Poly Press Programming & Operations Manual

Version 1.2 | June 20, 2025

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1. System Architecture

Controller: Trio Motion Controller (e.g., MC405)

Programming Language: Structured Text (ST) + Trio BASIC (legacy)

HMI: UNIPLAY 10" Touchscreen (Ethernet/IP)

Safety System: Schmersal SRB 206SQ Safety Relay

I/O Modules:

- IN16P (16 Digital Inputs)

- OUT16P (16 Digital Outputs)

- THC4 (4 Thermocouple Inputs)

Network Topology:

- EtherCAT for real-time motion control

- Ethernet/IP for HMI communication

- Modbus TCP for external SCADA integration

2. Axis Configuration

Z-Axis (Press Head)

```
AXIS(0);

CONFIG(0, 1, 1000, 5, 0);  // Servo, 1000 pulses/mm, 5:1 gear ratio

Z_MAX_SPEED := 200.0;        // mm/s

Z_MAX_ACCEL := 500.0;        // mm/s²
```

X-Axis (Feeder)

```
AXIS(1);

CONFIG(1, 1, 500, 2, 0);   // Servo, 500 pulses/mm, 2:1 gear ratio

X_MAX_SPEED := 300.0;

X_MAX_ACCEL := 600.0;
```

Axis Safety Limits:

```
SOFT_LIMIT(Axis_Z, 0.0, 150.0);  // Prevent overtravel

SOFT_LIMIT(Axis_X, -10.0, 200.0);
```

```
HARD_LIMIT_ENABLE(ALL, TRUE);      // Enable hardware limit switches
```

3. I/O Mapping & Wiring

Signal	Type	Address	Device	Wiring
Emergency Stop	DI	%I0.0	Schmersal E-stop	NC contact → IN0, COM → 0V
Door Interlock	DI	%I0.1	Schneider XCK-J115	NO contact → IN1, COM → 0V
Safety Curtain 1	DI	%I0.2	Leuze MLC OSSD1	PNP Out → IN2
Z Home Sensor	DI	%I0.6	Inductive Prox	Brown → 24V, Black → IN6, Blue → 0V
Heater Zone 1	DO	%Q0.0	Eaton DILMP20 Contactor	OUT0 → A1, A2 → 0V
Press Down Solenoid	DO	%Q0.4	MAC Valve	OUT4 → Solenoid (+)
Temp Zone 1	AI	%AI0.0	Type K Thermocouple	Yellow → THC0, Red → COM

> **Wiring Standards**:
>
> - 24VDC Power: Red (+), Black (-)
>
> - Shielded cables for analog signals (thermocouples)
>
> - Safety circuits wired with dual-channel redundancy

4. Core Programs

4.1 Homing Routine (`homing.st`)

```
PROGRAM Homing

VAR

homeZIn AT %I0.6 : BOOL;    // Z Home sensor
```

```
homeXIn AT %I0.7 : BOOL;    // X Home sensor

Z_HomeDir : INT := -1;      // Negative direction

Z_HomeSpeed : REAL := 10.0;

BEGIN

IF NOT SAFETY_OK THEN

PRINT("SAFETY FAULT: Homing aborted!");

RETURN;

END_IF;

// Home Z-axis

HOME(Axis_Z, Z_HomeDir, Z_HomeSpeed, 100.0); // 100 mm/s² accel

REPEAT

WAIT(0.01);

UNTIL homeZIn;

MOVE(Axis_Z, 5.0, 20.0, 100.0); // Retreat 5mm at 20mm/s

SETPOS(Axis_Z, 0.0);

// Repeat for X-axis...

END_PROGRAM
```

4.2 Safety Monitoring (`safety.st`)

```
PROGRAM Safety

VAR_GLOBAL

SAFETY_OK: BOOL;

END_VAR
```

```
VAR

E_Stop_In AT %I0.0: BOOL;

Door_Sw_In AT %I0.1: BOOL;

Curtain1_OSSD AT %I0.2: BOOL;

SafetyRelay_OK AT %I0.4: BOOL;

BEGIN

WHILE TRUE DO

SAFETY_OK := E_Stop_In AND Door_Sw_In AND Curtain1_OSSD AND SafetyRelay_OK;

IF NOT SAFETY_OK THEN

DISABLE;  // Halt all motion

OUT[0..15] := FALSE; // Kill all outputs

END_IF;

WAIT(0.1); // 100ms cycle

END_WHILE;

END_PROGRAM
```

4.3 Press Cycle (`press_cycle.st`)

```
PROGRAM Press_Cycle

VAR

feederExtendPos: REAL := 150.0; // mm

pressDownPos: REAL := 40.0;

dwellTime: TIME := T#5S;

BEGIN

IF NOT SAFETY_OK THEN RETURN; END_IF;
```

```
// Feed material

MOVE(Axis_X, feederExtendPos, 100.0, 200.0); // 100mm/s, 200mm/s²

WAIT UNTIL INPOS(Axis_X);

// Press down

MOVE(Axis_Z, pressDownPos, 50.0, 100.0);

WAIT UNTIL INPOS(Axis_Z);

// Dwell

WAIT(dwellTime);

// Retract

MOVE(Axis_Z, 0.0, 100.0, 200.0);

END_PROGRAM
```

5. HMI Interface Design

Dashboard Layout:

HMI Dashboard

Key Elements:

1. **Safety Status LED**:

- Green: SAFETY_OK = TRUE

- Red: Any fault

2. **Temperature Control Panel**:

- Setpoint entry fields for 4 zones

- Real-time trend graphs

3. **Cycle Counter**:

- Total cycles / Today's count

- Reset with password

Recipe Management:

```
{

"recipe_name": "3mm Polycarbonate",

"parameters": {

"heater_setpoints": [160, 160, 155, 155], // °C

"feed_position": 150.0, // mm

"press_dwell_time": 5.0 // seconds

}

}
```

6. Alarm Handling

Code	Description	Severity	Response
AL101	E-Stop Activated	Critical	Full shutdown
AL202	Heater Over-Temp	High	De-energize zone
AL303	Homing Timeout	Medium	Check sensors
AL404	Safety Relay Fault	Critical	Inspect SRB wiring

Alarm Reset Protocol:

1. Clear physical fault condition

2. Press HMI "Reset" button

3. Confirm SAFETY_OK = TRUE

7. Safety Validation

Test Cases:

1. **E-Stop During Press**:

- Trigger E-stop at 50% stroke

- Verify press stops within 100ms

- Confirm OUT4 (solenoid) = FALSE

2. **Door Open at 150°C**:

- Open door during heating

- Check heaters de-energize within 500ms

3. **Thermocouple Failure**:

- Disconnect THC0

- Verify AL202 logged and zone disabled

8. Maintenance Procedures

Monthly Tasks:

1. **Thermocouple Calibration**:

- Apply known temperatures (0°C, 100°C, 200°C)

- Adjust scaling in THC4 config if error > ±2°C

2. **Contactor Inspection**:

- Measure coil resistance (Eaton DILMP20: 180Ω ±10%)

- Check for contact pitting

Annual Tasks:

- Full axis re-calibration

- Safety relay functional test

9. Motion Tuning

Z-Axis PID Settings:

```
GAIN(100,  // KP

20,    // KI

0,     // KD

0.1); // Feedforward

JERK_LIMIT(5000.0); // mm/s³
```

Vibration Reduction:

- Increase trajectory filter from 5ms → 10ms

- Reduce KI by 30% if overshoot occurs

10. Simulation & Debugging

Motion Perfect Tools:

1. **Axis Simulator**:

- Test homing without hardware

2. **Watch Window**:

- Monitor SAFETY_OK, POS_Z in real-time

3. **Breakpoints**:

- Pause program at specific lines

Diagnostic Codes:

- Controller LED:

- Green: Normal

- Red blink (2/sec): I/O fault

- Red blink (4/sec): Motion error

11. Appendix

A. Wiring Diagrams

Power Distribution

Main power and branch circuits

Control Circuits

Safety relay and PLC I/O

B. Revision History

| Version | Date | Changes |

|---------|-----------|---------------------------|

| 1.0 | 2024-12-01 | Initial release |

| 1.1 | 2025-03-15 | Updated safety logic |

| 1.2 | 2025-06-20 | Added thermocouple cal steps|

C. Contact Information

Technical Support:

- Email: support@triomotion.com

- Phone: +1 (800) 555-CODE (2633)

Document Control:

- This manual must be reviewed annually.

```
### How to Convert to PDF:

1. **Install Pandoc**:

- Download from [pandoc.org](https://pandoc.org/installing.html)

2. **Save the markdown** above as `poly_press_manual.md`

3. **Run conversion command**:

```bash

pandoc poly_press_manual.md -o PolyPress_Manual.pdf --pdf-engine=xelatex -V geometry:margin=1in
```