

Readiness report — IV Curve Tracer (Solar Cell)

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Readiness: IV Curve Tracer (Solar Cell)

Verdict: At risk · 2026-09-02 · est. parts cost \$200–\$260 (PCB fabrication not priced)

Cybersecurity — software & network: Review before networking

Every line of this lab's bill of materials can still be bought today, but the two OPA549S power op-amps — the most expensive parts on the board and, by the lab's own account, the ones with the least substitution latitude — have run dry since the last check. DigiKey, Mouser and Arrow all show zero stock with 26-week factory lead times, and a single authorized distributor holds 32 pieces. Order those now and the build proceeds; miss them and the lab waits about six months. That is the whole of the change: the verdict moves from **Ready with caveats** (2026-07-19) to **At risk** because of one part. Two problems the previous report raised have actually improved — the 20 kΩ resistor is stocked again, and the relay is not obsolete after all (that verdict rested on a different part number, corrected below).

Action required

Part	Problem	Recommended action
OPA549S	New since the previous report. Zero stock at DigiKey, Mouser and Arrow; all three quote 26-week factory lead times. Only one authorized distributor holds stock (32 pieces).	Order both units now from Spirit Electronics at \$30.35 . No substitute clears the board's 11-pin footprint — see Substitutes.
1461067-7 (relay K1)	Changed since the previous report. The TE ordering number 1461067-7 has zero stock at every authorized distributor and a High lifecycle risk — but it is not obsolete: under its catalog name OJ-SS-124HM,000 the relay is Active. The previous report's "Obsolete" verdict came from a different relay (ORWH-SS-124D,N000).	Order as OJ-SS-124HM,000 (10 in stock at Newark) or take the same-family OJE substitute with 5,309 in stock — see Substitutes.
HS50 R82 J	Still zero stock at DigiKey (15-week lead time); unchanged since the previous report.	Buy from Arrow, 200 in stock at \$5.20 . Mouser has 176 at \$9.77 — 88% dearer for the same part.
FK20X7S1H106K	Not For New Designs (unchanged). Lifecycle risk Med at ECIA.	Buy the specified part while 140,934 pieces remain; only 1 per lab. The previous report's proposed replacement is also NFND — see Substitutes for the one Active option.

Part	Problem	Recommended action
FK18X7R1H104K	Not For New Designs (unchanged). Lifecycle risk Med at ECIA.	Buy the specified part while 31,520 pieces remain; only 4 per lab. An Active drop-in on electricals is listed under Substitutes.
MF1/4DCT52R2002F	Still zero stock at DigiKey (17-week lead), but easier than at the previous report , which found no stocked source at all.	Buy from Mouser, 849 in stock at \$0.12 , or use the Yageo equivalent to keep a single DigiKey cart.

Cybersecurity — software & network

Review before networking — No firmware, library or toolchain version could be matched to any advisory or support database, and the documented setup requires running a Windows installer that is absent from the lab materials and would have to be re-obtained from the web — though the instrument itself has no network interface at all.

Component	Version	How known	Support status
Solar Cell IV Curve Tracer firmware sketch (IVCurve4_27.ino)	4-27-16	inferred (date stamp in the sketch's own header comment as recorded in the lab snapshot; a revision date, not a package-registry version)	—
Upstream base project — re-innovation PV_IV_Tracer (Arduino Code/ PV_IV_Tracer_v7)	not determined	not determined (the repository was listed and its sketch and README fetched this run; the root and Arduino Code/ contain no manifest, lockfile or release metadata, so no version could be resolved)	—
DAC_MCP49xx Arduino library	not determined	unpinned (the sketch includes <DAC_MCP49xx.h> with no version constraint; no manifest exists in the lab upload or in the upstream repository)	—
Arduino SPI core library	not determined	not determined (bundled with whichever Arduino AVR core the builder installs; no version is recorded anywhere in the lab materials)	—
Arduino IDE (build toolchain)	not determined	not determined (the lab documentation states no version; the stated download page https://www.arduino.cc/en/software returned an HTML page this run, and endoflife.date publishes no 'arduino' product, so no release cycle could be matched)	—
IV Curve Tracer PC GUI (Installer.zip / VSProject.zip)	not determined	not determined (both archives are absent from the lab upload, so there is no binary or source to read a version from)	—

Component	Version	How known	Support status
Microsoft .NET Framework (host GUI runtime)	not determined	not determined (directions.md step 12 says only that the installer 'may require .NET framework'; no version is named and the host application is missing)	—

Component	Finding	Severity	Fix available?
IV Curve Tracer PC GUI (Installer.zip / VSProject.zip)	The documented setup has the operator install and run a Windows executable (Installer.zip) that is missing from the lab materials, so it would have to be re-obtained from somewhere on the web and run on a lab PC without any way to check what it is.	posture	Mitigation only — drive the board with a short serial script written from the protocol documented in the sketch (115200 baud 8N1, handshake 'C'/'A', 'B' plus sweep parameters, data lines Vvoltage:04dcurrent:04d), or obtain Installer.zip only from the original project page and have it scanned before it runs on a lab machine.

What this means for your lab

This instrument has no network connection of any kind — no Ethernet, no Wi-Fi, no Bluetooth, no listening services and no passwords to change. The only link out of it is a USB cable to a single PC, so nobody else on your campus network can reach the instrument, read its measurements or drive the relay. The usual network precautions do not apply here. The one thing worth care is on the PC side: the lab's Windows program is missing from the uploaded materials, so whoever sets this up would have to download an executable from the internet and run it on a lab computer. Get it only from the original project's own page, have your IT group scan it first, or skip it entirely and talk to the board with a short serial script instead — the serial protocol is fully documented in the Arduino sketch. Everything else here could not be checked rather than checked clean: the sketch, the DAC library and the Arduino IDE carry no version numbers in the materials, the upstream project has no dependency file, and there is no vulnerability database that covers Arduino libraries or a hand-written sketch. Read 'nothing found' below as 'nothing was checkable', not as 'proven safe'.

Not checked

- Solar Cell IV Curve Tracer firmware sketch (IVCurve4_27.ino): standalone Arduino sketch distributed with the lab; no package manager or registry, and no vulnerability database covers it
- Upstream re-innovation PV_IV_Tracer repository: listed this run: neither the repository root nor Arduino Code/ contains a manifest or lockfile, so nothing could be resolved to a checkable version
- DAC_MCP49xx Arduino library: unpinned — the sketch names the header with no version, no manifest exists, and no vulnerability database covers Arduino community libraries

- Arduino SPI core library: bundled with whichever Arduino AVR core is installed; no version recorded and no vulnerability database covers Arduino core libraries
- Arduino IDE (build toolchain): no version stated in the lab documentation, and endoflife.date publishes no 'arduino' product, so no support cycle could be matched
- IV Curve Tracer PC GUI (Installer.zip / VSProject.zip): both archives are absent from the lab upload; there is no binary or source to inspect
- Microsoft .NET Framework (host GUI runtime): version not stated in the lab documentation and the host application is missing, so nothing pins it
- arduino not stated: support status: endoflife.date has no such product

Parts

Integrated circuits and active semiconductors

Part	Spec/Package	Status	Stock	Price	Source	Drift
OPA549S	8 A power op-amp, supply span 8–60 V / TO-220-11 Power Package	Active, but single-sourced	0 at DigiKey (26-week lead); 32 at Spirit Electronics	\$30.35	Spirit Electronics (ECIA)	Stock 188 → 0 at DigiKey; DigiKey list \$34.44 unchanged
MCP4921-E/P	12-bit SPI DAC, 2.7–5.5 V / PDIP-8	Active	812	\$2.81	DigiKey	Stock 487 → 812; price flat
2N3904BU	NPN switching transistor / TO-92	Active	166,982	\$0.29	DigiKey	\$0.28 → \$0.29; stock 231,511 → 166,982
1N4004	Rectifier diode, 400 V 1 A / DO-41	Active	199,396	\$0.14	DigiKey	Stock 178,689 → 199,396; price flat

Passive components: resistors

Part	Spec/Package	Status	Stock	Price	Source	Drift
HS50 R82 J	0.82 Ω , $\pm 5\%$, 50 W, solder lugs / chassis mount, 49.10 $\times$ 14.20 mm	Active	0 at DigiKey (15-week lead); 200 at Arrow, 176 at Mouser	\$5.20	Arrow (ECIA)	Unchanged: Arrow 200 @ \$5.20 then and now; Mouser 186 → 176
MF1/4DCT52R1001F	1 k Ω , 1%, 0.25 W / axial	Active	72,713	\$0.10	DigiKey	Stock 79,993 → 72,713; price flat
MF1/4DCT52R3161F	3.16 k Ω , 1%, 0.25 W / axial	Active	4,535	\$0.10	DigiKey	Stock 4,560 → 4,535; price flat

Part	Spec/Package	Status	Stock	Price	Source	Drift
MF1/4DCT52R2002F	20 kΩ, 1%, 0.25 W / axial, 2.30 mm dia × 6.30 mm	Active	0 at DigiKey (17-week lead); 849 at Mouser, 75,000 at TTI	\$0.12	Mouser (ECIA)	Was "out of stock, no source"; now stocked at two distributors — improved
MF1/4DCT52R1003F	100 kΩ, 1%, 0.25 W / axial	Active	1,849	\$0.10	DigiKey	Stock 9,933 → 1,849 (–81%); price flat
MF1/4DCT52R3163F	316 kΩ, 1%, 0.25 W / axial	Active	4,873	\$0.10	DigiKey	Flat: 4,873 → 4,873, price unchanged
MF1/4DCT52R1002F	10 kΩ, 1%, 0.25 W / axial (BOM item 8)	not checked	—	—	—	—

The 10 kΩ line is in the paper BOM only: the snapshot records that no 10 kΩ resistor appears in the EAGLE board or schematic, and it carries no sourcing plan, so no lookup was made.

Passive components: capacitors

Part	Spec/Package	Status	Stock	Price	Source	Drift
UPW1J101MPD	100 μF, ±20%, 63 V / radial can, 5.00 mm lead spacing, 10.00 mm dia	Active	4,404	\$0.74	DigiKey	Stock 5,178 → 4,404; price flat
FK20X7S1H106K	10 μF, ±10%, 50 V, X7S / radial, 5.00 mm lead spacing (ordered as FK20X7S1H106KR000)	Not For New Designs	140,934	\$1.24	DigiKey	Stock 141,750 → 140,934; price and status unchanged
FK18X7R1H104K	0.1 μF, ±10%, 50 V, X7R / radial, 2.50 mm lead spacing (ordered as FK18X7R1H104KN020)	Not For New Designs	31,520	\$0.28	DigiKey	Stock 40,230 → 31,520 (–22%); price and status unchanged
FG18C0G1H100DNT06	10 pF, C0G, 50 V / radial, 2.5 mm lead pitch	Active	4,432	\$0.23	DigiKey	Stock 4,525 → 4,432; price flat

One mechanical note on C1: the board footprint is a 7.5 mm can on 5.0 mm pitch and the lab's own substitution rule says " ≤ 8 mm diameter", but DigiKey's parametrics put the specified UPW1J101MPD at 10.00 mm diameter. The lead spacing matches; the can is 2.5 mm wider than the footprint's nominal. Check clearance to the neighbouring parts, or pick a 100 μF / 63 V / 5 mm-pitch can of 8 mm or less.

Electromechanical, relays and power sources

Part	Spec/ Package	Status	Stock	Price	Source	Drift
1461067-7 (OJ-SS-124HM,000)	SPST-NO, 10 A contacts, 24 VDC coil (18.8 mA) / 5-pin through-hole PCB relay	Active under the catalog number; the TE ordering number 1461067-7 has High lifecycle risk and no stock anywhere	0 at DigiKey; 10 at Newark	\$2.31 list · \$2.55 in stock	DigiKey / Newark (ECIA)	Previously reported Obsolete, 0 stock — corrected: that verdict came from a different relay (ORWH-SS-124D,N000)
LRS-200-24	24 V DC, 8.8 A, 200 W / enclosed chassis PSU	Active	777	\$24.50	DigiKey	Stock 945 → 777; price flat
OD9225-24HSS	24 V DC axial fan / 92 × 92 × 25 mm	Active	119	\$9.97	DigiKey	Stock 161 → 119 (–26%); price flat

Microcontroller and interconnects

Part	Spec/Package	Status	Stock	Price	Source	Drift
A000073 (Arduino Uno Rev3)	ATmega328P, 5 V logic / Uno R3 form factor	Active	2,117	\$26.30	DigiKey	Same \$26.30 as before, now from an authorized-distributor line rather than a shopping result
PRT-00553 (0.1" breakaway male header, 40-pin)	2.54 mm pitch single-row male header strip	Active as a generic part; the SparkFun part number itself was not priced this run	Retail stock	\$0.95	Jameco	Previously \$0.30 for PRT-00553 at SparkFun; that listing did not return this run
RA-T2X-64E	Extruded heatsink, ~4.8 °C/W, solder tabs / TO-220 vertical	Active	1,147	\$6.05	DigiKey	Stock 1,338 → 1,147; price flat
1581-0	Black 4 mm banana jack / panel mount	Active	16,911	\$3.19	DigiKey	\$3.10 → \$3.19 (+2.9%); stock 18,687 → 16,911

Part	Spec/Package	Status	Stock	Price	Source	Drift
1581-2	Red 4 mm banana jack / panel mount	Active	10,719 at DigiKey (7 distributors stocked)	\$3.19	DigiKey (via ECIA)	\$3.10 → \$3.19 (+2.9%); stock 8,740 → 10,719
Wire terminals / test points (24V, GND, SC+, SC-)	Board wirepads and test pads	Not an orderable part — fabricated with the PCB	—	—	—	—

DigiKey's keyword search does not surface the Pomona part for the string "1581-2" — it returns a ferrite bead, a jumper, a header and an LED, none of which is this part. The stock and price above come from the authorized-distributor corroboration, which does return Pomona 1581-2.

Mechanical enclosure and assembly hardware

Part	Spec/Package	Status	Stock	Price	Source	Drift
Project enclosure box (Hefty 7099HFT-010-111-044, 6.5 qt)	Clear polypropylene box, needs ≥ 12" × 8" × 4.5" inside	Exact model not found; equivalents available	Retail stock	\$1.25	Target (Brightroom 6 qt clear box)	Previously \$5.97 at Walmart; that listing did not return this run
PG9 waterproof cable gland	PG9 thread, 4–8 mm cable	Readily available	Retail stock	\$0.20	Pixel Paradise USA	Unchanged at \$0.20, same seller
M3 nylon standoff / screw kit	M3 nylon male-female standoffs and screws	Readily available	Retail stock	\$3.75	SpeedyFPV (180-piece kit)	Previously bundled with M4 hardware at ~\$15.00; itemised here
Chassis nylon spacers (Hillman 880444)	5/8" OD × 1/4" ID × 3/8" long nylon	Readily available, exact dimensions matched	Retail stock	\$2.97	Home Depot (Everbilt)	—
M4-0.70 × 25 mm screws, lock nuts, washers	M4 metric hardware	Readily available	Retail stock	\$11.07	Harfington (100 pcs with hex locknuts)	Previously bundled with M3 hardware at ~\$15.00; itemised here

Part	Spec/Package	Status	Stock	Price	Source	Drift
Arctic Silver 5 thermal compound	3.5 g syringe, electrically non-conductive	Readily available	Retail stock	\$9.69	Quiet PC	—
14 AWG stranded hookup wire (red, black)	14 AWG stranded copper, ≥ 10 A	Readily available	Retail stock	\$14.95	ZYLtech (5 m red + 5 m black)	—
3-conductor grounded AC power cord	NEMA 5-15P to bare pigtail leads, 120 V 10 A	Readily available	Retail stock	\$12.99	eBay (bare-lead appliance cord)	—
4 mm banana test leads (red, black pair)	Shrouded/stackable, needs ≥ 10 A DC	Readily available; current rating not stated by any seller	Retail stock	\$18.29	eBay (Goupchn silicone shrouded set)	—

The enclosure and the test leads are the two retail lines whose deciding claim could not be confirmed: no listing states the box's internal dimensions, and none states the leads' current rating. Both are recorded as plausible but unverified — measure the box before drilling, and check the leads' rating before running the lab's 8 A test current through them.

Substitutes

For part	Substitute	Differences	Verified	Judgment
OPA549S	OPA549T	Identical electricals — 10 A output, 8–60 V supply span, 900 kHz gain-bandwidth — so the +24 V rail is covered. Package differs: "TO-220-11 Formed Leads" against the OPA549S's "TO-220-11, Power Package". Separately it has zero stock at every authorized distributor surveyed (Spirit 0, Arrow 0 at 26 weeks, DigiKey 0 at 26 weeks, Mouser 0 with 2,501 on order) and a High supply-chain risk.	verified: supply-voltage range 8–60 V against the lab's +24 V rail, output current 10 A, and both parts' package strings (DigiKey parametrics). not verified: that the OPA549T lead pattern mates with the board's 11-pin staggered footprint.	Not acceptable — the footprint is unverified and it is unobtainable anyway. No other part in the evidence combines 8 A continuous output with the 11-lead TO-220 footprint, and DigiKey lists no substitutes for the OPA549S.
1461067-7 (OJ-SS-124HM,000)	OJE-SS-124HM,000 — Active, 5,309 in stock, \$2.33	Same TE OJ/OJE family the lab specifies and the same catalogue description, "RELAY GEN PURPOSE SPST 10A 24V": SPST-NO contact form, 10 A contact rating and 24 VDC coil all match. DigiKey classifies it a "Parametric Equivalent" of the specified relay. Costs \$0.02 more and, unlike the specified part, is in stock in quantity.	verified: contact form (SPST, 1 Form A), 10 A contact rating, 24 VDC coil, and DigiKey's parametric-equivalent classification. not verified: the 5-pin footprint and pin layout — DigiKey's relay parametrics do not publish pin spacing.	Acceptable on electricals, footprint not verified. Check the OJE pinout drawing against the board's five 1.32 mm holes before ordering in quantity.

For part	Substitute	Differences	Verified	Judgment
1461067-7 (OJ-SS-124HM,000)	G5LE-14 DC24 — Active, 19,237 in stock, \$1.73	The substitute the previous report proposed. It comes from a different relay family than the OJ/OJE series the lab requires. Cheapest of the three options.	not stated beyond Active status, price and stock: this lookup was pre-screened as routine and returned no parametrics, so contact form, contact rating and coil voltage could not be re-confirmed this run, and the footprint remains unverified exactly as the previous report left it.	Not verified. Prefer the OJE-SS-124HM,000 — same family, only \$0.60 dearer.
MF1/4DCT52R2002F	MFR-25FBF52-20K — Active, 58,021 in stock, \$0.11	Resistance, tolerance, power rating and temperature coefficient are identical (20 kΩ, ±1%, 0.25 W, ±100 ppm/°C); axial in both cases; body 2.40 mm × 6.30 mm against 2.30 mm × 6.30 mm — 0.1 mm fatter, same length. Same nominal value, so the firmware's ADC scaling constants are untouched. Watch the suffix: DigiKey's top hit for this search is MFR-25FBF52-20K5, which is 20.5 kΩ, not 20 kΩ.	verified: resistance, tolerance, power rating, temperature coefficient, axial package and body dimensions, from DigiKey parametrics for both parts. Lead pitch on an axial resistor is set at assembly, so the board's 10 mm pitch needs no separate check.	Acceptable — exact functional equivalent.

For part	Substitute	Differences	Verified	Judgment
FK20X7S1H106K	FG20X7R1H106KRT00 — Active, 915 in stock, \$1.41	10 μ F, 50 V, radial, with an X7R dielectric instead of X7S — explicitly inside the lab's stated latitude of X5R/X7R/X7S. DigiKey classifies it a "Direct" substitute for the specified part. The only Active option found; \$0.17 dearer.	verified: capacitance, 50 V rating and X7R dielectric (DigiKey substitute record and product description), and that the lab permits X7R. not verified: lead spacing and body size — this lookup was pre-screened as routine and returned no parametrics.	Acceptable on electricals, footprint not verified. Measure the lead pitch against the 2.5/5.0 mm pads before committing.
FK20X7S1H106K	FG20X7S1H106KRT06 — 9,556 in stock, \$1.36	The substitute the previous report recommended. Dimensionally identical to the original — 10 μ F, $\pm 10\%$, 50 V, X7S, 5.50 $\times$ 4.00 mm, 7.00 mm tall, 5.00 mm lead spacing — but it is also Not For New Designs , and costs 10% more.	verified: capacitance, tolerance, voltage rating, dielectric, body size and lead spacing (5.00 mm), from DigiKey parametrics for both parts.	A true drop-in, but not an upgrade — it carries the same Not For New Designs status as the part it would replace, which the previous report did not record.

For part	Substitute	Differences	Verified	Judgment
FK18X7R1H104K	K104K15X7RF5TL2 — Active, 218,939 in stock, \$0.29	0.1 μ F, 50 V, X7R, radial — matches the requirement of 100 nF, $\geq$ 50 V radial ceramic exactly on electricals. DigiKey classifies it a "Direct" substitute. \$0.01 dearer, with seven times the stock.	verified: capacitance, voltage rating, dielectric and radial construction (DigiKey substitute record and product description) plus DigiKey's own "Direct" classification. not verified: lead spacing and body size — this lookup was pre-screened as routine and returned no parametrics, so the 2.5 mm pitch the previous report claimed cannot be reproduced from this run's evidence.	Electrically equivalent, footprint not verified. A same-family alternative, TDK FG18X7R1H104KNT00 ("Direct", \$0.23, 6,808 in stock), is cheaper but equally unverified on footprint.

Verify any substitute against its own datasheet before ordering — particularly the footprint and lead pitch, which this check could not confirm for the relay or for either ceramic capacitor.

Other dependencies

- **PCB fabrication** — the package is complete and ready to quote as-is: 2 copper layers, **100.00 mm × 80.00 mm**, RS-274X Gerbers (top and bottom copper, both solder masks, top silkscreen, mechanical outline) plus Excellon drill data, 142 plated through-holes across 13 tool diameters, generated with the SparkFun 2-layer CAM script. Not priced this run — no fabrication quote was in the sourcing plan. Correction: the previous report gave the board as "approx. 69 mm × 53 mm"; the mechanical outline Gerber gives 100 × 80 mm.

- **Advanced Circuits (4pcb.com)**, the fabricator the lab names — a fetch was attempted this run and the page returned no readable text, so the fabricator's current status is **not checked**. Any 2-layer prototype house can take this package.
- **Instructables project page** (<https://www.instructables.com/IV-Curve-Tracer/>) — a fetch was attempted this run; the page downloaded but no readable text could be extracted, so its contents are **not checked**. The previous report stated that the lab's missing archives are "likely available on the project's Instructables page"; nothing gathered this run confirms that, and it should not be relied on until someone opens the page by hand.
- **Open-source base repository link** (github.com/re-innovation/PV_IV_Tracer) — the link is live: a directory listing returned five entries on branch master this run.
- **Missing curriculum documents** — Capstone Lesson Presentation.pdf and Solar Powered Energy Demo.docx are referenced by the lab but absent from the upload, and no URL is given for either. **Not checked** — there is nothing to fetch.

Watch list

- **OPA549S** — the whole verdict rests on this part. Two are needed, 32 exist at one authorized distributor, and everyone else quotes 26 weeks. If those 32 go before the next check, this lab becomes unbuildable for roughly half a year, and there is no footprint-compatible alternative.
- **MF1/4DCT52R1003F (100 kΩ)** — fell from 9,933 to 1,849 pieces in seven weeks, the fastest decline of any passive here. Only 2 are needed and 1% metal-film 100 kΩ resistors are a commodity, but it is the line to watch.
- **Both TDK ceramics (FK20X7S1H106K, FK18X7R1H104K)** — Not For New Designs, ECIA lifecycle risk Med, and only one stocked authorized distributor each beyond DigiKey. Today's stock is deep enough that this is a two-or-three-year problem rather than a next-check problem, but the escape routes are unverified on footprint.
- **The relay's footprint** — the OJE-SS-124HM,000 is the practical way to get this relay in quantity, and the one thing nobody has checked is whether its pins land in the board's five 1.32 mm holes. Confirm that once, from the datasheet, and the risk disappears permanently.
- **OD9225-24HSS (fan)** — down 26% to 119 pieces. Low consequence: any 92 × 92 × 25 mm 24 V axial fan does the job.