Family edition

PLC Lab: Start, Stop and the Seal-In, a First Ladder Logic Program

Ages 15-18 · about 45 minutes, in one sitting

In PLC Lab your teen writes the program for a factory conveyor, the way technicians program real machines, and watches a pretend crew run it. Nothing in the app drives real hardware.

What you need

- A computer or Chromebook with a current browser.
- The link: mytekdev.com/try/plclab?lesson=start-stop-and-the-seal-in&ref=fam-plclab-1. No account, no email and nothing to install.

Before you start: try it once yourself

Open mytekdev.com/try/plclab?lesson=start-stop-and-the-seal-in&ref=fam-plclab-1. A short guide opens over Job 1, Start and Stop, on the Build it tab. The top half is the station: a conveyor on a bench, its operator panel, and the PLC. Under it is the run bar and the ladder; on the right are the jobs, the job card, a hint box, the wiring list and the program check.

1. **The wiring list.** Start at %IX0.0, wired normally open. Stop at %IX0.1, wired normally closed: ON until pressed, and its Field lamp is lit at rest. Motor at %QX0.0. Labels switches the addresses to Allen-Bradley (I:0/0), Siemens or CLICK, and the instruction names under each contact (XIC, XIO, OTE by default).
2. **The starting program.** One rung: a normally open Start contact to the Motor coil. Turn the line on (or the space bar) and hold Start (or the S key): the belt runs only while Start is held.
3. **The seal-in.** Click the Start contact, press Branch, then Normally open and pick Motor. Then click the wire after the branch, press Normally open and pick Stop. The guide card on the right gives the same moves.
4. **The shift.** Run the shift: a crew presses Start, lets go, presses Stop about 10 to 14 seconds in, and starts it again, with 8 boxes. The result lists the checks: kept running, stopped and stayed stopped, every box to the tote. A Build it job passes on three different shifts.
5. **Fix the line.** The second tab holds the finished program with Stop changed to a normally closed contact. The belt never moves. On this tab the result names only the symptoms: Delivered 0 of 8, and the checks that failed. One clean shift passes it.
6. **Ways back.** Start this job over puts the starting program back for the job and tab that is open. Undo works one change at a time.

> In the wiring list, Field is the wire at the PLC's terminal right now, and Image is the PLC's own copy, taken at the start of each scan. Image only changes while the line is on. Under More on the right, Cut the Stop button's wire turns Stop's input OFF while the line is on, the same as pressing it.

The ideas, in plain words

Tony Kuphaldt, whose free textbook many PLC teachers use, calls this "the main problem children have comprehending PLC Ladder Diagram programs": they expect the contact in the program to match the physical switch, so a normally closed stop button gets a normally closed contact, and the motor never runs. PMMI's PLC 1 competency list names the same idea: "Describe how input device logic affects input instruction logic."

The way out is to separate the field from the program. The button is wired one way, and that decides whether its input bit is ON or OFF at rest. The contact in the program is a question about that bit. A stop button is wired normally closed so that a broken wire looks the same as a press, and the line stops. Wired normally open, a broken wire would leave a line nobody can stop.

The scan explains why the seal-in works. The PLC copies the inputs, works the rungs from top to bottom, and writes the outputs. On the scan after Start is let go, the Motor contact on the branch still reads the Motor bit from the scan before, which is ON, so Motor stays on until Stop breaks the rung. Most small PLCs scan this way; some larger ones update inputs and outputs on their own schedule.

> The E-stop on the panel is not part of Job 1's program. On a real machine it cuts power through a safety relay, outside the PLC. Job 6 shows the program side of it.

Do it together

1. Open mytekdev.com/try/plclab?lesson=start-stop-and-the-seal-in&ref=fam-plclab-1 together. Before pressing anything, find `Stop` in the wiring list on the right. Ask: why is its lamp lit when nobody is pressing it?

   > **You'll know it worked when:** Your teen notices Stop is wired normally closed, so its input is ON at rest.

2. Press `Turn the line on`, hold `Start`, then let go.

   > **You'll know it worked when:** The belt runs only while Start is held.

3. Use the guide card on the right to add a `Branch` around Start with a normally open `Motor` contact, and a normally open `Stop` contact after it.

   > **If you get stuck:** A normally closed contact on Stop makes a belt that never starts. Read the lamp again.
   >
   > **You'll know it worked when:** The belt keeps running after Start is let go, and Stop stops it.

4. Press `Run the shift` until three shifts pass.

   > **You'll know it worked when:** The job shows built in the list of jobs.

5. With the line on and running, open `More` on the right and tick `Cut the Stop button's wire`.

   > **You'll know it worked when:** The belt stops, as if Stop were pressed.

6. Open the `Fix the line` tab and find what changed in a program that used to work.

   > **You'll know it worked when:** Your teen finds the normally closed Stop contact and changes it back.

Talk about it

Ask these while you work together. A child who has understood it can answer them without help:

- Which input is ON while nobody touches anything? How do you know?
- What does a normally open contact on Stop ask about the Stop bit?
- Why does the belt keep running after you let go of Start?
- What would happen if the wire to Stop broke?
- In what order does the PLC read the inputs, run the rung and write Motor?

> The second question is the one that matters. A child who says "normally open, because it is ON until pressed" has it. A child who says "it just works that way" will put a normally closed contact on the next normally closed device too.

For younger and older kids

Younger: For a younger teen, stop once the belt keeps running after Start is let go, and talk about why the stop button is wired the way it is.

Older: For an older teen, set Stop to `Wired normally open` in the wiring list and make the program work again. Then ask what a broken wire does now.

Keep going

- In the wiring list, set Stop to Wired normally open, then fix the program so it still works. What does a broken wire do now?
- Set the scan time to 100 ms under Line settings. Does the belt still start and stop? What could a press shorter than one scan do on a real PLC?
- Open Job 2, Stop at the Eye. A seal-in like yours is already rung 1, on a bit called Running: what does each rung do now?

Bring it into other subjects

- Math: write the seal-in as a Boolean expression, Motor = (Start OR Motor) AND Stop, and fill in its truth table.
- Science: look up how a relay coil and its contacts work. A seal-in was built from relays long before PLCs.
- Writing: write the rung comment a technician would want to read at 3 a.m., in twelve words or fewer.
- Careers: look up what an industrial maintenance technician or a controls technician does on a normal day.

For your records

Ready to copy into an hour log, a portfolio or a transcript.

LESSON	PLC Lab: Start, Stop and the Seal-In, a First Ladder Logic Program
SUBJECTS	Career and technical education, Engineering
TIME	45 minutes
WHAT WE DID	Wrote a start/stop seal-in ladder program for a simulated conveyor, explained why a normally closed stop button uses a normally open contact, and fixed a program with a changed contact.
SKILLS PRACTICED	Ladder logic; Reading a wiring list; Troubleshooting

Activity sheet (optional)

Name: _____ Date: _____

Open the app: scan the QR code, or go to mytekdev.com/try/plclab?lesson=start-stop-and-the-seal-in

Essential question: Why does a normally closed stop button get a normally open contact in the program?

Warm-up: Should a stop button's circuit be open or closed while nobody touches it? Why?

_____

1. **Vocabulary.** PLC, rung, normally open contact, normally closed contact, seal-in, scan: write each in your own words.

2. **Wiring.** Start is wired normally _____. Stop is wired normally _____. With nobody touching anything, the lit Field lamp is _____.
3. **My rung.** Draw your finished rung: each contact, its tag, and the coil.

4. **The shift.** Shifts passed (circle): 1 2 3. The first time a shift failed, the result said: _____
5. **Cut the wire.** With the belt running, I cut Stop's wire. The belt _____.
6. **Fix the line.** Symptom: _____ The contact that changed: _____

1. Stop is wired normally closed. Why does the program use a normally open contact for it?

2. If Stop were wired normally open and its wire broke, what would happen? Why is that worse?

Quick check

Name: _____

1. Stop is wired normally closed. While nobody presses it, its input bit is: (A) ON (B) OFF (C) it changes every scan

2. Which rung keeps the belt running after Start is let go? (A) Start to Motor (B) Start, or Motor, then Stop, to Motor (C) Stop, then Start, to Motor

3. A program has a normally closed contact on a normally closed Stop. What does the belt do, and why?

Answers

QUESTION	ANSWER	WHY
1	A	A normally closed button passes current until it is pressed, so the input is ON at rest. The Field lamp in the wiring list is lit.
2	B	The Motor contact on the branch keeps the rung true after Start is let go; Stop in series breaks it.
3	Open answer	It never starts. The Stop bit is ON at rest, and a normally closed contact passes power only when its bit is OFF, so no power reaches Motor.

If your state or umbrella school asks, this lesson covers Texas Programmable Logic Controller I (innovative course N1303689) (3)(F), Texas Programmable Logic Controller I (innovative course N1303689) (5)(C), Texas Programmable Logic Controller I (innovative course N1303689) (6)(A), Texas Programmable Logic Controller I (innovative course N1303689) (6)(B), Texas Programmable Logic Controller I (innovative course N1303689) (6)(C), Texas Programmable Logic Controller II (innovative course N1303690) Recommended activity, Massachusetts Robotics and Automation Engineering Technology, July 2025 Standard 9, PMMI Mechatronics: Programmable Logic Controllers 1 PLC 1 competency, PMMI Mechatronics: Programmable Logic Controllers 1 PLC 1 competency, SACA C-207 Programmable Controller Systems 1 C-207 key skills, CSTA 2017 3A-AP-16.

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