# ArenaController Performance Summary (Long Run)

Run: Pattern playback, target 200 Hz, 100-minute duration (6,000,000 ms).

| Target rate | 200.00 Hz (period 5,000 us) |
|---|---|
| Measured rate | 199.99 fps, tick_hz 200.00 Hz, frames/tick 1.000 |
| Duration | window_ms 6,000,153 (about 100.00 min) |
| Drops | 37 total (post 0, defer_overflow 37) ~31 ppm, about 1 every 2.7 min |
| Defers / Late | 162 defers; 3 late frames (late_max_us +12,685) |

## Timing and jitter (inter-frame interval, IFI)

IFI is the time from one frame-start to the next. At 200 Hz the ideal IFI is 5,000 us.

● IFI mean 5,000 us; std 90 us (inflated by rare outliers).

● IFI p95 5,001 us; IFI p99 5,037 us (99% of frames start within +37 us of target).

● Worst-case gaps: min 3,446 us (early) and max 48,597 us (late). Jitter range vs 5,000 us: -1,554 to +43,597 us.

## Transfer pipeline cost (per frame)

• Frame transfer mean 3,440 us; p99 3,467 us; max 17,685 us (rare extreme).

• SPI portion mean 3,134 us; p99 3,160 us; max 17,379 us. Overhead mean 306 us (max 397 us).

• Panel-set mean 285 us; p99 315 us; max 14,530 us; 12 panel-sets per frame.

• Duty at 200 Hz: xfer 68.79% and spi 62.68% (typical slack around 1.53 ms per 5 ms frame using p99 transfer).

## CPU stages (SD read / decode / fill)

• SD read mean 149 us; p99-ish 1,236 us; max 45,147 us. Spike frequency: >500 us = 10,786 (0.89%), >1,000 us = 8,393 (0.69%).

• Decode mean 118 us (very stable); Fill mean 40 us (very stable).

• Stage duty over full window: SD 2.98%, Decode 2.35%, Fill ~0.8% (CPU work often overlaps DMA).

## Reliability interpretation

• Average rate is essentially perfect (199.99 fps) for 100 minutes, with 37 missed refresh opportunities (drops) and 162 defers.

• Drops were not ISR-post failures (post=0). They are consistent with occasional long stalls that exceed the 1-deep defer cushion.

• The heavy tail (rare 10-50 ms events) is the main driver of large IFI gaps and the conservative worst-case safe FPS.

## Safe max FPS estimate (from on-device stats)

Estimator uses crit_us + guard (10% of crit, with a small minimum).

- Steady-state estimate: safe_fps_p99 262 (crit_p99_us 3,467; guard 346).

- Worst-case estimate: safe_fps_max 20 (crit_max_us ~45,307; guard 4,530) dominated by rare SD/transfer stalls.

- At 200 Hz: headroom_p99_us 1,533; headroom_min_us -40,307 (meaning a very rare worst-case event can exceed a 5 ms deadline).

## Takeaways and next steps

- If the goal is 'no missed frames ever', focus on reducing tail latency (SD card stalls). Options: preload/caching, faster card, larger read sizes, filesystem tuning, or moving patterns to RAM/flash.

- If rare glitches are acceptable, current 200 Hz behavior is strong: tight p99 timing and very low drop rate (~31 ppm).

- Consider increasing the refresh defer depth (from 1 to 2+) if memory allows, to tolerate occasional multi-period stalls without drops.

Generated from QS PERF_* summary (pattern finished).