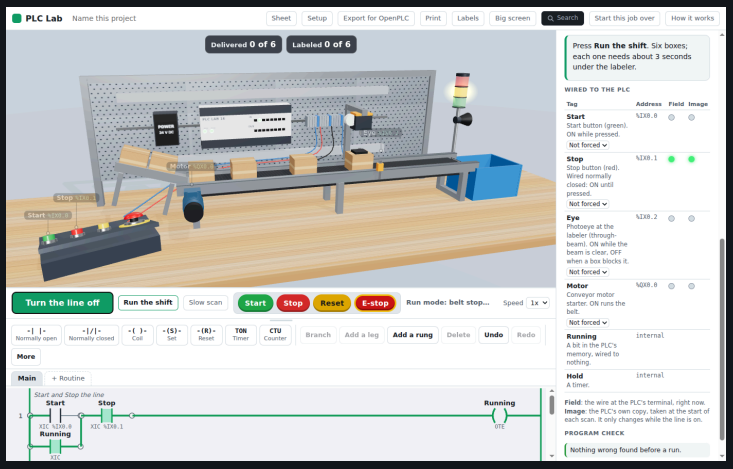
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PLC Lab: Timers on the Line, On-Delay and Pulse Timers on a Conveyor

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 timer comparison table
- 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, SACA and CSTA 2017

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Two jobs on the same conveyor. In Job 2 a labeler presses a label onto each box, and the box has to stand still under it for 3 seconds. A through-beam photoeye marks the spot: its input is ON while the beam is clear and OFF when a box blocks it. Students stop the belt on the eye, time the wait with an on-delay timer, and let the box go on the timer's done bit. Too short a time and every label smears. In Job 7 the line has to sound a horn for 3 seconds before the belt moves, which is a pulse timer's job, with a flashing amber light for students who get that far.

At a glance

ESSENTIAL QUESTION

How does a PLC make a machine wait, and how does it know what to wait for?

OBJECTIVES

Students will be able to:

- explain why a through-beam photoeye's input is OFF when a part blocks it
- use an on-delay timer's done bit to hold an output off for a set time
- choose a preset from what the machine needs and test it on a shift
- tell an on-delay timer from a pulse timer and an off-delay timer

VOCABULARY

Through-beam photoeye, On-delay timer (TON), Preset and accumulated, Done bit, Pulse timer (TP), Off-delay timer (TOF)

STANDARDS

(2)(A), (2)(B), Recommended activity, Recommended activity, (3)(F), Standard 9, PLC 1 competency, C-207 key skills, 3A-AP-16

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=timers-on-the-line&ref=tpt-plclab-2 once on a student computer: it opens on Job 2, Build it. Follow the short guide yourself, Job 7 included, about fifteen minutes; the flasher on Job 7 is the slow part. 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 machine that waits a set time, and what goes wrong if the wait is too short.	Answer the warm-up on the worksheet.
5 to 12	**Direct instruction (I do)** Model it	Project Job 2. Read the story: each box stands still under the labeler for 3 seconds. Point at Eye in the wiring list. Turn the line on, press Start, and let the class call out what Eye's Field lamp does as a box passes. Show The box waits at the eye, then Three timers. Use the warm-up's headlights for TOF. Do not build the timer. **It's working when:** Many students expect a sensor to be ON when it sees something. A through-beam eye sees the beam, so it is ON when nothing is there. Say it, then let them watch the lamp.	Watch, fill in the vocabulary, and fill in the eye line on the worksheet.
12 to 24	**Guided practice (We do)** Job 2	Students open the link or scan the QR code. The guide has them watch Eye, then build from the hints on the right: a normally open Eye contact in the Motor rung, a rung that runs a Timer named Hold on a normally closed Eye, and a branch around Eye with Hold.DN. Then Run the shift: six boxes, every label clean. **Watch for:** Students who stop the belt on Eye with no timer. The belt stops at the eye for good: the result says something has to let Motor back on. **If they ask:** "Try 2000 ms. What happens to the labels, and what does that tell you about how long the labeler needs?" The preset	Follow the guide, and fill in the Job 2 box on the worksheet after the first shift.
24 to 39	**Independent practice (You do)** Job 7, the warning	Students pick Job 7, The Signal Tower. The horn must sound for 3 seconds before the belt moves. They add a Pulse timer (under More) named Warn, 3000 ms, on Running; hold Motor off while Warn.Q is ON; sound Horn on Warn.Q. The flasher, two 500 ms timers that restart each other, is for those who get there. Walk the room with the What to look for questions. **Watch for:** Students who time the warning with an on-delay timer on Start. The crew's press lasts under half a second, so the timer never finishes and the belt never moves. A pulse timer gives the full 3 seconds from one press.	Build the warning, run the shift, and fill in the timer table on the worksheet.
39 to 45	**Closure** Share and exit ticket	Show Back to the warm-up. Two students say which timer their machine needs and why. Hand out the exit ticket.	Answer the exit ticket.

Before you teach: a fifteen-minute walkthrough

Open mytekdev.com/try/plclab?lesson=timers-on-the-line&ref=tpt-plclab-2. A short guide opens over Job 2, Stop at the Eye, on the Build it tab. A labeler stands over the belt, and a photoeye shines across it where a box should stop.

1. **The wiring list.** Start, Stop and Motor as in Job 1, plus Eye at %IX0.2: a through-beam photoeye, ON while the beam is clear, OFF when a box blocks it.
2. **The starting program.** Two rungs: Job 1's seal-in on a bit called Running, and Running to Motor. Run the shift: six boxes ride past the labeler and none is labeled.
3. **Job 2's answer.** A rung with a normally closed Eye to a Timer named Hold, 3000 ms; in the Motor rung, after Running, a branch of normally open Eye or normally open Hold.DN. The hint box gives these one at a time.
4. **The preset.** The labeler needs the box still for about 2.7 seconds. At 2650 ms or less every label smears; from 2700 ms up the shift passes. Fix the line on Job 2 is the same program with the preset at 300 ms.
5. **Job 7.** Pick The Signal Tower. Its panel has only Start and Stop. The starting program runs the belt with no warning. The answer: a Pulse timer (under More) named Warn, 3000 ms, on Running; a normally closed Warn.Q in the Motor rung; Warn.Q to Horn; and a flasher of two 500 ms timers for the amber light. The crew starts, stops and restarts the line, so there are two warnings to pass.

> 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. A timer's accumulated time shows on the ladder while the line is on.

Background for the teacher

Most students first meet sensors that are ON when they see something. A through-beam photoeye sees its own beam, so it is ON while nothing is in the way, the "light-on" setting. The app's wiring list says which way each eye is set up, and on Build it Eye can be switched to dark-on, which flips it. Reading that line before writing a rung is the habit to build.

An on-delay timer's time resets when its rung goes false, which is why the Job 2 timer goes on a normally closed Eye: it times only while a box is in the way, and starts fresh for the next box. The belt starts again on the done bit, Hold.DN, while the box still blocks the eye.

Texas's PLC II course lists TON, TOF and TP together, and a flasher made from two timers, as recommended activities. Allen-Bradley Micro800 has a TP instruction; MicroLogix and ControlLogix do not, and do the same job with a TON whose done bit is read normally closed. The app's More menu has all three IEC timers and a retentive timer.

> On a real line the warning time is set by each plant; 3 to 5 seconds is common. Job 7 uses 3.

What to look for

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

- Is Eye ON or OFF while a box is under the labeler? Why?
- Why does the timer rung use a normally closed Eye contact?
- What lets the belt start again while the box is still blocking the eye?
- Why does a pulse timer suit the horn better than an on-delay timer on Start?
- Where would you use an off-delay timer on this line?

> The third question is the one that matters. A student who points at Hold.DN on the branch understands the done bit as a signal other rungs can read.

Cross-curricular extensions

- Math: the belt moves at 0.12 m per second. How far would a box travel in the 0.3 seconds of a 300 ms timer? In 3 seconds?
- Physics: look up how a through-beam, a retroreflective and a diffuse photoeye differ, and which one Job 5's bottle sensor is.
- Writing: write the warning sign for a conveyor that starts after a horn, in fifteen words or fewer.
- Careers: find a job posting for a packaging machine technician and underline every skill this lesson touched.

Vocabulary

Through-beam photoeye	A light beam across the belt to a receiver. Its input is ON while the beam is clear and OFF while a part blocks it.
On-delay timer (TON)	Starts timing when its rung turns true. Its done bit turns ON once the rung has been true for the preset. If the rung goes false, the time resets.
Preset and accumulated	The preset (PRE) is the time to reach, in milliseconds here. The accumulated value (ACC) is how far the timer has got.
Done bit	A timer's output bit, written Hold.DN for a timer named Hold. Other rungs read it with contacts.
Pulse timer (TP)	Once its rung turns on, its bit (Q) is ON for the preset, then OFF, whatever the rung does next.
Off-delay timer (TOF)	Stays done for its preset after its rung turns false. Used to keep something running a little after the signal stops.

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.

STUDENTS WITH IEPS OR 504 PLANS

- Pair students, one building and one watching the Eye lamp and the timer's ACC.

- Act out the eye: one student holds a hand across a line of light from a phone flashlight; the class says ON or OFF.
- Give each timer a sentence frame: A _____ timer is ON / done _____ its rung turns _____.

- Turn on Big screen to see the labeler up close.
- Where the IEP allows a modified assignment, finish Job 2 only and score the first two rubric rows.

STUDENTS WHO NEED MORE SUPPORT

- Build the Job 2 timer rung together on the board, then let students add the branch.
- Press Show me how in the hint box for each step.
- Give the three Job 2 rungs on a card in words, not pictures.

STUDENTS READY FOR MORE

- Job 7's flasher: two 500 ms timers that restart each other. Change it to 250 ms on and 750 ms off.
- Find the shortest Hold preset that still labels all six boxes on Job 2. Why is the shortest one not the best one to use on a real line?
- Job 7's Fix the line tab: the crew says the horn only chirps now. Find it.

Adapting for other grades

Younger students: In grade 9, do Job 2 together on the board and let students change the preset to see the labels smear. Skip Job 7. Score the first two rubric rows, total 8, and 6 meets the objectives.

Older students: In a second-year PLC course, add an off-delay timer of their own to Job 7 (under More), for example the green light staying on for 2 seconds after Stop, and compare TON, TOF and TP on one sheet.

Student worksheet

Name: _____ Date: _____

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

Essential question: How does a PLC make a machine wait, and how does it know what to wait for?

Warm-up: A machine that waits a set time: _____ What goes wrong if the wait is too short?

_____

1. **Vocabulary.** Through-beam photoeye, on-delay timer, preset, done bit, pulse timer, off-delay timer: write each in your own words.

2. **The eye.** While a box blocks the beam, Eye is _____. While the beam is clear, Eye is _____.
3. **Job 2.** My timer's name and preset: _____ The contact that lets the box go: _____ With a preset of 2000 ms, the labels _____.
4. **Timers.** Fill in: TON is done _____. TP is ON _____. TOF stays done _____.

5. **Job 7.** The timer I used for the horn: _____ Its preset: _____ Did the shift pass? _____ If not, the result said: _____

1. Why does the Job 2 timer rung use a normally closed Eye contact, not a normally open one?

2. Name one place on a real line, or at home, for each kind of timer: TON, TP, TOF.

Exit ticket

Name: _____

1. A through-beam photoeye's input while a box blocks the beam is: (A) ON (B) OFF (C) it depends on the box's color

2. An on-delay timer with a 3000 ms preset. Its rung is true for 2 seconds, then false. Its done bit: (A) turns on at 3 seconds anyway (B) never turns on, and the time resets (C) turns on at 2 seconds

3. A horn must sound for exactly 3 seconds each time Start is pressed, however long Start is held. Which timer, and why?

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Answer key: exit ticket

QUESTION	ANSWER	WHY
1	B	The receiver sees the beam while nothing is in the way, so the input is ON when clear and OFF when blocked.
2	B	An on-delay timer resets when its rung goes false before the preset is reached.
3	Open answer	A pulse timer (TP): its bit is ON for the preset from the moment the rung turns on, whatever the rung does next. A TON on Start would last only while Start is held.

Worksheet: what students should find

BLANK	WHAT THE APP SHOWS
The eye	Blocked: OFF. Clear: ON.
Job 2	A timer such as Hold, about 3000 ms (2700 ms and up passes). Hold.DN on a branch around Eye. At 2000 ms every label smears.
Timers	TON: done after its rung has been true for the preset. TP: ON for the preset from when its rung turns on. TOF: stays done for the preset after its rung turns off.
Job 7	A pulse timer (TP), 3000 ms. The shift checks the horn lasts about 3 seconds before each start; without a flasher it fails on Amber flashed during the warning.
Question 1	A normally closed Eye is true only while a box blocks the beam, so the timer runs only then and resets for the next box.

> A preset from 2700 ms to 8000 ms passes Job 2. A longer one slows the line, and from about 10 seconds the shift reads the belt as stuck at the eye.

Rubric

Score each row from 1 to 4.

Name: _____

CRITERIA	4 EXCEEDS	3 MEETS	2 APPROACHING	1 BEGINNING
The eye	Explains a through-beam eye from the beam, and uses both a normally open and a normally closed Eye contact correctly.	Explains that Eye is OFF when blocked and stops the belt on it.	Stops the belt on Eye but cannot say why the contact is normally open.	Does not use Eye.
The on-delay timer	Passes Job 2 on three shifts and explains why the preset has to be about 3 seconds.	Passes a Job 2 shift with a timer and its done bit.	Adds a timer, but the belt never starts again or every label smears.	No timer.
Choosing a timer	Builds Job 7's warning with a pulse timer and explains the difference from TON and TOF in their own words.	Fills in the timer table correctly and starts Job 7's warning.	Fills in part of the timer table.	Cannot tell the timers apart.

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

Standards

The lesson addresses the timer lines of Texas's Programmable Logic Controller II course, and the matching lines in Massachusetts's Standard 9, PMMI's PLC 1 list and SACA C-207. It is practice for these skills on a simulated station, 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)	**(2)(A)**	11-12	differentiate between on-delay timers and off-delay timers;	Direct instruction and the worksheet's timer table compare TON, TOF and TP; the exit ticket asks students to choose.
Texas Programmable Logic Controller II (innovative course N1303690)	**(2)(B)**	11-12	apply the use of a timer to cause a delay in the action of an output;	Job 2 holds Motor off for 3 seconds at the eye; Job 7 delays Motor until the 3-second warning ends.
Texas Programmable Logic Controller II (innovative course N1303690)	**Recommended activity**	11-12	Write a ladder logic program that creates a flasher circuit using two timers.	Job 7's amber light is that flasher, for students who reach it.
Texas Programmable Logic Controller II (innovative course N1303690)	**Recommended activity**	11-12	Write a ladder logic program to create a conveyor system that uses sensors.	Job 2 runs a conveyor from a through-beam photoeye.
Texas Programmable Logic Controller I (innovative course N1303689)	**(3)(F)**	10-12	identify normally open (NO) and normally closed (NC) states for common field input devices;	Students read the photoeye's light-on state and use it both ways round in two rungs.
Massachusetts Robotics and Automation Engineering Technology, July 2025	**Standard 9**	9-12	Develop PLC programs using functions such as delay and retentive timers, counters, program control instructions (Master Control Reset, Jump, and Subroutines), data manipulation, data comparison, basic math functions, sequencer and shift register instructions, and programming blocks for analog inputs/outputs and PID control.	Students develop programs with delay timers (on-delay and pulse) on Jobs 2 and 7. The other functions in the line are taught elsewhere in the app, not in this lesson.

FRAMEWORK	CODE	GRADES	STANDARD	HOW THE LESSON MEETS IT
PMMI Mechatronics: Programmable Logic Controllers 1	**PLC 1 competency**	Entry-level technicians	Enter and edit a PLC program that uses a TON instruction	Job 2: students enter a TON, set its preset, and edit it after a failed shift.
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 and write timer logic controlling a conveyor motor and a warning horn.
CSTA 2017	**3A-AP-16**	9-10	Design and iteratively develop computational artifacts for practical intent, personal expression, or to address a societal issue by using events to initiate instructions.	A box blocking the eye and a press of Start are events that start the timers; students revise the program from each shift's result.

Checked November 2026 against: Texas Education Agency: Programmable Logic Controller I, innovative course (2020-2021), 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, CSTA K-12 Computer Science Standards, Revised 2017.

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/timers-on-the-line/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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