HIGH-SPEED MULTI-SERVO SYNC – 1000 PPM

SYSTEM OVERVIEW

A master servo generates a 10–100 kHz master sync pulse.
All follower servos lock to this pulse, creating deterministic electronic gearing.
Eye-mark registration and multi-roll tension control close the loop in real time.

Core Performance Specs

- **Master Pulse Frequency:** 10–100 kHz
- **Servo Update Rate:** ~2 ms (500 Hz)
- **End-to-End Loop Latency:** ~2 ms
- **Throughput:** up to **1000 ppm**
- **6 Servos**, each with independent correction loops
- Fully deterministic, jitter-minimized motion planning

SERVO ARCHITECTURE

Servo 1 — Master Cutting Axis (POSITION CONTROL)

- Generates master sync
- All downstream motion aligned to this axis
- Defines virtual cam profile (electronic camshaft)

Servo 2 — Print Registration (Eye-Mark Correction)

- Reads eye-mark error
- Applies registration offset
- Corrects print-to-cut alignment on the fly

Servo 3, 4, 5 — Unwind Roll Servo Tension Control

- Each roll has:
  - Encoder feedback
  - Tension control loop (torque/speed mode)
- Maintains stable web tension despite speed variation

Servo 6 — Glue & Heater Station Tension Control

- Follows master movement to maintain constant gap
- Additional correction for thermal / glue process variations

CORE CONTROL CONCEPTS

1. Master Sync Pulse
A deterministic high-frequency pulse defines the time base for the entire system.
This creates a fully electronic gear train replacing mechanical cams.

2. **Electronic Registration Control**
Servo 2 applies real-time phase correction:

- Eye-mark sensor → error calculation → registration offset
- Error injected as time-based shift relative to Servo 1

3. Multi-Roll Tension Control Loops
Each unwind roll has:

- Encoder feedback
- Tension error function
- Real-time correction into servo torque/speed command

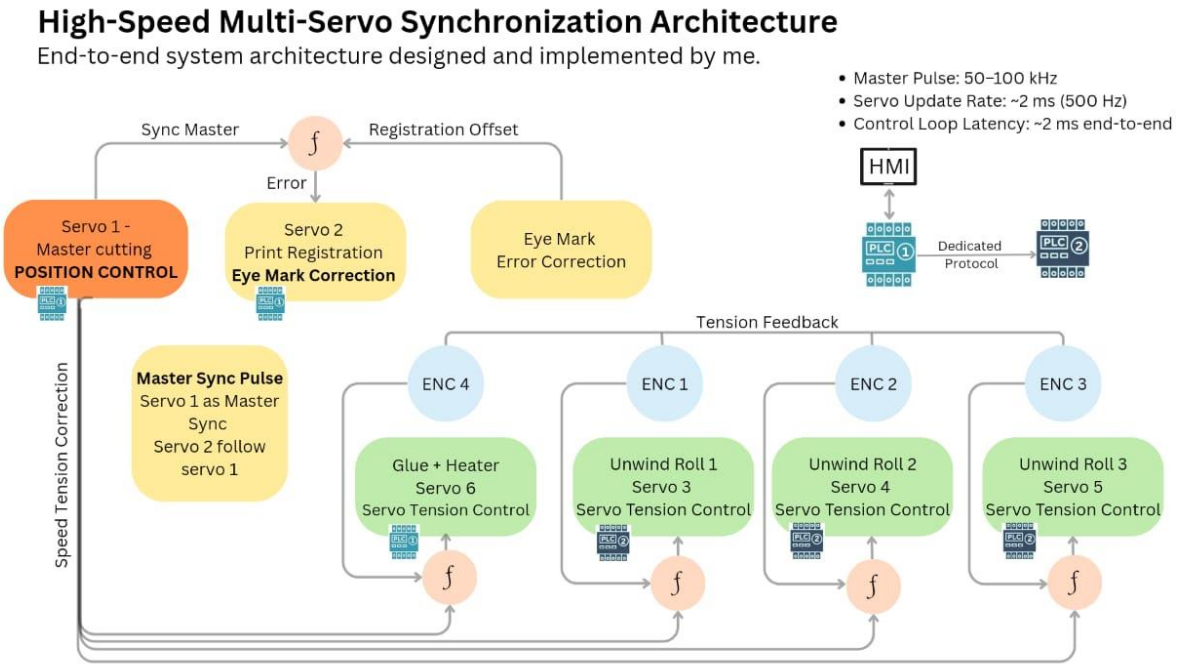
4. End-to-End Deterministic Latency
All control loops (sensor → PLC → servo) kept within **~2 ms**
This is the requirement for stable 1000 ppm cutting.

END-TO-END SYSTEM OWNERSHIP

I designed and implemented the full motion architecture:

- Multi-servo synchronization
- High-frequency master pulse generation (10–100 kHz)
- Registration (eye-mark) correction algorithm
- Tension control across three unwind rolls
- Glue & heater station servo control
- Full motion logic state machine
- HMI interface flow
- On-site tuning, commissioning, and test validation
- Delivered 1000 ppm production stability

DIAGRAM



Note : Due to NDA, I cannot share machine videos — but I can share the architecture I personally designed and implemented.