OSH GLOBAL SYSTEMS, INC.

FARO vs PID Oracle

Complete Three-Regime Physical Benchmark

MEDIUM + FAST + SLOW | 6 scored physical profiles | privileged PID baseline

PROFILE WINS	AGGREGATE IAE	PID ORACLE IAE	IAE REDUCTION
6 / 6	201,458.04	210,780.12	4.42%
FARO recorded lower raw nominal IAE in every scored profile.	FARO total across all 6 scored profiles.	Oracle total across the same 6 profiles.	Relative reduction vs PID Oracle.

PRIMARY RESULT

FARO: 6/6 physical profiles with lower nominal IAE

Across MEDIUM, FAST and SLOW, FARO produced 201,458.04 count-seconds of nominal IAE versus 210,780.12 for a PID Oracle whose gains were selected per physical regime before commissioning.

Aggregate difference: 9,322.08 count-seconds. Relative IAE reduction: 4.42%. Symmetric FARO advantage: 4.52%. The Oracle was deliberately information-advantaged with plant characterization, exact future profiles and the IAE objective.

CONSOLIDATION NOTE

MEDIUM and FAST were completed in the first physical block. SLOW was completed later in a separate physical block after a pre-score conditioning amendment. No failed SLOW attempt produced a scored profile; the successful SLOW block supplied the first scored SLOW_UP and SLOW_DOWN results. This PDF consolidates the six completed scored profiles.

Information-asymmetric challenge

The PID Oracle is intentionally given more information than FARO

IMPORTANT: THIS IS NOT AN INFORMATION-SYMMETRIC CONTEST

The PID Oracle receives physical plant characterization, the exact future profiles and the IAE objective before scoring. FARO receives none of that characterization. The asymmetry favors the PID baseline by design.

WHAT THE ORACLE KNEW

Physical regime characterization
Used by PID Oracle before scoring.

Exact two future profiles
Known before commissioning.

Primary metric
IAE objective known during gain selection.

Per-regime gains
Frozen before commissioning and scoring.

WHAT FARO RECEIVED

Physical characterization
Not delivered to FARO.

Commissioning
192 physical decisions per regime.

Scored profiles
FARO model locked before scoring.

Action limit
Same +/-12 counts per decision.

PHYSICAL REGIMES AND ORACLE GAINS

REGIME	TAU	DC GAIN	DC BIAS	ORACLE GAINS	
MEDIUM	1.1225s	0.961670	106.250	kp 1.6875 | ki 11.0 | kd 0.018 tf 0.48 | tt 0.12	extended physical characterization
FAST	1.0510s	0.967285	90.500	kp 1.25 | ki 11.0 | kd 0.0 tf 0.12 | tt 0.12	extended physical characterization
SLOW	3.7590s	0.922201	160.333	kp 3.75 | ki 0.7125 | kd 0.018 tf 0.12 | tt 0.24	Q-derived physical characterization

SLOW PRECONDITIONING AMENDMENT

The inherited host condition required ADC 2048 +/-16. On the real SLOW branch, the original firmware Q gate validly accepted 2048 within +/-128. Before any scored SLOW profile existed, the host preconditioning was amended to a deterministic 512-stable -> 2048-stable sequence using the original Q acceptance envelope (last-10 span <=8, minimum 30 observations, maximum 30 s per phase), applied identically to FARO and PID Oracle.

Raw nominal IAE

Lower is better; all six scored profiles favor FARO



Aggregate: FARO 201,458.04 vs PID Oracle 210,780.12 **-4.42% IAE**

Absolute difference: 9,322.08 count-seconds | FARO profile record: 6/6

Error quality and control effort

Primary IAE is the decision metric; secondary metrics expose the trade-off

MEDIUM AGGREGATE

57,916.68

Oracle 58,705.80 | FARO reduction 1.34% | FARO 2/2

FAST AGGREGATE

57,482.52

Oracle 58,515.12 | FARO reduction 1.76% | FARO 2/2

SLOW AGGREGATE

86,058.84

Oracle 93,559.20 | FARO reduction 8.02% | FARO 2/2

AGGREGATE SECONDARY METRICS

FARO 42.314

Oracle 73.736

-42.6%

Mean tail RMSE across 6 scored profiles

FARO 37,164

Oracle 31,547

+17.8%

Total DAC variation counts

INTERPRETATION

Across all six profiles, FARO reduced mean tail RMSE by 42.6% and the host-time-weighted error proxy by 4.10%, while using 17.8% more total DAC movement. The SLOW regime dominates the tail-error magnitude for both controllers; therefore the aggregate tail-RMSE percentage should be read together with the per-regime IAE results, not as a universal quality score.

Comparable completed pairs

No scored profile had a cycle above 150 ms

PAIR TIMING

MEDIUM_UP	FARO 65.503s	Oracle 65.263s	**diff 0.368%**	**>150 ms: 0 / 0**
MEDIUM_DOWN	FARO 65.506s	Oracle 65.253s	**diff 0.387%**	**>150 ms: 0 / 0**
FAST_UP	FARO 65.515s	Oracle 65.265s	**diff 0.384%**	**>150 ms: 0 / 0**
FAST_DOWN	FARO 65.505s	Oracle 65.283s	**diff 0.341%**	**>150 ms: 0 / 0**
SLOW_UP	FARO 65.503s	Oracle 65.303s	**diff 0.307%**	**>150 ms: 0 / 0**
SLOW_DOWN	FARO 65.502s	Oracle 65.264s	**diff 0.364%**	**>150 ms: 0 / 0**

TRACE IDENTIFIERS

MEDIUM_UP	FARO 93efce11954a70f80ecfbc4c6237...	ORACLE 35b669fabc552cc8b4730cc235b2...
MEDIUM_DOWN	FARO 28981620a24f1a76e6ae619d4c7d...	ORACLE 679b2137a4bfc5ea7876f8d1157a...
FAST_UP	FARO f777476c7e43152c6dd8b6d59337...	ORACLE 706c98c23ea9420f2cc196f63851...
FAST_DOWN	FARO d0ec7c759227620b714fc627a9a2...	ORACLE 006dffdd22ab7659101a11531b9f...
SLOW_UP	FARO 3113088b4bc4822a460904a3428d...	ORACLE 5d13b912554ff1711ab7b89d7bf8...
SLOW_DOWN	FARO 911927c5959758f2d70151ab3a19...	ORACLE abe5414138dd9ce714747fbaf6b5...

TIMING AND CONSOLIDATION CAVEAT

exact_hardware_adc_timestamps=false in all six scored runs. Every pair reports timing_comparable=true and zero cycles above 150 ms. MEDIUM/FAST and SLOW were not one uninterrupted physical session; SLOW is a later scored block consolidated here. The controller loop is host-driven, so this is not a native-MCU latency benchmark.

SLOW scored initial ADC values were 1946/1931 for UP and 1940/1940 for DOWN after the deterministic 512 -> 2048 conditioning. These differ from the near-2048 initial values of MEDIUM/FAST and are disclosed rather than normalized away.

What this completed benchmark supports

A strong narrow result, not a universal control claim

SUPPORTED RESULT

FARO recorded lower IAE than the privileged PID Oracle in all 6 scored profiles

Across MEDIUM, FAST and SLOW, FARO achieved 201,458.04 nominal IAE versus 210,780.12 for the information-advantaged PID Oracle: 4.42% lower IAE, 9,322.08 count-seconds less absolute error, and a 6/6 profile record.

WHAT IT DOES NOT SUPPORT

- No universal claim that FARO is superior to PID for all plants, regimes, costs or objectives.
- The six scored profiles are a consolidation of two physical blocks, not one uninterrupted three-regime session.
- SLOW used a pre-score host-conditioning amendment after the inherited +/-16 center rule proved incompatible with the Q-accepted SLOW branch. The amendment was applied identically to both controllers and occurred before any SLOW scored profile.
- The PID Oracle was deliberately privileged with plant characterization, exact future profiles and the IAE objective. FARO did not receive those inputs; the information asymmetry favors the PID baseline by design.
- FARO used more total actuator movement (+17.8% DAC variation), so the result is lower tracking error, not dominance on every cost metric.

ONE-LINE SUMMARY

Physical three-regime benchmark: FARO 6/6 scored profiles, 4.42% lower aggregate IAE and 42.6% lower mean tail RMSE versus a deliberately information-advantaged per-regime PID Oracle, with 17.8% more DAC variation.