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MAINTENANCE RESOURCE

Sink vs. Source and NO/NC Field Guide

Choosing PNP or NPN sensors, wiring them to a PLC input, reading them with a meter, and catching the look-alike failure that plugs right in and never works.

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Why this matters

Sinking vs. sourcing and normally open vs. normally closed answer two different questions, and understanding what they actually mean is critical in industrial maintenance.

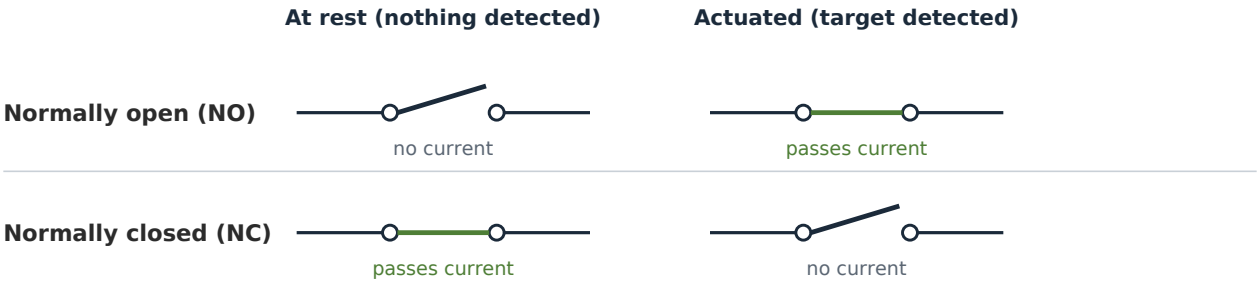
Sinking and sourcing tell you *which side of the circuit gets switched*: the +24V side or the 0V side. Normally open and normally closed tell you *whether the contact passes current at rest*. Any sensor or switch has an answer to both questions, and the answers are independent.

I find this isn't well understood throughout our industry, so it bears discussion. I vividly remember the day I learned this lesson. It was a long day. This guide is the explanation I wish someone had given me.

1. Two separate questions

NO vs. NC is about continuity

A normally open (NO) contact does not pass current until it is actuated. A normally closed (NC) contact passes current until it is actuated. That's the whole idea. It says nothing about voltage, polarity, or which wire is doing the switching.



A contact or sensor output, shown at rest and when actuated.

Sink vs. source is about which rail does the switching

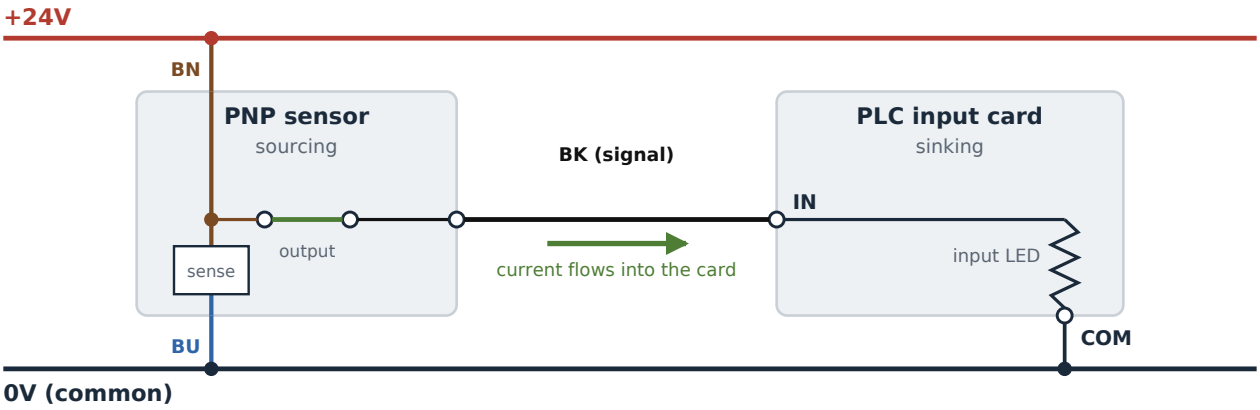
Every DC control circuit has a +24V rail and a 0V (common) rail. The load (a PLC input, a relay coil, an indicator) is permanently tied to one of them. The switch connects it to the other one.

- **Sourcing:** the load is preloaded with 0V. The switch closes and *supplies* +24V to it. Current flows out of the switch into the load.
- **Sinking:** the load is preloaded with +24V. The switch closes and *connects it to 0V*. Current flows from the load into the switch and down to common.

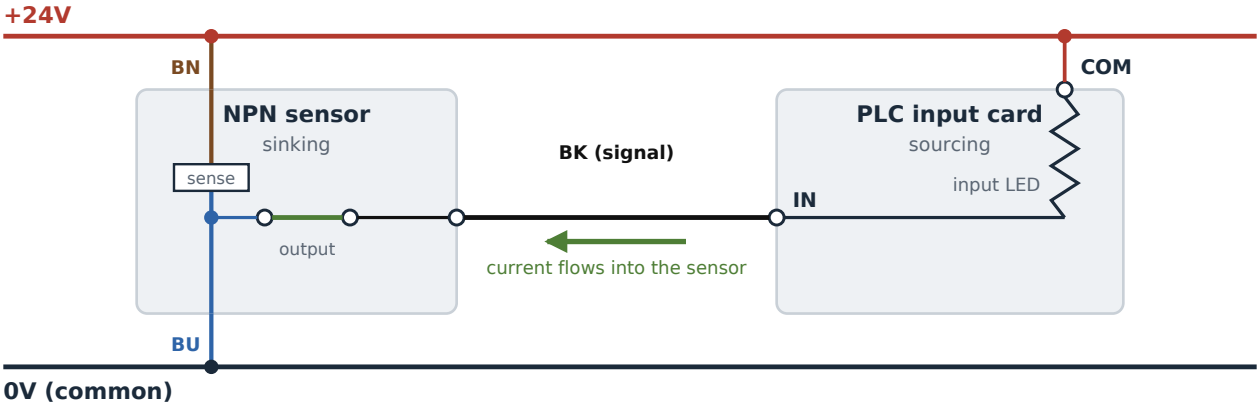
In both cases the load sees 24V across it when the switch is on. What changes is which terminal moves. On a sourcing circuit, the signal wire goes to +24V. On a sinking circuit, the signal wire goes to 0V. Same result at the load, opposite behavior on the wire you're probing.

2. Wiring it to a PLC input

The two standard pairings for a 3-wire DC sensor. Wire colors follow the common convention: brown +24V, blue 0V, black output.



PNP sensor on a sinking input card (a “PNP machine”). The card's common is tied to 0V, so the input rests at 0V. When the sensor detects, it pushes +24V onto the black wire and current flows into the card.



NPN sensor on a sourcing input card (an “NPN machine”). The card's common is tied to +24V, so the input rests at +24V. When the sensor detects, it pulls the black wire to 0V and current flows out of the card into the sensor.

3. The naming trap: the sensor and the card are opposites

The words describe what a device does with current, so a matched pair always carries opposite labels. A sourcing sensor pushes current out, so it needs an input card that sinks it. A sinking sensor pulls current in, so it needs an input card that sources it.

Sensor type	What the sensor does	Input card it needs	Input terminal at rest
PNP	Sources +24V on its output	Sinking input	0V
NPN	Sinks its output to 0V	Sourcing input	+24V

This is why people on the floor tend to say “PNP machine” or “NPN machine” instead. It names what the machine expects to see plugged into it, and nobody has to remember which way the card label points. I

will use that shorthand for the rest of this guide.

4. Four combinations, not two

Because the questions are independent, every 3-wire DC sensor falls into one of four boxes.

	Normally open (NO)	Normally closed (NC)
PNP (sourcing)	Output goes to +24V when it detects	Output sits at +24V, drops off when it detects
NPN (sinking)	Output goes to 0V when it detects	Output sits at 0V, releases when it detects

Photoeyes usually say light-on (light-operate) and dark-on (dark-operate) instead of NO and NC. Same idea, one catch: which one turns on with a part present depends on the sensing mode. On a diffuse eye the part reflects light back, so light-on acts like NO. On a through-beam or retroreflective eye the part blocks the beam, so dark-on is the one that turns on.

4-wire sensors often give you both answers at once: black is the NO output and white is the NC output. Check which one the old sensor actually had landed.

> **Match both axes.** A replacement sensor has to match on PNP/NPN *and* on NO/NC. Get NO/NC right but PNP/NPN wrong and you have a dead input. Get PNP/NPN right but NO/NC wrong and you have an input that is backwards: on when it should be off.

5. Reading it with a meter

The habit most of us learn is to put the black lead on 0V, the red lead on the signal, and look for 24V when the thing is on. That works on a PNP machine. On an NPN machine it reads exactly backwards.

Machine type	Black lead on	Sensor OFF	Sensor ON
PNP	0V	~0V	~24V
NPN	0V	~24V	~0V
NPN	+24V	~0V	~−24V

On an NPN machine, a tech looking for voltage sees 24V sitting on an input that is *off*, and nothing when it turns on. It is easy to call that a bad sensor or a shorted card when the circuit is working perfectly.

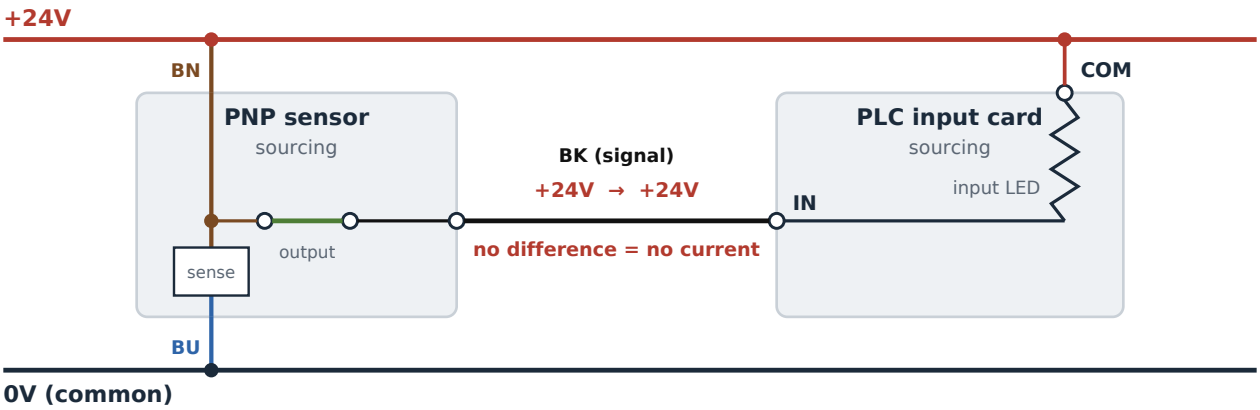
The fix is simple: reference the rail the sensor switches *against*. On an NPN machine, put your black lead on +24V. Now you read about 24V when the sensor is on and about 0V when it's off, the same pattern you're used to. A digital meter shows it as −24V because the leads are reversed from the usual habit; swap them (red on +24V, black on the signal) if you'd rather see +24V.

> **Better yet, read the PLC input LED first.** It tells you what the controller actually sees, regardless of polarity.

6. The look-alike failure: a PNP sensor on an NPN machine

This is the most expensive version of the mistake, because everything looks fine. The replacement sensor has the same body, the same thread, the same sensing distance, and the same M12 connector. It plugs right in. Its indicator LED lights every time a part goes by. And the machine never sees a thing.

Here's why. On an NPN machine, the input terminal already sits at +24V, waiting for something to pull it down to 0V. A PNP sensor does the opposite: when it detects, it drives its output *up* to +24V. So it raises a wire that was already at +24V. No voltage difference, no current, no input. The sensor is doing its job perfectly. It's just answering a question the machine never asked.



PNP sensor on an NPN machine. Both ends of the input circuit sit at +24V, so no current flows. The sensor LED lights; the PLC input LED never does.

The reverse is equally dead. An NPN sensor on a PNP machine pulls its output to 0V when it detects, onto an input that was already sitting at 0V.

Why it fools people

- **The sensor LED is not proof.** It shows the sensor detected the target. It does not show that the signal reached the PLC.
- **The meter can agree with the sensor.** Measured against the wrong rail, the output looks like it's switching, or looks stuck in a state that seems plausible.
- **The PLC input LED is the tell.** Sensor LED on, input LED off is the classic signature of a polarity mismatch. Check it before you condemn the card, the cable, or the program.

This tends to happen after a rushed swap from the crib, or when a sensor from a PNP line gets borrowed for an NPN machine. It is cheap to prevent and slow to find.

7. How to tell PNP from NPN

Start with the part number. Most manufacturers put a P or an N in the model code to mark the output type, so compare the old sensor's number with the new one before you install it. Two sensors that differ only by that one letter are not interchangeable.

Not every brand uses P and N, though. Some use other letter or number codes for output type. If the part number doesn't make it obvious, use one of these:

1	**The wiring diagram on the label or datasheet.** On a PNP sensor, the load is drawn between the black output wire and blue (0V). On an NPN sensor, the load is drawn between the black output wire and brown (+24V).
2	**A test light on the bench.** Power the sensor with brown to +24V and blue to 0V. Trigger it. A PNP output lights a test light connected to 0V. An NPN output lights a test light connected to +24V. Use a light or a load, not a bare meter: an unloaded output can float and give a misleading reading. Use an LED test light or another small load; an incandescent test light can draw more than the sensor's output is rated for.
3	**The machine side.** Look at the input card's common. If it's tied to 0V, the machine expects PNP. If it's tied to +24V, the machine expects NPN. The PLC manual or the electrical drawings will confirm it.

8. Where you'll see each

As a rule of thumb, North American and European equipment is mostly PNP, and Japanese and other Asian-built equipment is often NPN. That's a tendency, not a law. Plenty of machines break it, and some input cards can be wired either way.

The pattern matters most in a mixed plant. A filler from one country and a case packer from another can sit side by side, use identical-looking sensors, and need opposite ones. That's exactly where the shared spare bin causes trouble.

One reason PNP is favored in many places: with the 0V rail grounded, a signal wire that shorts to ground on a PNP circuit tends to drop the input to off. On an NPN circuit, the same short can turn the input on. Neither is a safety function (that's what safety-rated circuits are for), but it explains some of the preference.

Normally open vs. normally closed follows a different logic entirely: the job. Part-present and position sensing are usually normally open. Anything where a broken wire should stop the machine, like stop buttons and overtravel limits, is usually normally closed. That choice is made the same way on PNP and NPN machines.

9. Field checklist

Before replacing or troubleshooting a DC sensor:

- ☐ Identify the machine type: input common on 0V means PNP, on +24V means NPN.
- ☐ Read the old sensor's part number and match the P or N, plus the NO/NC code.
- ☐ If the part number isn't clear, check the label wiring diagram or bench-test with a test light.
- ☐ After installing, trigger the sensor and watch the PLC input LED, not just the sensor LED.
- ☐ When metering, put your reference lead on the rail the sensor switches against: 0V for PNP, +24V for NPN.
- ☐ Sensor LED on, input LED off? Suspect polarity before you suspect the card or the program.

> **The short version:** ask *which wire moves, and where it rests* to get sink or source. Ask *does it conduct when nothing is there* to get NO or NC. Two questions, two answers, every time.

Wire colors, part-number codes, and input card behavior vary by manufacturer. This guide describes common patterns; confirm against the sensor's datasheet and your machine's electrical drawings.

Quick Reference Card

Print this page and keep it in the cabinet or your toolbag. Every item is drawn from the sections above.

Two questions, two answers

Question	Answer it tells you	How to ask it
Which rail does it switch?	Sink (NPN) or source (PNP)	Which wire moves, and where does it rest?
Does it conduct at rest?	NO or NC	Does it conduct when nothing is there?

Four combinations

	Normally open (NO)	Normally closed (NC)
PNP (sourcing)	Output goes to +24V when it detects	Output sits at +24V, drops off when it detects
NPN (sinking)	Output goes to 0V when it detects	Output sits at 0V, releases when it detects

PNP machine or NPN machine?

	PNP machine	NPN machine
Input card type	Sinking	Sourcing
Input card common tied to	0V	+24V
Input terminal at rest	0V	+24V
Sensor output when on	+24V	0V
Meter reference (black) lead	0V	+24V (reads −24V when on)
Bench test: test light to	0V	+24V

Common 3- and 4-wire sensor colors

Wire	Typical function
Brown	+24V supply
Blue	0V supply
Black	Output (on 4-wire sensors, usually the NO output)
White	Second output on 4-wire sensors (often NC)

Sensor LED on, PLC input LED off? Suspect a PNP/NPN mismatch before you condemn the card, the cable, or the program.