




TOWN OF FAIRFAX

STAFF REPORT

October 7, 2015

TO: Mayor and Town Council

FROM: Garrett Toy, Town Manager 
Jim Moore, Director of Planning and Building Services

SUBJECT: Adoption of a Resolution adopting the Checklist and Standard Plan(s) Pursuant to Section 17.138.250 ('Processing of Small Residential Rooftop Solar Energy System Applications') of Ordinance No. 794

RECOMMENDATION

Adopt a Resolution adopting the Checklist and Standard Plan(s) pursuant to section 17.138.250 ('Processing of Small Residential Rooftop Solar Energy System Applications') of Ordinance No. 794.

BACKGROUND

On July 16, 2015 the Planning Commission (PC) adopted resolution 15-24 recommending the Town Council (TC) adopt Ordinance No. 794 to provide a streamlined permitting process for small residential rooftop solar energy systems.

At its August 5th meeting, the Council considered Ordinance No. 794 and continued the item to August 26th. One of the suggestions from the August 5th meeting was that the solar energy system checklist and standard plan(s) should not be exhibits to the Ordinance, but rather the Ordinance should state such Checklist and Standard Plan(s) will be approved by Town Council resolution to provide more flexibility regarding future revisions to such documents. At its August 26th meeting, the Council made additional revisions to Ordinance No. 794.

On September 2, 2015 the Town Council introduced Ordinance No.794, as revised, to provide a permitting process for small residential rooftop solar energy systems. The second reading of Ordinance No. 794 is also on tonight's agenda and if adopted, Ordinance No. 794 will go into effect in thirty (30) days.

Section 17.138.250 of the Ordinance does indicate the standard plan(s), and checklist(s) shall substantially conform to the checklist and standard plans contained in the most current version of the *California Solar Permitting Guidebook* adopted by the Governor's Office of Planning and Research. The "California Solar Permitting Guidebook" is available on-line (starting on page 22) at: www.opr.ca.gov/docs/California_Solar_Permitting_Guidebook_Spring_2015.pdf

The resolution does allow staff to make modifications to the checklist and standard plans to keep it in substantial conformity to state guidelines.

FISCAL IMPACT

None

ATTACHMENT

Resolution

RESOLUTION 15-__

A RESOLUTION OF THE TOWN COUNCIL OF TOWN OF FAIRFAX ADOPTING A 'CHECKLIST AND STANDARD PLAN(S)' SETTING FORTH ALL REQUIREMENTS WITH WHICH SMALL RESIDENTIAL ROOFTOP SOLAR ENERGY SYSTEMS MUST COMPLY TO BE ELIGIBLE FOR EXPEDITED REVIEW

WHEREAS, in 2014 Assembly Bill 2188 was signed into law, imposing a new requirement on towns and cities to adopt a solar energy permitting ordinance designed to streamline the approval of small, residential rooftop solar energy systems; and

WHEREAS, on July 16, 2015, the Planning Commission adopted Resolution No. 15-24 after holding a duly-noticed public hearing, recommending the Town Council adopt Ordinance No. 794 which streamlines the review and approval process for small residential rooftop solar energy systems; and

WHEREAS, on August 5, 2015, the Town Council suggested that the 'Checklist and Standard Plan(s)' should not be exhibits to the ordinance, but rather the ordinance should state such checklist and standard plans will be approved by Town resolution to provide more flexibility regarding future revisions to such documents; and

WHEREAS, on September 2, 2015, the Town Council held a duly-noticed public hearing for the introduction and first reading by title only of Ordinance No. 794 to Streamline Review and Approval of Small Residential Rooftop Solar Energy Systems, which provided for the 'Checklist and Standard Plan(s)' to be adopted and amended by resolution of the Town Council; and

WHEREAS, on October 7, 2015, the Town Council waived the second reading and read by title only and adopted Ordinance No. 794 Adding Article II to Chapter 17.138 of the Town Municipal Code ('Small Residential Rooftop Solar and Renewable Energy Systems') to Provide a Permitting Process for Small Residential Rooftop Solar Energy Systems; and

WHEREAS, the 'Checklist and Standard Plan(s)' shall substantially conform to the checklist and standard plans contained in the most current version of the *California Solar Permitting Guidebook* adopted by the Governor's Office of Planning and Research, and

WHEREAS, the Town Council desires that any future revisions to the 'Checklist and Standard Plan(s)' be done administratively; and

WHEREAS, Exhibit A of this resolution (attached) includes 'Checklist and Standard Plan(s)';

NOW THEREFORE, BE IT RESOLVED that the Town Council hereby adopts a 'Checklist and Standard Plan(s)' for expedited review of small residential rooftop solar energy systems and authorizes staff to make revisions from time to time to ensure that the 'Checklist and Standard Plan(s)' substantially conform to the checklist and standard plans contained in the most current version of the *California Solar Permitting Guidebook* adopted by the Governor's Office of Planning and Research.

The foregoing resolution was duly passed and adopted at a regular meeting of the Town Council of the Town of Fairfax held in said Town on the 7th day of October 2015 by the following vote:

AYES:

NOES:

ABSENT:

ABSTAIN:

BARBARA COLER, Mayor

Attest: _____
Michele Gardner, Town Clerk

EXHIBIT A



PV TOOLKIT DOCUMENT #2

Eligibility Checklist for Expedited Solar Photovoltaic Permitting for One- and Two-Family Dwellings

GENERAL REQUIREMENTS

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

ELECTRICAL REQUIREMENTS

- 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 Y N
 - 1) No more than two strings per MPPT input where source circuit fusing is not included Y N
 - 2) Fuses (if needed) are rated to the series fuse rating of the PV module Y N
 - 3) No more than one noninverter-integrated DC combiner is utilized per inverter Y N
- B. For central inverter systems: No more than two inverters are utilized Y N
- 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 Y N
- D. The PV system is connected to the load side of the utility distribution equipment Y N
- E. A Solar PV Standard Plan and supporting documentation is completed and attached Y N

STRUCTURAL REQUIREMENTS

- A. A completed Structural Criteria and supporting documentation is attached (if required) Y N

FIRE SAFETY REQUIREMENTS

- A. Clear access pathways provided Y N
- B. Fire classification solar system is provided Y N
- C. All required markings and labels are provided Y N
- 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 Y N

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.*



PV TOOLKIT DOCUMENT #3

Solar PV Standard Plan -- Simplified Central/String Inverter Systems for One- and Two-Family Dwellings

SCOPE: Use this plan ONLY for utility-interactive 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 structure. 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.

MANUFACTURER'S SPECIFICATION SHEETS MUST BE PROVIDED for proposed inverter, modules, combiner/junction boxes and racking systems. Installation instructions for bonding and grounding equipment 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 identified and listed for the application (CEC 690.4[D]).

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_L) = Between -1° to -5° C
 Lowest expected ambient temperature for the location (T_L) = Between -6° to -10° C
Average ambient high temperature (T_H) = 47° C
Note: For a lower T_L or a higher T_H, use the Comprehensive Standard Plan

DC Information:

Module Manufacturer: _____ Model: _____
2) Module V_{oc} (from module nameplate): _____ Volts 3) Module I_{sc} (from module nameplate): _____ Amps
4) Module DC output power under standard test conditions (STC) = _____ Watts (STC)

5) DC Module Layout

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

DC/DC Converter Model #: _____	DC/DC Converter Max DC Input Voltage: _____ Volts
Max DC Output Current: _____ Amps	Max DC Output Current: _____ Volts
Max # of DC/DC Converters in an Input Circuit: _____	DC/DC Converter Max DC Input Power: _____ Watts

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 $-1 \leq T_c \leq -5^\circ\text{C}$, STEP 1) = _____ V

A2. Module V_{oc} (STEP 2) = _____ x # in series (STEP 5) _____ x 1.14 (If $-6 \leq T_c \leq -10^\circ\text{C}$, STEP 1) = _____ V

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	76.53	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 $-1 \leq T_c \leq -5^\circ\text{C}$, STEP 1) = _____ V

B2. Module V_{oc} (STEP 2) = _____ x # of modules per converter (STEP 6) _____ x 1.14 (If $-6 \leq T_c \leq -10^\circ\text{C}$, STEP 1) = _____ V

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) Maximum Source Circuit Current
Is Module I_{sc} below 9.6 Amps (Step 3)? Yes No (If No, use Comprehensive Standard Plan)

10) 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.

11) 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): 15 Amps

12) Sizing PV Output Circuit Conductors — If a combiner box will NOT be used (Step 11),
 Output Circuit Conductor Size = Min. #6 AWG copper conductor

13) 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)

14) 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:

15) 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

16) 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 Step 15 (or Step S20), bus bar Rating, and Main OCPD as shown in Table 4.

If No, circle the Max Combined PV System OCPD(s) at 100% value as determined from Step 15 (or Step S20), bus bar Rating, and Main OCPD as shown in Table 4.

Per 705.12(D)(2): [Inverter output OCPD size [Step #15 or S20] + Main OCPD Size] ≤ [bus size x (100% or 120%)]

Table 4. Maximum Combined Supply OCPDs Based on Bus Bar Rating (Amps) per NEC 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.

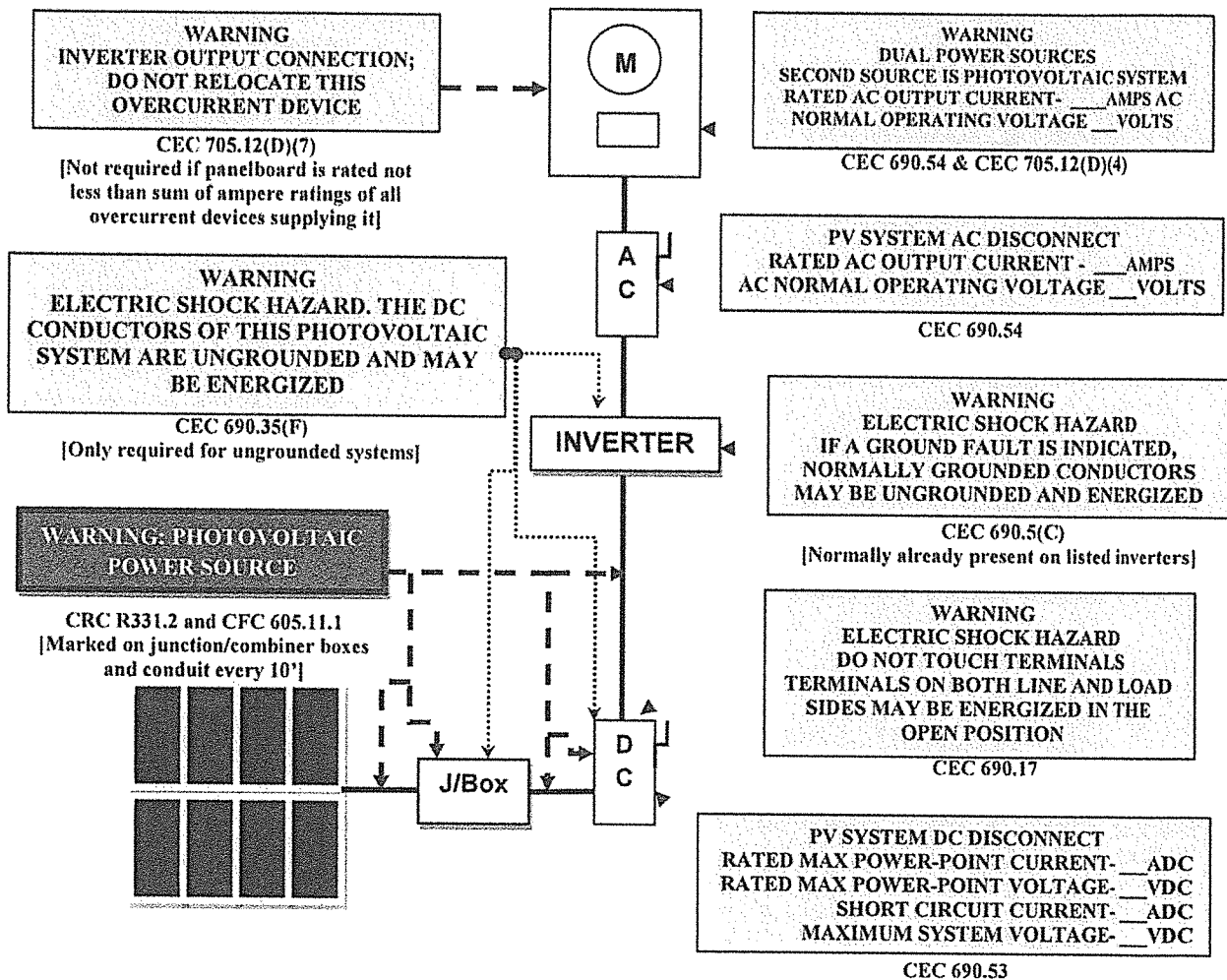
17 & 18 & 19) Labels and Grounding and Bonding

This content is covered by the labels on the next page and the Single Line Diagram(s). For background information, refer to the Comprehensive Standard Plan.

Solar PV Standard Plan — Simplified Central/String Inverter Systems for One- and Two-Family Dwellings

Markings

CEC Articles 690 and 705 and CRC Section R331 require the following labels or markings be installed at these components of the photovoltaic system:



Code Abbreviations:

- California Electrical Code (CEC)
- California Residential Code (CRC)
- California Fire Code (CFC)

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 Systems for One- and Two-Family Dwellings

△ TAG DESCRIPTION

1 SOLAR PV MODULE / STRING

2 DC/DC CONVERTERS INSTALLED? YES / NO (IF YES, STEPS 6 & 8 REQUIRED)

3 SOURCE CIRCUIT JUNCTION BOX INSTALLED? YES / NO

4 SEPARATE DC DISCONNECT INSTALLED? YES / NO

5 INTERNAL INVERTER DC DISCONNECT? YES / NO

6 CENTRAL INVERTER

7 LOAD CENTER INSTALLED? YES / NO

8 PV PRODUCTION METER INSTALLED? YES / NO

9 *SEPARATE AC DISCONNECT INSTALLED? YES / NO

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

* Consult with your local AHI and /or Utility

SINGLE-LINE DIAGRAM #1 – NO STRINGS COMBINED 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.

IF DC/DC CONVERTERS ARE USED, CHECK THE BOX BELOW THE CORRESPONDING CONFIGURATION

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)

CONDUCTOR/CONDUIT SCHEDULE			
TAG	DESCRIPTION AND CONDUCTOR TYPE	NUMBER OF CONDUCTORS	CONDUIT/CABLE TYPE AND CONDUIT SIZE
A	USE-2 Ø OR PV-WIRE Ø EGC/GEC:		
B	EGC/GEC:		
C	EGC/GEC:		
D	EGC/GEC:		

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

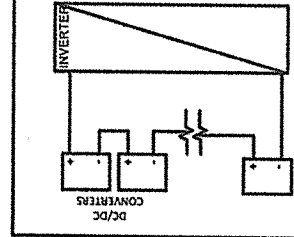
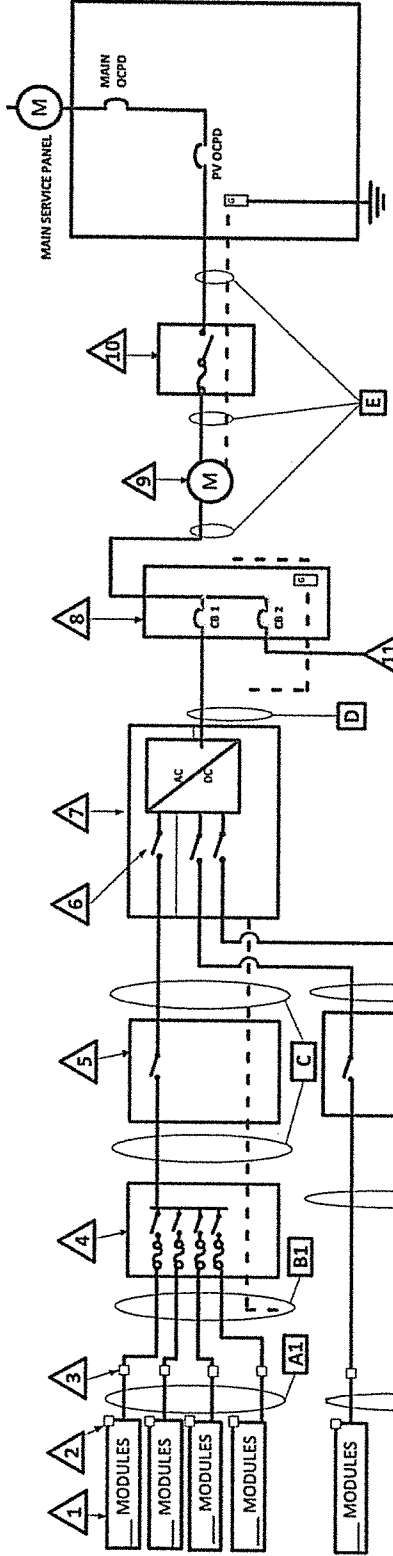
Solar PV Standard Plan — Simplified Central/String Inverter Systems for One- and Two-Family Dwellings

△ TAG	DESCRIPTION	YES / NO	(IF YES, STEPS 6 & 8 REQUIRED)
1	SOLAR PV MODULE / STRING	YES / NO	(IF YES, STEPS 6 & 8 REQUIRED)
2	DC/DC CONVERTERS INSTALLED?	YES / NO	(IF YES, STEPS 6 & 8 REQUIRED)
3	SOURCE CIRCUIT JUNCTION BOX INSTALLED?	YES / NO	
4	COMBINER BOX (STEPS 11 & 12 REQUIRED)	YES / NO	
5	SEPARATE DC DISCONNECT INSTALLED?	YES / NO	
6	INTERNAL INVERTER DC DISCONNECT	YES / NO	
7	CENTRAL INVERTER	YES / NO	
8	LOAD CENTER INSTALLED?	YES / NO	
9	PV PRODUCTION METER INSTALLED?	YES / NO	
10	*SEPARATE AC DISCONNECT INSTALLED?	YES / NO	
11	CONNECT TO INVERTER #2 (USE LINE DIAGRAM 4)		

* Consult with your local AHJ and /or Utility

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.



IF DC/DC CONVERTERS ARE USED, THEY ARE RUN IN SERIES (PRIMED SOURCE CIRCUIT VOLTAGE DC/DC CONVERTERS)

□ TAG	DESCRIPTION AND CONDUCTOR TYPE	CONDUCTOR SIZE	NUMBER OF CONDUCTORS	CONDUIT/CABLE TYPE	CONDUIT/CABLE SIZE
A2	USE 2-D OR PV-WIRE □				
B2	EGC/GEC:				
	EGC/GEC:				

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

□ TAG	DESCRIPTION AND CONDUCTOR TYPE	CONDUCTOR SIZE	NUMBER OF CONDUCTORS	CONDUIT/CABLE TYPE	CONDUIT/CABLE SIZE
A1	USE 2-D OR PV-WIRE □				
B1	EGC/GEC:				
C	EGC/GEC:				
D	EGC/GEC:				
E	EGC/GEC:				

**Solar PV Standard Plan — Simplified
Central/String Inverter Systems for One- and Two-Family Dwellings
Supplemental Calculation Sheets for Inverter #2
(Only include if second inverter is used)**

DC Information:

Module Manufacturer: _____		Model: _____	
S2) Module V_{oc} (from module nameplate): _____ Volts		S3) Module I_{sc} (from module nameplate): _____ Amps	
S4) Module DC output power under standard test conditions (STC) = _____ Watts (STC)			
S5) DC Module Layout			
Identify each source circuit (string) for inverter 1 shown on the roof plan with a Tag (e.g. A,B,C,...)	Number of modules per source circuit for inverter 1	Identify, by tag, which source circuits on the roof are to be paralleled (if none, put N/A)	
		Combiner 1:	
		Combiner 2:	
Total number of source circuits for inverter 1: _____			
S6) Are DC/DC Converters used? <input type="checkbox"/> Yes <input type="checkbox"/> No		If No, skip to Step S7. If Yes, enter info below.	
DC/DC Converter Model #: _____		DC/DC Converter Max DC Input Voltage: _____ Volts	
Max DC Output Current: _____ Amps		Max DC Output Current: _____ Volts	
Max # of DC/DC Converters in an Input Circuit: _____		DC/DC Converter Max DC Input Power: _____ Watts	

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} (STEP S2) = _____ x # in series (STEP S5) _____ x 1.12 (If $-1 \leq T_L \leq -5^\circ\text{C}$, STEP S1) = _____ V

A2. Module V_{oc} (STEP S2) = _____ x # in series (STEP S5) _____ x 1.14 (If $-6 \leq T_L \leq -10^\circ\text{C}$, STEP S1) = _____ V

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	76.53	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 S6).

B1. Module V_{oc} (STEP S2) = _____ x # of modules per converter (STEP S6) _____ x 1.12 (If $-1 \leq T_L \leq -5^\circ\text{C}$, STEP S1) = _____ V

B2. Module V_{oc} (STEP S2) = _____ x # of modules per converter (STEP S6) _____ x 1.14 (If $-6 \leq T_L \leq -10^\circ\text{C}$, STEP S1) = _____ V

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

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)

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 Systems for One- and Two-Family Dwellings

△ TAG DESCRIPTION

1. SOLAR PV MODULE / STRING

2. DC/DC CONVERTERS INSTALLED? YES / NO (IF YES, STEPS 6 & 8 REQUIRED)

3. SOURCE CIRCUIT JUNCTION BOX INSTALLED? YES / NO

4. SEPARATE DC DISCONNECT INSTALLED? YES / NO

5. INTERNAL INVERTER DC DISCONNECT: YES / NO

6. CENTRAL INVERTER

7. *SEPARATE AC DISCONNECT INSTALLED? YES / NO

8. TO LOAD CENTER ON LINE DIAGRAM 1

* Consult with your local AHJ and /or Utility

□ 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.

INVERTER # 2

IF DC/DC CONVERTERS ARE USED, CHECK THE BOX BELOW THE CORRESPONDING CONFIGURATION

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)

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

TAG	DESCRIPTION AND CONDUCTOR TYPE	CONDUCTOR SIZE	NUMBER OF CONDUCTORS	CONDUIT/CABLE TYPE	CONDUIT SIZE
A	USE 2 □ OR PV-WIRE □				
B	EGC/GEC:				
C	EGC/GEC:				

Solar PV Standard Plan — Simplified Central/String Inverter Systems for One- and Two-Family Dwellings

△ TAG DESCRIPTION

1 SOLAR PV MODULE / STRING

2 DC/DC CONVERTERS INSTALLED? YES / NO (IF YES, STEPS 6 & 8 REQUIRED)

3 SOURCE CIRCUIT JUNCTION BOX INSTALLED? YES / NO

4 COMBINER BOX (STEPS 11 & 12 REQUIRED)

5 SEPARATE DC DISCONNECT INSTALLED? YES / NO

6 INTERNAL INVERTER DC DISCONNECT? YES / NO

7 CENTRAL INVERTER

8 SEPARATE AC DISCONNECT INSTALLED? YES / NO

9 TO LOAD CENTER ON LINE DIAGRAM 3

* Consult with your local AHJ and /or utility

**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.

COMBINER CONDUCTOR/CONDUIT SCHEDULE

TAG	DESCRIPTION AND CONDUCTOR TYPE	NUMBER OF CONDUCTORS	CONDUIT/CABLE TYPE	CONDUIT SIZE
<input type="checkbox"/> A1	USE-2 Ø OR PV-WIRE Ø EGC/GEC:			
<input type="checkbox"/> B1	EGC/GEC:			
<input type="checkbox"/> C	EGC/GEC:			
<input type="checkbox"/> D	EGC/GEC:			

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

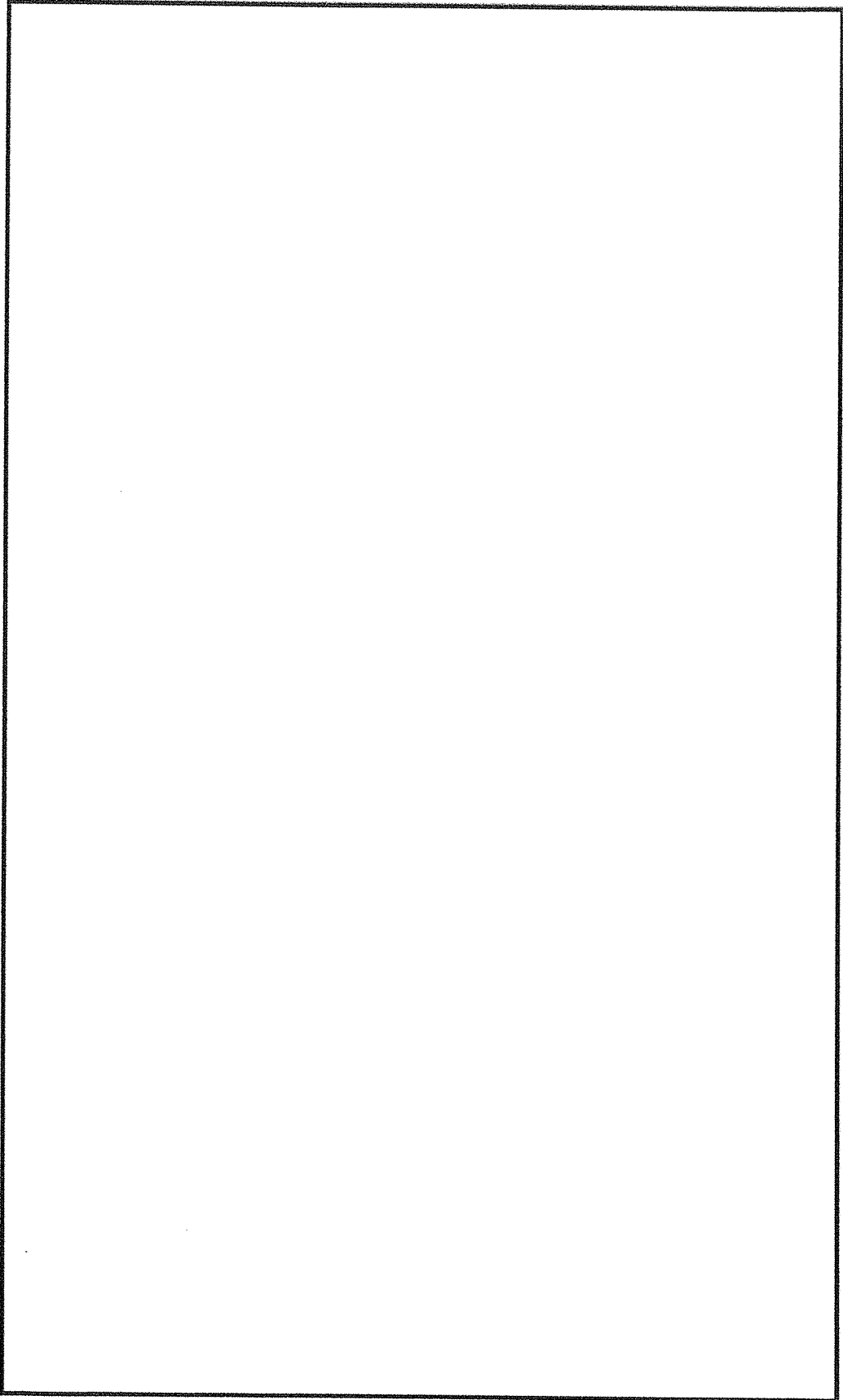
TAG	DESCRIPTION AND CONDUCTOR TYPE	NUMBER OF CONDUCTORS	CONDUIT/CABLE TYPE	CONDUIT SIZE
<input type="checkbox"/> A2	USE-2 Ø OR PV-WIRE Ø EGC/GEC:			
<input type="checkbox"/> B2	EGC/GEC:			
<input type="checkbox"/>	EGC/GEC:			

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

IF DC/DC CONVERTERS ARE USED, THEY ARE RUN IN SERIES FIXED SOURCE CIRCUIT VOLTAGE DC/DC CONVERTERS

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.

2.2 Nominal AC voltage rating: _____ Volts

2.3 Rated (continuous) AC output current: _____ Amps

If installing ACMs, skip [STEPS 2.4]

2.4 Maximum DC input voltage rating: _____ Volts (limited to 79 V, otherwise use the Comprehensive Standard Plan)

2.5 Maximum AC output overcurrent protection device (OCPD) _____ Amps

2.6 Maximum number of microinverters or ACMs per branch circuit: _____

3. PV Module Information

(If installing ACMs, skip to [STEP 4])

PV Module Manufacturer: _____

Model: _____

Module DC output power under standard test conditions (STC) = _____ Watts

3.1 Module V_{oc} at STC (from module nameplate): _____ Volts

3.2 Module I_{sc} at STC (from module nameplate): _____ Amps

3.3 Adjusted PV Module DC voltage at minimum temperature = [Table 1] _____ [cannot exceed Step 2.4]

Table 1. Module V_{oc} at STC Based on Inverter Maximum DC Input Voltage Derived from CEC 690.7																
Microinverter Max. DC Input [STEP 2.4] (Volts)	34	37	40	43	46	49	52	55	58	61	64	67	70	73	76	79
Max. Module V_{oc} @ STC, 1.12 (-1° to -5° C) Correction Factor (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. Module V_{oc} @ STC, 1.14 (-6° to -10° C) Correction Factor (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

4. Branch Circuit Output Information

Fill in [Table 3] to describe the branch circuit inverter output conductor and OCPD size. Use [Table 2] for determining the OCPD and Minimum Conductor size.

Table 2. Branch Circuit OCPD and Minimum Conductor Size*				
Circuit Current (Amps)	Circuit Power (Watts)	OCPD (Amps)	Minimum Conductor Size (AWG)	Minimum Metal Conduit Size for 6 Current Carrying Conductors
12	2880	15	12	¾"
16	3840	20	10	¾"
20	4800	25	8	1"
24	5760	30	8	1"

*CEC 690.8 and 210.19 (A)(1) factored in Table 2, conductors are copper, insulation must be 90° C wet-rated. Table 2 values are based on maximum ambient temperature of 69° C, which includes 22° C adder, exposed to direct sunlight, mounted > 0.5 inches above rooftop, ≤ 6 current carrying conductors (3 circuits) in a circular raceway. Otherwise use Comprehensive Standard Plan.

Table 3. PV Array Configuration Summary			
	Branch 1	Branch 2	Branch 3
Number of Microinverters or ACMs [Step 1]			
Selected Conductor Size [Table 2] (AWG)			
Selected Branch and Inverter Output OCPD [Table 2]			

5. Solar Load Center (if used)

5.1 Solar Load Center is to have a bus bar rating not less than 100 Amps. Otherwise use Comprehensive Standard Plan.

5.2 Circuit Power see [STEP 1] = _____ Watts

5.3 Circuit Current = (Circuit Power) / (AC voltage) = _____ Amps

Table 4. Solar Load Center and Total Inverter Output OCPD and Conductor Size**				
Circuit Current (Amps)	Circuit Power (Watts)	OCPD (Amps)	Minimum Conductor Size (AWG)	Minimum Metal Conduit Size
24	5760	30	10	½"
28	6720	35	8	¾"
32	7680	40	8	¾"
36	8640	45	8	¾"
40	9600	50	8	¾"
41.6	≤ 10000	60	6	¾"

**CEC 690.8 and 210.19 (A)(1) factored in Table 4, conductors are copper, insulation must be 90° C wet-rated. Table 4 values are based on maximum ambient temperature of 47° C (no rooftop temperature adder in this calculation), ≤ 3 current carrying conductors in a circular raceway. Otherwise use Comprehensive Standard Plan.

6. Point of Connection to Utility:

6.1 Load Side Connection only! Otherwise use the Comprehensive Standard Plan.

6.2 Is the PV OCPD positioned at the opposite end from input feeder location or main OCPD location?
 Yes No (If No, then use 100% row in Table 5)

6.3 Per 705.12(D)(2): (Combined inverter output OCPD size + Main OCPD size) ≤ [bus bar size × (100% or 120%)]

Table 5. Maximum Combined Inverter Output Circuit OCPD										
Bus Bar Size (Amps)	100	125	125	200	200	200	225	225	225	
Main OCPD (Amps)	100	100	125	150	175	200	175	200	225	
Maximum Combined Inverter OCPD with 120% of bus bar rating (Amps)	20	50	25	60'	60'	40	60'	60'	45	
Maximum Combined Inverter OCPD with 100% of bus bar rating (Amps)	0	25	0	50	25	0	50	25	0	

†This plan limits the maximum system size to less than 10 kW, therefore the OCPD size is limited to 60 A. Reduction of Main Breaker is not permitted with this plan.

7. Grounding and Bonding

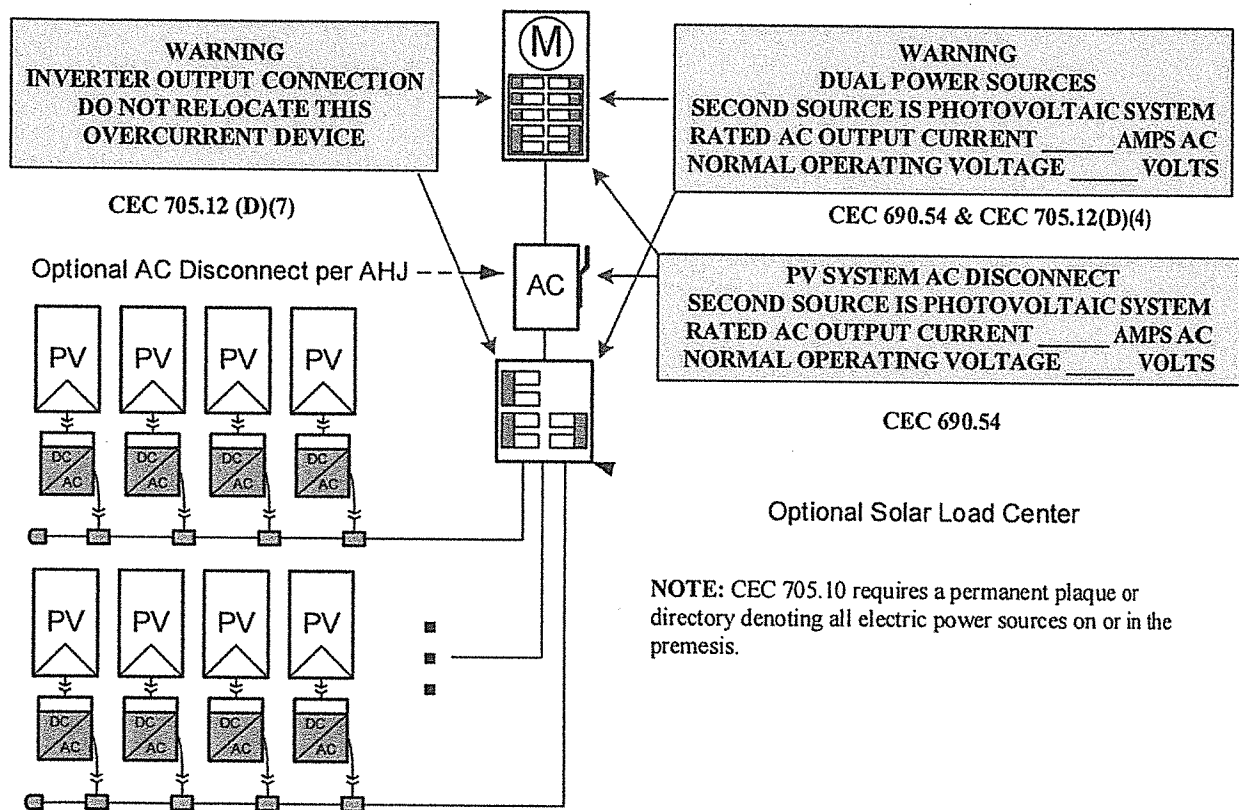
Check one of the boxes for whether system is grounded or ungrounded: Grounded Ungrounded

For Microinverters with a grounded DC input, systems must follow the requirements of GEC (CEC 690.47) and EGC (CEC 690.43).

For ACM systems and Microinverters with ungrounded a DC input follow the EGC requirements of (CEC 690.43).

8. Markings

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.



Solar PV Standard Plan — Simplified Central/String Inverter Systems for One- and Two-Family Dwellings

9. Single-Inverter Line Diagram

Equipment Schedule

TAG	DESCRIPTION: (Provide model # if provided)
1	Solar PV Module or ACM:
2	Microinverter (if not ACM):
3	Junction Box (es):
4	Solar Load Center, Yes / No:
5	Performance Meter Yes / No:
6	*Utility External Disconnect Switch Yes / No:
7	Main Electrical Service Panel

Single-Line Diagram for Microinverters or ACMs

Check a box for dc system grounding: Grounded, Ungrounded
 For ungrounded dc power systems, EGC is required
 For grounded dc power systems, GEC & EGC are required
 Refer to CEC 250.120 for EGC installation & Table 250.122 for sizing

* Consult with your local AHJ and /or Utility

Branch Circuit OCPDs (Table 3)

Branch 1 OCPD size _____
 Branch 2 OCPD size _____
 Branch 3 OCPD size _____
 Solar Load Center
 Busbar(Section 5) _____

Main Service Panel OCPDs

Main OCPD size: (table 5) _____
 Combined Inverter Output OCPD: (Table 4) _____
 Main Service Panel Busbar: (Table 5) _____

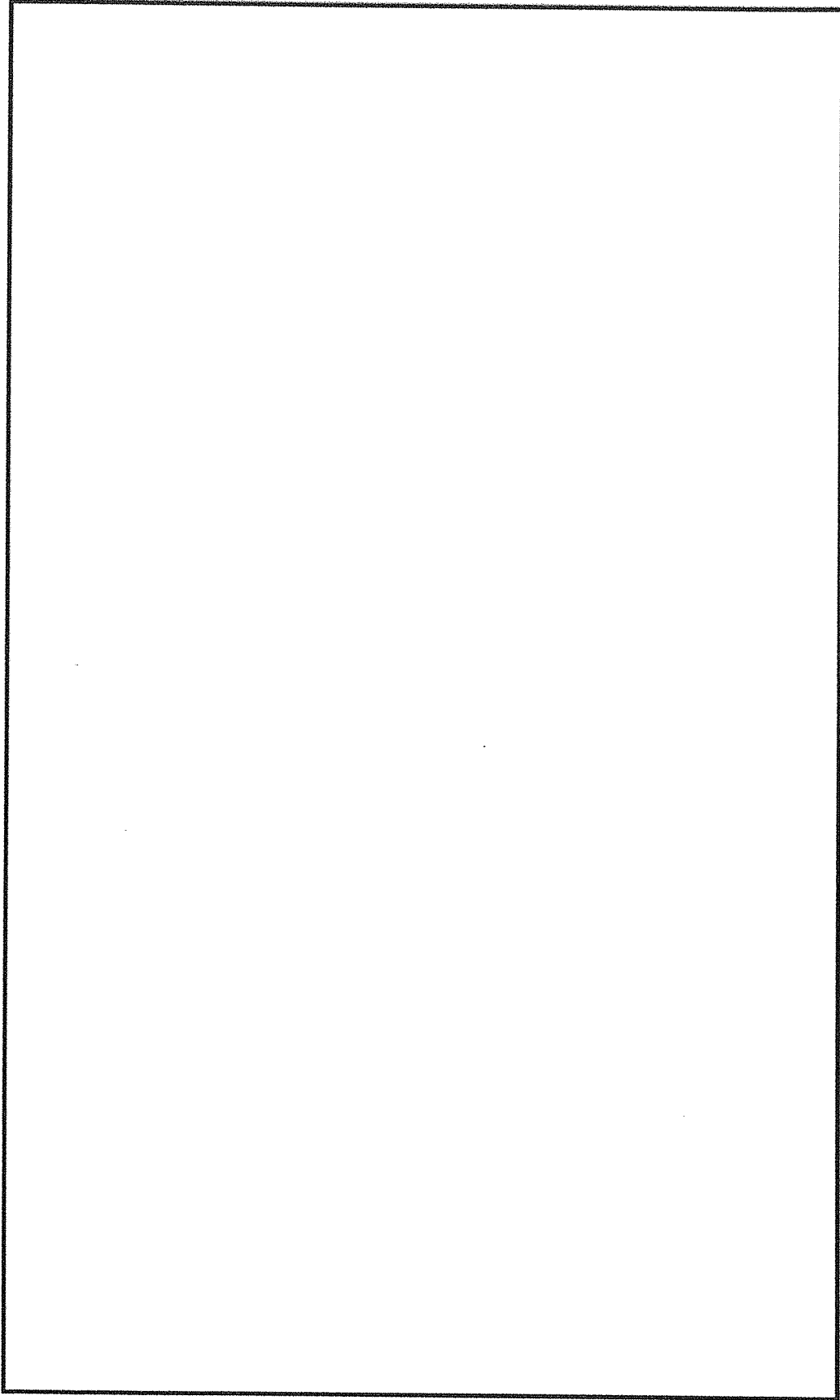
Conductor, Cable and Conduit Schedule

TAG	Description and Conductor Type: (Table 3)	Conductor Size	Number of Conductors	Conduit/Conductor/Cable Type	Conduit Size
A	Current-Carrying Conductors: (for each branch circuit) EGC: GEC (when required):				
B	Current-Carrying Conductors: EGC: GEC (when required):				

SOLAR PV STANDARD PLAN — SIMPLIFIED

Microinverter and ACM Systems for One- and Two-Family Dwellings

ROOF LAYOUT PLAN



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