EXPEDITED SOLAR PHOTOVOLTAIC PERMITTING FOR ONE- AND TWO-FAMILY DWELLINGS
CENTRAL STRING INVERTER SYSTEMS - 2016 CODES

This guide is for a streamlined permitting process for solar photovoltaic (PV) projects 10 kW in size or smaller, and includes information about submittal requirements for plan review, required fees and inspections.

1. Approval Requirements
   a) Planning department approval is required.
   b) A building permit is required.
   c) An electrical permit is required.
   d) A fire department permit is not required.
   e) Silicon Valley Power approval is required.

2. Submittal Requirements
   a) Completed permit application form. This permit application form can be downloaded at http://santaclaraca.gov/government/departments/community-development.
   b) Demonstrate compliance with the eligibility checklist for expedited permitting.
   c) A completed Standard Electrical Plan. The standard plan may be used for proposed solar installations 10 kW in size or smaller. This will include:
      - Locations of main service or utility disconnect
      - Total number of modules, number of modules per string and the total number of strings
      - Make and model of inverter(s) and/or combiner box if used
      - One-line diagram of system
      - Specify grounding/bonding, conductor type and size, conduit type and size and number of conductors in each section of conduit
      - Equipment cut sheets including inverters, modules, AC and DC disconnects, combiners and racking system.
      - Labeling of equipment as required by CEC, Sections 690 and 705
      - Site diagram showing the arrangement of panels on the roof or ground, north arrow, lot dimensions and the distance from property lines to adjacent buildings/structures (existing and proposed)
   d) A roof plan showing roof layout, PV panels and the following fire safety items: approximate location of roof access point, location of code-compliant access pathways, PV system fire classification and the locations of all required labels and markings. Examples of clear path access pathways are available in the State Fire Marshal Solar PV Installation Guide. http://osfm.fire.ca.gov/pdf/reports/solarphotovoltaicguideline.pdf
   e) Complete expedited Structural Criteria along with required documentation.

For non-qualifying systems, provide structural drawings and calculations stamped and signed by a California-licensed Civil or Structural Engineer, along with the following information.
   - The type of roof covering and the number of roof coverings installed
   - Type of roof framing, size of members and spacing
   - Weight of panels, support locations and method of attachment
   - Framing plan and details for any work necessary to strengthen the existing roof structure
   - Site-specific structural calculations
   - Provide manufacturer documentation of the rack system, maximum allowable weight the system can support, attachment methods, and product evaluation information or structural design.
3. Plan Review

Permit applications can be submitted to the Building Division, City of Santa Clara Community Development Department, in person at 1500 Warburton Ave, Santa Clara, CA 95050. Permit applications utilizing the standard plan may be approved “over the counter.” Permits not approved “over the counter” will be reviewed in one to fifteen business days. Permits submitted on line cannot be an expedited review.

4. Fees

<table>
<thead>
<tr>
<th>kW</th>
<th>Bld. Permit Fee</th>
<th>Plan Review Fee</th>
<th>Electrical Permit Fee</th>
<th>Seismic Fee</th>
<th>Bldg Standards Fee</th>
<th>Document Image Fee</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 – 5.0</td>
<td>100.60</td>
<td>75.45</td>
<td>50.00</td>
<td>.50</td>
<td>1.00</td>
<td>30.00</td>
<td>256.90</td>
</tr>
<tr>
<td>5.01 – 10.0</td>
<td>156.60</td>
<td>117.40</td>
<td>50.00</td>
<td>.91</td>
<td>1.00</td>
<td>30.00</td>
<td>355.90</td>
</tr>
</tbody>
</table>

5. Inspections

Once all permits to construct the solar installation have been issued and the system has been installed, it must be inspected before final approval is granted for the solar system. On-site inspections can be scheduled by contacting the building division by our automated telephone system (408) 615-2400. Inspection requests are scheduled on a first-come first-served basis. If there is no other related work on the permit (such as a service upgrade) the first scheduled inspection can be the building and electrical final – menu codes 599 and 299 on the automated system.

Compliance with current smoke and carbon-monoxide alarm requirements is mandatory for all building permits.

Permit holders must be prepared to show conformance with all technical requirements in the field at the time of inspection. The inspector will verify that the installation is in conformance with applicable code requirements and with the approved plans.

The inspection checklist provides an overview of common points of inspection for which applicant should be prepared to show compliance. If not available, common checks include the following.

- Number of PV modules and model number match plans and specification sheets number match plans and specification sheets.
- Array conductors and components are installed in a neat and workman-like manner.
- PV array is properly grounded.
- Electrical boxes are accessible and connections are suitable for environment.
- Array is fastened and sealed according to attachment detail.
- Conductors ratings and sizes match plans.
- Appropriate signs are properly constructed, installed and displayed, including the following.
  - Sign identifying PV power source system attributes at DC disconnect
  - Sign identifying AC point of connection
  - Sign identifying switch for alternative power system
- Equipment ratings are consistent with application and installed signs on the installation, including the following.
  - Inverter has a rating as high as max voltage on PV power source sign.
  - DC-side overcurrent circuit protection devices (OCPDs) are DC rated at least as high as max voltage on sign.
  - Switches and OCPDs are installed according to the manufacturer’s specifications (i.e., many 600VDC switches require passing through the switch poles twice in a specific way).
  - Inverter is rated for the site AC voltage supplied and shown on the AC point of connection sign.
  - OCPD connected to the AC output of the inverter is rated at least 125% of maximum current on sign and is no larger than the maximum OCPD on the inverter listing label.
  - Sum of the main OCPD and the inverter OCPD is rated for not more than 120% of the bus bar rating.
ELIGIBILITY CHECKLIST FOR EXPEDITED SOLAR PHOTOVOLTAIC PERMITTING
FOR ONE- AND TWO-FAMILY DWELLINGS – 2016 CODES

GENERAL REQUIREMENTS

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Y</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. System size is 10 kW AC CEC rating or less</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. The solar array is roof-mounted on one- or two-family dwelling or accessory structure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. The solar panel/module arrays will not exceed the maximum legal building height</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. Solar system is utility interactive and without battery storage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. Permit application is completed and attached</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ELECTRICAL REQUIREMENTS

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Y</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. No more than four photovoltaic module strings are connected to each Maximum Power Point Tracking (MPPT) input where source circuit fusing is included in the inverter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1) No more than two strings per MPPT input where source circuit fusing is not included</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2) Fuses (if needed) are rated to the series fuse rating of the PV module</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3) No more than one noninverter-integrated DC combiner is utilized per inverter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. For central inverter systems: No more than two inverters are utilized</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. The PV system is interconnected to a single-phase AC service panel of nominal 120/220 Vac with a bus bar rating of 225 A or less</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. The PV system is connected to the load side of the utility distribution equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E. A Solar PV Standard Plan and supporting documentation is completed and attached</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

STRUCTURAL REQUIREMENTS

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Y</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. A completed Structural Criteria and supporting documentation is attached (next page)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

FIRE SAFETY REQUIREMENTS

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Y</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Clear access pathways provided</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. Fire classification solar system is provided</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. All required markings and labels are provided</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D. A diagram of the roof layout of all panels, modules, clear access pathways and approximate locations of electrical disconnecting means and roof access points is completed and attached</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes:
1. These criteria are intended for expedited solar permitting process.
2. If any items are checked NO, revise design to fit within Eligibility Checklist, otherwise permit application may go through standard process.
Eligibility Checklist – Structural Criteria for Residential Flush-Mounted Solar Arrays

1. ROOF CHECKS

A. Visual Review/Contractor’s Site Audit of Existing Conditions:
   1) Is the roof a single roof without a reroof overlay?  □ Y  □ N
   2) Does the roof structure appear structurally sound, without signs of alterations or significant structural deterioration or sagging, as illustrated in Figure 1?  □ Y  □ N

B. Roof Structure Data:
   1) Measured roof slope (e.g. 6:12):
   2) Measured rafter spacing (center-to-center):
   3) Type of roof framing (rafter or manufactured truss):  □ Rafter  □ Truss

2. SOLAR ARRAY CHECKS

A. Flush-mounted Solar Array:
   1) Is the plane of the modules (panels) parallel to the plane of the roof?  □ Y  □ N
   2) Is there a 2” to 10” gap between underside of module and the roof surface?  □ Y  □ N
   3) Modules do not overhang any roof edges (ridges, hips, gable ends, eaves)?  □ Y  □ N

B. Do the modules plus support components weigh no more than:
   4 psf for photovoltaic arrays or 5 psf for solar thermal arrays?  □ Y  □ N

C. Does the array cover no more than half of the total roof area (all roof planes)?  □ Y  □ N

D. Are solar support component manufacturer’s project-specific completed worksheets, tables with relevant cells circled, or web-based calculator results attached?  □ Y  □ N

E. Is a roof plan of the module and anchor layout attached? (see samples & last page)  □ Y  □ N

F. Downward Load Check (Anchor Layout Check):
   1) Proposed anchor horizontal spacing:
   2) Manufacturer specification for anchor spacing:

G. Wind Uplift Check (Anchor Fastener Check):
   1) Anchor fastener data (provide cut sheets):
      a. Diameter of lag screw, hanger bolt or self-drilling screw:
      b. Embedment depth of rafter:
      c. Number of screws per anchor (typically one):
      d. Are 5/16” diameter lag screws embeded 2.5” into the rafters or does the anchor fastener have a different manufacturer specification?  □ Y  □ N

3. SUMMARY

□ A. All items above are checked YES. No additional calculations are required.
□ B. One or more items are checked NO. Attach project-specific drawings and calculations stamped and signed by a California-licensed civil or structural engineer.

Job Address: ____________________________  Permit #: ____________________________
Contractor/Installer: ____________________________  License # & Class: ____________________________
Signature: ____________________________  Date: ____________  Phone #: ____________________________
SCOPe: Use this plan only for electrical review of utility central/string inverter systems not exceeding a system AC inverter output rating of 10kW on the roof of a one- or two-family dwelling or accessory building. The specific structural and fire requirements are covered in other parts of the California Solar Permitting Guidebook. The photovoltaic system must interconnect to the load side of a single-phase AC service panel of nominal 120/240Vac with a bus bar rating of 225A or less. This plan is not intended for bipolar systems, hybrid systems or systems that utilize storage batteries, charge controllers, trackers, more than two inverters or more than one DC combiner (noninverter-integrated) per inverter. Systems must be in compliance with current California Building Standards Codes and local amendments of the authority having jurisdiction (AHJ). Other Articles of the California Electrical Code (CEC) shall apply as specified in 690.3. For systems beyond this scope or the criteria in this plan, consult the AHJ for details regarding comprehensive process.

MANUFACTURER’S SPECIFICATION SHEETS MUST BE PROVIDED for proposed inverters, modules, combiner/junction boxes,racking systems, and rapid shutdown system or equipment. Installation instructions for bonding and grounding equipment and rapid shutdown systems shall be provided, and local AHJs may require additional details. Listed and labeled equipment shall be installed and used in accordance with any instructions included in the listing or labeling (CEC 110.3). Equipment intended for use with PV system shall be listed for the PV application (CEC 690.4[B]).

Job Address: ____________________________  Permit #: ____________________________
Contractor/Engineer Name: ____________________________ License # and Class: ____________________________
Signature: ____________________________ Date: ____________________ Phone Number: ____________________________

Total # of Inverters installed: __________ (If more than one inverter, complete and attach the “Supplemental Calculation Sheets” and the “Load Center Calculations” if a new load center is to be used.)

Inverter 1 AC Output Power Rating: ____________ Watts
Inverter 2 AC Output Power Rating (if applicable): ____________ Watts
Combined Inverter Output Power Rating: ____________ ≤ 10,000 Watts

Location Ambient Temperatures (Check box next to which lowest expected temperature is used):

1) ☐ Lowest expected ambient temperature for the location \( T_e \) = Between -1° to -5° C
☐ Lowest expected ambient temperature for the location \( T_e \) = Between -6° to -10° C

Average ambient high temperature \( T_{h} \) = 47° C

Note: For a lower \( T_e \) or a higher \( T_{h} \), use the Comprehensive Standard Plan

DC Information:

<table>
<thead>
<tr>
<th>Module Manufacturer: ____________________________</th>
<th>Model: ____________________________</th>
</tr>
</thead>
<tbody>
<tr>
<td>2) Module ( V_{oc} ) (from module nameplate): __Volts</td>
<td>3) Module ( I_{sc} ) (from module nameplate): __Amps</td>
</tr>
<tr>
<td>4) Module DC output power under standard test conditions (STC) = ________ Watts (STC)</td>
<td></td>
</tr>
</tbody>
</table>
5) DC Module Layout

<table>
<thead>
<tr>
<th>Identify each source circuit (string) for inverter 1 shown on the roof plan with a Tag (e.g. A,B,C,...)</th>
<th>Number of modules per source circuit for inverter 1</th>
<th>Identify, by tag, which source circuits on the roof are to be paralleled (if none, put N/A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combiner 1:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combiner 2:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total number of source circuits for inverter 1: 

6) Are DC/DC Converters used?  Yes ☐ No ☐  

If No, skip to Step 7. If Yes enter info below.

<table>
<thead>
<tr>
<th>DC/DC Converter Model #:</th>
<th>DC/DC Converter Max DC Input Voltage: _______ Volts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max DC Output Current: ___<strong><strong>-</strong></strong> Amps</td>
<td>Max DC Output Current: ___<strong><strong>-</strong></strong> Volts</td>
</tr>
<tr>
<td>Max # of DC/DC Converters in an Input Circuit:</td>
<td>DC/DC Converter Max DC Input Power: _______ Watts</td>
</tr>
</tbody>
</table>

7) Maximum System DC Voltage — Use A1 or A2 for systems without DC/DC converters, and B1 or B2 with DC/DC Converters.

☐ A1. Module $V_{oc}$ (STEP 2) = _______ x # in series (STEP 5) _______ x 1.12 (if -1 ≤ $T_i$ ≤ -5°C, STEP 1) = _______ V

☐ A2. Module $V_{oc}$ (STEP 2) = _______ x # in series (STEP 5) _______ x 1.14 (if -6 ≤ $T_i$ ≤ -10°C, STEP 1) = _______ V

| Table 1. Maximum Number of PV Modules in Series Based on Module Rated $V_{oc}$ for 600 Vdc Rated Equipment (CEC 690.7) |
|---|---|
| Max. Rated Module $V_{oc}$ (*1.12) (Volts) | 29.76 31.51 33.48 35.71 38.27 41.21 44.64 48.70 53.57 59.52 66.96 75.63 89.29 |
| Max. Rated Module $V_{oc}$ (*1.14) (Volts) | 29.24 30.96 32.89 35.09 37.59 40.49 43.86 47.85 52.63 58.48 65.79 75.19 87.72 |
| Max # of Modules for 600 Vdc | 18 17 16 15 14 13 12 11 10 9 8 7 6 |

Use for DC/DC converters. The value calculated below must be less than DC/DC converter max DC input voltage (STEP 6).

☐ B1. Module $V_{oc}$ (STEP 2) = _______ x # of modules per converter (STEP 6) _______ x 1.12 (if -1 ≤ $T_i$ ≤ -5°C, STEP 1) = _______ V

☐ B2. Module $V_{oc}$ (STEP 2) = _______ x # of modules per converter (STEP 6) _______ x 1.14 (if -6 ≤ $T_i$ ≤ -10°C, STEP 1) = _______ V

| Table 2. Largest Module $V_{oc}$ for Single-Module DC/DC Converter Configurations (with 80 V AFCI Cap) (CEC 690.7 and 690.11) |
|---|---|
| Max. Rated Module $V_{oc}$ (*1.12) (Volts) | 30.4 33.0 35.7 38.4 41.1 43.8 46.4 49.1 51.8 54.5 57.1 59.8 62.5 65.2 67.9 70.5 |
| Max. Rated Module $V_{oc}$ (*1.14) (Volts) | 29.8 32.5 35.1 37.7 40.4 43.0 45.6 48.2 50.9 53.5 56.1 58.8 61.4 64.0 66.7 69.3 |
| DC/DC Converter Max DC Input (Step #6) (Volts) | 34 37 40 43 46 49 52 55 58 61 64 67 70 73 76 79 |

8) Maximum System DC Voltage from DC/DC Converters to Inverter — Only required if Yes in Step 6  

Maximum System DC Voltage = _______ Volts
9) Sizing Source Circuit Conductors
Source Circuit Conductor Size = Min. #10 AWG copper conductor, 90° C wet (USE-2, PV Wire, XHHW-2, THWN-2, RHW-2)
For up to 8 conductors in roof-mounted conduit exposed to sunlight at least ½” from the roof covering (CEC 310)
Note: If > 8 conductors in the conduit or mounting height of lower than ½” from the roof, expedited plan not applicable.

10) Are PV source circuits combined prior to the inverter?  □ Yes  □ No
If No, use Single Line Diagram 1 and proceed to Step 13.
If Yes, use Single Line Diagram 2 with Single Line Diagram 4 and proceed to Step 12.
Is source circuit OCPD required?  □ Yes  □ No
Source circuit OCPD size (if needed):

11) Sizing PV Output Circuit Conductors — If a combiner box will NOT be used (Step 10),
Output Circuit Conductor Size =

12) Inverter DC Disconnect
Does the inverter have an integrated DC disconnect?  □ Yes  □ No  If Yes, proceed to step 14.
If No, the external DC disconnect to be installed is rated for _____ Amps (DC) and _____ Volts (DC)

13) Inverter Information
Manufacturer: ____________________________  Model: ____________________________
Max. Continuous AC Output Current Rating: _____ Amps
Integrated DC Arc-Fault Circuit Protection?  □ Yes  □ No (If No is selected, Expedited Plan not applicable)
Grounded or Ungrounded System?  □ Grounded  □ Ungrounded

AC Information:

14) Sizing Inverter Output Circuit Conductors and OCPD
Inverter Output OCPD rating = _____ Amps (Table 3)
Inverter Output Circuit Conductor Size = _____ AWG (Table 3)

<table>
<thead>
<tr>
<th>Table 3. Minimum Inverter Output OCPD and Circuit Conductor Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inverter Continuous Output Current Rating (Amps) (Step 14)</td>
</tr>
<tr>
<td>Minimum OCPD Size (Amps)</td>
</tr>
<tr>
<td>Minimum Conductor Size (AWG, 75° C, Copper)</td>
</tr>
</tbody>
</table>
15) Point of Connection to Utility

Only load side connections are permitted with this plan. Otherwise, use Comprehensive Standard Plan.

Is the PV OCPD positioned at the opposite end from input feeder location or main OCPD location?  □ Yes  □ No

If Yes, circle the Max Combined PV System OCPD(s) at 120% value as determined from Table 4.
If No, rating of main OCPD and Max Combined PV System OCPDs must be ≤ bus bar rating.

If the panel has a “center-fed” main, the same rule can be used as when the breaker is at the opposite end from the main, provided there are loads between the main and PV breakers. (pre-approved AMM per Building Standards Commission recommendation)

| Table 4. Maximum Combined Supply OCPDs Based on Bus Bar Rating (Amps) per CEC 705.12(D)(2) |
|---------------------------------------------------|--------|--------|--------|--------|--------|--------|--------|--------|
| Bus Bar Rating                                   | 100    | 125    | 125    | 200    | 200    | 200    | 225    | 225    | 225    |
| Main OCPD                                        | 100    | 100    | 125    | 150    | 175    | 200    | 175    | 200    | 225    |
| Max Combined PV System OCPD(s) at 120% of Bus Bar Rating | 20    | 50     | 25     | 60*    | 60*    | 40     | 60*    | 60*    | 45     |
| Max Combined PV System OCPD(s) at 100% Bus Bar Rating | 0     | 25     | 0      | 50     | 25     | 0      | 50     | 25     | 0      |

*This value has been lowered to 60 A from the calculated value to reflect 10 kW AC size maximum.

Reduction of the main breaker is not permitted with this plan. Otherwise, use Comprehensive Standard Plan.
16) Rapid Shutdown
The rapid shutdown initiation device shall be labeled according to CEC 690.56(C), and its location shall be shown on the site plan drawing. The rapid shutdown initiation device may be the inverter output or input circuits’ disconnecting means, the service main disconnect, or a separate device as approved by the AHJ. The disconnecting means shall be identified for the purpose, suitable for their environment, and listed as a disconnecting means. A single rapid shutdown initiation device shall operate all disconnecting means necessary to control conductors in compliance with CEC 690.12.

Note: Check with the AHJ regarding approval where field verification of reduction of voltage within the time required by CEC 690.12 is performed.

Rapid shutdown shall be provided as required by CEC 690.12 with one of the following methods (Select one):

- The inverter(s) is within 10 feet of the array, and the location of the inverter is such that uncontrolled PV system conductors are no greater than 5 feet of length within the building. A remotely-controlled AC disconnecting means is required immediately adjacent to or as close as practicable to the inverters, and located within 10 feet of the array.
- The inverter(s) is within 10 feet of the array, and the location of the inverter is such that uncontrolled PV system conductors are no greater than 5 feet of length within the building. Reduction of the voltage for the inverter output within the time required by CEC 690.12 shall be verified in the field, or the inverter output is listed to UL 1741 with rapid shutdown capability.
- Remotely-controlled DC disconnecting means are located within 10 feet of the PV array and DC input of the inverter(s), and the locations of the disconnecting means are such that uncontrolled PV system conductors are no greater than 5 feet of length within the building. Reduction of the voltage for the inverter output within the time required by CEC 690.12 shall be verified in the field, or the inverter output is listed to UL 1741 with rapid shutdown capability.
- Remotely-controlled DC disconnecting means is located within 10 feet of the array at the DC input of inverter(s) connected to a module level DC-DC converter circuit where the DC-DC converter circuit meets the requirements for controlled conductors when disconnected from the inverter. Reduction of the voltage for the DC-DC converter output and the inverter output within the time required by CEC 690.12 shall be verified in the field, or the DC-DC converter output and the inverter output are listed to UL 1741 with rapid shutdown capability.
- A UL 1741-listed and identified inverter(s) with input and output rapid shutdown capability supplying module level DC-DC converter circuit where the DC-DC converter circuit meets the requirements for controlled conductors when disconnected from the inverter.
- A UL 1741-listed rapid shutdown system:

Manufacturer: ________________________________________________________________
Testing Agency Name: __________________________________________________________
System Model Number: _________________________________________________________
System Components: ___________________________________________________________

17) Grounding and Bonding of Modules and Racking System (select one):

- Racking system listed to UL 2703 using modules identified in the listing.
- Other method subject to approval by City of Santa Clara
Markings

Labels are required by articles 690 and 705 of the CEC and R324 of the California Residential Code. Not all of these labels are required at each project. Provide a plan showing which labels go at each of the locations.

Informational note: ANSI Z535.4 provides guidelines for the design of safety signs and labels for application to products. A phenolic plaque with contrasting colors between the text and background would meet the intent of the code for permanency. No type size is specified, but 20 point (3/8") should be considered the minimum.

CEC 705.12 requires a permanent plaque or directory denoting all electric power sources on or in the premises.
Solar PV Standard Plan – Simplified
Central/String Inverter System for One- and Two-Family Dwellings
Refer to Step 16 for Rapid Shutdown details

**DESCRIPTION**

**SOLAR PV MODULE** / **STRING**
**DC/DC CONVERTERS INSTALLED?**  YES / NO  (IF YES, STEPS 6 & 8 REQUIRED)
**SOURCE CIRCUIT JUNCTION BOX INSTALLED?**  YES / NO
**SEPARATE DC DISCONNECT INSTALLED?**  YES / NO
**INTERNAL INVERTER DC DISCONNECT?**  YES / NO
**CENTRAL INVERTER?**  YES / NO
**LOAD CENTER INSTALLED?**  YES / NO
**PV PRODUCTION METER INSTALLED?**  YES / NO
**SEPARATE AC DISCONNECT INSTALLED?**  YES / NO
**INTERNAL INVERTER AC DISCONNECT?**  YES / NO

* CHECK A BOX FOR WHETHER SYSTEM IS GROUNDED OR UNGROUNDED:
  - GROUNDED (INCLUDE GEC)
  - UNGROUNDED

**DESCRIPTION AND CONDUCTOR TYPE**

<table>
<thead>
<tr>
<th>TAG</th>
<th>DESCRIPTION AND CONDUCTOR TYPE</th>
<th>CONDUCTOR SIZE</th>
<th>NUMBER OF CONDUCTORS</th>
<th>CONDUIT/CABLE TYPE</th>
<th>CONDUIT SIZE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>USE-2 □ OR PV-WIRE □</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>EGC/GEC:</td>
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<td></td>
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</tr>
<tr>
<td>C</td>
<td>EGC/GEC:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>EGC/GEC:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**SINGLE-LINE DIAGRAM #1 – NO STRINGS COMBINED PRIOR TO INVERTER**

Enter “N/A” where suitable for when not using conduit or cable as permitted by code

**CHECK A BOX FOR WHETHER SYSTEM IS GROUNDED OR UNGROUNDED:**
- GROUNDED (INCLUDE GEC)
- UNGROUNDED

**FOR UNGROUNDED SYSTEMS:**
- DC OCPD MUST DISCONNECT BOTH CONDUCTORS OF EACH SOURCE CIRCUIT
- UNGROUNDED CONDUCTORS MUST BE IDENTIFIED PER 210.5(C). WHITE-FINISHED CONDUCTORS ARE NOT PERMITTED.

* Consult with your local AHJ and/or Utility
Solar PV Standard Plan – Simplified
Central/String Inverter System for One- and Two-Family Dwellings
Refer to Step 16 for Rapid Shutdown details

DESCRIPTION
SOLAR PV MODULE / STRING
DC/DC CONVERTERS INSTALLED? YES / NO (IF YES, STEPS 6 & 8 REQUIRED)
SOURCE CIRCUIT JUNCTION BOX INSTALLED? YES / NO
COMBINED BOX (STEPS 11 & 12 REQUIRED)
SEPARATE DC DISCONNECT INSTALLED? YES / NO
CENTRAL INVERTER
LOAD CENTER INSTALLED? YES / NO
PV PRODUCTION METER INSTALLED? YES / NO
* SEPARATE AC DISCONNECT INSTALLED? YES / NO

CONNECT TO INVERTER #2 (USE LINE DIAGRAM #2)

SINGLE-LINE DIAGRAM #2 – COMBINING STRINGS PRIOR TO INVERTER

CHECK A BOX FOR WHETHER SYSTEM IS GROUNDED OR UNGROUNDED: GROUNDED (INCLUDE GEC) UNGROUNDED
FOR UNGROUNDED SYSTEMS:
- DC OCPD MUST DISCONNECT BOTH CONDUCTORS OF EACH SOURCE CIRCUIT
- UNGROUNDED CONDUCTORS MUST BE IDENTIFIED PER 210.5(C). WHITE-FINISHED CONDUCTORS ARE NOT PERMITTED.

* Consult with your local AHJ and/or Utility

COMBINER CONDUCTOR/CONDUIT SCHEDULE

<table>
<thead>
<tr>
<th>TAG</th>
<th>DESCRIPTION AND CONDUCTOR TYPE</th>
<th>CONDUCTOR SIZE</th>
<th>NUMBER OF CONDUCTORS</th>
<th>CONDUIT/CABLE TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>USE-2 □ OR PV-WIRE □</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B1</td>
<td>EGC/GEC.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>EGC/GEC.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>EGC/GEC.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>EGC/GEC.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NON-COMBINED STRINGS CONDUCTOR/CONDUIT SCHEDULE (IF APPLICABLE)

<table>
<thead>
<tr>
<th>TAG</th>
<th>DESCRIPTION AND CONDUCTOR TYPE</th>
<th>CONDUCTOR SIZE</th>
<th>NUMBER OF CONDUCTORS</th>
<th>CONDUIT/CABLE TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A2</td>
<td>USE-2 □ OR PV-WIRE □</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B2</td>
<td>EGC/GEC.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ENTER "N/A" WHERE SUITABLE FOR WHEN NOT USING CONDUIT OR CABLE AS PERMITTED BY CODE
### Supplemental Calculation Sheets for Inverter #2 (Only include if second inverter is used)

**DC Information:**

<table>
<thead>
<tr>
<th>Module Manufacturer</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>S2) Module $V_{oc}$ (from module nameplate): _____ Volts</th>
<th>S3) Module $I_{sc}$ (from module nameplate): _____ Amps</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>S4) Module DC output power under standard test conditions (STC) = _____ Watts (STC)</th>
</tr>
</thead>
</table>

**S5) DC Module Layout**

<table>
<thead>
<tr>
<th>Identify each source circuit (string) for inverter 1 shown on the roof plan with a Tag (e.g. A,B,C,...)</th>
<th>Number of modules per source circuit for inverter 1</th>
<th>Identify, by tag, which source circuits on the roof are to be paralleled (if none, put N/A)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Combiner 1:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Combiner 2:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total number of source circuits for inverter 1:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>S6) Are DC/DC Converters used?</th>
<th>☐ Yes</th>
<th>☐ No</th>
</tr>
</thead>
</table>

If No, skip to Step S7. If Yes, enter info below.

<table>
<thead>
<tr>
<th>DC/DC Converter Model #:</th>
<th>DC/DC Converter Max DC Input Voltage: _____ Volts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max DC Output Current:</td>
<td>Max DC Output Current: _____ Volts</td>
</tr>
<tr>
<td>Max # of DC/DC Converters in an Input Circuit:</td>
<td>DC/DC Converter Max DC Input Power: _____ Watts</td>
</tr>
</tbody>
</table>


S7) Maximum System DC Voltage — Use A1 or A2 for systems without DC/DC converters, and B1 or B2 with DC/DC Converters.

- A1. Module $V_{oc}(\text{STEP S2}) = ____ \times \text{# in series (STEP S5)} \times 1.12$ (if $-1 \leq T_i \leq -5^\circ C$, STEP S1) = _______ V
- A2. Module $V_{oc}(\text{STEP S2}) = ____ \times \text{# in series (STEP S5)} \times 1.14$ (if $-6 \leq T_i \leq -10^\circ C$, STEP S1) = _______ V

<table>
<thead>
<tr>
<th>Table 1. Maximum Number of PV Modules in Series Based on Module Rated $V_{oc}$ for 600 Vdc Rated Equipment (CEC 690.7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. Rated Module $V_{oc} (\times 1.12)$ (Volts)</td>
</tr>
<tr>
<td>Max. Rated Module $V_{oc} (\times 1.14)$ (Volts)</td>
</tr>
<tr>
<td>Max # of Modules for 600 Vdc</td>
</tr>
</tbody>
</table>

Use for DC/DC converters. The value calculated below must be less than DC/DC converter max DC input voltage (STEP S6).

- B1. Module $V_{oc}(\text{STEP S2}) = ____ \times \text{# of modules per converter (STEP S6)} \times 1.12$ (if $-1 \leq T_i \leq -5^\circ C$, STEP S1) = _______ V
- B2. Module $V_{oc}(\text{STEP S2}) = ____ \times \text{# of modules per converter (STEP S6)} \times 1.14$ (if $-6 \leq T_i \leq -10^\circ C$, STEP S1) = _______ V

<table>
<thead>
<tr>
<th>Table 2. Largest Module $V_{oc}$ for Single-Module DC/DC Converter Configurations (with 80 V AFCI Cap) (CEC 690.7 and 690.11)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. Rated Module $V_{oc} (\times 1.12)$ (Volts)</td>
</tr>
<tr>
<td>Max. Rated Module $V_{oc} (\times 1.14)$ (Volts)</td>
</tr>
<tr>
<td>DC/DC Converter Max DC Input (Step 6) (Volts)</td>
</tr>
</tbody>
</table>

S8) Maximum System DC Voltage from DC/DC Converters to Inverter — Only required if Yes in Step S6

Maximum System DC Voltage = _______ Volts

S9) Maximum Source Circuit Current

Is Module $I_{sc}$ below 9.6 Amps (Step S3)?  Yes  No (If No, use Comprehensive Standard Plan)

S10) Sizing Source Circuit Conductors

Source Circuit Conductor Size = Min. #10 AWG copper conductor, 90° C wet (USE-2, PV Wire, XHHW-2, THWN-2, RHW-2)

For up to 8 conductors in roof-mounted conduit exposed to sunlight at least ½" from the roof covering (CEC 310)

Note: For over 8 conductors in the conduit or mounting height of lower than ½" from the roof, use Comprehensive Plan.

S11) Are PV source circuits combined prior to the inverter?  Yes  No

If No, use Single Line Diagram 1 and proceed to Step S13.

If Yes, use Single Line Diagram 2 with Single Line Diagram 4 and proceed to Step S12.

Is source circuit OCPD required?  Yes  No

Source circuit OCPD size (if needed): 15 Amps

S12) Sizing PV Output Circuit Conductors — If a combiner box will NOT be used (Step S11), Output Circuit Conductor Size = Min. #6 AWG copper conductor

S13) Inverter DC Disconnect

Does the inverter have an integrated DC disconnect?  Yes  No  If Yes, proceed to Step S14.

If No, the external DC disconnect to be installed is rated for _______ Amps (DC) and _______ Volts (DC)
S14) Inverter Information
Manufacturer: __________________________ Model: __________________________
Max. Continuous AC Output Current Rating: _____Amps
Integrated DC Arc-Fault Circuit Protection?  ☐ Yes  ☐ No (If No is selected, Comprehensive Standard Plan)
Grounded or Ungrounded System?  ☐ Grounded  ☐ Ungrounded

AC Information:

S15) Sizing Inverter Output Circuit Conductors and OCPD
Inverter Output OCPD rating = _____Amps (Table 3)
Inverter Output Circuit Conductor Size = _____AWG (Table 3)

| Table 3. Minimum Inverter Output OCPD and Circuit Conductor Size |
|-----------------|----|----|----|----|----|----|----|----|
| Inverter Continuous Output Current Rating (Amps) (Step 14) | 12 | 16 | 20 | 24 | 28 | 32 | 36 | 40 | 48 |
| Minimum OCPD Size (Amps) | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 60 |
| Minimum Conductor Size (AWG, 75° C, Copper) | 14 | 12 | 10 | 10 | 8  | 8  | 6  | 6  | 6  |

Load Center Calculations
(Omit if a load center will not be installed for PV OCPDs)

S20) Load Center Output:
Calculate the sum of the maximum AC outputs from each inverter.
Inverter #1 Max Continuous AC Output Current Rating [STEP S14] _____× 1.25 = _____Amps
Inverter #2 Max Continuous AC Output Current Rating [STEP S14] _____× 1.25 = _____Amps
Total inverter currents connected to load center (sum of above) = _____Amps

Conductor Size: _____AWG
Overcurrent Protection Device: _____Amps
Load center bus bar rating: _____Amps
The sum of the ampere ratings of overcurrent devices in circuits supplying power to a bus bar or conductor
shall not exceed 120 percent of the rating of the bus bar or conductor.
Solar PV Standard Plan – Simplified
Central/String Inverter System for One- and Two-Family Dwellings

SINGLE-LINE DIAGRAM #3 – ADDITIONAL INVERTER FOR DIAGRAM #1
INVERTER # 2

CHECK A BOX FOR WHETHER SYSTEM IS GROUNDED OR UNGROUNDED:  
☐ GROUNDED (INCLUDE GEC)  ☐ UNGROUNDED

FOR UNGROUNDED SYSTEMS:
- DC OCPD MUST DISCONNECT BOTH CONDUCTORS OF EACH SOURCE CIRCUIT
- UNGROUNDED CONDUCTORS MUST BE IDENTIFIED PER 210.5(C). WHITE-FINISHED CONDUCTORS ARE NOT PERMITTED.

* Consult with your local AHJ and/or Utility

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<tbody>
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<td>A</td>
<td>USE-2 □ OR PV-WIRE □</td>
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<td>B</td>
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<td></td>
</tr>
<tr>
<td>C</td>
<td>EGC/GEC:</td>
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</tr>
</tbody>
</table>

ENTER "N/A" WHERE SUITABLE FOR WHEN NOT USING CONDUIT OR CABLE AS PERMITTED BY CODE

PARALLEL DC/DC CONVERTERS ON ONE SOURCE CIRCUIT (FIXED UNIT VOLTAGE DC/DC CONVERTERS)
DC/DC CONVERTERS ARE ALL RUN IN SERIES (FIXED SOURCE CIRCUIT VOLTAGE DC/DC CONVERTERS)
Solar PV Standard Plan – Simplified
Central/String Inverter System for One- and Two-Family Dwellings

DESCRIPTION
SOLAR PV MODULE / STRING
DC/DC CONVERTERS INSTALLED? YES / NO (IF YES, STEPS 6 & 8 REQUIRED)
1
SOURCE CIRCUIT JUNCTION BOX INSTALLED? YES / NO
2
COMBINER BOX (STEPS 11 & 12 REQUIRED)
3
SEPARATE DC DISCONNECT INSTALLED? YES / NO
4
INTERNAL INVERTER DC DISCONNECT? YES / NO
5
CENTRAL INVERTER
6
SEPARATE AC DISCONNECT INSTALLED? YES / NO
7
TO LOAD CENTER ON LINE DIAGRAM
8
* Consult with your local AHJ and/or Utility
9

SINGLE-LINE DIAGRAM #4 – ADDITIONAL INVERTER FOR DIAGRAM #2

INVERTER # 2
CHECK A BOX FOR WHETHER SYSTEM IS GROUNDED OR UNGROUNDED:
☐ GROUNDED (INCLUDE GEC)
☐ UNGROUNDED

FOR UNGROUNDED SYSTEMS:
- DC OCPD MUST DISCONNECT BOTH CONDUCTORS OF EACH SOURCE CIRCUIT
- UNGROUNDED CONDUCTORS MUST Be IDENTIFIED PER 210.5(C). WHITE-FINISHED CONDUCTORS ARE NOT PERMITTED.

CONDUIT/CABLE SCHEDULE

A1 USE-2 □ OR PV-WIRE □

B1 EGC/GEC:

C EGC/GEC:

D EGC/GEC:

* Consult with your local AHJ and/or Utility

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SOLAR PV STANDARD PLAN

Roof Layout Diagram for One- and Two-Family Dwellings

Items required: roof layout of all panels, modules, clear access pathways and approximate locations of electrical disconnecting means and roof access points.