vifalio

FREE GUIDE FOR MECHANICS

NO PINOUTS, NO DIAGRAMS?
YOU'RE WORKING BLIND.



WIRING DIAGRAMS & PINOUTS GUIDE

How to read a car wiring diagram, use a pinout and find the fault the scan tool doesn't show, with drawn circuits and real test values.

- 24 diagram symbols + wire color codes
- 4 real circuits explained and drawn
- Pinouts: connector views + ECU example
- Meter, voltage drop, scope and CAN bus
- Diagnostic flowchart + checklist



HOW TO USE THIS GUIDE

Read it once in order, then keep it on the bench and jump to the page you need.

1 LEARN THE LANGUAGE

Symbols (p. 3), wire colors (p. 4) and diagram codes (p. 6). Ten minutes and any diagram starts to make sense.

2 READ REAL CIRCUITS

Fuel pump relay, headlights, cooling fan and a 3-wire sensor, each drawn with test points (p. 7 to 10).

3 TEST, DON'T GUESS

Pinouts, meter, voltage drop, scope and CAN bus (p. 11 to 16). Every test with the value you should see.

4 FOLLOW THE ROUTE

Avoid the 10 mistakes (p. 17), follow the flowchart (p. 18) and run the checklist (p. 19) on every job.

WHAT'S INSIDE

3 24 wiring diagram symbols
4 Wire color codes and stripes
5 How to read a diagram, step by step
6 Diagram codes: C, G, S, splices, hot at
7 Circuit 1: fuel pump relay
8 Circuit 2: headlights
9 Circuit 3: radiator cooling fan
10 Circuit 4: 3-wire sensor (5 V reference)
11 Pinouts and connector views
12 Generic ECU pinout (example)
13 Multimeter on the car: 5 tests
14 Voltage drop: the hidden fault
15 Scope basics: CKP, CMP, injector, PWM
16 CAN bus basics: 2 wires, 60 Ω, 2.5 V
17 10 mistakes that waste parts
18 Diagnostic flowchart
19 Checklist for every electrical job
20 Where to get diagrams
21 Final word

24 SYMBOLS Drawn and explained

4 CIRCUITS Read step by step

REAL VALUES 5 V, CAN, voltage drop

vifalio.com Free guide

Training guide with typical values. Always confirm pin numbers, wire colors and specs in the service information for that exact vehicle (VIN).

24 WIRING DIAGRAM SYMBOLS

The drawing changes a little from one automaker to another, but the idea is always the same.

01


Battery
Long plate is +. Source of all power.

02


Ground
Chassis/body ground: the return path.

03

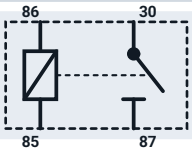

Fuse
Opens if current goes too high.

04


Fusible link
Special wire that melts on a big short.

05


Circuit breaker
Opens on overload, then resets.

06


Relay
Small current (85-86) switches a big one (30-87).

07


Switch
Opens or closes the circuit by hand.

08

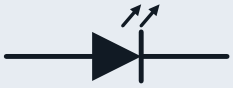

Momentary switch
Closed only while you press it.

09


Motor
Fuel pump, fan, wipers, windows.

10


Bulb
Headlight, brake light, any lamp.

11


LED
Lets current flow one way and lights up.

12


Diode
One-way valve for current.

13


Resistor
Limits current. Value in ohms (Ω).

14


Potentiometer
3-wire sensor: TPS, pedal, some MAP.

15


Thermistor
Resistance changes with temperature: ECT, IAT.

16

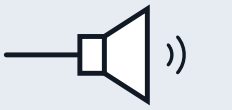

Solenoid / coil
Injector, valve, relay coil, actuator.

17


Capacitor
Stores charge, filters noise.

18


Heating element
O2 heater, seat heater, rear defrost.

19


Horn / speaker
Turns current into sound.

20


Connector
Plug: pin goes into socket. Has a C number.

21


Splice
A dot: wires joined. Has an S number.

22


Crossing wires
No dot: wires cross, NOT joined.

23


Twisted pair
Two wires twisted together: CAN bus.

24


Module / ECU
Computer: ECM, PCM, BCM, TCM, ABS.

24 SYMBOLS
Drawn and explained

4 CIRCUITS
Read step by step

REAL VALUES
5 V, CAN, voltage drop

vifalio.com
Free guide

Training guide with typical values. Always confirm pin numbers, wire colors and specs in the service information for that exact vehicle (VIN).

WIRE COLOR CODES

Diagrams name each wire by color. American manuals use 3 letters; many Asian manuals use 1 or 2.

Wire	Code	Color	Asian
	BLK	Black	B
	BRN	Brown	BR
	RED	Red	R
	ORG	Orange	O
	YEL	Yellow	Y
	GRN	Green	G
	BLU	Blue	L

Wire	Code	Color	Asian
	VIO	Violet / purple	V
	GRY	Gray	GR
	WHT	White	W
	PNK	Pink	P
	TAN	Tan	-
	LT GRN	Light green	LG
	DK BLU	Dark blue	-

BASE COLOR / STRIPE

The first color is the insulation, the second is the stripe (tracer).



GRN/WHT
Green wire with a white stripe



BLK/YEL
Black wire with a yellow stripe



RED/BLK
Red wire with a black stripe



DK BLU/ORG
Dark blue wire with an orange stripe

LT and DK

LT = light, DK = dark: LT GRN, DK BLU. PPL and VIO are both purple.

Wire size

Next to the color: 0.5, 0.8, 2.0 (mm²) or 18, 20 (AWG gauge).

The trap

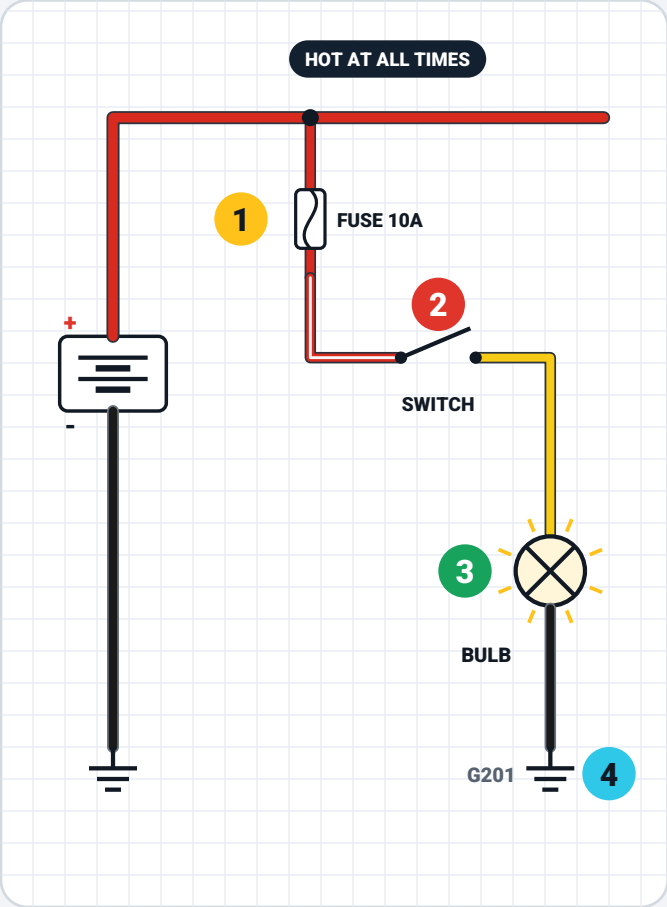
In Asian manuals L = blue, not black. B = black, BR = brown.

Colors lie

Faded, dirty or repaired wires. Confirm by pin number and meter.

HOW TO READ A DIAGRAM

Every circuit is a loop. Follow the current in this order and you will never get lost.



1 POWER

Start at the top: battery, fuse, and when it is live (hot at all times or hot in run).

2 CONTROL

Find what turns it on: a switch, a relay or a module (ECU) that switches the ground or the power.

3 LOAD

The part that does the work: bulb, motor, solenoid. It should get almost full battery voltage.

4 GROUND

Follow the return to the ground point (G). A bad ground acts like a bad part.

ONLY 3 THINGS GO WRONG IN A CIRCUIT



OPEN

Broken wire, blown fuse, loose pin. No current, nothing works.



SHORT

Power touches ground or another wire. Fuses blow, things turn on by themselves.



HIGH RESISTANCE

Corrosion, loose ground, burnt pin. Works weak: dim, slow, intermittent.

24 SYMBOLS
Drawn and explained

4 CIRCUITS
Read step by step

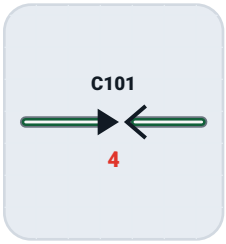
REAL VALUES
5 V, CAN, voltage drop

vifalio.com
Free guide

Training guide with typical values. Always confirm pin numbers, wire colors and specs in the service information for that exact vehicle (VIN).

DIAGRAM CODES AND CONVENTIONS

The letters and numbers on a diagram tell you where things are in the car.



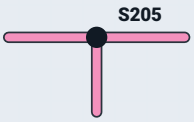
C101 · pin 4

Connector C101, cavity 4. The C number is how you find the plug in the locator view.



G102

Ground point. The locator shows where it is bolted to the body or engine.



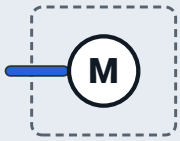
S205

Splice: several wires joined inside the harness. One bad splice kills many circuits.



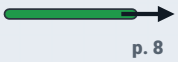
HOT IN RUN

Power only with the key in RUN (or START). HOT AT ALL TIMES = always live.



Dashed box

Only part of the component is shown. The rest is on another page.



Arrow / tab

The wire goes on to another circuit or page. Follow the reference.



DK GRN/WHT 0.5

Wire label: color, stripe and size. Some add a circuit number.



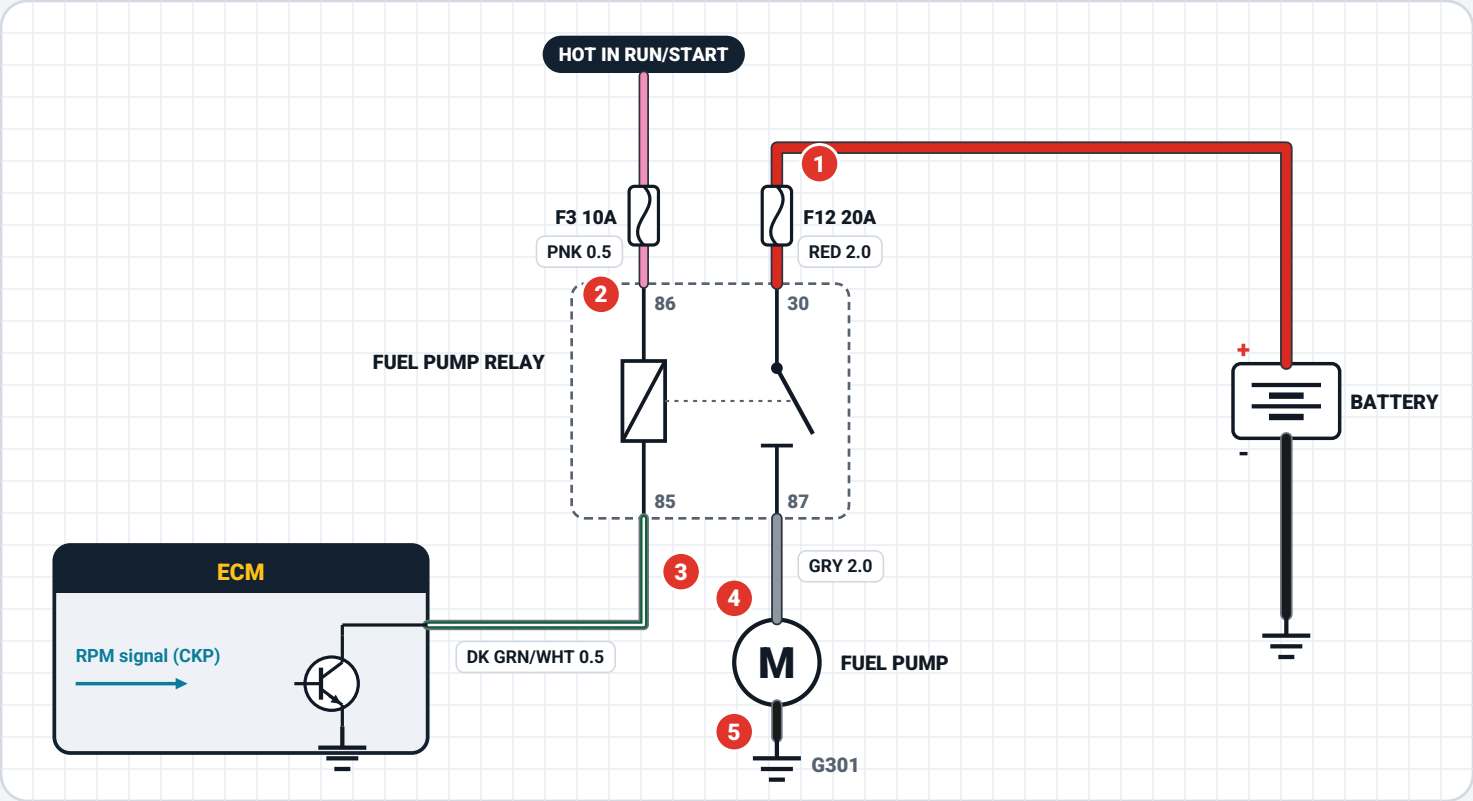
Switch at rest

Switches and relays are drawn at rest: key off, not pressed.

Read it like a road map: the diagram shows how it is connected, not where it sits in the car. For that, use the connector and ground locator views.

CIRCUIT 1: FUEL PUMP RELAY

The ECU switches a small current to ground; the relay sends the big current to the pump.



HOW IT WORKS

- Key ON: pin 86 gets 12 V. The ECM grounds pin 85 and the relay clicks: 30 connects to 87 and the pump runs.
- The ECM usually primes the pump for about 2 seconds, then keeps it on only while it sees the RPM signal.
- No crank signal means no pump: a bad CKP sensor can look exactly like a bad fuel pump.

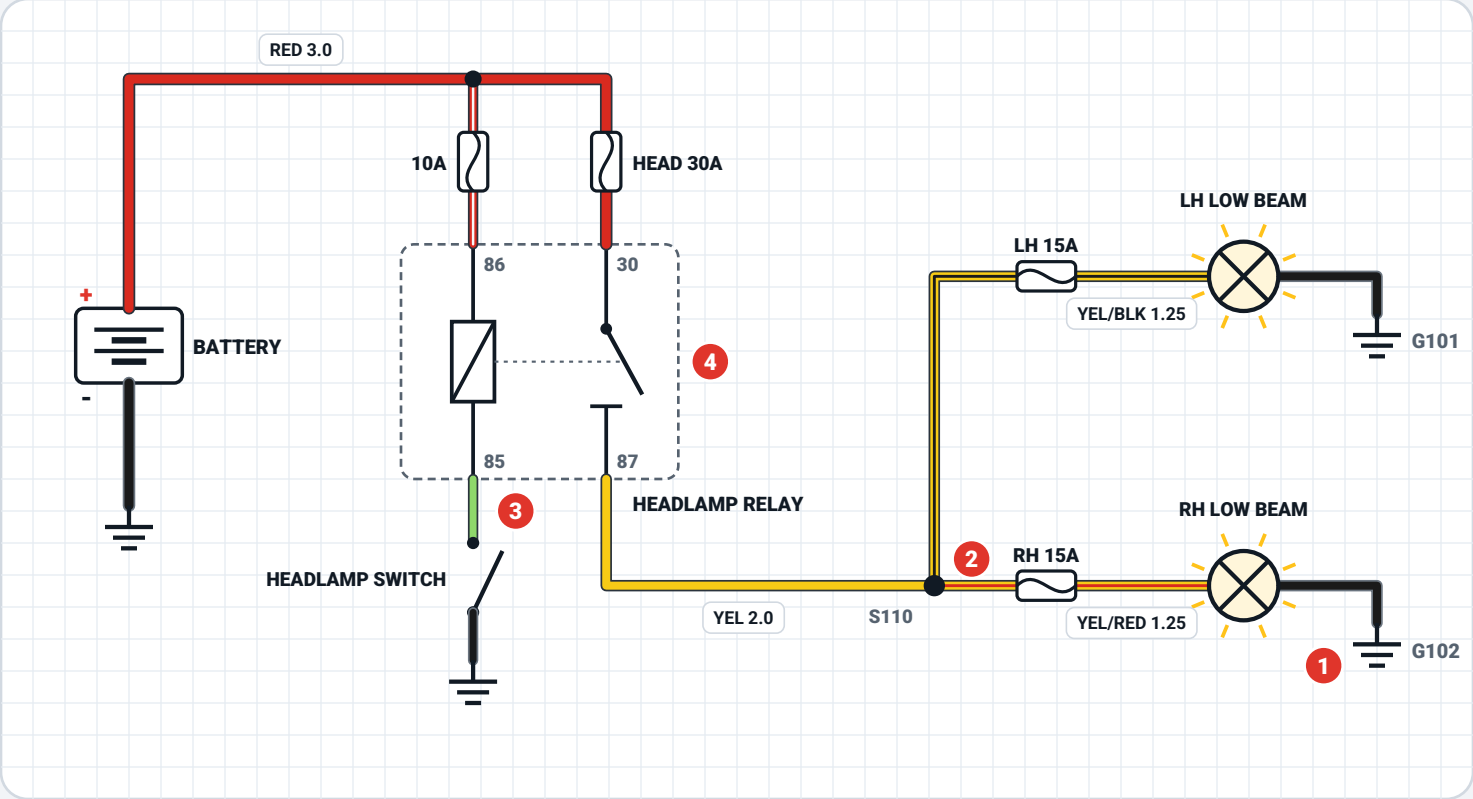
TEST POINTS

1. Pin 30: battery voltage at all times.
2. Pin 86: battery voltage with the key ON.
3. Pin 85: about 12 V off; near 0 V when the ECM turns it on.
4. Pump +: within about 0.5 V of battery while running.
5. Pump ground: under 0.1 V of drop to battery negative.

24 SYMBOLS Drawn and explained
4 CIRCUITS Read step by step
REAL VALUES 5 V, CAN, voltage drop
vifalio.com Free guide

CIRCUIT 2: HEADLIGHTS

One relay feeds both low beams. Each side has its own fuse and its own ground.



HOW IT WORKS

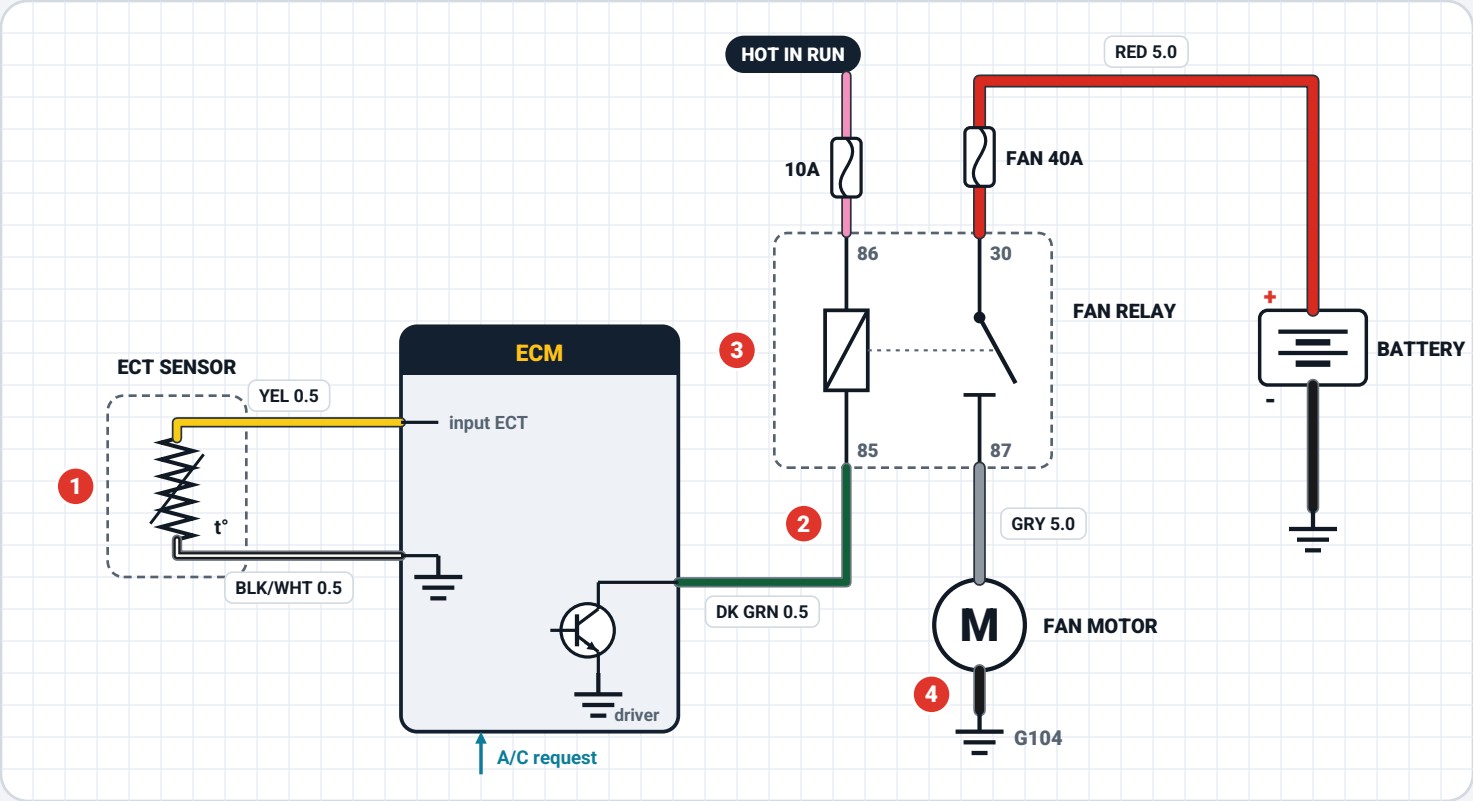
- Pin 86 is live through the 10 A fuse. The headlamp switch grounds pin 85 and the relay closes 30 to 87.
- From pin 87 the power splits at splice S110: left fuse to the left lamp, right fuse to the right lamp.
- Both lamps out: look at the relay, the 30 A fuse or the switch. One lamp out or dim: that side only.

READ THE SYMPTOM

1. One side dim: voltage drop on G102, under load. More than 0.1 V = clean the ground.
2. One side dead: bulb, RH 15A fuse, then voltage at the bulb connector.
3. Both dead: 12 V on pin 30? Pin 85 goes to 0 V with the switch on?
4. Relay clicks but no light: contacts 30-87 worn. Check drop across them (should be under 0.3 V).

CIRCUIT 3: RADIATOR COOLING FAN

The ECM reads the coolant sensor and the A/C request, then turns on the fan relay.



HOW IT WORKS

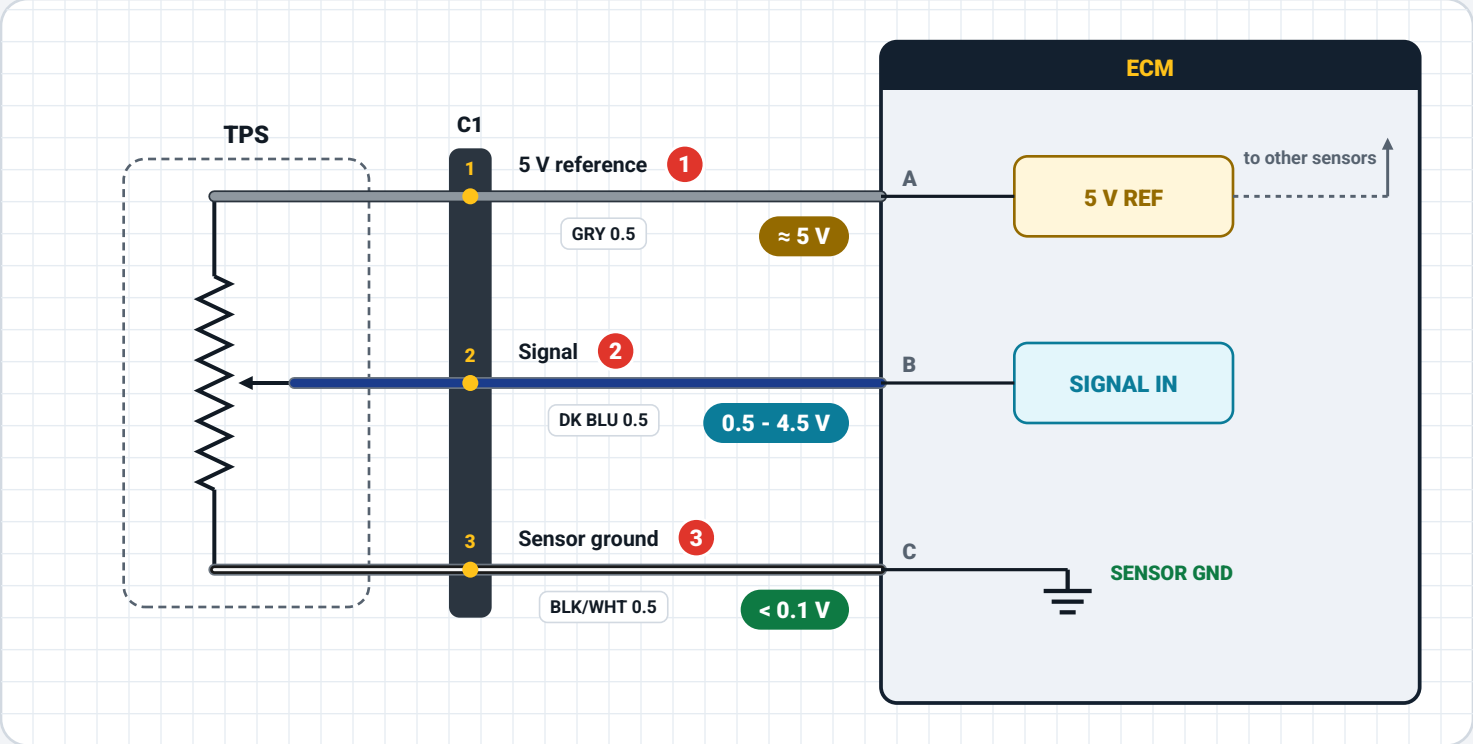
- The ECT sensor is a thermistor: its resistance (and voltage) drops as the engine heats up.
- When the ECM sees the temperature it was programmed for, or an A/C request, it grounds relay pin 85.
- The relay feeds the motor through the 40 A fuse. A fan that never runs is not always a dead motor.

TEST IN THIS ORDER

1. Scan tool: is the ECT reading believable? Many tools can command the fan on.
2. Command it on: does pin 85 go near 0 V? If not, look at the input, not at the fan.
3. Fused jumper 30 to 87 (relay out): fan runs = motor and wiring OK.
4. Fan slow: voltage drop on the feed and on G104 while it runs.

CIRCUIT 4: 3-WIRE SENSOR

TPS, pedal and many MAP sensors: 5 V reference, signal and ground, all from the ECU.



Wire	Key ON, engine off	What it means if wrong
5 V reference	About 5 V (typical 4.8 to 5.2 V)	0 V: open wire or shorted sensor pulling it down. 12 V: shorted to power.
Signal	Moves smoothly, about 0.5 V to 4.5 V	Stuck at 0 V or 5 V, or jumps: worn sensor or open wire.
Sensor ground	Under 0.1 V to battery negative	Higher: bad ground, so every sensor on it reads high.

Shared 5 V
One 5 V reference often feeds several sensors. If it reads low, unplug them one at a time: when the 5 V comes back, the last one you unplugged is the shorted one.

PINOUTS AND CONNECTOR VIEWS

A pinout tells you what each cavity does. The view tells you which side you are looking at.

TERMINAL SIDE
front, the face that plugs in

WIRE SIDE
back, where the wires go in



1 2 3 4 5 6 — same connector, mirror image — 6 5 4 3 2 1

HOW TO READ THE NUMBERING

1 Check the view first
Every pinout says terminal side (front) or wire side (back). Same plug, numbers mirrored.

2 Use the molded numbers
Most housings have small numbers next to the end cavities. Find pin 1 there.

3 Use the lock as north
Keep the lock tab on top like in the drawing, then count.

4 Count empty cavities
Unused cavities still have a number. Skip them and you land on the wrong pin.

5 Match color and pin
Pin number and wire color should both agree with the diagram. If not, stop.

6 Probe from the back
Back-probe the wire side with the plug connected. Never jam the front terminals.

GENERIC ECU PINOUT (EXAMPLE)

A teaching example, not a real car. Real ECUs have dozens to well over 100 pins in several connectors.



TERMINAL SIDE

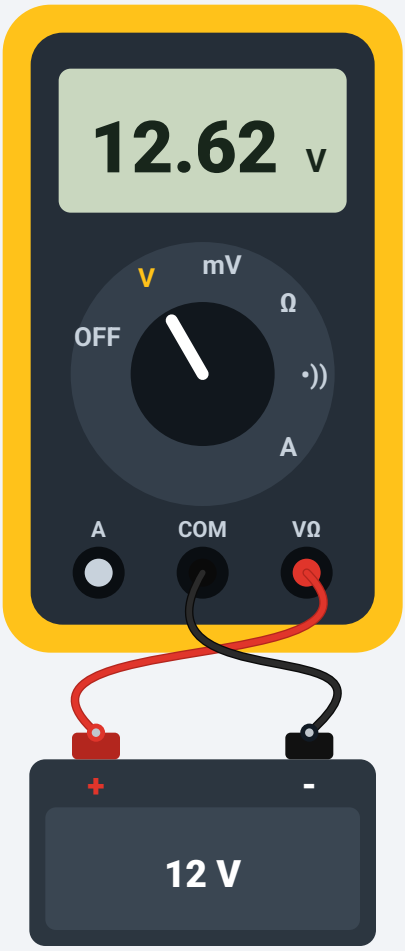
- Power
- Ground
- Sensors
- Outputs
- Network

Pin	Function	Wire		Typical reading
1	Battery feed (hot at all times)	RED		12.4-12.6 V engine off
2	Ignition feed (hot in run)	PNK		Battery voltage, key ON
3	Power ground	BLK		Under 0.1 V to battery -
4	Power ground	BLK		Under 0.1 V to battery -
5	5 V reference	GRY		About 5 V
6	Sensor ground	BLK/WHT		Under 0.1 V to battery -
7	TPS signal	DK BLU		About 0.5 V closed, rises with throttle
8	MAP signal	LT GRN		Changes with vacuum
9	ECT signal	YEL		High when cold, low when hot
10	IAT signal	TAN		High when cold, low when hot
11	CKP + (inductive)	BLU		AC, grows with rpm
12	CKP - (inductive)	WHT		AC, mirror of CKP +
13	CMP signal (Hall)	VIO		Square wave 0-5 V
14	Injector 1 control	LT BLU/BLK		Battery V, pulled low to inject
15	Injector 2 control	LT BLU/RED		Battery V, pulled low to inject
16	Injector 3 control	LT BLU/WHT		Battery V, pulled low to inject
17	Injector 4 control	LT BLU/YEL		Battery V, pulled low to inject
18	Fuel pump relay control	DK GRN/WHT		12 V off, near 0 V on
19	Fan relay control	DK GRN		12 V off, near 0 V on
20	O2 sensor signal (upstream)	PPL		Switches 0.1-0.9 V when warm
21	O2 heater control	BRN		Pulled low / PWM when on
22	CAN-H	ORG/BLK		About 2.5 V, rises to 3.5 V
23	CAN-L	ORG		About 2.5 V, drops to 1.5 V
24	Not used	-		Empty cavity

Readings are typical with a good battery, back-probing the wire side. Use your vehicle's pinout and specs for real work.

MULTIMETER ON THE CAR: 5 TESTS

A digital meter with 10 MΩ input is enough for most electrical work.



VOLTAGE

V DC

Black lead on battery negative or a good ground, red on the point. Battery at rest: about 12.6 V fully charged; 13.5-14.7 V running.

VOLTAGE DROP

V DC, low range

Both leads on the same wire, switch or ground, with the circuit ON. It shows what is being lost on the way (p. 14).

CONTINUITY

beep

Circuit OFF and unplugged at both ends. A beep only says the wire is not broken; it can still fail under load.

RESISTANCE

Ω

Part unplugged, no power. High-impedance injectors are often 12-16 Ω; relay coils roughly 50-120 Ω. Check the spec.

BACK-PROBE

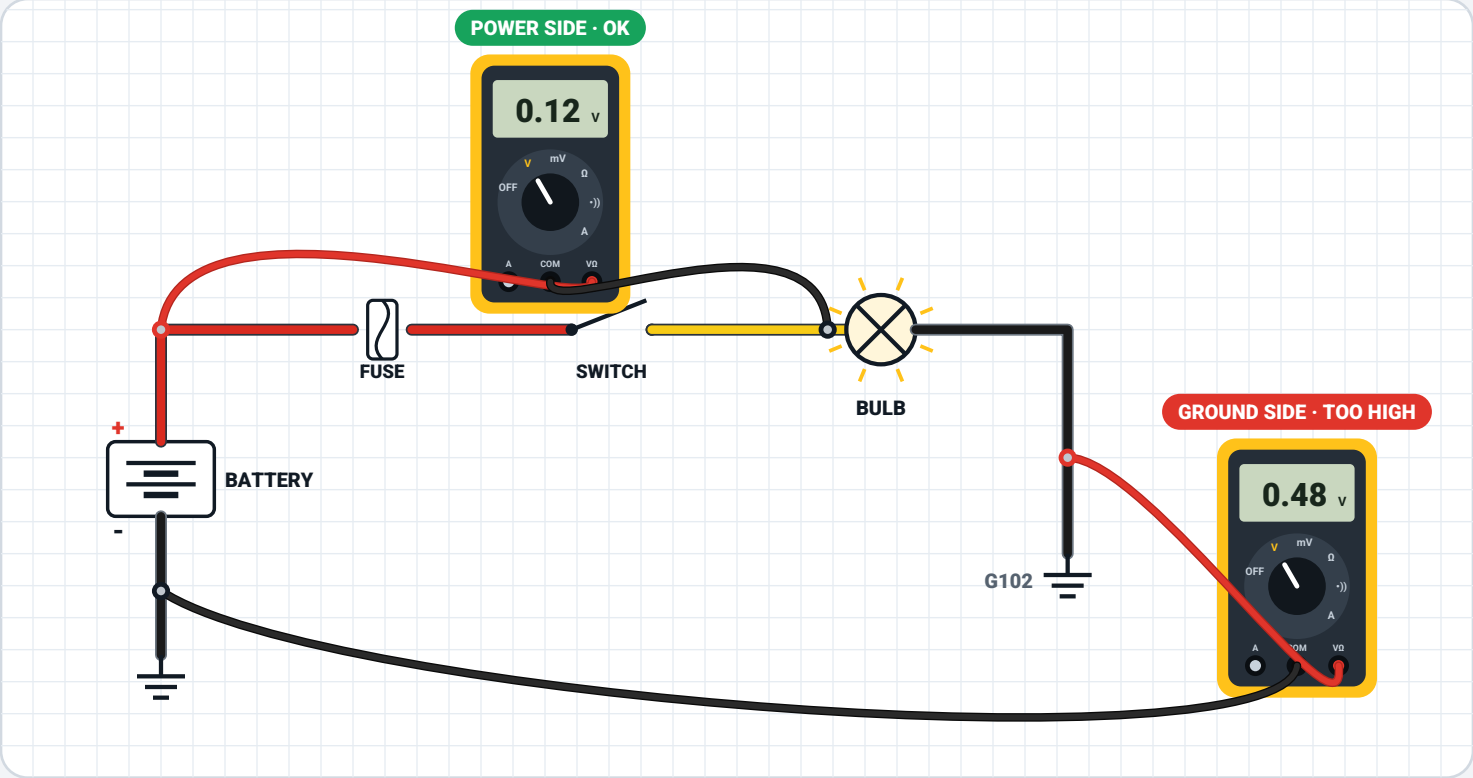
thin pins

Slide a back-probe pin along the wire, past the seal, into the back of the connector. Never pierce the insulation.

Never on computer circuits:
a test light can draw too much current and damage the ECU. Use the meter.

VOLTAGE DROP: THE HIDDEN FAULT

The fault the scan tool doesn't show: no code, the wire beeps fine, and the part still works weak.



HOW TO DO IT

1. Turn the circuit ON. No current, no drop: testing with it off proves nothing.
2. Power side: red lead on battery +, black lead on the input of the load.
3. Ground side: red lead on the load ground, black lead on battery -.
4. Too high? Move the leads closer, connector by connector, until the drop disappears. The fault is in the last piece you left out.

Across	Max drop
A connection	0.00 V (ideal)
A wire or cable	0.20 V
A switch	0.30 V
A ground	0.10 V
Computer circuits	0.10 V

Limits from Fluke for when the manual gives none. Your vehicle's spec comes first.

Real case: dim right headlight

Bulb new, fuse OK, no codes. Ground side under load: 0.48 V. Cleaned and tightened G102: 0.04 V. Fixed without buying parts.

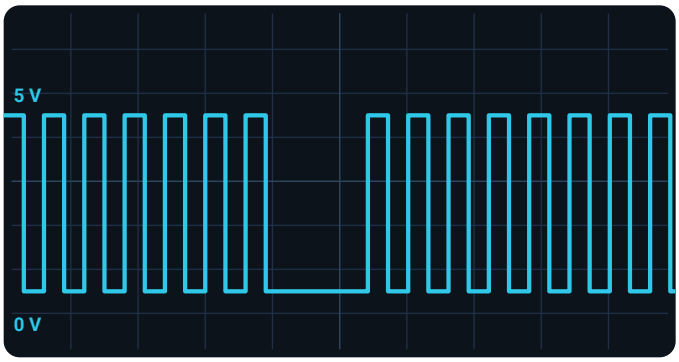
SCOPE BASICS

A meter shows an average number. A scope draws the signal, so you see what the ECU sees.



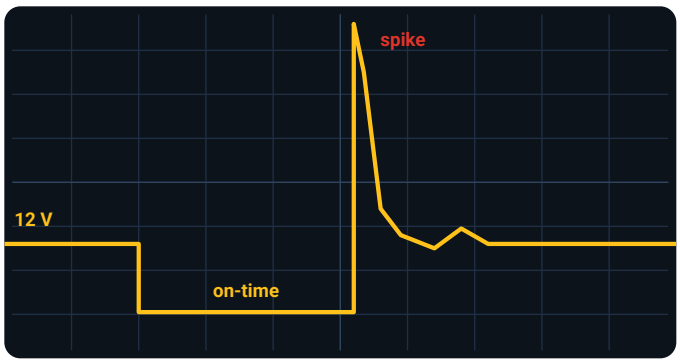
CKP INDUCTIVE (2 wires)

Makes its own AC signal. It gets bigger as rpm goes up. The missing-tooth gap is the reference mark.



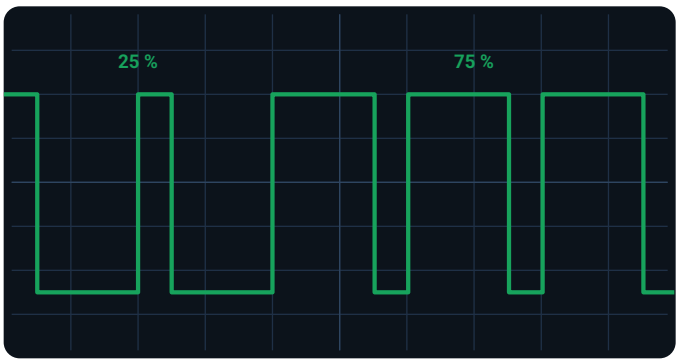
CKP / CMP HALL (3 wires)

Needs power and ground. Clean square wave, usually 0 to 5 V. Height stays the same; only the frequency changes.



INJECTOR (voltage)

Sits at battery voltage. The ECU pulls it to near 0 V to inject (about 2.5-5 ms at idle), then a spike of tens of volts.



PWM (duty cycle)

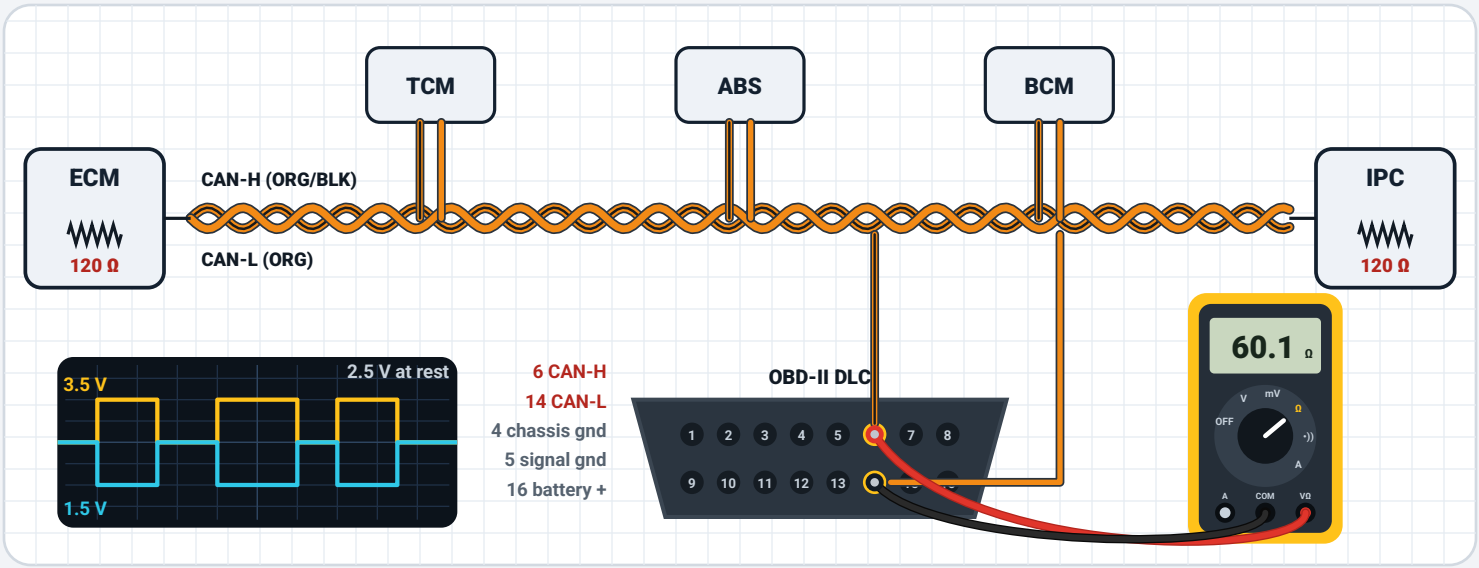
Same frequency, the on-time changes: 25 % on, 75 % on. Used for purge, fans, O2 heaters, idle valves.

SETUP THAT ALWAYS WORKS

- **DC coupling for Hall, injector and PWM**
- **Volts/div so the signal fills the screen**
- **Time/div to see 2 or 3 full cycles**
- **Ground lead on a clean ground**

CAN BUS BASICS

Modules talk on two twisted wires. Two numbers solve most CAN problems: 60 Ω and 2.5 V.



2 wires

CAN-H and CAN-L, twisted together. At the OBD-II plug: pin 6 = CAN-H, pin 14 = CAN-L.

2 x 120 Ω

One terminating resistor at each end of the bus. In parallel they read about 60 Ω.

2.5 V

At rest both wires sit near 2.5 V. When talking, CAN-H goes up to about 3.5 V and CAN-L down to about 1.5 V.

You measure	It means
About 60 Ω (6 to 14)	Both terminators OK, main bus closed
About 120 Ω	One terminator missing or the main bus is open
About 0 Ω	CAN-H shorted to CAN-L
A wire stuck at 0 V	That wire shorted to ground
A wire near 12 V	That wire shorted to battery power

Measure ohms only with every module asleep (key off, wait) or with the battery disconnected. A meter shows only an average voltage; for the real signal use a scope. This is high-speed CAN; slow, fault-tolerant buses work differently.

10 MISTAKES THAT WASTE PARTS

Each one sends good parts to the scrap bin and the comeback to your bay.

1 Replacing the part the code names

A code points to a circuit, not a part. Test power, ground and signal first.

2 Testing with no load

12 V with the circuit off means nothing. One strand can show 12 V and still not run a motor.

3 Wrong diagram

Same model, other engine or year: other wires. Match the VIN, engine and options.

4 Reading the plug from the wrong side

Terminal side and wire side are mirror images. Check the view.

5 Forgetting the ground

Half of all electrical faults are grounds. Do a voltage drop on it under load.

6 Piercing wires

The hole lets water in and corrosion grows inside the wire. Back-probe instead.

7 Test light on ECU circuits

It can damage the module. Use a 10 MΩ meter on computer circuits.

8 Ohms on a live circuit

Wrong reading and maybe a blown meter fuse. Power off, part unplugged.

9 Trusting color only

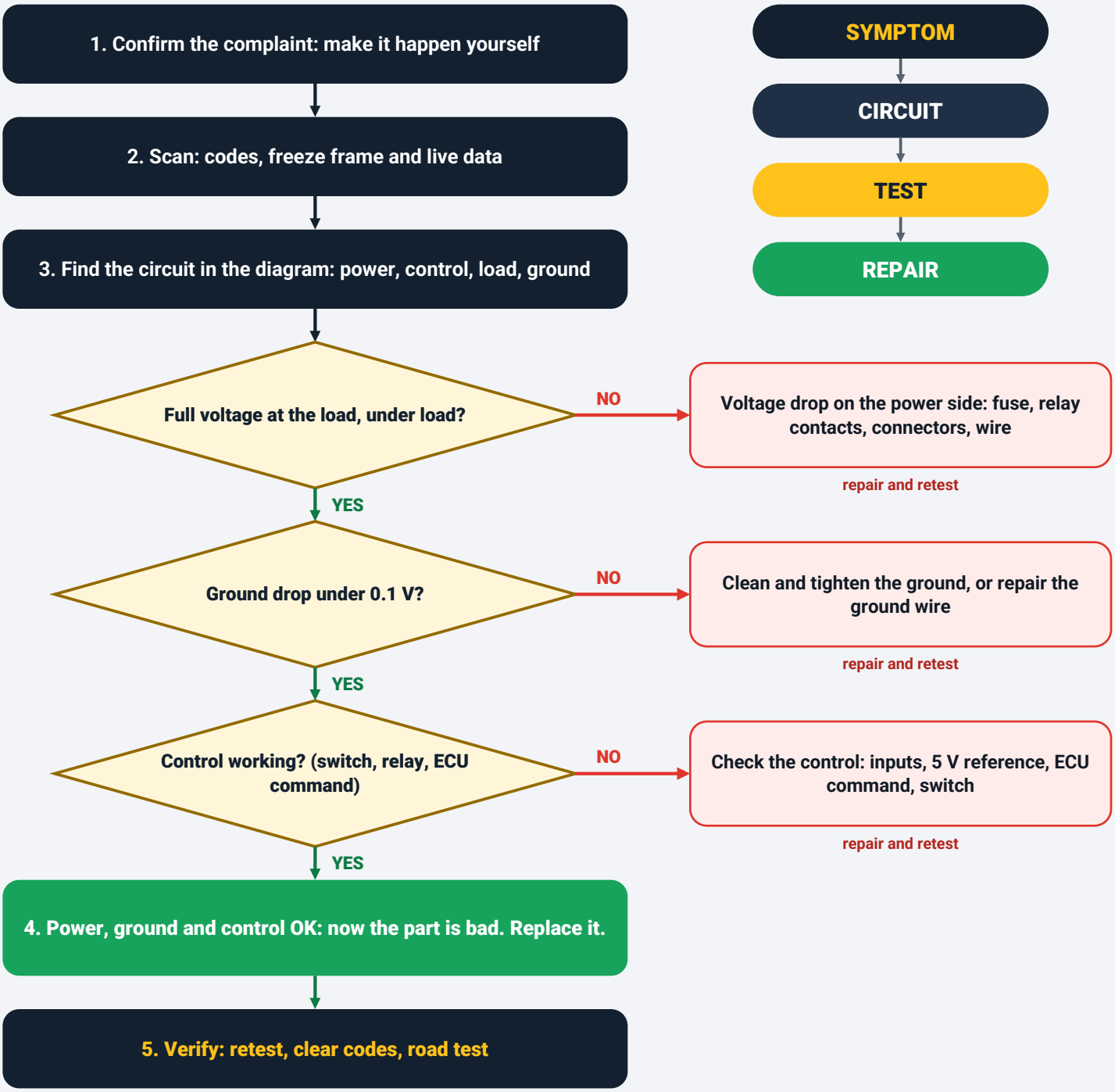
Colors fade and get repaired. Asian L = blue. Confirm with the pin number.

10 Skipping the battery

Weak battery or loose clamps cause ghost codes. Check it first, retest after.

DIAGNOSTIC FLOWCHART

Symptom, circuit, test, repair. Follow the arrows and every step proves something.



24 SYMBOLS
Drawn and explained

4 CIRCUITS
Read step by step

REAL VALUES
5 V, CAN, voltage drop

vifalio.com
Free guide

Training guide with typical values. Always confirm pin numbers, wire colors and specs in the service information for that exact vehicle (VIN).

CHECKLIST FOR EVERY ELECTRICAL JOB

Print it, keep it on the bench and tick it off.

- [ ] **Battery first**
  12.6 V at rest, clean and tight clamps, good charging (13.5-14.7 V).
- [ ] **Right diagram**
  VIN, year, engine and options match. Note the C, G and S numbers you need.
- [ ] **Codes and data**
  Save codes and freeze frame before clearing anything.
- [ ] **Fuses under load**
  Check both sides of the fuse with the circuit ON, not only by looking.
- [ ] **Power at the load**
  Battery voltage within about 0.5 V at the load while it works.
- [ ] **Ground drop**
  Under 0.1 V from the load ground to battery negative, circuit ON.
- [ ] **Control**
  Relay or ECU command really happens (pin goes low or high when it should).
- [ ] **Connectors**
  Look for green corrosion, pushed-back pins, loose terminals, water.
- [ ] **Back-probe only**
  No pierced wires, no spread terminals, seals back in place.
- [ ] **Repair right**
  Solder or proper crimp, heat-shrink, same wire size. No twist-and-tape.
- [ ] **Verify the fix**
  Retest the same reading that was bad. Clear codes, road test.
- [ ] **Write it down**
  Readings before and after, for the customer and the next job.

WHERE TO GET DIAGRAMS

Use the official source for the exact vehicle. A diagram for the wrong car is worse than none.

1 Automaker service sites

Every automaker sells access to its official service information: diagrams, pinouts, locators. Many offer short-term access.

2 NASTF

nastf.org links to the automakers' service sites and has a free request form when you can't find something.

3 Factory service manual

The printed or digital manual for your exact model and year. Best for one car you work on a lot.

4 Shop repair databases

Professional subscriptions cover many brands in one place. Worth it if you see many makes every week.

5 Public library

Many libraries give free access to repair databases with a library card. Ask at the desk.

6 Scan tools with wiring

Some scan tools show the diagram and pinout for the code. Always confirm it against the VIN.

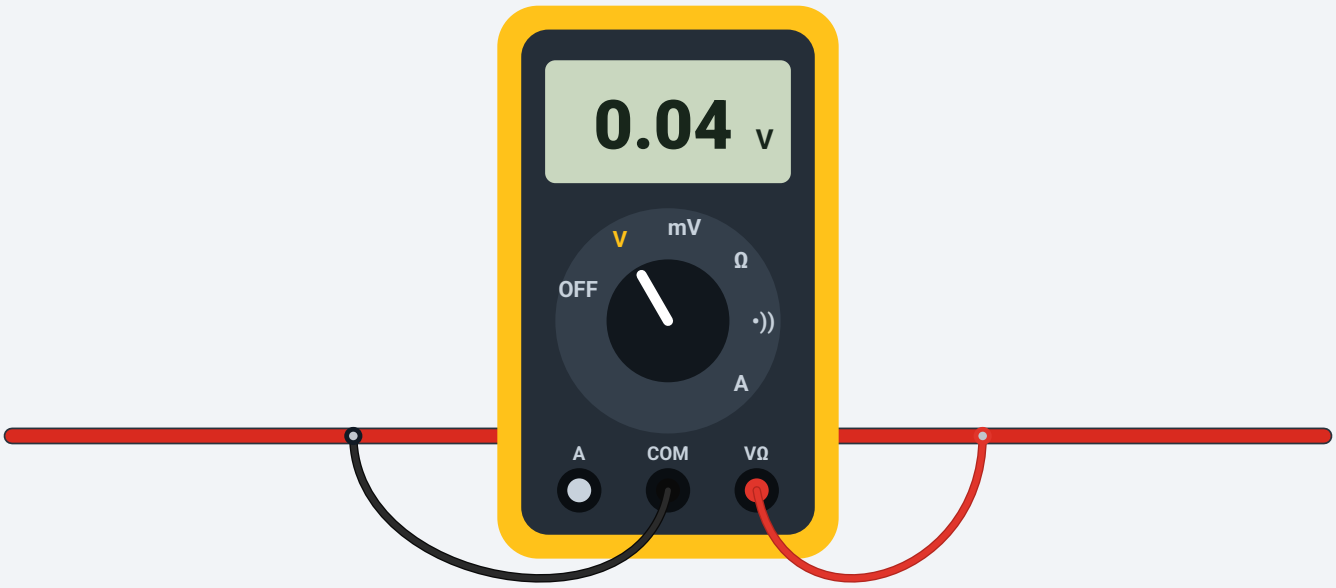
BEFORE YOU TRUST A DIAGRAM

- Same VIN, year, engine and trim
- Look at the option notes (with / without)
- Check the connector view and the pin count
- Print it and color it: red power, black ground

SOURCES WE READ FOR THIS GUIDE

Sources we read: Fluke (voltage drop limits), MVW Autotechniek (CAN bus diagnosis), Pico Technology guided tests (CKP inductive, CKP Hall effect, multi-point injector), "Analog Sensors" (automotivetechinfo.com), troubleshootmyvehicle.com (wire color legend), philipmcgaw.com (DIN 72552), Repairer Driven News (NASTF).





STOP REPLACING PARTS BLIND

Read the diagram, find the circuit, measure under load. The meter tells you what is wrong before you buy anything.

Training guide with typical values. Always confirm pin numbers, wire colors and specs in the service information for that exact vehicle (VIN).