Wire and Fuse Sizing Worksheet

Print this sheet and work one step at a time. Do every calculation twice, the way Chapter 11 does. Use your own panel spec sheet, inverter manual, and site temperatures. See Chapter 11.

This is a planning worksheet, not a design approval. Verify every result against your manuals, your local code, and the NEC. Where a manual and this sheet disagree, the manual wins.

Your site. Date: _____ Prepared by: _____ AHJ code edition: _____

Your starting numbers (See Chapters 3, 7, 9, and 11)

Fill the "Your system" column from your spec sheets. The sample-house column is the book's example: 16 x 500 W panels, two strings of 8 (one ground, one roof), a 48 V class LiFePO4 bank of 15.36 kWh (3 x 5.12 kWh), and a 6,000 W all-in-one. Those inverter figures are from the sample manual used in the book. Use only the numbers in your manual.

Item	Sample house	Your system
Panel watts (STC)	500 W	_____ W
Voc (open-circuit)	40 V	_____ V
Vmp (max power)	34 V	_____ V
Isc (short-circuit)	15.6 A	_____ A
Imp (max power current)	14.7 A	_____ A
Voc temperature coefficient	minus 0.28% per °C	_____ % per °C
Vmp or Pmax temperature coefficient	minus 0.34% per °C (Pmax used as a stand-in if no Vmp figure)	_____ % per °C
Panels in string 1 (ground)	8	
Panels in string 2 (roof)	8	
Inverter max PV input	480 V	_____ V
MPPT operating range	120 to 385 V	_____ to _____ V
Max usable current per MPPT input	17 A (sample manual)	_____ A
Max short-circuit current per MPPT input	25 A (sample manual)	_____ A
Usable watts per MPPT input	4,000 W (sample manual)	_____ W
AC pass-through (sample manual)	50 A	_____ A
Battery fuse called for in the sample manual	200 A	_____ A
Inverter continuous output	6,000 W at 120/240 V	_____ W
Inverter efficiency used in the battery-current estimate	0.9 (sample)	
Low-end battery voltage used in that estimate	48 V (sample)	_____ V
Coldest expected temperature	minus 20 °C (minus 4 °F)	_____ °C
Hottest cell temperature (sample, roof in summer)	70 °C	_____ °C
Your design target for cold string voltage, if you set one	about 400 V on the house, under the 480 V limit	_____ V
Ground-array one-way wire length	150 ft (example run)	_____ ft
Roof-array one-way wire length	60 ft (example run)	_____ ft

The lowest expected temperature often comes from the ASHRAE extreme annual mean minimum design dry bulb temperature for the nearest weather station. Your AHJ may tell you which number to use. Write down which method your AHJ wants for cold voltage: the module coefficient, or NEC Table 690.7(A).

Step 1. String size, cold side (See Chapters 3 and 11)

A string's voltage must never go over the inverter's maximum PV input, even on the coldest morning. Also check the 600 V limit for PV circuits on or in one- and two-family dwellings (NEC 690.7).

Method 1, the panel's temperature coefficient (690.7(A)(1))

Degrees down from 25 °C: 25 minus (your coldest °C) = _____ °C

Coefficient as a decimal: _____ (sample: 0.28% = 0.0028)

Percent rise: degrees x coefficient = _____ % (sample: 45 x 0.28% = 12.6%)

Cold Voc per panel = nameplate Voc x (1 + percent rise) = _____ V (sample: 40 x 1.126 = 45.04 V)

Cold string Voc = per panel x panels in the string = _____ V (sample, 8 panels: **360.3 V**)

Method 2, NEC Table 690.7(A) (690.7(A)(2), crystalline and multicrystalline silicon modules)

These factors are from NEC Table 690.7(A) in the 2023 edition, for crystalline and multicrystalline silicon modules. Confirm them in the code book your AHJ uses. Later editions, including 2026, may change a factor, a row, or the table number.

Ambient temperature (°C)	Factor
24 to 20	1.02
19 to 15	1.04
14 to 10	1.06
9 to 5	1.08
4 to 0	1.10
minus 1 to minus 5	1.12
minus 6 to minus 10	1.14
minus 11 to minus 15	1.16
minus 16 to minus 20	1.18
minus 21 to minus 25	1.20
minus 26 to minus 30	1.21
minus 31 to minus 35	1.23
minus 36 to minus 40	1.25

The sample house uses minus 20 °C, so the factor is **1.18**.

Your Table 690.7(A) factor: _____ (sample at minus 20 °C: 1.18)

Cold Voc per panel = nameplate Voc x factor = _____ V (sample: 40 x 1.18 = 47.2 V)

Cold string Voc = per panel x panels in the string = _____ V (sample, 8 panels: **377.6 V**)

Check backward (sample): 360.3 divided by 8 = 45.04, and 45.04 divided by 40 = 1.126. And 377.6 divided by 47.2 = 8.

Check	Limit	Sample house	Your string 1	Your string 2	Pass?
Cold Voc, Method 1, under inverter max	_____ V (sample 480 V)	360.3 V	_____ V	_____ V	☐
Cold Voc, Method 2, under inverter max	same	377.6 V	_____ V	_____ V	☐
Under your own design target, if you set one	_____ V (sample about 400 V)	yes	☐	☐	☐
Under 600 V dwelling limit (690.7)	600 V	377.6 V is well under	_____ V	_____ V	☐

If cold Voc is within a few percent of the inverter limit, stop and call a pro (See Chapter 11).

Step 2. String size, hot side (See Chapter 11)

On a hot afternoon, panel voltage drops. The string has to stay inside the MPPT's working range. Vmp drops with heat roughly at the Pmax temperature coefficient (use the Vmp coefficient instead if your spec sheet gives one).

Degrees up from 25 °C: (your hottest cell °C) minus 25 = _____ °C (sample: 70 minus 25 = 45)

Percent drop: degrees x coefficient = _____ % (sample: 45 x 0.34% = 15.3%)

Hot Vmp per panel = nameplate Vmp x (1 minus that percent) = _____ V (sample: 34 x 0.847 = 28.8 V)

Hot string Vmp = per panel x panels = _____ V (sample, 8 panels: **230.4 V**)

Cold Vmp per panel, using the same rise as Method 1: _____ V (sample: 34 x 1.126 = 38.3 V)

Cold string Vmp = _____ V (sample, 8 panels: **306.3 V**)

Check	Sample house	Your string 1	Your string 2	Pass?
Hot Vmp above the bottom of the MPPT range	230.4 V, above 120 V	_____ V	_____ V	☐
Cold Vmp under the top of the MPPT range	306.3 V, under 385 V	_____ V	_____ V	☐

Leave room for voltage drop on a long ground run when you compare hot Vmp to the bottom of the window.

Step 3. Current checks (See Chapter 11)

Maximum circuit current (NEC 690.8(A)(1)): Isc x 1.25 = _____ A (sample: 15.6 x 1.25 = **19.5 A** per string)

Check: 19.5 divided by 1.25 = 15.6.

Check	Sample house	Your string 1	Your string 2	Pass?
Isc (and 1.25 x Isc) under the input's short-circuit limit	15.6 A (19.5 A with 1.25), under 25 A	_____ A	_____ A	☐
Imp under the input's usable current limit	14.7 A, under 17 A	_____ A	_____ A	☐
String watts under the input's power limit	8 x 500 W = 4,000 W	_____ W	_____ W	☐

One string per input on the sample house, so currents do not add. If you parallel two strings on one input, the current doubles and you have to recheck everything. Some manuals compare 1.25 x Isc to their input limit. Follow what yours says.

Step 4. String fuses (See Chapter 11)

String fuses protect a string from current fed back into it by other strings in parallel during a fault. With one string per MPPT input, there is nothing in parallel to feed a fault, and the conductors are sized for the string's maximum current, so the sample house does not need string fuses.

The rule of thumb many installers use: one or two strings in parallel usually do not need fuses, and three or more usually do. The real test is in 690.9 and the panel's **maximum series fuse rating**. If parallel strings could push more current into a faulted string than that rating, you need fuses.

Where fuses are needed, 690.9(B) sizes them at not less than 125% of the maximum current from 690.8(A), and not more than the module's maximum series fuse rating. Fuses must be listed for PV use and DC-rated at the system voltage.

Module maximum series fuse rating (from the label): _____ A

Do you need string fuses? Yes / No Why: _____

If yes, 1.25 x maximum circuit current (1.25 x 1.25 x Isc) = _____ A

Fuse size you will use: _____ A

If you need string fuses and are not sure how to size them against the panel's maximum series fuse rating, stop and call a pro.

Step 5. Conductor sizing (See Chapter 11)

Two checks, and the wire has to pass both (NEC 690.8(B)).

Check A, without derating: ampacity at least 125% of the maximum current.

19.5 A x 1.25 = **24.4 A** on the sample house. Equivalently, Isc x 1.56: 15.6 x 1.5625 = 24.4 A.

Your Check A minimum: (your 1.25 x Isc) x 1.25 = _____ A, or Isc x 1.56 = _____ A

Use the ampacity column that matches your **terminal** temperature rating, usually 75 °C.

Check B, with derating: ampacity after correcting for temperature and conduit fill must be at least the maximum current (19.5 A on the sample house; yours: _____ A).

The sample house uses **10 AWG copper THWN-2** for every PV conductor in conduit, from each array's junction box to the inverter, and **PV wire only in free air at the array,** from the module leads to that junction box. Inside conduit, the conductor has to be listed for a wet location (300.5(B), 300.9). The equipment grounding conductor rides in the same conduit, green THWN-2 or bare copper.

Values from Table 310.16 (2023 NEC) for copper conductors, not more than three current-carrying conductors in raceway, cable, or earth, 30 °C ambient. Confirm them in the code book your AHJ uses. Later editions, including 2026, may change a value or the table number. Use the column that matches your terminal rating, usually 75 °C.

Size (copper)	75 °C column (A)	90 °C column (A)
14 AWG	20	25
12 AWG	25	30
10 AWG	35	40
8 AWG	50	55
6 AWG	65	75
4 AWG	85	95
2 AWG	115	130
1/0 AWG	150	170
2/0 AWG	175	195
3/0 AWG	200	225
4/0 AWG	230	260

The book uses **10 AWG** at **35 A** (75 °C) and **40 A** (90 °C), **8 AWG** at **50 A** (75 °C), **2/0** at **175 A** (75 °C), and **3/0** at **200 A** (75 °C).

Sample house Check A: 10 AWG copper, 75 °C column, 35 A, which is more than 24.4 A. Pass.

Sample house Check B: start from the 90 °C column, 40 A. Inside the house, the ground and roof circuits may share a conduit, so there are 4 current-carrying conductors: adjustment factor **0.80** (310.15(C)(1), for 4 to 6 conductors). Equipment grounding conductors do not count. Hot location at 40 °C (sample): correction factor **0.91**. 40 x 0.91 x 0.80 = **29.1 A**, which is more than 19.5 A. Pass. Check B again: 40 x 0.8 = 32, and 32 x 0.91 = 29.1.

Ambient correction factors from NEC 310.15(B) (2023), based on 30 °C, for the 75 °C and 90 °C conductor ratings. The sample house Check B uses the **90 °C** column: **0.91** at 36 to 40 °C. Confirm the factors and the table number in the code book your AHJ uses. Later editions, including 2026, may change a factor or the table number.

Ambient (°C)	75 °C factor	90 °C factor
21 to 25	1.05	1.04
26 to 30	1.00	1.00
31 to 35	0.94	0.96
36 to 40	0.88	0.91
41 to 45	0.82	0.87
46 to 50	0.75	0.82
51 to 55	0.67	0.76
56 to 60	0.58	0.71

Your ambient temperature: _____ °C Your Table 310.15(B) correction factor: _____

Number of current-carrying conductors in the raceway: _____

Adjustment factor: _____ (book gives 80% for 4 to 6)

On the roof, keep the conduit at least 7/8 inch above the roof surface. Closer than that, the code adds 33 °C to the ambient temperature for the correction, which can change the wire size (310.15(B)(2)).

Run	Wire size and type	Check A ampacity	Check A minimum	Check B ampacity after derating	Check B minimum	Pass both?
Sample, each PV run in conduit	10 AWG copper THWN-2	35 A	24.4 A	29.1 A (sample conditions)	19.5 A	Yes
Your ground PV run						☐
Your roof PV run						☐

Sample house conduit (See Chapters 11 and 16): the buried run is **1 in Schedule 40 PVC**, with three 10 AWG THWN-2 conductors (positive, negative, and the EGC). From NEC Chapter 9, Table 5, each 10 AWG THWN-2 takes 0.0211 sq in, so three take 0.0633 sq in. Table 1 allows 40% fill for more than two conductors, and Table 4 gives 1 in Schedule 40 PVC 0.832 sq in total, so 40% is 0.333 sq in. 0.0633 is about 7.6% of 0.832, far under 40%. A second 1 in conduit is laid beside it as a spare (See Chapter 16).

Your conduit size and type: _____ Fill %: _____

Spare conduit?: _____

240.4(D): 10 AWG copper is limited to 30 A overcurrent protection in most uses.

Step 6. Voltage drop (See Chapter 11)

Voltage drop is not a code requirement for these circuits. It is a performance target, given as an informational note. Many designers aim for 2% or less on PV circuits. That is a common practice target, not a rule.

Voltage drop = 2 x one-way length (ft) x current (A) x resistance (ohms per 1,000 ft), divided by 1,000

Use Imp for the current. Circuit voltage for the percent is string Vmp (sample: 8 x 34 V = **272 V**).

Resistances from NEC Chapter 9, Table 8 (2023), stranded uncoated copper, ohms per 1,000 ft, at the table's 75 °C basis. Confirm them in the code book your AHJ uses. Later editions, including 2026, may change a value.

Size	Ohms per 1,000 ft
14 AWG	3.14
12 AWG	1.98
10 AWG	1.24
8 AWG	0.778
6 AWG	0.491
4 AWG	0.308
2 AWG	0.194
1/0 AWG	0.122
2/0 AWG	0.0967
3/0 AWG	0.0766
4/0 AWG	0.0608

The book uses **1.24** for 10 AWG and **0.778** for 8 AWG.

Run	One-way ft	Current (Imp)	Wire	Ohms per 1,000 ft	Voltage drop (V)	Divided by string Vmp	%	Notes
Sample, ground array	150	14.7 A	10 AWG	1.24	5.47 V	272 V	**2.0%**	Right at the common 2% target
Sample, same run, 8 AWG option	150	14.7 A	8 AWG	0.778	3.43 V	272 V	about **1.3%**	Bigger wire must still fit the inverter's PV terminals
Sample, roof array	60	14.7 A	10 AWG	1.24	2.19 V	272 V	**0.8%**	
Your ground run								
Your roof run								
Other: _____								

Sample checks: 2 x 150 x 14.7 x 1.24 / 1,000 = 5.47 V; 5.47 / 272 = 0.0201. Roof: 2 x 60 x 14.7 x 1.24 / 1,000 = 2.19 V.

Step 7. Battery cable and fuse (See Chapters 11 and 18)

Maximum DC current. Use the number in the inverter manual if it gives one. To estimate it: inverter watts divided by the low end of battery voltage, divided by inverter efficiency.

Sample: 6,000 / 48 / 0.9 = **139 A**. Check: 139 x 0.9 x 48 = 6,005 W.

Your estimate, or the manual's number: _____ A

Continuous current x 1.25: 139 x 1.25 = **174 A** on the sample house. Yours: _____ A

The fuse: the sample manual used in the book calls for a **200 A** battery fuse, which is at least 174 A. Use only the fuse size your own inverter manual specifies. Use a DC-rated fuse with an interrupting rating above the battery's short-circuit current, often a Class T fuse, mounted as close to the battery as practical (See Chapter 3).

Your manual's battery fuse size: _____ A Type: _____

Interrupting rating: _____

The cable: it has to be protected by that fuse. Values the book gives from the 75 °C column of Table 310.16: **2/0 copper is 175 A** (too small for a 200 A fuse) and **3/0 copper is 200 A**. So the sample house uses **3/0 copper** with a 200 A Class T fuse as an example, unless the manual calls for larger, in which case the manual wins.

Before you buy, confirm the termination temperature of the lugs and the fuse holder (if they are limited to 60 °C, 3/0 is too small for a 200 A fuse), the conductor ampacity after any required corrections, and that the fuse and holder are listed for the voltage and interrupting rating. The sample is sized at exactly the 75 °C ampacity, so there is no extra margin if those conditions are not met.

Your battery cable size: _____ Ampacity at your terminal rating: _____ A

If the manual's battery cable and fuse sizes disagree with what you calculated and you cannot tell why, stop and call a pro.

Step 8. AC output and generator input (See Chapters 11, 22, and 23)

AC output. Sample: 6,000 W at 240 V = **25 A**. At 125%, that is 31.25 A. But the sample manual lets this unit pass generator power through at up to **50 A**. The output conductors and breaker must handle the larger of the two. The sample house uses a **50 A, 2-pole breaker** and **8 AWG copper** (50 A in the 75 °C column) as an example matching that sample rating.

Your continuous output current: _____ A 125% of that: _____ A

Pass-through or output rating from your manual: _____ A

Your output breaker: _____ A, 2-pole Your output conductors: _____ AWG copper

EGC (sample at 50 A: 10 AWG copper, Table 250.122): _____ AWG

Feeder, subpanel to house panel (See Chapter 22). Sample rating: a 50 A 2-pole breaker in the subpanel, 8 AWG copper L1, L2, and neutral, plus a 10 AWG copper EGC. Four wires. Never use the neutral as the ground. If you upsize the ungrounded conductors for voltage drop, upsize the EGC in proportion (250.122(B)).

Sample house feeder: **40 ft** one way, 8 AWG copper at 50 A. Voltage drop: 2 x 40 x 50 x 0.778 / 1,000 = **3.11 V**, or **1.3%** of 240 V (Chapter 22). This length is a sample house example. Measure yours and size it per your manual, the NEC, and your local AHJ.

Your feeder breaker: _____ A Your feeder conductors: _____

Feeder length: _____ ft

Generator input. Size the generator input breaker and conductors for the inverter's maximum AC input current from the manual, and the generator's output breaker. See Chapter 23.

Sample house generator input breaker: **50 A, 2-pole**, matching the sample manual's 50 A pass-through rating, and above the sample 8,000 W generator's 33 A at 240 V (Chapters 11 and 23). This is a sample house example. Size yours per your manual, the NEC, and your local AHJ.

Your generator input breaker: _____ A

Neutral and ground. There is only **one** neutral-to-ground bond in the system. Where it goes depends on the inverter and the generator. See Chapter 22. Write your case here: _____

Step 9. Disconnects, arc-fault, and ground-fault (See Chapters 3 and 11)

- ☐ PV disconnect for each array (690.13), readily accessible, with the "terminals may be energized on both sides" warning. Some all-in-ones have a built-in DC switch. Ask your AHJ whether it counts.
- ☐ Equipment disconnects so the inverter can be isolated for service (690.15).
- ☐ Battery disconnect near the bank (480.7, 706.15).
- ☐ AC output breaker and the house panel main.
- ☐ Generator disconnect (See Chapter 23).
- ☐ DC arc-fault protection (690.11) confirmed in the listing, for PV circuits at 80 V or more.
- ☐ Ground-fault detection (690.41(B)) confirmed.

Step 10. Rapid shutdown (See Chapters 11 and 15)

The roof array is on a building, so it needs rapid shutdown (690.12). On the sample house, a small rapid shutdown device sits under each roof panel. The initiator, the switch a firefighter uses, goes outside. The devices, the transmitter, and the inverter must be listed to work together. Do not mix brands without a compatibility listing.

Outside the array boundary (1 ft from the array), controlled conductors must drop to 30 V or less within 30 seconds of initiation. Inside the boundary, the 2023 NEC gives two choices: a listed PV hazard control system, or drop to 80 V or less within 30 seconds.

The ground array is in the yard, but its wires run into the house. Ask your AHJ how they want the ground array handled before you buy equipment.

☐ Roof-array rapid shutdown plan is listed and compatible.

☐ I have my AHJ's answer for the ground array: _____

Step 11. Grounding, bonding, and battery location (See Chapters 11, 14, 18, and 24)

For the sample house, 19.5 x 1.25 = 24.4 A rounds up to an assumed 25 A device, which falls in the Table 250.122 row up to 60 A, so the minimum EGC is **10 AWG copper**, the same size as the circuit conductors. Where an EGC smaller than 6 AWG is exposed to damage, protect it or use 6 AWG (250.120(C)).

Your EGC size: _____ AWG Battery location checked against Chapter 18 and the IRC rules your AHJ uses: ☐

Fuse and disconnect map (See Chapter 11)

Fill this in before you buy anything. One line per protective device. Sample-house ratings are in the "Sample house" column.

#	Location	Protects	Device	Rating	DC or AC	Sample house	Your system
1	Ground array	String to MPPT 1	PV disconnect	600 V DC, 25 A or more	DC	600 V DC, 25 A or more	
2	Roof array	String to MPPT 2	PV disconnect, RSD	600 V DC, 25 A or more	DC	600 V DC, 25 A or more	
3	Battery	Battery cable	Class T fuse	200 A	DC	200 A (sample manual)	
4	Battery	Bank	Battery disconnect	Rated for battery voltage and current	DC	per battery voltage and current	
5	Inverter AC out	Output conductors	2-pole breaker	50 A	AC	50 A	
6	Generator input	Input conductors	2-pole breaker	50 A (sample; size yours per your manual)	AC	50 A (sample)	
7	House panel	Feeder and bus	Main breaker	50 A (sample, matching the feeder)	AC	50 A (sample); 125 A bus	
8	Equipment-wall subpanel feeder (See Chapter 22)	Feeder to house panel	2-pole breaker	50 A (sample)	AC	50 A	
9							
10							

Stop and call a pro (See Chapter 11) if your AHJ wants a professional engineer's letter or stamped drawings and you cannot provide them; if your cold Voc is within a few percent of the inverter limit; if you need string fuses and are not sure how to size them; if the manual's battery cable and fuse sizes disagree with what you calculated and you cannot tell why; or if you are not sure where the neutral-ground bond belongs.