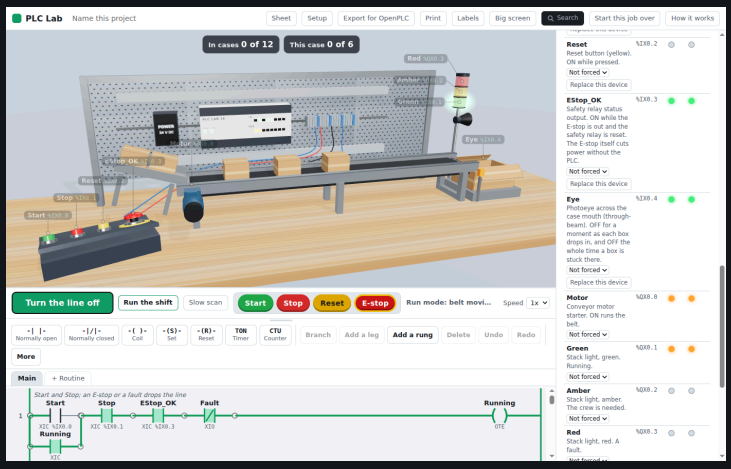
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PLC Lab: Find the Fault, Troubleshooting a Line from Symptom to Rung

Grades 10-12 · 45 minutes

Career and technical education · Engineering · Manufacturing technology



Slides, rubric and answer key | **Print and go** | **No student accounts** | **Chromebook friendly**

What's included

- A one-page overview: objectives, essential question, vocabulary, standards and assessment
- A 45-minute lesson sequence: warm-up, direct instruction, guided practice, independent practice, closure
- Slides for the board: a PowerPoint file that also opens in Google Slides
- A student worksheet with a QR code and a fix report for each job
- A 3-question exit ticket, two to a page, with an answer key
- A rubric: 3 criteria, 4 levels, scored out of 12
- Differentiation for English learners, students with IEPs or 504 plans, and students who need more support or more challenge
- Cross-curricular extensions, and notes for teaching it in grade 9 and in a second-year PLC course
- Standards: Texas PLC courses, Massachusetts 2025, PMMI and SACA

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Every job in PLC Lab has a Fix the line tab: a finished program with one fault planted in it, and a complaint from the crew. The result after a shift names only the symptoms, the way a supervisor would, so students have to go from what the line did to the rung that caused it. They work Jobs 1 to 6 in this starter, which shows Fix the line only. Job 6 is the turn: nobody changed the program, a sensor has failed, and swapping a good part for a good part costs money. Each fix ends in a short written report, scored with the rubric.

At a glance

ESSENTIAL QUESTION

How do you find a fault you cannot see, and prove you found it?

OBJECTIVES

Students will be able to:

- describe a fault by its symptoms before changing anything
- use the Field and Image lamps, and forcing, to test an idea about the cause
- tell a fault in the program from a failed field device
- write a fix report: symptom, what was checked, the fault, and the proof

VOCABULARY

Symptom, Field and Image, Force, Stuck ON, Fix report

STANDARDS

Course description, (2)(D), Standard 9, PLC 1 competency, PLC 1 competency, C-207 key skills

TIME AND MATERIALS

45 minutes, grades 10-12.

- One computer or Chromebook per student
- A projector
- The worksheet and exit ticket, one copy each per student
- The rubric, one copy per student if you grade the work

PREP

Make copies of the worksheet and exit ticket. Before class, open mytekdev.com/try/plclab?lesson=find-the-fault&ref=tpt-plclab-4 once on a student computer: it opens on Job 1's Fix the line, and this starter shows only Fix the line on Jobs 1 to 6 (set in Setup). Work Jobs 1, 3 and 6 yourself with the guide, about fifteen minutes. Setup's Print answer key lists every job's fault; keep it away from students until the end. Nothing in the app drives real hardware.

ASSESSMENT

- Formative: the questions under What to look for, asked while students work, and the exit ticket (answer key included).
- Summative: the worksheet, scored with the rubric.

TECHNOLOGY AND PRIVACY

Runs in any browser, Chromebooks included, with nothing to install. Students need no account and no email: the link works signed out, and nothing they do is stored on our server unless they choose to save. Nothing in the app drives real hardware. If a computer cannot draw the 3D station, the program still runs, and the lamps in the wiring list show what it does.

Lesson sequence

MINUTES	STAGE	WHAT YOU DO	WHAT STUDENTS DO
0 to 5	**Warm-up** Hook	Show the title, essential question and Today I can slides (about 1 minute). Then the warm-up: a bike with a new noise, and what you check before buying a part.	Answer the warm-up on the worksheet.
5 to 12	**Direct instruction (I do)** Model it	Show Symptom to rung. Project Job 1's Fix the line and think aloud: read the complaint, run the shift (Delivered 0 of 8), name the symptom (the belt never starts), turn the line on and read Stop's lamps (lit, as it should be), look at the contact on Stop (normally closed), change it, run the shift. Fill in the first fix report on the board. Show What the result tells you. **It's working when:** Say "I think it is ... because the lamp shows ..." before every change. One idea, one change, one shift.	Watch, and copy the Job 1 fix report onto the worksheet.
12 to 20	**Guided practice (We do)** Job 3 together	Students open the link or scan the QR code. The guide has them redo Job 1, then pick Job 3. Pause the room after their first Job 3 shift and take symptoms only: 6 of 12 in cases, the line never starts again after the first case. Then let them find the rung. **Watch for:** Students who rewrite the whole program. Ask what the result said, and which one rung could cause that.	Fix Jobs 1 and 3, and write the Job 3 fix report.
20 to 38	**Independent practice (You do)** Jobs 2, 4, 5 and 6	Students work Jobs 2, 4 and 5 in any order, then Job 6, writing a fix report for each. On Job 6 the program is right and the case eye has failed, stuck ON: they have to find it from the lamps and replace it in the wiring list with the line off. Walk the room with the What to look for questions, and do not confirm a fix: the shift does. **If they ask:** "The program reads right. What would the Eye lamp do as a box drops in, if the eye were working?" Program or device **Watch for:** Students who replace every device on Job 6 until one works. The app tells them each good part they swapped cost time and money; the fix report has to say what pointed at Eye.	Fix as many as you can, Job 6 last, and write a fix report for each.
38 to 45	**Closure** The program was right	Show The program was right. A student who fixed Job 6 explains what the Eye lamp did. Close with the rule: check the program, then check the devices, and prove it with a shift. Hand out the exit ticket.	Answer the exit ticket.

Before you teach: a fifteen-minute walkthrough

Open mytekdev.com/try/plclab?lesson=find-the-fault&ref=tpt-plclab-4. A short guide opens over Job 1's Fix the line. This starter shows Jobs 1 to 6 with Fix the line only; Setup changes that. Each job's card holds the crew's complaint,

and the program is a finished one with one fault planted in it.

1. **The result.** On Fix the line the result after a shift lists the counts and the checks that failed, and never the cure: on Job 1, Delivered 0 of 8, and all three checks. One clean shift passes a Fix the line job.
2. **The faults.** Job 1: Stop changed to a normally closed contact, the belt never starts. Job 2: the Hold timer at 300 ms, every label smears. Job 3: the counter's reset reads Start instead of Reset, so the line never starts after the first case. Job 4: the Reset Pusher output deleted, so the pusher stays out and parts pile up and fall. Job 5: the Bottle contact taken out of the valve rung, so liquid pours between bottles.
3. **Job 6.** The program is right. The case eye has failed, stuck ON, so nothing is counted: a shift ends with 6 of 12 in cases and 6 on the floor, and the jam check fails too, because the jam timer reads the same eye.
4. **Forcing and replacing.** With the line on, each row of the wiring list can force a signal ON or OFF; forces end when the line goes off. With the line off, Fix the line shows Replace this device on each input. Replacing Eye on Job 6 says the old one was dead; replacing a good device says it tested fine and the swap cost time and money. Start this job over puts the program back and undoes the replacements.

> 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. On Job 6 the Eye lamp stays lit as boxes drop in; on Job 3 it goes OFF for a moment each time. The app's Sheet button has a maintenance log question on every Fix the line tab, which can be printed instead of the worksheet.

Background for the teacher

Texas's PLC II course says students should "be able to troubleshoot the PLCs in common industrial applications", and PMMI's PLC 1 list asks for using the force function and troubleshooting a filler program. The hard part for beginners is not the fix: it is resisting the urge to change things before they know what is wrong.

The Fix the line result is written to make that hard to skip. It reports what a supervisor would see (counts, and which checks failed) and never names the rung. A student who reads "the line never starts again after the first case" has the symptom; the rung that clears the counter is one step away.

Job 6 is the case most students are least ready for. After five jobs where the fault was in the program, they expect another. The program is right and the case eye is stuck ON, which the Field lamp shows if anyone watches it while a box falls. On a real line a technician would check the sensor's own light and its wiring, and swap it only once it is proven dead; the app charges nothing but a message for a wrong swap, so ask about every replacement in the fix report.

> Setup can give any job a failed sensor, stuck ON or stuck OFF, in place of its own fault, for a retest that the answer key does not give away.

What to look for

Ask these while students work. A student who has understood the lesson can answer them without help:

- What did the line do wrong, in words the crew would use?
- What is your idea, and which lamp or force would show it is right?
- You changed something. How will you prove it fixed the fault?
- On Job 6, how could you tell the program apart from the sensor?
- What will the next technician need from your fix report?

> The second question is the one that matters. A student who can say which lamp would prove the idea before changing anything is troubleshooting; a student who cannot is guessing.

Cross-curricular extensions

- Writing: rewrite one fix report for a reader who was not there, in five sentences or fewer.
- Math: if a technician earns $30 an hour and a wrong part costs $85, what did replacing two good sensors on Job 6 cost, with ten minutes each?
- Science: compare the troubleshooting steps with the steps of an experiment. Where do the idea and the test fit?
- Careers: look up the job of an industrial maintenance technician. How much of the day is finding faults?

Vocabulary

Symptom	What the line does wrong, in words anyone on the floor would use: the belt will not start, labels smear, boxes fall.
Field and Image	Field is the wire at the PLC's terminal right now. Image is the PLC's copy, taken at the start of each scan. If Field is wrong for what is in front of the device, suspect the device.
Force	Making an input or output ON or OFF whatever the field or the program says, to test an idea. On a real machine, only with permission and nobody near it.
Stuck ON	A failed sensor whose output stays ON whatever is in front of it.
Fix report	A short record for the next technician: the symptom, what was checked first, the fault, and how the fix was proved.

Differentiation

ENGLISH LEARNERS

- Keep the vocabulary slide up, and point at the lamp in the wiring list or the instruction on the ladder as you say each word: the picture carries the meaning.
- Give the fix report as frames: The line _____. I checked _____. The fault was _____. I proved it by _____.

STUDENTS WITH IEPS OR 504 PLANS

- Pair students, one running the line and one keeping the fix report.
- Turn on Big screen to watch the station.
- Where the IEP allows a modified assignment, score Jobs 1, 3 and 6 only.

- Let students name the symptom by pointing and acting it out before writing it.

STUDENTS WHO NEED MORE SUPPORT

- Do Job 3 together on the board, all the way to the fix report, before students work alone.
- Give the four steps from Symptom to rung on a card.
- For Job 6, tell students to turn the line on and watch only the Eye row of the wiring list as a box drops into the case.

STUDENTS READY FOR MORE

- Jobs 7 to 12 have a Fix the line tab too: Job 8's fuses blew, Job 10's arm hits the guard. Pick one.
- Write a troubleshooting card for the next technician: five steps, each one a thing to look at, in order.
- Setup can give any job a failed sensor instead of its own fault. Set one up for a partner and swap.

Adapting for other grades

Younger students: In grade 9, do Jobs 1 and 3 together and let students try Job 6 in pairs. Score the first two rubric rows, total 8, and 6 meets the objectives.

Older students: In a second-year PLC course, have students set each other's faults in Setup (a stuck-ON or stuck-OFF sensor on any job) and trade, with a fix report for each.

Student worksheet

Name: _____ Date: _____

Open the app: scan the QR code, or go to mytekdev.com/try/plclab?lesson=find-the-fault

Essential question: How do you find a fault you cannot see, and prove you found it?

Warm-up: A bike makes a new grinding noise. What do you check first, before buying a part?

_____

1. **Job 1 (together).** Symptom: _____ Checked: _____ Fault: _____ Proof: _____
2. **Job 3.** Symptom: _____ Checked: _____ Fault: _____ Proof: _____
3. **Job ____.** Symptom: _____ Checked: _____ Fault: _____ Proof: _____
4. **Job ____.** Symptom: _____ Checked: _____ Fault: _____ Proof: _____
5. **Job 6.** Symptom: _____ What told me it was not the program: _____ Devices I replaced: _____ Proof: _____

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1. On Job 6, the program was right. What did you look at that showed it?

_____

_____

2. Write one rule for the next technician: Before you change _____, check _____.

_____

_____

Exit ticket

Name: _____

1. A belt will not start. What is the best first step? (A) rewrite the rung (B) run it and watch, and read the input lamps (C) replace the Start button

2. As a box drops past a working through-beam eye, its Field lamp: (A) stays lit (B) goes off for a moment (C) stays off

3. Name one thing a fix report must say, and why the next technician needs it.

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Exit ticket

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Answer key: exit ticket

QUESTION	ANSWER	WHY
1	B	The symptom and the lamps come before any change: a change made without them may hide the fault or add a new one.
2	B	A through-beam eye is ON while the beam is clear and OFF while something blocks it. On Job 6 the lamp stayed lit: the eye was stuck ON.
3	Open answer	For example: the symptom, so the next person knows if it comes back; or the proof, so they know the fix was tested and not guessed.

Worksheet: what students should find

BLANK	WHAT THE APP SHOWS
Job 1	The belt never starts, Delivered 0 of 8. Stop's lamps are lit as they should be; the Stop contact was normally closed. Changed to normally open; the shift passes.
Job 2	Every label smears. The Hold timer's preset was 300 ms; about 3000 ms fixes it.
Job 3	6 of 12 in cases; after the first case the line never starts, even after Reset. The counter's reset rung reads Start; it should read Reset.
Job 4	Parts pile up at the pusher and fall. Reset Pusher was deleted from the PusherOut rung; put it back.
Job 5	Every bottle fills, but liquid pours on the belt between bottles. The Bottle contact was taken out of the valve rung; put a normally open Bottle back in it.
Job 6	6 of 12 in cases, 6 on the floor, and the jam check fails. The Eye lamp never goes off as boxes drop in: Eye is stuck ON. Replace Eye with the line off; the shift passes.

> How many boxes land on the floor on Job 4 changes a little from shift to shift. Setup's Print answer key lists every job's fault too.

Rubric

Score each row from 1 to 4.

Name: _____

CRITERIA	4 EXCEEDS	3 MEETS	2 APPROACHING	1 BEGINNING
Symptom before change	For every job, names the symptom from the line and the result before changing anything, and states an idea with the lamp or force that tested it.	Names the symptom before changing anything on most jobs.	Changes the program first and names the symptom afterward.	Changes things until something works, with no symptom written.
Finding the fault	Fixes Job 6 by replacing only Eye, and four or more of Jobs 1 to 5 with one change each.	Fixes Job 6 and at least two of Jobs 1 to 5.	Fixes some of Jobs 1 to 5 but not Job 6, or fixes Job 6 by replacing several devices.	Fixes none.
The fix report	Every report has the symptom, what was checked, the fault, and the passing shift as proof, clear enough for someone else to follow.	Reports have all four parts for the jobs fixed.	Reports name the fault but leave out the symptom or the proof.	No reports.

Total: ____ / 12. A score of 9 or more meets the objectives.

Standards

The lesson addresses the troubleshooting goal of Texas's Programmable Logic Controller II course, the interpreting line of Massachusetts's Standard 9, and PMMI's and SACA's troubleshooting and interpreting competencies. It is practice for these skills on a simulated line, not a replacement for time on a real trainer.

FRAMEWORK	CODE	GRADES	STANDARD	HOW THE LESSON MEETS IT
Texas Programmable Logic Controller II (innovative course N1303690)	**Course description**	11-12	... be able to troubleshoot the PLCs in common industrial applications.	Students troubleshoot six conveyor applications: a start/stop, a labeler, a case packer, a sorter, a filler and a whole line with a failed sensor.
Texas Programmable Logic Controller II (innovative course N1303690)	**(2)(D)**	11-12	integrate timers and counters within event sequencing applications;	Jobs 2, 3 and 6 put a timer or a counter inside a running sequence, and the fault is in how it fits there.
Massachusetts Robotics and Automation Engineering Technology, July 2025	**Standard 9**	9-12	Develop and interpret PLC programming and wiring diagrams for components like motor starters, contactors, manually operated switches, and sensors, and create diagrams from electromagnetic relay logic and narrative descriptions.	Students interpret programs and the wiring list (devices, how each is wired, addresses) to find each fault. They do not draw wiring diagrams in this lesson.
PMMI Mechatronics: Programmable Logic Controllers 1	**PLC 1 competency**	Entry-level technicians	Use the Force Function to force an input or output	With the line on, students force inputs and outputs from the wiring list to test an idea, and the app explains that forces end when the line goes off, unlike on a real PLC.
PMMI Mechatronics: Programmable Logic Controllers 1	**PLC 1 competency**	Entry-level technicians	Troubleshoot a PLC program which controls a piston filler machine	Job 5 is a bottle filler with a fill valve and a level switch, not a piston filler, so it is close practice rather than the same machine.

FRAMEWORK	CODE	GRADES	STANDARD	HOW THE LESSON MEETS IT
SACA C-207 Programmable Controller Systems 1	**C-207 key skills**	Industry credential	Interpreting basic and intermediate level PLC ladder logic programs (with contacts, coils, timers, counters, math, comparison instructions); interpreting common PLC program logic applications using electro-pneumatic actuators and on/off motor control systems.	Students interpret ladder programs with contacts, coils, timers and counters, and a pusher driven by an electro-pneumatic valve, to find what each fault changed.

Checked November 2026 against: Texas Education Agency: Programmable Logic Controller II, innovative course (2021-2022), Massachusetts DESE: Robotics and Automation Engineering Technology Standards and Skills (July 2025), PMMI: Programmable Logic Controllers (PLCs) 1 certification test, Polk State College: PMMI PLC 1 competency list, O*NET: SACA C-207 Programmable Controller Systems 1.

Optional: save student work in a free class

The whole lesson runs at the link on the worksheet, with no accounts and no sign-up.

To keep students' work, and see it all in one place, make a free class. It takes about ten minutes, once, and covers every lesson in this series: mytekdev.com/tools/class-setup

Students in a class open mytekdev.com/tools/plc-lab/lessons/find-the-fault/start instead of the worksheet link. Each one gets their own copy of the starter, and the same link reopens it next time.

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