### Functional Design Specification (FDS)

System: Double Acting Cylinder Control using FBD Logic  
Platform: Mitsubishi PLC (FBD)  
Control Modes: Auto & Manual  
Document Type: Stepwise FDS

### 1. System Overview

The system controls a Double Acting Pneumatic Cylinder with two modes: Manual and Automatic.

* Auto Mode: Extends and retracts based on process sequence and interlocks.
* Manual Mode: Allows manual commands for extend/retract.
* Feedback Monitoring: Ensures cylinder reached position with time monitoring.
* Fault Handling: Detects feedback delay to raise faults.

### 2. Inputs and Outputs

#### VAR\_INPUT

| Tag Name | Data Type | Description |
| --- | --- | --- |
| Extend\_Cmd | Bit | Command to extend cylinder (Manual or Auto) |
| Retract\_Cmd | Bit | Command to retract cylinder (Manual or Auto) |
| Extend\_FB | Bit | Feedback: cylinder fully extended |
| Retract\_FB | Bit | Feedback: cylinder fully retracted |
| Auto\_Mode | Bit | System in automatic mode |
| Manual\_Mode | Bit | System in manual mode |
| Interlock | Bit | System permission for movement (safety) |
| Exend\_Rs | Bit | Reset extend fault |
| Retract\_Rs | Bit | Reset retract fault |
| RESET | Bit | General system reset |

#### VAR

| Tag Name | Data Type | Description |
| --- | --- | --- |
| EX\_FB\_T | Bit | Timer active for extend FB monitoring |
| RE\_FB\_T | Bit | Timer active for retract FB monitoring |

#### VAR\_OUTPUT

| Tag Name | Data Type | Description |
| --- | --- | --- |
| Out\_Extend | Bit | Output to extend cylinder |
| Out\_Retract | Bit | Output to retract cylinder |
| Status | Bit | Cylinder is in a valid state (no fault) |
| Auto\_On | Bit | Auto mode status |
| Manual\_On | Bit | Manual mode status |
| Extend\_Fault | Bit | Extend fault if feedback delay |
| Retract\_Fault | Bit | Retract fault if feedback delay |
| Extend\_Fb\_Time | Word [Int] | Feedback delay time during extend |
| Extend\_Time | Word [Int] | Total time of extend operation |
| Retract\_Fb\_Time | Word [Int] | Feedback delay time during retract |
| Retract\_Time | Word [Int] | Total time of retract operation |

### \*MANUAL MODE (Extend Operation)

#### 1. Manual Mode Activation

* When Manual\_Mode bit is ON,  
  → System enters Manual Mode.  
  → Manual\_On output bit is set TRUE.

#### 2. Manual Extend Command Execution

* When Extend\_Cmd bit turns ON (manual command),  
  → AND Manual\_On is TRUE,  
  → THEN Out\_Extend output bit is set TRUE (Cylinder starts extending).

#### 3. Timer Start for Extend Feedback

* On activation of Out\_Extend,  
  → Start a 3-second timer (T\_EXT).

#### 4. Feedback Validation within Timer

* If Extend\_FB becomes TRUE before T\_EXT completes,  
  → THEN:
  + Out\_Extend is set to FALSE (stop output),
  + Extend\_Fb\_Time is stored,
  + Status is set TRUE,

5. Alarm on Feedback Timeout

* If Extend\_FB remains FALSE after 3 seconds,  
  → THEN:
  + Out\_Extend = FALSE,
  + Extend\_Fault is set TRUE,
  + Status = FALSE,

6. Alarm Reset Logic

* If Extend\_Fault = TRUE,  
  → AND Exend\_Rs or RESET button is pressed,  
  → THEN:
  + Extend\_Fault is set to FALSE,
  + System ready for next command.

### \*MANUAL MODE (Retect Operation)

### 1. Manual Mode Activation

* When Manual\_Mode bit is ON,  
  → System enters Manual Mode.  
  → Manual\_On output bit is set TRUE.

#### 2. Manual Retract Command Execution

* When Retract\_Cmd bit turns ON (manual command),  
  → AND Manual\_On is TRUE,  
  → THEN Out\_Retract output bit is set TRUE (Cylinder starts retracting).

#### 3. Timer Start for Retract Feedback

* On activation of Out\_Retract,  
  → Start a 3-second timer (T\_RET).

#### 4. Feedback Validation within Timer

* If Retract\_FB becomes TRUE before T\_RET completes,  
  → THEN:
  + Out\_Retract is set to FALSE,
  + Retract\_Fb\_Time is stored,
  + Status is set TRUE,

#### 5. Alarm on Feedback Timeout

* If Retract\_FB remains FALSE after 3 seconds,  
  → THEN:
  + Out\_Retract = FALSE,
  + Retract\_Fault is set TRUE,
  + Status = FALSE,

#### 6. Alarm Reset Logic

* If Retract\_Fault = TRUE,  
  → AND Retract\_Rs or RESET button is pressed,  
  → THEN:
  + Retract\_Fault is set to FALSE,
  + System ready for next command.

### \*AUTO MODE (Extend Operation)

#### 1. Auto Mode Activation

* When Auto\_Mode bit is ON,  
  → System enters Auto Mode.  
  → Auto\_On output bit is set TRUE.

#### 2. Auto Extend Command Execution

* When Extend\_Cmd bit turns ON,  
  → AND Interlock is TRUE,  
  → AND Auto\_On is TRUE,  
  → THEN:
  + Out\_Extend output bit is set TRUE (start cylinder extension),
  + A 3-second timer (T\_EXT) is started to monitor extend feedback.

#### 3. Feedback Validation

* If Extend\_FB becomes TRUE before T\_EXT completes,  
  → THEN:
  + Out\_Extend = FALSE,
  + Store elapsed time in Extend\_Fb\_Time,
  + Set Status = TRUE,

#### 4. Fault on Timeout

* If Extend\_FB remains FALSE after 3 seconds,  
  → THEN:
  + Out\_Extend = FALSE,
  + Set Extend\_Fault = TRUE,
  + Set Status = FALSE,
  + Message: "Auto Extension Failed – Alarm Set".

#### 5. Alarm Reset Logic

* If Extend\_Fault = TRUE,  
  → AND Exend\_Rs OR RESET is pressed,  
  → THEN:
  + Extend\_Fault is reset to FALSE,
  + System is ready for next cycle.

### \*AUTO MODE (Retract Operation)

#### 1. Auto Mode Activation

* When Auto\_Mode bit is ON,  
  → System enters Auto Mode.  
  → Auto\_On output bit is set TRUE.

#### 2. Auto Retract Command Execution

* When Retract\_Cmd bit turns ON,  
  → AND Interlock is TRUE,  
  → AND Auto\_On is TRUE,  
  → THEN:
  + Out\_Retract output bit is set TRUE (start cylinder retraction),
  + A 3-second timer (T\_RET) is started to monitor retract feedback.

#### 3. Feedback Validation

* If Retract\_FB becomes TRUE before T\_RET completes,  
  → THEN:
  + Out\_Retract = FALSE,
  + Store elapsed time in Retract\_Fb\_Time,
  + Set Status = TRUE,

#### 4. Fault on Timeout

* If Retract\_FB remains FALSE after 3 seconds,  
  → THEN:
  + Out\_Retract = FALSE,
  + Set Retract\_Fault = TRUE,
  + Set Status = FALSE,
  + Message: "Auto Retraction Failed – Alarm Set".

#### 5. Alarm Reset Logic

* If Retract\_Fault = TRUE,  
  → AND Retract\_Rs OR RESET is pressed,  
  → THEN:
  + Retract\_Fault is reset to FALSE,
  + System is ready for next cycle.

### \*TIME TRACKING

1. Extend Feedback Time → Extend\_Fb\_Time

2. Total Extend Time → Extend\_Time

3. Retract Feedback Time → Retract\_Fb\_Time

4. Total Retract Time → Retract\_Time

### Data Register Assignment (example):

| Time Value | Tag | Data Register | Format |
| --- | --- | --- | --- |
| Extend Feedback Time | Extend\_Fb\_Time | D100 | INT (Word) |
| Extend Total Time | Extend\_Time | D101 | INT (Word) |
| Retract Feedback Time | Retract\_Fb\_Time | D102 | INT (Word) |
| Retract Total Time | Retract\_Time | D103 | INT (Word) |