard rate bounds du	±2000 to ±131070
Sample time dt	0.015 s (67 Hz)

Default tuning (ships with the kit): Q=0.471, Q_e=614.6, R=0.000336, N=24, M=24.

System requirements	
Language	Python 3.x
Dependencies	cvxpy, OSQP, pyserial, NumPy, Matplotlib (simple-pid optional)
MATLAB / toolbox	**Not required**
OS	Windows 10 / 11, with a terminal
Port	One free USB 2.0 port
Hardware	CARIMO DC Motor Kit, position mode
Control	Position loop · real OSQP QP · 12 chapters
Setpoints	Single-step, staircase, custom staircase, sine

4.31× On the kit's 6-step angle staircase (0° → 90° → 180° → 360° → 180° → 90° → 0°), the locked MPC settles **4.31× faster than a hand-tuned PID with 71.7% less mean overshoot**, at comparable peak PWM, inside **±1°**. Every metric is backed by two or more trials with published variance bands.

What's included

- ✓ **The MPC controller** (cvxpy + OSQP) + input-additive Kalman observer
- ✓ **Metrics module** (settle, overshoot, steady-state error)
- ✓ **12-chapter lab manual** + user manual
- ✓ **Live plots** + auto-saved CSV and PNG per run
- ✓ **Nine hardware driver scripts**, one terminal command per experiment
- ✓ **Two locked tunings**: J (fast) and I (gentle), both shipped
- ✓ **PID baseline runner** for the head-to-head comparison
- ✓ **Perpetual licence**, readable and editable Python

Licensing & scope

Perpetual lab licence. The software is **pure Python** and needs **no MATLAB or toolbox**. It runs on the user's own PC and is licensed separately from the hardware. The **CARIMO DC Motor Kit** is sold separately. The same position lab is also available as **Simulink editions**: a Python-QP bridge, or a premium pure-MATLAB quadprog build, both giving the same results as this Python edition.

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