OnCallGrid Academy

Industrial Knowledge. On Call.

PLC Fundamentals

What Every Maintenance Technician Should Know

LESSON 001 • OCG-C001 Industrial Automation Fundamentals

Student Reference PDF • OCG-PDF001
Building Skills. Solving Problems. Driving Industry.

LESSON TIME (estimated)	
Reading	~15 min
Video (OCG-V001, once published)	~18 min
Knowledge Check (OCG-Q001)	~5 min

Total Estimated Time: *≈* ***38 minutes*** *— reading and quiz timing measured from this document; video timing is an estimate until OCG-V001 is recorded and its actual runtime is known.*

1. LEARNING OBJECTIVES

- Learn what a PLC is and why it's used.
- Identify the major PLC components.
- Explain the PLC scan cycle.
- Recognize common industrial applications.

2. INTRODUCTION

Industrial machines and processes need to run **reliably, safely and efficiently.** Programmable Logic Controllers (PLCs) were developed to replace hardwired relay logic, making systems easier to modify, troubleshoot, and adapt to expansion.

PLCs are used in almost every industry — from material handling and conveyors to packaging machines, warehouses, water treatment plants, HVAC systems, and almost every modern manufacturing process.

Common applications: Conveyors • Packaging • Warehousing • Manufacturing

Conveyors

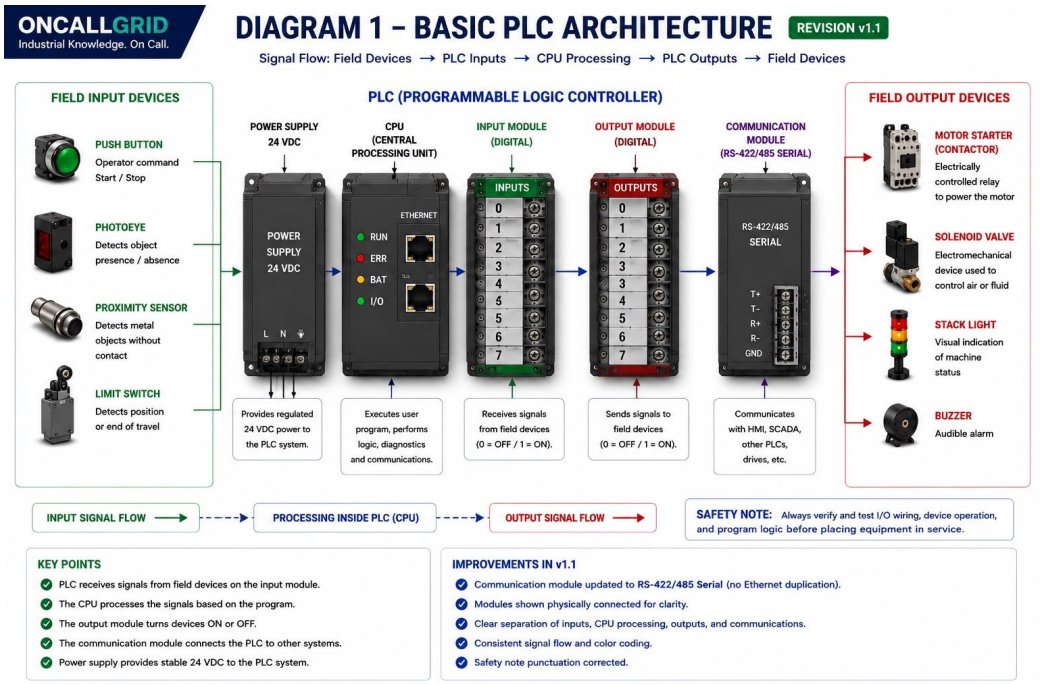
Packaging

Warehousing

Manufacturing

3. WHAT IS A PLC?

A PLC is a rugged industrial computer designed to monitor inputs, process them, make decisions based on a user program, and drive outputs in real time.

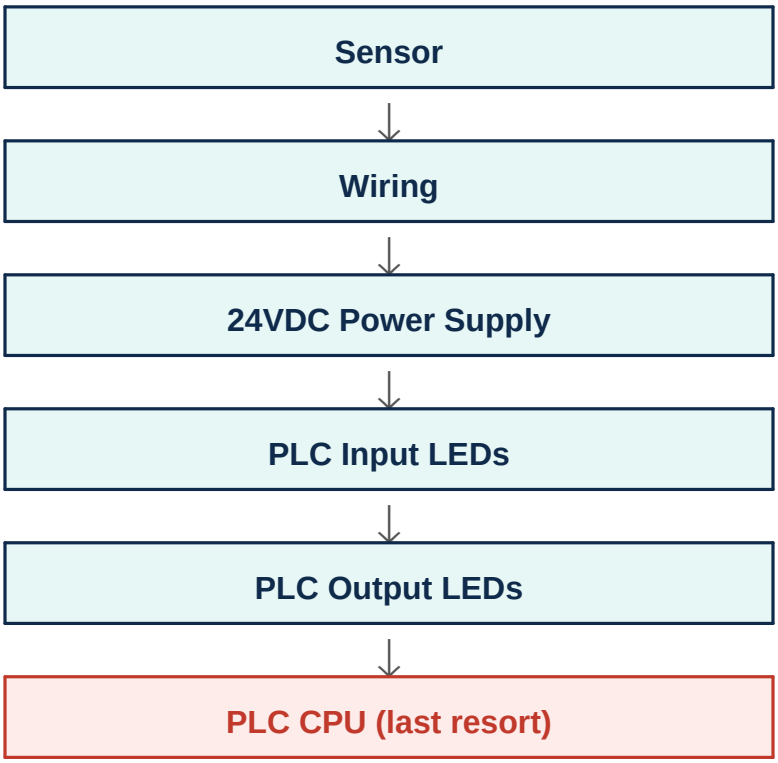


OCG-D001 — Basic PLC Architecture (Rev v1.1)

GRID KNOWLEDGE — WHY EXPERIENCED TECHNICIANS RARELY BLAME THE PLC FIRST

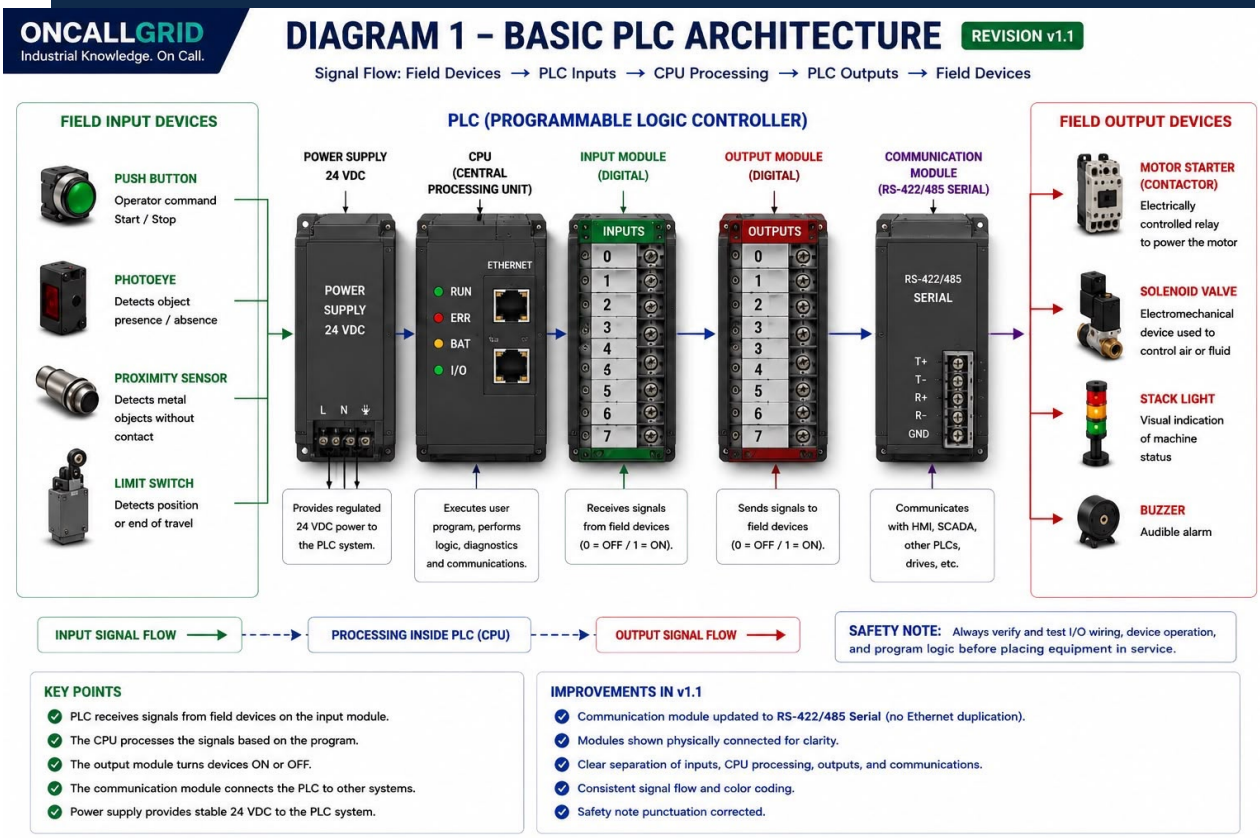
When a machine stops working, the PLC is usually not the failed component. Experienced technicians check the field-level causes first, because they're far more common than an internal PLC failure.

Technicians should inspect, in this order, before replacing the PLC:



This order matters because it goes from **most likely** to **least likely** cause. Field devices, wiring, and power supplies fail far more often than the PLC's internal logic — checking them first saves time and avoids unnecessary parts replacement.

REFERENCE DIAGRAM — OCG-D001: BASIC PLC ARCHITECTURE



Signal flow: Field Devices → PLC Inputs → CPU Processing → PLC Outputs → Field Devices

INSTRUCTOR TIP

Pause the lesson here. Identify every input device shown in Diagram D001 before continuing. Can you locate:

- Push Button
- Photoeye
- Proximity Sensor
- Limit Switch

WHAT D001 LOOKS LIKE IN THE REAL WORLD

1. CPU
2. Input Module
3. Output Module
4. Power Supply
5. Terminal Blocks
6. Ethernet Port

Typically Inside a PLC Cabinet

1. CPU Module — runs the program and scan cycle

2. Input Module — terminal block where field devices (sensors, switches) land

3. Output Module — terminal block where field devices (contactors, valves) are driven

4. Power Supply — converts incoming AC to regulated 24VDC

5. Terminal Blocks — 24VDC and common wiring distributed to field devices

6. Ethernet Port — connection to HMI, SCADA, or other PLCs

Left: a real PLC cabinet. Center: a generic numbered reference — module positions vary by manufacturer and panel design, so the numbers map to the reference diagram and list, not to exact positions in this specific photo. Refer to OCG-D001 for the labeled signal-flow diagram of these same components.

4. HOW A PLC WORKS — THE SCAN CYCLE

The PLC runs a program in a continuous loop (scan) in four steps:

1. READ INPUTS	The PLC reads input status and stores it in memory.
2. EXECUTE LOGIC	The CPU executes the user program instructions.
3. UPDATE OUTPUTS	The PLC updates outputs based on program results.
4. REPEAT	The cycle repeats continuously — scan time varies by PLC and program size.

Key points: inputs are read before logic execution; outputs are updated after logic execution; communication and diagnostics occur within this cycle (no separate step). Always verify and test I/O wiring, device operation, and program logic before placing equipment in service.

GRID INSIGHT

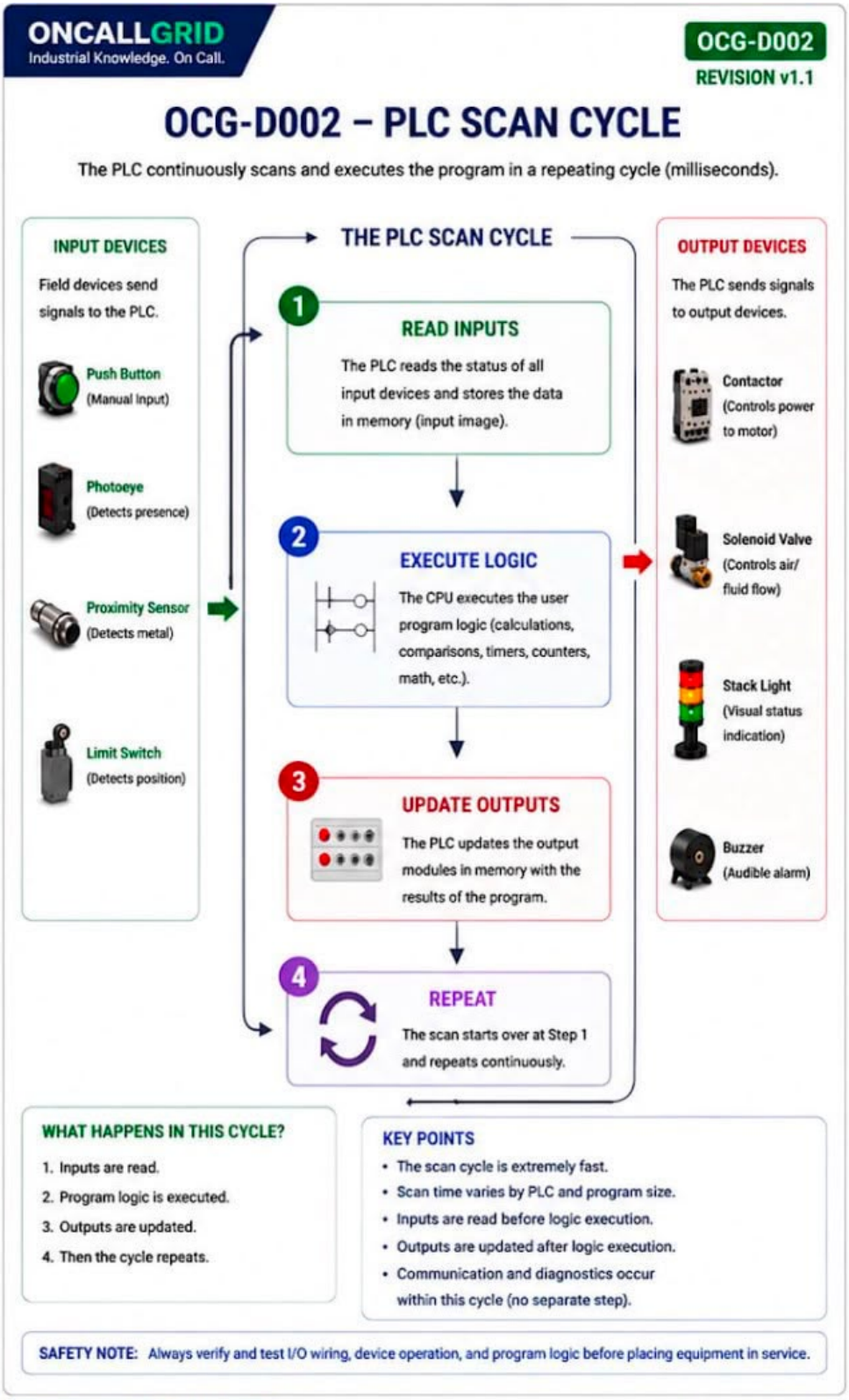
A PLC executes the entire scan in only a few milliseconds.

Because of this, many “intermittent” faults are actually caused by loose wiring or unstable sensors — not slow PLC processing.

DID YOU KNOW?

A PLC with a fast scan time can complete its entire program hundreds to thousands of times every second — fast enough to catch a sensor change happening quicker than the human eye can register.

REFERENCE DIAGRAM — OCG-D002: PLC SCAN CYCLE

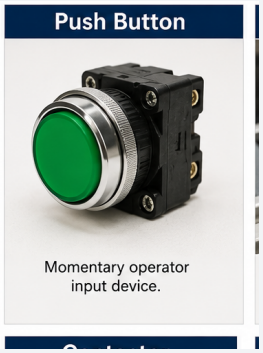


OCG-D002 — PLC Scan Cycle (Rev v1.1)

5 & 6. TYPICAL INPUTS AND OUTPUTS

Field devices you'll encounter connected to PLC inputs and outputs:

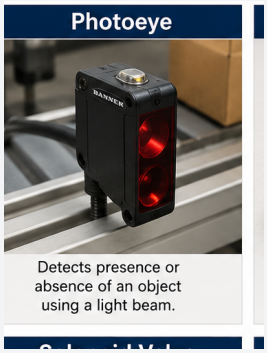
INPUT DEVICES



Push Button

Momentary operator input device

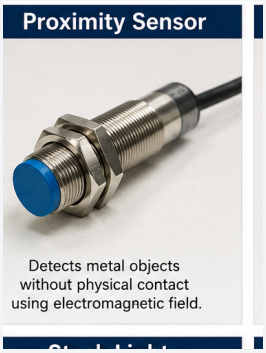
Common failure: *worn contacts, stuck plunger*



Photoeye

Detects presence/absence via light beam

Common failure: *dirty lens, misalignment*



Proximity Sensor

Detects metal without contact

Common failure: *sensing distance drift, damaged face*

Limit Switch

Detects position or end-of-travel

Common failure: *broken roller arm, loose mounting*

OUTPUT DEVICES

Contactor

Switches high-voltage power to loads

Common failure: *pitted contacts, failed coil*

Solenoid Valve

Controls air, gas, or fluid flow

Common failure: *coil burnout, debris in valve*

Stack Light

Visual machine status indication

Common failure: *burnt-out bulb/LED segment*

VFD

Controls AC motor speed and torque

Common failure: *tripped fault, cooling fan failure*

Also common: Indicator Lights, Buzzer/Alarm (audible)

GRID TROUBLESHOOTING TIP

If an input never changes ON, work through this order — don't jump straight to the PLC:

Step 1 → Measure 24VDC.
Step 2 → Check the sensor LED.
Step 3 → Verify wiring continuity.
Step 4 → Watch the PLC input LED.
Step 5 → Only then suspect the PLC input.

GRID FIELD EXPERIENCE

If the PLC output LED is ON but the contactor never pulls in, don't replace the PLC. Check:

- Coil voltage
- Blown fuse
- Overload relay
- Broken wire
- Failed contactor coil

GRID BEST PRACTICE

Never clear a VFD fault before recording the fault code.

The fault history often tells you more than the current machine condition.

7. REAL EXAMPLE — CONVEYOR CONTROL

This example demonstrates a typical PLC-controlled conveyor system. A Start Push Button, Limit Switch, and Photoeye send input signals to the PLC. The PLC evaluates these inputs and controls the conveyor through a VFD/Contactor while operating a Stack Light for machine status indication.

- Emergency Stop is reset.
- Limit Switch indicates the conveyor is in position.
- Product is detected by the Photoeye.
- Operator presses Start Push Button.

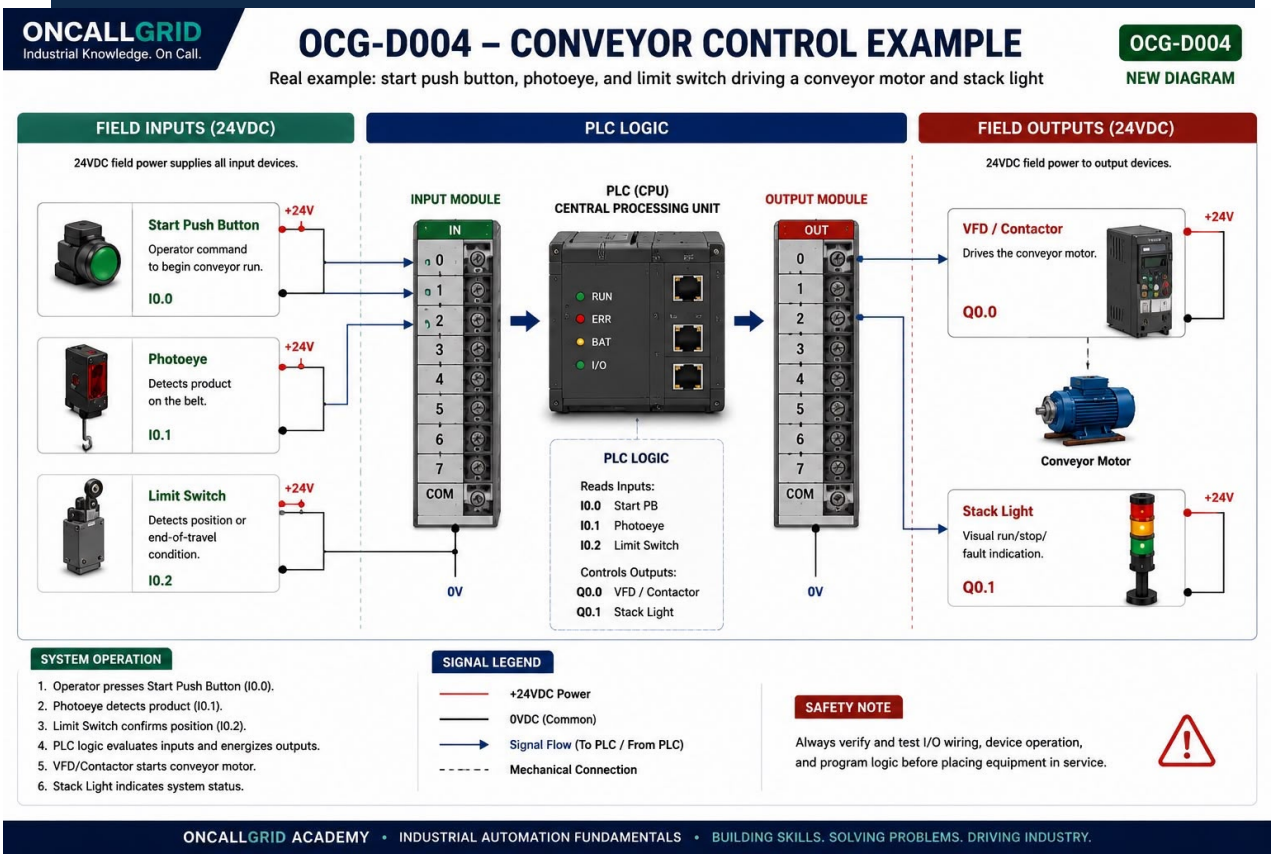
See OCG-D004 — Conveyor Control Example for the complete wiring layout, PLC I/O assignments, signal flow, and system operation (next page).

GRID REAL-WORLD EXAMPLE

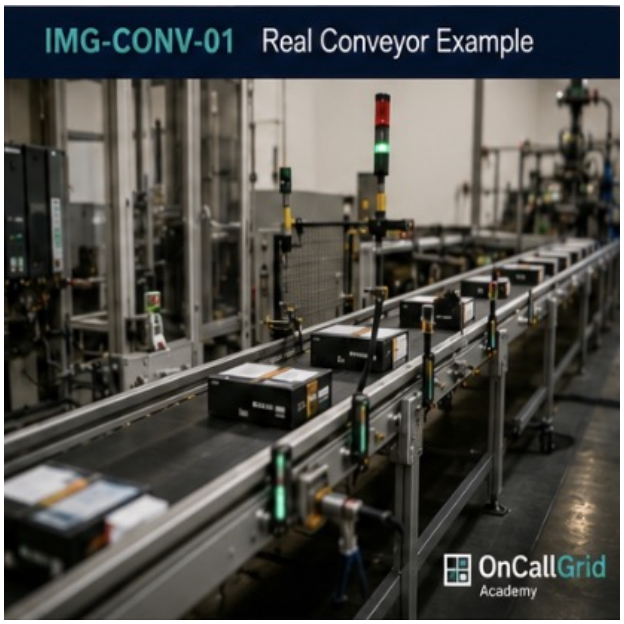
Operator presses START
↓
Photoeye confirms product
↓
PLC starts conveyor
↓
Product reaches limit switch
↓
PLC stops conveyor
↓
Stack light changes GREEN

This is exactly how thousands of warehouse conveyor systems operate every day.

REFERENCE DIAGRAM — OCG-D004: CONVEYOR CONTROL EXAMPLE



OCG-D004 — Conveyor Control Example (New Diagram)



What OCG-D004 looks like in the real world.

INSTRUCTOR CHALLENGE

The motor doesn't start. The PLC RUN LED is ON. The Photoeye is ON. The Output LED is OFF.

What should you check next?

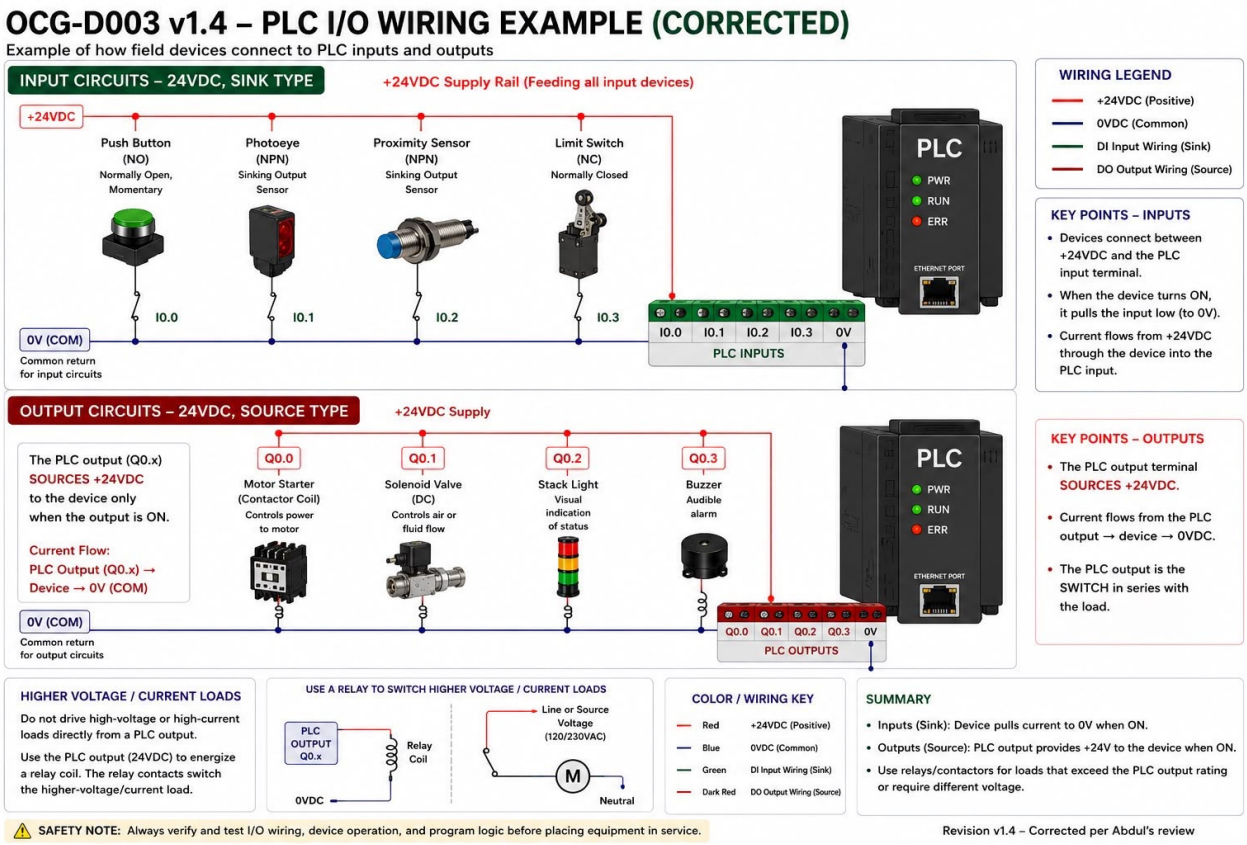
Think it through before turning the page.

INSTRUCTOR CHALLENGE — ANSWER

Check the PLC's program logic next — not the wiring or the output module yet.

The RUN LED confirms the PLC is scanning normally, and the Photoeye being ON confirms that input signal is reaching the PLC correctly. But the Output LED is OFF, which means the PLC itself has not yet decided to energize that output. Since the input side is confirmed good, the next step is checking whether the program logic actually requires additional conditions to be met (another interlock, a timer, an E-Stop reset, or a second sensor) before it will turn that output on — not assuming the output module or field wiring has failed.

REFERENCE DIAGRAM — OCG-D003: PLC I/O WIRING EXAMPLE (CORRECTED)



OCG-D003 v1.4 — PLC I/O Wiring Example, corrected per Abdul's technical review

8. COMMON MAINTENANCE MISTAKES

- Assuming the PLC is bad before checking inputs.
- Ignoring safety device status.
- Not verifying outputs.
- Incorrect wiring or loose connections.
- Not checking field devices.
- Not checking logs or alarms.
- Not following lockout/tagout procedures.

GRID SAFETY REMINDER

A PLC cannot replace Lockout/Tagout.

Always isolate electrical energy before touching wiring, even if the PLC is in STOP mode.

SAFETY NOTE: Always verify and test I/O wiring, device operation, and program logic before placing equipment in service.

GRID: THINK LIKE A TECHNICIAN

Before replacing any component, ask yourself:

- Is power available?
- Is the input reaching the PLC?
- Is the PLC making the correct decision?
- Is the output energized?
- Is the field device working?

Follow the signal — not your assumptions.

9. KNOWLEDGE CHECK — OCG-Q001

☐ **1. What does PLC stand for?**

☐ **2. What are the four steps of the scan cycle?**

☐ **3. What is the purpose of the input module?**

☐ **4. Name two common PLC outputs.**

☐ **5. What device would you use to control a motor's speed?**

ANSWERS — KNOWLEDGE CHECK

1. Programmable Logic Controller

2. Read Inputs, Execute Logic, Update Outputs, Repeat

3. Receives signals from field devices

4. Contactors, Solenoid Valves, Indicator Lights, VFDs, or Buzzers (any two)

5. VFD (Variable Frequency Drive)

GRID CHALLENGE

A conveyor refuses to start. The PLC RUN light is ON. The Start Push Button works.

What should you check first?

- ☐ PLC CPU
- ☐ Output LED
- ☐ Contactor Coil
- ☐ Motor Voltage
- ☐ Overload Relay

(Answer appears at the bottom of this page.)

Answer: Output LED. Since the RUN light is on and the Start Push Button works, the PLC is scanning normally and receiving the input. The fastest next check is whether the PLC's output LED for the conveyor is actually energizing — that tells you whether the PLC is commanding the output before you start checking the contactor coil, motor voltage, or overload relay downstream.

10. GLOSSARY

PLC	Programmable Logic Controller
CPU	Central Processing Unit
Input	Device that sends a signal to the PLC
Output	Device that performs an action
Scan Cycle	The PLC's repeating loop: Read Inputs → Execute Logic → Update Outputs → Repeat
HMI	Human Machine Interface
SCADA	Supervisory Control and Data Acquisition
VFD	Variable Frequency Drive
Contactor	Electrically controlled relay used to switch power to a load

11. SUGGESTED HARDWARE FOR THIS LESSON

- Siemens S7-1200 Starter Kit
- Push Button
- Photoeye Sensor
- Limit Switch (Position)
- Contactor
- Stack Light

SAFETY NOTE: Always verify and test I/O wiring, device operation, and program logic before placing equipment in service.

LESSON COMPLETE — PLC FUNDAMENTALS

LESSON 001 COMPLETE

Skills unlocked:

- ☐ PLC Architecture
- ☐ Scan Cycle
- ☐ Inputs
- ☐ Outputs
- ☐ Basic Troubleshooting

Estimated Readiness: Beginner PLC Technician

Continue → Lesson 002: PLC Inputs & Outputs

LESSON RESOURCES

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Reserved — activates when the online quiz platform launches

The website QR code is live today. The video and quiz QR codes are placeholders — they'll be activated with real links once OCG-V001 is published and the quiz platform is available, rather than pointing anywhere before those exist.

MY NOTES

Use this page for voltages, PLC addresses, fault codes, or anything else worth remembering from this lesson.