

Solar + storage — 24V, 1.2kW

Project ID: —

Designed by	CircuitProof — MarinePowerLab Team
Jurisdiction	NEC 690 / 706 / 710 — US off-grid, PV, energy storage
System	24 V DC · 1200 W PV · 9.6 kWh storage · 2400 W inverter
Generated	2026-08-02
Code revision basis	2023 NEC / 2024 ABYC (confirm locally-adopted revision)
Revision	A — issued for review · 2026-08-02

Sheet index

T-1	Cover / title sheet
G-1	Executive summary
E-1	One-line diagram + conductor schedule
E-2	DC schematic — two-line + EGC return
EQ-1	Equipment schedule / bill of materials
E-3	Wire-sizing calculations
E-4	Voltage-drop calculations
E-5	Overcurrent protection + AIC
E-6	Labels & placards schedule
N-1	Compliance checklist
R-1	References + document control

Scope: electrical documentation package. Site plans, roof framing plans, and structural sheets are outside this document's scope — see the cover note on what this document is and is not.

What this document is

A multi-page design report covering the modeled system: one-line schematic, bill of materials with manufacturer SKUs, wire-sizing calculations, voltage-drop verification per circuit, overcurrent-protection justification, and a code compliance checklist. Each calculation cites its source clause.

What it is not

This is not a Professional Engineer (P.Eng / PE) stamped drawing. It does not replace AHJ approval where one is required. Verify all calculations and code references with a licensed professional before installation.

Disclaimer

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Executive summary

This design models 6 components across 5 wire runs. Battery storage totals 9,600 Wh at a 24 V nominal DC bus. PV array totals 1200 W. Peak combined DC + AC load is 1200 W (continuous 0 W). All values below are derived deterministically from the canvas state and cited against the controlling code sections.

System capacity

Nominal DC bus voltage	24 V
Battery storage	9,600 Wh (400 Ah at bus)
PV array	1200 W
Inverter continuous rating	2400 W
AC load total	1200 W
Peak load (DC + AC)	1200 W
Continuous load	0 W
Components modeled	6
Wire runs modeled	5
Estimated equipment cost †	\$3,130 USD

Compliance rollup

Overall	FAIL
Errors (must address)	1
Warnings	0
Notes / informational	1
Passing rules	9

Detailed per-rule findings appear in the Compliance Checklist page later in this document.

Approval blocks

Filing under: Generic / unsubmitted · Code references as cited per page

Designer: _____ Date: _____

Reviewed by (P.Eng / PE): _____ Lic. #: _____ Date: _____

AHJ / inspector: _____ Date: _____

Insurance reviewer: _____ Date: _____

Submit with your jurisdiction's permit form. CircuitProof produces design documentation, not a P.Eng stamp.

Signature blocks are blanks for the appropriate parties to complete. CircuitProof does not pre-fill any of them and never represents itself as a stamping engineer.

One-line diagram

Wire tags (W1...Wn) key to the conductor schedule on-sheet and to the wire-sizing and overcurrent tables on the following sheets — all values computed by the same engine. Drawing not to scale (NTS).

CONDUCTOR SCHEDULE						
TAG	FROM TO	SIZE	LEN	AMPS	OCPD	EGC (250.122)
W1	Solar panel ' Charge controller	#10 CU	20 ft	12 A	15 A	#14 CU
W2	Charge controller ' Battery	#4 CU	5 ft	55 A	70 A	#8 CU
W3	Battery ' Breaker	#1/0 CU	2 ft	120 A	150 A	#6 CU
W4	Breaker ' Inverter / charger	#1/0 CU	2 ft	120 A	150 A	#6 CU
W5	Inverter / charger ' AC load	#12 CU	12 ft	10 A	15 A	#14 CU

ALL CONDUCTORS: CU, THWN-2 (90°C) UNLESS NOTED — TERMINATIONS PER NEC 110.14(C)

EQUIPMENT RATINGS

Solar panel: 1200 W STC · VOC 100 V · ISC 12 A
Charge controller: MPPT 60 A MAX OUTPUT
Battery: 400 Ah @ 24 V LIFEP04
Inverter / charger: 2400 W CONT · 4800 W SURGE

LEGEND · GENERAL NOTES

PV = Solar panel · MPPT = Charge controller · BATTERY = Battery · BREAKER = Breaker · INVERTER = Inverter / charger · RESISTOR = AC load

STAND-ALONE SYSTEM — NO UTILITY INTERCONNECTION. NEC 705.12 (120% RULE) NOT APPLICABLE; NEC 710 APPLIES.
ESS DISCONNECTING MEANS: READILY ACCESSIBLE, VISIBLE OR LOCKABLE OPEN — NEC 706.15. SEE LABELS SCHEDULE.
WIRE TAGS W1...Wn REFERENCE THE CONDUCTOR SCHEDULE ABOVE. VALUES COMPUTED BY THE CIRCUITPROOF ENGINE — IDENTICAL ACROSS ALL SHEETS.
DRAWING NOT TO SCALE (NTS). DESIGN DOCUMENTATION — NOT A PENGUPE-STAMPED DRAWING.

REV	DATE	DESCRIPTION
A	2026-08-02	ISSUED FOR REVIEW

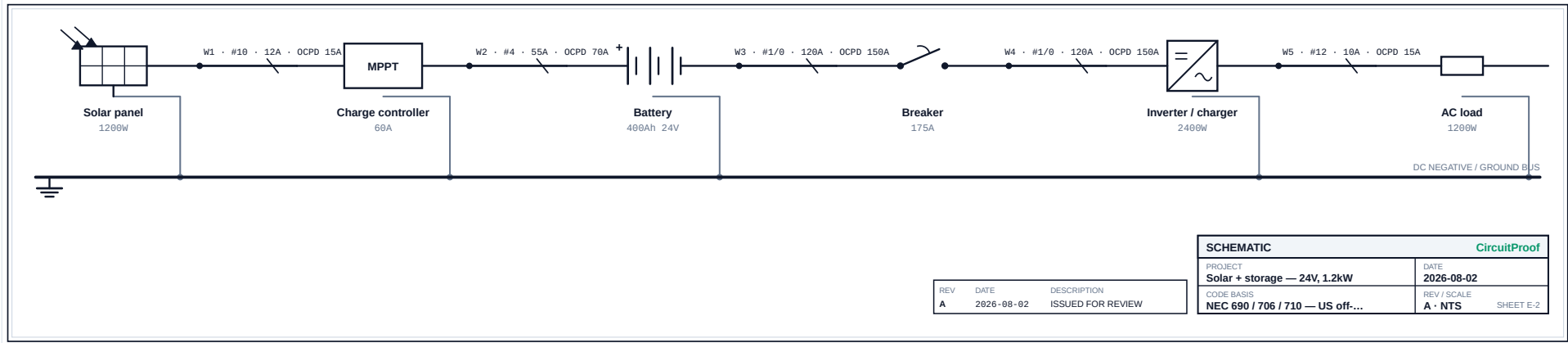
ONE-LINE DIAGRAM		CircuitProof
PROJECT	Solar + storage — 24V, 1.2kW	
DATE	2026-08-02	
CODE BASIS	REV / SCALE	SHEET E-1
NEC 690 / 706 / 710 — US off-...	A · NTS	

Sheet title: Solar + storage — 24V, 1.2kW — one-line diagram
Drawn by: CircuitProof

Date: 2026-08-02 · Scale: NTS · Rev A
Jurisdiction: NEC 690 / 706 / 710 — US off-grid, PV, energy storage

DC schematic — two-line + EGC return

Positive conductors are routed per run; the negative return and equipment-grounding path are drawn to the DC negative/ground bus below the components. Wire tags key to the E-1 conductor schedule. Drawing not to scale (NTS).



Sheet title: Solar + storage — 24V, 1.2kW — dc schematic — two-line + egc return
Drawn by: CircuitProof

Date: 2026-08-02 · Scale: NTS · Rev A
Jurisdiction: NEC 690 / 706 / 710 — US off-grid, PV, energy storage

Bill of materials

Quantities aggregated by item identity (label, manufacturer, SKU, spec). Prices below are estimated MSRP only — verify with current supplier quotes before ordering.

#	Item	Manufacturer	SKU / Model	Spec	Qty	Unit †	Total †
1. Sources & generation							
1.1	Solar panel	Renogy	RNG-400D	1200 W	1	\$340	\$340
	Sources & generation subtotal †						\$340
2. Storage							
2.1	Battery	Battle Born	BB10012	400 Ah @ 24 V 1		\$950	\$950
	Storage subtotal †						\$950
3. Conversion & charging							
3.1	Charge controller	Victron	SmartSolar MPPT 100/50	60 A	1	\$330	\$330
3.2	Inverter / charger	Victron	MultiPlus 12/2000	2400 W con- tinuous	1	\$1,450	\$1,450
	Conversion & charging subtotal †						\$1,780
4. Protection & disconnects							
4.1	Breaker	Blue Sea	7184	175 A	1	\$60	\$60
	Protection & disconnects subtotal †						\$60
5. Loads							
5.1	AC load	—	—	1200 W	1	—	—
	Loads subtotal †						\$0
	Grand total †						\$3,130 USD

† Estimated MSRP only — verify the current price with your supplier before ordering. CircuitProof does not warrant price accuracy.

Wire sizing calculations

For each modeled wire run, the table lists the design current, run length, allowable voltage drop, the smallest conductor that satisfies both the ampacity and voltage-drop constraints, and the cited source. Code basis: NEC 690 / 706 / 710 / 240 / 310.16.

From 'To	Amps	Len (ft)	VD limit	AWG	Ampaci-ty	VD %	Citation
Solar panel 'Charge con-troller	12	20	3%	10	35	2.42%	NEC 310.16 derated + 210.19(A) voltage drop + 210.19(A) 125% continu-ous
Charge controller 'Battery	55	5	3%	4	85	0.71%	NEC 310.16 derated + 210.19(A) voltage drop + 210.19(A) 125% continu-ous
Battery 'Breaker	120	2	3%	1/0	150	0.24%	NEC 310.16 derated + 210.19(A) voltage drop + 210.19(A) 125% continu-ous
Breaker 'Inverter / charger	120	2	3%	1/0	150	0.24%	NEC 310.16 derated + 210.19(A) voltage drop + 210.19(A) 125% continu-ous
Inverter / charger 'AC load	10	12	3%	12	25	1.93%	NEC 310.16 derated + 210.19(A) voltage drop + 210.19(A) 125% continu-ous

Method

Selected AWG is the smallest conductor whose ampacity (after temperature + bundling derating) meets or exceeds the design current AND whose voltage drop across the round-trip length stays at or below the 3% design limit (NEC 210.19(A) Informational Note / ABYC E-11.4.d for critical circuits). Where the engine could not find a conductor in range, the row is flagged "oversize" — the design needs a parallel run, a higher system voltage, or a shorter physical route.

Voltage-drop verification

Each circuit's voltage drop is recomputed here from first principles using NEC Chapter 9, Table 8 DC resistance values. The formula is shown alongside the values used.

Formula (DC)
$$Vd_v = (2 \times L_{ft} \times I_a \times R_{kft}) / 1000$$
$$Vd_{pct} = (Vd_v / V_{system}) \times 100$$

L = one-way run length (ft); the factor of 2 accounts for the round trip of a 2-wire DC circuit. R = DC resistance per 1000 ft from NEC Ch.9, Table 8. AC analysis adds the reactance term per Table 9; for the conductor sizes here the reactance term is small enough to ignore (resistance-dominated).

Per-circuit results

From To	AWG	L (ft)	I (A)	R kft	Vd (V)	Vd (%)	Limit	Result
Solar panel 'Charge controller	10	20	12	1.21	0.581	2.42%	3%	PASS
Charge controller 'Battery	4	5	55	0.308	0.169	0.71%	3%	PASS
Battery 'Breaker	1/0	2	120	0.122	0.059	0.24%	3%	PASS
Breaker 'Inverter / charger	1/0	2	120	0.122	0.059	0.24%	3%	PASS
Inverter / charger 'AC load	12	12	10	1.93	0.463	1.93%	3%	PASS

Sample worked example
$$Vd = 2 \times 20 \text{ ft} \times 12 \text{ A} \times 1.21 \text{ kft} \div 1000 = 0.581 \text{ V (2.42\%)}$$

Overcurrent protection

For each modeled wire run, the selected overcurrent device rating must protect the conductor — i.e. its ampere rating must not exceed the conductor's allowable ampacity. Where the design current is between two standard sizes (NEC 240.6(A)), the engine applies NEC 240.4(B) and selects the next standard size up.

From To	Design A	AWG	Ampacity	OCPD A	240.4(B)	Citation	Result
Solar panel 'Charge controller	12	10	35	15	yes	NEC 240.4 / 240.6(A)	PASS
Charge controller 'Battery	55	4	85	70	yes	NEC 240.4 / 240.6(A)	PASS
Battery 'Breaker	120	1/0	150	150	yes	NEC 240.4 / 240.6(A)	PASS
Breaker 'Inverter / charger	120	1/0	150	150	yes	NEC 240.4 / 240.6(A)	PASS
Inverter / charger 'AC load	10	12	25	15	yes	NEC 240.4 / 240.6(A)	PASS

Interrupting rating (AIC) check

Estimated available short-circuit current at the battery terminals: 15,271 A (Ohm's-law loop model, datasheet-typical internal resistance). Every overcurrent device on the battery side must carry an interrupting rating (AIC) above this value — NEC 110.9 / ABYC E-11. Common device families: ANL (automotive) 2,500 A (NOT OK) · ANL (marine-rated) 6,000 A (NOT OK) · MRBF terminal fuse 10,000 A (NOT OK) · Class T 20,000 A (OK). Verify with manufacturer fault-current curves before purchase.

Notes on selection

Standard OCPD sizes used: NEC 240.6(A) for AC, an extended low-end rung set for DC practice (5 / 7.5 / 10 / 15 / 20 / 25 / 30 / 35 / 40 / 45 / 50 / 60 / 70 / 80 / 90 / 100 / 110 / 125 / 150 / 175 / 200 / 225 / 250 / 300 / 350 / 400 A). Code basis: NEC 690 / 706 / 710 / 240 / 310.16. Where ABYC is in effect, battery-to-inverter feeds must carry overcurrent protection within 7 in (178 mm) of the positive post per E-11.10.

Labels & placards schedule

Fabricate and apply the placards below at the stated locations. Numeric values (voltages, currents, fault current) are computed from the modeled system by the same engine that produced the diagrams and calculation sheets — the values cannot disagree between sheets. Use durable, weather-resistant labels suitable for the environment; wording keys to the code cycle on the cover.

Placard text	Code basis	Location	Status
PHOTOVOLTAIC DC DISCONNECT	NEC 690.13(B)	PV DC disconnecting means	REQ
PHOTOVOLTAIC POWER SOURCE — MAX VOLTAGE 100 V DC · MAX CIRCUIT CURRENT 15 A	NEC 690.53; 690.8(A)(1) (125% of Isc)	At the PV DC disconnecting means	REQ
WARNING: PHOTOVOLTAIC POWER SOURCE	NEC 690.31(D)(2)	Every 10 ft of exposed PV source-circuit raceway/cable	REQ
ENERGY STORAGE SYSTEM DISCONNECT — NOMINAL 24 V DC · AVAILABLE FAULT CURRENT 15.3 kA (CALCULATED — VERIFY WITH MANUFACTURER DATA)	NEC 706.15(C)	ESS disconnecting means	REQ
ENERGY STORAGE SYSTEM — DO NOT SERVICE ENERGIZED	NEC 706.15(A) (readily accessible disconnect)	Adjacent to the battery bank	REQ
POWER SOURCE OUTPUT CONNECTION — INVERTER OUTPUT 120 V AC	NEC 690.54 (stand-alone: 710.10 plaque)	At the AC distribution equipment	REQ
STAND-ALONE SYSTEM — NOT CONNECTED TO A UTILITY GRID	NEC 710.10 (plaque at service/system entrance)	System power entrance / main panel	REQ
RAPID SHUTDOWN LABEL — N/A: NOT A BUILDING PER 690.12 SCOPE (VERIFY WITH AHJ FOR DWELLING-MOUNTED ARRAYS)	NEC 690.56(C)	—	N/A

Available fault current basis

Estimated available short-circuit current at the battery terminals: 15,271 A (Ohm's-law loop model with datasheet-typical internal resistance for the modeled chemistry and bank size). This is an order-of-magnitude engineering estimate for label and AIC-selection purposes — verify against the battery manufacturer's published fault-current data before fabrication.

Compliance checklist

Per-rule findings from the deterministic compliance engine. Items not flagged are marked PASS because the engine had no matching error/warning/info to surface against them. Final acceptance rests with the AHJ and any licensed reviewer of record.

Result	Rule	Code	Detail
PASS	PV must be regulated Photovoltaic input must pass through a charge controller before reaching the battery.	NEC 690	Charge controller present on PV array.
PASS	Charge controller ≥125% Isc Controller input current rating must be at least 125% of the array's short-circuit current.	NEC 690.8(A)(1)	Charge controller rated ≥125% of PV short-circuit current.
PASS	OCPD present at source Every ungrounded conductor leaving a source must be protected.	NEC 240.21(B)	At least one fuse or breaker is present in the circuit.
PASS	Battery-inverter local OCPD Battery feeding an inverter requires OCPD within 7 in (178 mm) of the positive post.	NEC 240.21(B)	Battery-to-inverter feed is locally protected.
FAIL	OCPD ≤conductor ampacity Fuse / breaker rating must not exceed the protected conductor's ampacity.	NEC 240.4	Breaker 175A exceeds the 130A ampacity of its 1 AWG conductor — protect the wire, not just the load.
PASS	Critical-circuit voltage drop ≤3% Battery-inverter and other critical feeds drop ≤3% at full load.	NEC 210.19(A)	Battery-inverter run within 3% voltage drop.
PASS	Standard OCPD ampere size Fuse and breaker ratings must be a standard ampere value listed in 240.6(A).	NEC 240.6(A)	All OCPD ratings are standard sizes.
PASS	Inverter rated for AC load Inverter continuous output equals or exceeds total connected AC load.	Design	Inverter continuous rating ≥ summed AC load.
PASS	Battery bank voltage uniformity All batteries in a paralleled bank should share a nominal voltage.	Design	All batteries share the same nominal voltage.
PASS	Battery chemistry uniformity Do not parallel different battery chemistries (LiFePO4 / AGM / lead-acid) in one bank.	Best practice	Battery bank uses a single chemistry.
NOTE	Battery monitor present A shunt-based battery monitor is recommended for accurate state-of-charge.	Best practice	No battery monitor/shunt — recommended for accurate state-of-charge.

Rules above are the subset the CircuitProof engine checks today. Code coverage will expand over time; absence from this list does not imply a requirement is waived.

Appendix — references

Cited code sections

NEC 240 Overcurrent Protection (NFPA 70 Article 240) — NFPA	www.nfpa.org/codes-and-standards/all-codes-and-s...
NEC 310.16 Allowable Ampacities of Insulated Conductors — NFPA	www.nfpa.org/codes-and-standards/all-codes-and-s...
NEC 690 Solar Photovoltaic (PV) Systems — NFPA	www.nfpa.org/codes-and-standards/all-codes-and-s...
NEC 706 Energy Storage Systems — NFPA	www.nfpa.org/codes-and-standards/all-codes-and-s...
NEC 710 Stand-Alone Systems — NFPA	www.nfpa.org/codes-and-standards/all-codes-and-s...
ABYC E-11 AC and DC Electrical Systems on Boats — American Boat & Yacht Council	abycinc.org/page/Standards
ISO 13297 Small craft — Electrical systems — Alternating and direct current installations — International Organization for Standard-ization	www.iso.org/standard/72539.html
AS/NZS 3001 Electrical installations — Connectable installations and supplies up to and including 32 A — Standards Australia / Standards New Zealand	www.standards.org.au/standards-catalogue/standard-details
AS/NZS 3008.1.1 Electrical installations — Selection of cables — Standards Australia / Standards New Zealand	www.standards.org.au/standards-catalogue/standard-details

Component datasheets

Solar panel Renogy · RNG-400D	www.renogy.com/400-watt-monocrystalline-solar-panel/
Battery Battle Born · BB10012	battlebornbatteries.com/product/12v-100ah-lithium-battery-b...
Breaker Blue Sea · 7184	www.blueseas.com/products/7184

Document metadata

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