PLC Automation – Material Mixing System (CODESYS)

Automated bulk material mixing process implemented in CODESYS using Structured Text (ST) and Continuous Function Chart (CFC).

Project Overview

This project simulates an automated mixing process for bulk materials. The plant has two bunkers, two conveyor belts, and a mixer to handle defined batch quantities (e.g., 2 kg per bunker). System logic is written in Structured Text for deterministic sequence control and expressed in CFC for a clear visual flow and easier troubleshooting.

System Description

Bunkers (2×)

- Each bunker has a weight sensor to measure dispensed mass (typical batch: 2 kg).
- A release valve meters the discharge into the downstream conveyor.
- Interlocks ensure the valve cannot open unless the conveyor is ready and the mixer has capacity.

Conveyor Belts (2×)

- Each conveyor is driven by a motor with start/stop control and status feedback (optional).
- Transports material from each bunker to the common mixer inlet.
- Run permissives prevent simultaneous overload or backflow conditions.

Mixer (1×)

- Powered by a mixer motor; runs for a configured mixing duration (e.g., 30 s).
- A discharge valve opens after mixing to transfer the product to the next stage.
- Safety and sequence interlocks prevent opening the discharge valve while mixing.

Process Flow

1. Bunker Dosing: Each bunker releases a specified quantity (e.g., 2 kg) via the release valve under weight feedback.
2. Transfer: Conveyors transport the material from bunkers to the mixer.
3. Mixing: Mixer runs for the configured duration, ensuring homogeneous blend.
4. Discharge: Mixer release valve opens to transfer product to the next step.
5. Reset: Sequence resets; alarms and counters updated; ready for next batch.

Implementation

Structured Text (ST)

- Read weight sensors and evaluate setpoints for each bunker.
- Batch control logic: start/stop dosing, compare actual vs target weight, and close valves with tolerance.

- Sequencing: state machine (IDLE → DOSE → TRANSFER → MIX → DISCHARGE → COMPLETE).
- Interlocks: ensure permissives (E-Stop, guards, drive healthy) before starting actuators.
- Timers: enforce minimum ON/OFF times and mixing duration using TON timers.

Continuous Function Chart (CFC)

- Visual layout of the batch sequence with clearly labeled steps and transitions.
- Blocks for timers, comparisons, and coils, connected to depict signal flow and dependencies.
- Great for commissioning: operators and technicians can trace the process at a glance.

Repository Structure (Suggested)

Path	Description
st/BunkerControl.st	Dosing logic using bunker weight feedback and valve control.
st/ConveyorControl.st	Motor start/stop, permissives, and transfer interlocks.
st/MixerControl.st	Mixing duration, discharge sequence, and safety interlocks.
st/MainProgram.st	Top-level sequencing state machine and I/O mapping.
cfc/BatchSequence.cfc	Visual batch sequence and timing network.
docs/IO_List.xlsx	Signals, addresses, and descriptions (inputs/outputs).
docs/Process_Diagram.pdf	P&ID-style diagram of the mixing line.
README.md	Project documentation.

Control Logic Summary

Inputs

- Bunker1_Weight, Bunker2_Weight (AI): mass feedback used for dosing control.
- Start/Stop push buttons; Batch_Start command.
- Emergency Stop; safety interlocks (e.g., guard door, overload).

Outputs

- Valve1, Valve2 (DO): bunker release valves.
- Conveyor1_Motor, Conveyor2_Motor (DO): conveyor drives.
- Mixer_Motor (DO): mixing drive; Mixer_Valve (DO): discharge valve.

Timers & Setpoints

- Dosing window and valve minimum ON/OFF times to prevent chatter.
- Mixing time (e.g., 30 s) with optional minimum run before discharge.
- Fault/timeout timers to detect stalled conditions (no weight change, jammed valve).

Engineering Notes & Best Practices

- Implement a state machine for clarity and deterministic control; log state transitions for diagnostics.

- Include tolerances for dosing (e.g., ±50 g) and a top-up mode if underweight is detected.
- Use rising-edge triggers for push buttons; debounce inputs in software if hardware filtering is absent.
- Design permissives: conveyor ready, mixer not full, no active fault, E-Stop healthy.
- Plan for abnormal scenarios: overweight/underweight, motor trip, sensor failure, E-Stop pressed.

“Automating bulk material mixing for efficiency and reliability.”