PROJECT TITLE

SCOPE OF WORK :

SHEET INDEX :

CODE & STANDARD

DESIGN COMPLYING WITH THE LATEST EDITION OF CALIFORNIA BUILDING CODE, CALIFORNIA ELECTRICAL CODE, NEC, AND THE STOCKTON MUNICIPAL CODE

GENERAL NOTES

SOLAR PHOTOVOLTAIC SYSTEM TO BE INSTALLED ON RESIDENTIAL STRUCTURE.

THIS PROJECT HAS BEEN DESIGNED IN COMPLIANCE WITH THE CBC SECTION 1609 TO WITHSTAND A MINIMUM 85 MPH WIND LOAD.

THE HOUSE IS . . . . . STORY(IES) TALL.

THE RAFTERS ARE . . . . . x . . . . . AND . . . . . INCHES ON CENTER.

THIS SYSTEM WILL NOT BE INTERCONNECTED UNTIL APPROVAL FROM THE LOCAL JURISDICTION AND THE UTILITY IS OBTAINED.

WHEN A STORAGE BATTERY IS PROVIDED, THIS SYSTEM SHALL BE AN UTILITY INTERACTIVE SYSTEM WITH LISTED STORAGE BATTERIES PER CEC ARTICLE 706, AND CRC SECTION R327 REQUIREMENTS. STATIONARY STORAGE BATTERY SYSTEMS SHALL COMPLY CFC, AND HAVING CAPACITIES NOT EXCEEDING THE VALUES SHOWN IN TABLE 608.1 2016 CFC.

THE SOLAR PHOTOVOLTAIC INSTALLATION SHALL NOT OBSTRUCT ANY PLUMBING, MECHANICAL OR BUILDING ROOF VENTS.

IF THE EXISTING MAIN SERVICE PANEL DOES NOT HAVE VERIFIABLE GROUNDING ELECTRODE, IT IS THE CONTRACTOR'S RESPONSIBILITY TO INSTALL A SUPPLEMENTAL GROUNDING ELECTRODE.

EACH MODULE WILL BE GROUNDED USING THE SUPPLIED CONNECTIONS POINTS IDENTIFIED ON THE MODULE AND THE MANUFACTURER'S INSTALLATION INSTRUCTIONS.

A LADDER SHALL BE IN PLACE FOR INSPECTION IN COMPLIANCE WITH CAL-OSHA REGULATIONS.

PROPER ACCESS AND WORKING CLEARANCE WILL BE PROVIDED AS PER SECTION 110.26 CEC.

THIS PROJECT HAS BEEN DESIGNED IN COMPLIANCE WITH THE CITY OF SAN DIEGO PROP D & FAA REQUIREMENTS.

As the home owner of the subject project, I certify that I am requesting to install the solar photovoltaic system shown on these plans.
_____ _____ Home Owner Signature _____ Home Owner's Name (Printed)

CITY APPROVAL STAMP

FOR ADMINISTRATIVE USE ONLY

COMPANY LOGO

SIGNATURE & LICENSE NUMBER

KW RATING OF THE SYSTEM

PROJECT NAME

PROJECT ADRESS

LEGAL DESCRIPTION / ASSESSOR'S PARCEL NUMBER

REVISION	DATE

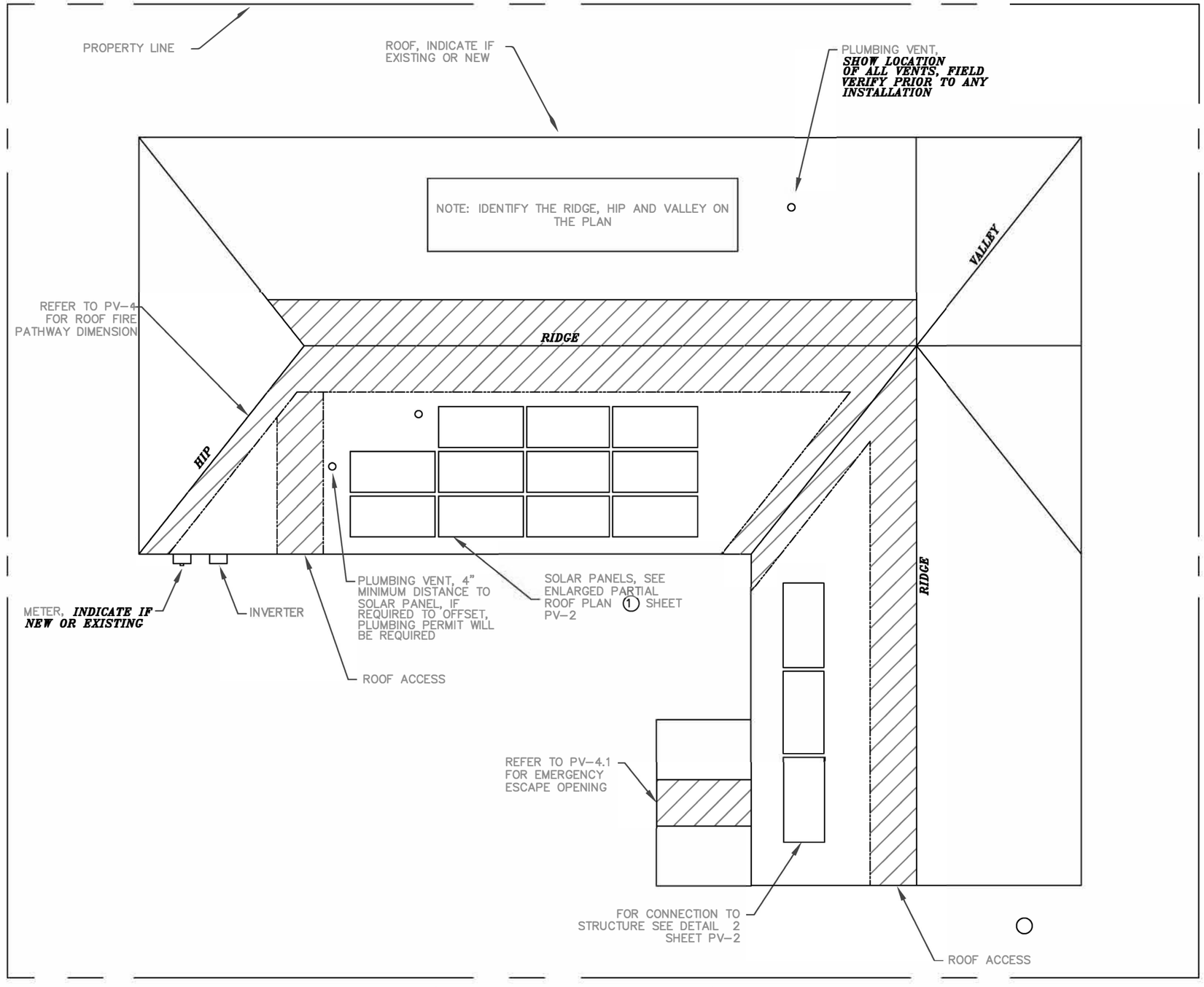
DRAWN BY:

PROJECT NO.

DATE:

SHEET

PV-0



SAMPLE ROOF PLAN / SITE PLAN
SCALE: ?

NOTE:
INDICATE PERCENTAGE OF THE PANEL COVERAGE

COMPANY LOGO

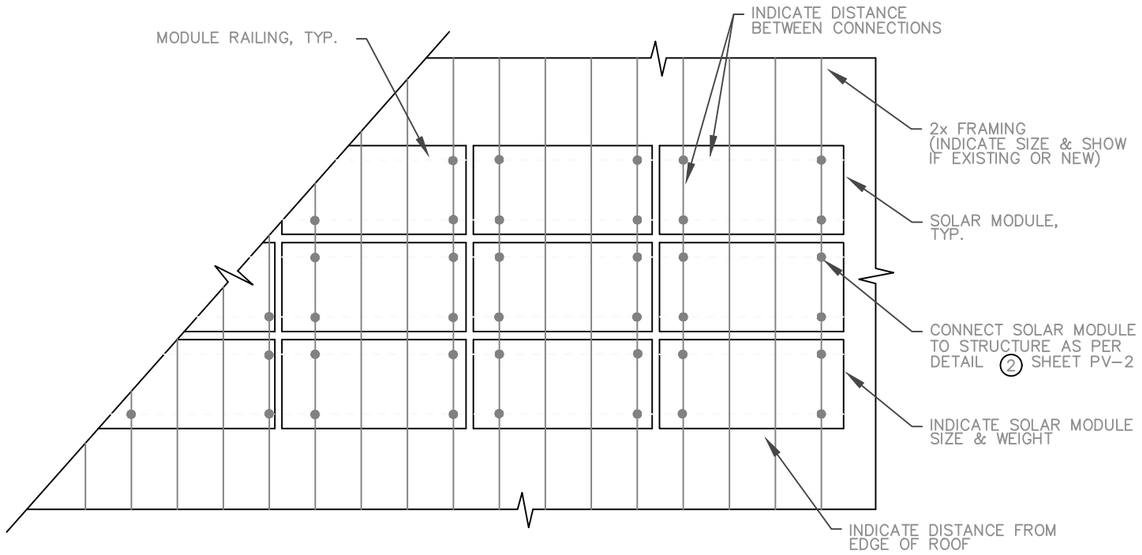
SIGNATURE & LICENSE NUMBER

KW RATING OF THE SYSTEM

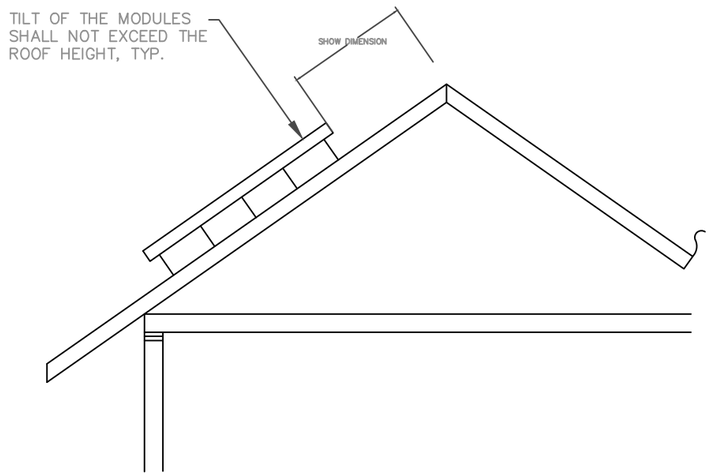
PROJECT NAME
PROJECT ADDRESS
LEGAL DESCRIPTION / ASSESSOR'S PARCEL NUMBER

REVISION	DATE

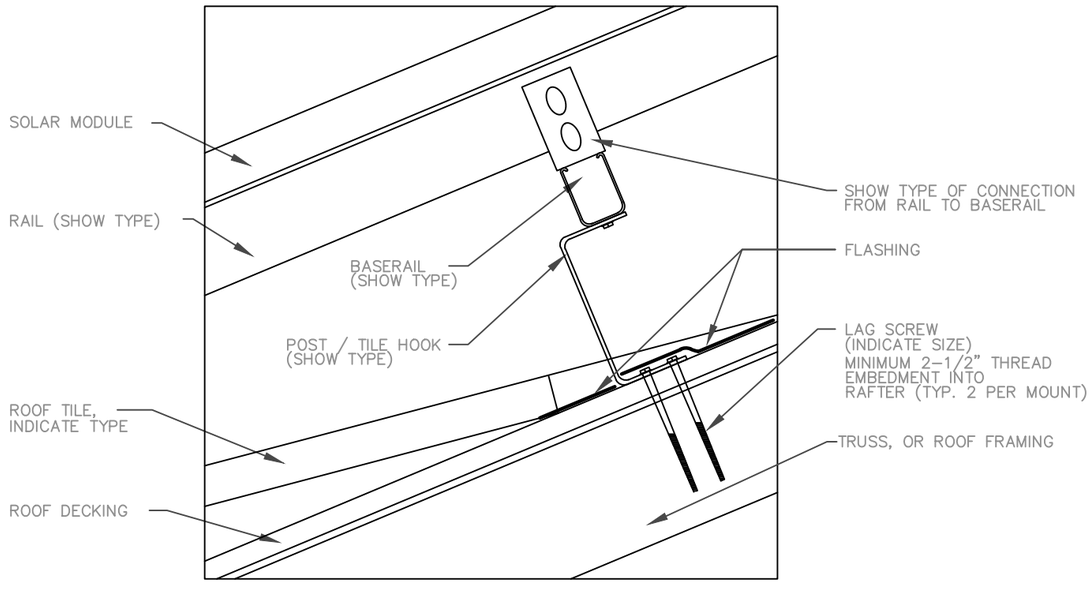
DRAWN BY:
PROJECT NO.
DATE:
SHEET
PV–1



ENLARGED PARTIAL ROOF PLAN DETAIL ①
NTS



ELEVATION
NTS



SOLAR MODULE MOUNTING DETAIL DETAIL ②
NTS

NOTE:

1. THIS IS ONLY A SAMPLE FOR THE MOUNTING. SHOW EXACT MOUNTING DETAIL AS APPLIES TO YOUR PROJECT.

2. ALL ITALIC FONTS SHALL BE MODIFIED TO REFLECT ACTUAL PROJECT SPECIFIC DETAILS.

COMPANY LOGO

SIGNATURE & LICENSE NUMBER

KW RATING OF THE SYSTEM

PROJECT NAME

PROJECT ADRESS

LEGAL DESCRIPTION / ASSESSOR'S PARCEL NUMBER

REVISION	DATE

DRAWN BY:

PROJECT NO.

DATE:

SHEET

PV-2

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

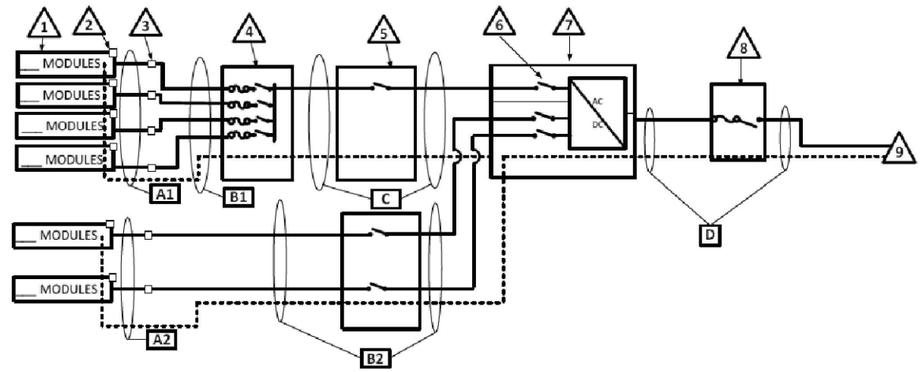
SINGLE-LINE DIAGRAM #4 – ADDITIONAL INVERTER FOR DIAGRAM #2

INVERTER # 2

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

REFER TO STEP 16 FOR RAPID SHUTDOWN DETAILS

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.



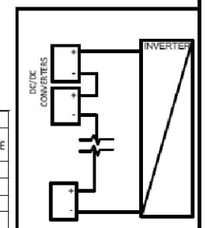
COMBINER CONDUCTOR/CONDUIT SCHEDULE

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

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

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

General Notes

1. ALL PLAQUES AND SIGNAGE REQUIRED BY THE LATEST EDITION OF CALIFORNIA ELECTRICAL CODE AND THE SAN DIEGO AREA ELECTRICAL NEWSLETTER, WILL BE INSTALLED AS REQUIRED.
2. ALTERNATE POWER SOURCE PLACARD SHALL BE METALLIC OR PLASTIC, ENGRAVED OR MACHINE PRINTED LETTERS IN A CONTRASTNG COLOR TO THE PLAQUE. THIS PLAQUE WILL BE ATTACHED BY POP RIVETS OR SCREWS OR OTHER APPROVED METHOD. IF EXPOSED TO SUNLIGHT, IT SHALL BE UV RESISTANCE.
3. PHOTOVOLTAIC DC CONDUCTORS ENTERING THE BUILDING SHALL BE INSTALLED IN METAL CONDUIT AND THE CONDUIT SHALL BE LABELED, "CAUTION DC CIRCUIT" OR EQUIVALENT EVERY 10 FT."
4. EXPOSED NON-CURRENT CARRYING METAL PARTS OF MODULE FRAMES, EQUIPMENTS, AND CONDUCTOR ENCLOSURES SHALL BE GROUNDED IN ACCORDANCE WITH 250.134 OR 250.136 (A) REGARDLESS OF VOLTAGE.
5. EACH MODULE SHALL BE GROUNDED USING THE SUPPLIED CONNECTION POINT IDENTIFIED ON THE MODULE AND THE MANUFACTURER'S INSTRUCTIONS.
6. IF THE EXISTING GROUNDING ELECTRODE SYSTEM CAN NOT BE VERIFIED OR IS ONLY METALIC WATER PIPING, IT IS THE CONTRACTOR'S RESPONSIBILITY TO INSTALL A SUPPLEMENTAL GROUNDING ELECTRODE.
7. THE INVERTER SHALL BE LISTED AS A UTILITY INTERACTIVE
8. UNIT INSTALLED ON THE SAME BUILDING AS THE MODULES BUT NOT ON THE ROOF.
9. THE INVERTER OUTPUT CIRCUIT CONDUCTORS SHALL TERMINATE WITHIN THE SERVICE PANEL IN ACCORDANCE WITH CEC 690.64(B)(7).
10. BACKFEED BREAKERS IN THE SERVICE PANEL SHALL BE SUITABLE FOR THAT USE.
11. ALL EQUIPMENT SHALL BE INSTALLED IN ACCORDANCE WITH THE MANUFACTURER'S APPROVED INSTALLATION INSTRUCTIONS. A COPY OF THESE INSTRUCTIONS ARE INCLUDED AS PART OF THIS PLAN.
12. ALL EQUIPMENT AND WIRING SHALL BE LISTED BY NATIONAL RECOGNIZED TESTING AGENCY
13. USE MINIMUM 8 AWG EQUIPMENT GROUNDING CONDUCTOR (EGC) WHEN IT IS SUBJECT TO PHYSICAL DAMAGE, OR INSTALL THE EGC IN AN APPROVED RACEWAY.
14. ALL WIRING SHALL BE OF COPPER MATERIAL, AND KEPT OUTSIDE OF THE BUILDING.
15. ALL ELECTRICAL EQUIPMENT INCLUDING THE SERVICE SHALL HAVE A LEGIBLE, VISIBLE, AND DURABLE MARKING INDICATING THE MANUFACTURER NAME, CURRENT, VOLTAGE, FREQUENCY, AND NUMBER OF PHASES.
16. EACH INSTALLED EQUIPMENT, WIRING AND OVERCURRENT PROTECTIVE DEVICE (OCPD) SHALL HAVE A SHORT CIRCUIT RATING NOT LESS THAN THE AVAILABLE SHORT CIRCUIT CURRENT AT THEIR INPUT TERMINALS.
17. THE INVERTER SHALL COMPLY ACCORDANCE WITH CEC 690.11.

SAMPLE STRING INVERTER SINGLE LINE DIAGRAM
SCALE:

SCOPE: Use this plan ONLY for electrical review of utility-interactive central/string inverter systems not exceeding a combined system AC inverter output of 10kW on the roof of a single or duplex family dwelling or accessory building. The specific structural and fire requirements are covered under a separate permit. The photovoltaic system must interconnect to the load side of a single-phase AC service panel of 240Vac or less with a busbar rating of 225A or less. This plan is not intended for bipolar systems, hybrid systems or systems that utilize storage batteries, charge controllers, trackers, ac modules, more than two inverters or more than one DC combiner (non-inverter-integrated) per inverter. Systems must be in compliance with current California Building Standards Codes and all applicable STOCKTON Codes. Other Articles of the California Electrical Code (CEC) shall apply as specified in 690.3.

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)).

COMPANY LOGO

SIGNATURE & LICENSE NUMBER

KW RATING OF THE SYSTEM

PROJECT NAME
PROJECT ADRESS
LEGAL DESCRIPTION / ASSESSOR'S PARCEL NUMBER

REVISION	DATE

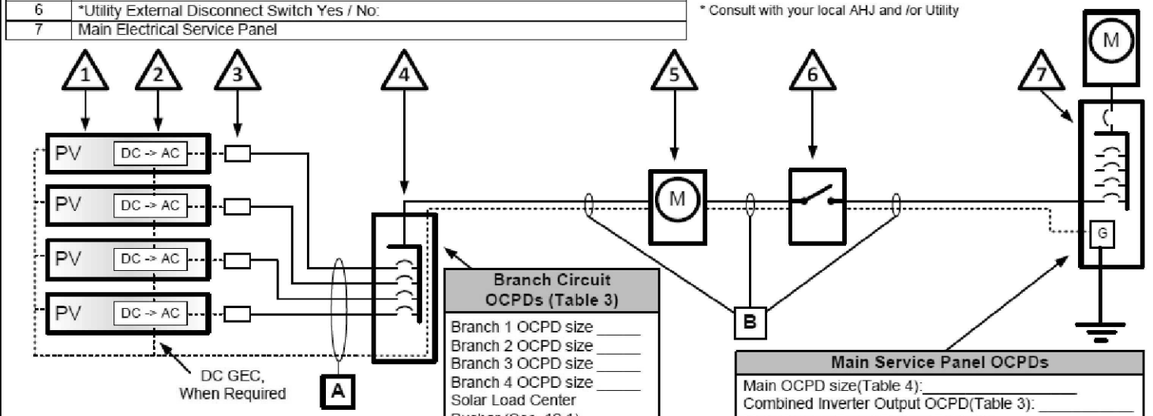
DRAWN BY:
PROJECT NO.
DATE:
SHEET
PV–3A

Equipment Schedule	
△ TAG	DESCRIPTION: (provide model number and description)
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



Conductor, Cable and Conduit Schedule

☐ TAG	Description and Conductor Type: (Table 2)	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):				

General Notes

1. ALL PLAQUES AND SIGNAGE REQUIRED BY THE LATEST EDITION OF CALIFORNIA ELECTRICAL CODE AND THE SAN DIEGO AREA ELECTRICAL NEWSLETTER, WILL BE INSTALLED AS REQUIRED.
2. ALTERNATE POWER SOURCE PLACARD SHALL BE METALLIC OR PLASTIC, ENGRAVED OR MACHINE PRINTED LETTERS IN A CONTRASTNG COLOR TO THE PLAQUE. THIS PLAQUE WILL BE ATTACHED BY POP RIVETS OR SCREWS OR OTHER APPROVED METHOD. IF EXPOSED TO SUNLIGHT, IT SHALL BE UV RESISTANCE.
3. PHOTOVOLTAIC DC CONDUCTORS ENTERING THE BUILDING SHALL BE INSTALLED IN METAL CONDUIT AND THE CONDUIT SHALL BE LABELED, "CAUTION DC CIRCUIT" OR EQUIVALENT EVERY 10 FT."
4. EXPOSED NON-CURRENT CARRYING METAL PARTS OF MODULE FRAMES, EQUIPMENTS, AND CONDUCTOR ENCLOSURES SHALL BE GROUNDED IN ACCORDANCE WITH 250.134 OR 250.136 (A) REGARDLESS OF VOLTAGE.
5. EACH MODULE SHALL BE GROUNDED USING THE SUPPLIED CONNECTION POINT IDENTIFIED ON THE MODULE AND THE MANUFACTURER'S INSTRUCTIONS.
6. IF THE EXISTING GROUNDING ELECTRODE SYSTEM CAN NOT BE VERIFIED OR IS ONLY METALIC WATER PIPING, IT IS THE CONTRACTOR'S RESPONSIBILITY TO INSTALL A SUPPLEMENTAL GROUNDING ELECTRODE.
7. THE INVERTER SHALL BE LISTED AS A UTILITY INTERACTIVE
8. UNIT INSTALLED ON THE SAME BUILDING AS THE MODULES BUT NOT ON THE ROOF.
9. THE INVERTER OUTPUT CIRCUIT CONDUCTORS SHALL TERMINATE WITHIN THE SERVICE PANEL IN ACCORDANCE WITH CEC 690.64(B)(7).
10. BACKFEED BREAKERS IN THE SERVICE PANEL SHALL BE SUITABLE FOR THAT USE.
11. ALL EQUIPMENT SHALL BE INSTALLED IN ACCORDANCE WITH THE MANUFACTURER'S APPROVED INSTALLATION INSTRUCTIONS. A COPY OF THESE INSTRUCTIONS ARE INCLUDED AS PART OF THIS PLAN.
12. ALL EQUIPMENT AND WIRING SHALL BE LISTED BY NATIONAL RECOGNIZED TESTING AGENCY
13. USE MINIMUM 8 AWG EQUIPMENT GROUNDING CONDUCTOR (EGC) WHEN IT IS SUBJECT TO PHYSICAL DAMAGE, OR INSTALL THE EGC IN AN APPROVED RACEWAY.
14. ALL WIRING SHALL BE OF COPPER MATERIAL, AND KEPT OUTSIDE OF THE BUILDING.
15. ALL ELECTRICAL EQUIPMENT INCLUDING THE SERVICE SHALL HAVE A LEGIBLE, VISIBLE, AND DURABLE MARKING INDICATING THE MANUFACTURER NAME, CURRENT, VOLTAGE, FREQUENCY, AND NUMBER OF PHASES.
16. EACH INSTALLED EQUIPMENT, WIRING AND OVERCURRENT PROTECTIVE DEVICE (OCPD) SHALL HAVE A SHORT CIRCUIT RATING NOT LESS THAN THE AVAILABLE SHORT CIRCUIT CURRENT AT THEIR INPUT TERMINALS.
17. THE INVERTER SHALL COMPLY ACCORDANCE WITH CEC 690.11.

SAMPLE MICRO INVERTER SINGLE LINE DIAGRAM
SCALE:

SCOPE: Use this plan ONLY for systems using utility-interactive Microinverters or AC Modules (ACM) not exceeding a combined system ac inverter output rating of 10 kW on a roof of a one or two family dwelling or accessory structure. The photovoltaic system must interconnect to a single-phase ac service panel of 120/240 Vac with service panel busbar rating of 225 A or less. This plan is not intended for bipolar systems, hybrid systems, or systems that utilize storage batteries, charge controllers, or tracker or more than 4 branch circuits. 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 section 690.3.

MANUFACTURER'S SPECIFICATION SHEETS MUST BE PROVIDED for proposed inverters, 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)).

COMPANY LOGO

SIGNATURE & LICENSE NUMBER

KW RATING OF THE SYSTEM

PROJECT NAME
PROJECT ADRESS
LEGAL DESCRIPTION / ASSESSOR'S PARCEL NUMBER

REVISION	DATE

DRAWN BY:
PROJECT NO.
DATE:
SHEET
PV–3B

SCOPE: Use this plan ONLY for electrical review of utility-interactive central/string inverter systems not exceeding a combined system AC inverter output of 10kW on the roof of a single or duplex family dwelling or accessory building. The specific structural and fire requirements are covered under a separate permit. The photovoltaic system must interconnect to the load side of a single-phase AC service panel of 240Vac or less with a busbar rating of 225A or less. This plan is not intended for bipolar systems, hybrid systems or systems that utilize storage batteries, charge controllers, trackers, ac modules, more than two inverters or more than one DC combiner (non-inverter-integrated) per inverter. Systems must be in compliance with current California Building Standards Codes and all applicable STOCKTON Codes. Other Articles of the California Electrical Code (CEC) shall apply as specified in 690.3.

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)).

General Notes

1. ALL PLAQUES AND SIGNAGE REQUIRED BY THE LATEST EDITION OF CALIFORNIA ELECTRICAL CODE AND THE SAN DIEGO AREA ELECTRICAL NEWSLETTER, WILL BE INSTALLED AS REQUIRED.
2. ALTERNATE POWER SOURCE PLACARD SHALL BE METALLIC OR PLASTIC, ENGRAVED OR MACHINE PRINTED LETTERS IN A CONTRASTNG COLOR TO THE PLAQUE. THIS PLAQUE WILL BE ATTACHED BY POP RIVETS OR SCREWS OR OTHER APPROVED METHOD. IF EXPOSED TO SUNLIGHT, IT SHALL BE UV RESISTANCE.
3. PHOTOVOLTAIC DC CONDUCTORS ENTERING THE BUILDING SHALL BE INSTALLED IN METAL CONDUIT AND THE CONDUIT SHALL BE LABELED, "CAUTION DC CIRCUIT" OR EQUIVALENT EVERY 10 FT."
4. EXPOSED NON-CURRENT CARRYING METAL PARTS OF MODULE FRAMES, EQUIPMENTS, AND CONDUCTOR ENCLOSURES SHALL BE GROUNDED IN ACCORDANCE WITH 250.134 OR 250.136 (A) REGARDLESS OF VOLTAGE.
5. EACH MODULE SHALL BE GROUNDED USING THE SUPPLIED CONNECTION POINT IDENTIFIED ON THE MODULE AND THE MANUFACTURER'S INSTRUCTIONS.
6. IF THE EXISTING GROUNDING ELECTRODE SYSTEM CAN NOT BE VERIFIED OR IS ONLY METALIC WATER PIPING, IT IS THE CONTRACTOR'S RESPONSIBILITY TO INSTALL A SUPPLEMENTAL GROUNDING ELECTRODE.
7. THE INVERTER SHALL BE LISTED AS A UTILITY INTERACTIVE
8. UNIT INSTALLED ON THE SAME BUILDING AS THE MODULES BUT NOT ON THE ROOF.
9. THE INVERTER OUTPUT CIRCUIT CONDUCTORS SHALL TERMINATE WITHIN THE SERVICE PANEL IN ACCORDANCE WITH CEC 690.64(B)(7).
10. BACKFEED BREAKERS IN THE SERVICE PANEL SHALL BE SUITABLE FOR THAT USE.
11. ALL EQUIPMENT SHALL BE INSTALLED IN ACCORDANCE WITH THE MANUFACTURER'S APPROVED INSTALLATION INSTRUCTIONS. A COPY OF THESE INSTRUCTIONS ARE INCLUDED AS PART OF THIS PLAN.
12. ALL EQUIPMENT AND WIRING SHALL BE LISTED BY NATIONAL RECOGNIZED TESTING AGENCY
13. USE MINIMUM 8 AWG EQUIPMENT GROUNDING CONDUCTOR (EGC) WHEN IT IS SUBJECT TO PHYSICAL DAMAGE, OR INSTALL THE EGC IN AN APPROVED RACEWAY.
14. ALL WIRING SHALL BE OF COPPER MATERIAL, AND KEPT OUTSIDE OF THE BUILDING.
15. ALL ELECTRICAL EQUIPMENT INCLUDING THE SERVICE SHALL HAVE A LEGIBLE, VISIBLE, AND DURABLE MARKING INDICATING THE MANUFACTURER NAME, CURRENT, VOLTAGE, FREQUENCY, AND NUMBER OF PHASES.
16. EACH INSTALLED EQUIPMENT, WIRING AND OVERCURRENT PROTECTIVE DEVICE (OCPD) SHALL HAVE A SHORT CIRCUIT RATING NOT LESS THAN THE AVAILABLE SHORT CIRCUIT CURRENT AT THEIR INPUT TERMINALS.
17. THE INVERTER SHALL COMPLY ACCORDANCE WITH CEC 690.11.

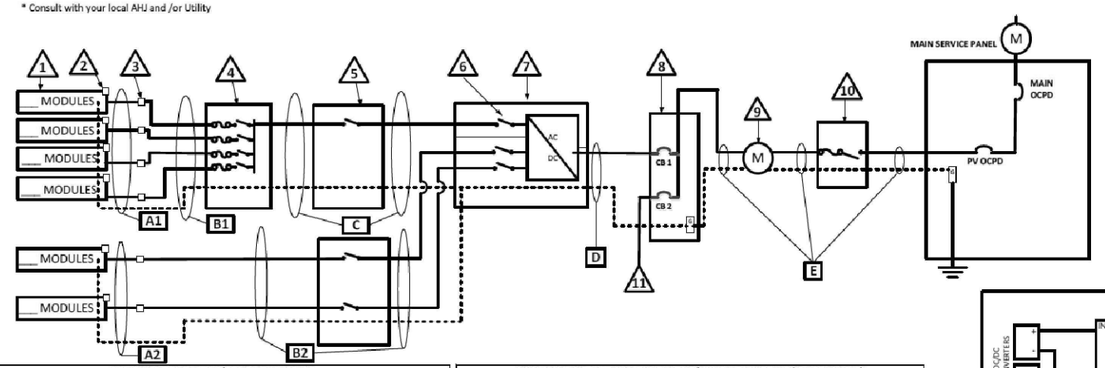
TAG	DESCRIPTION
1	SOLAR PV MODULE / STRING
2	DC/DC CONVERTERS INSTALLED? YES / NO (IF YES, STEPS 6 & 8 REQUIRED)
3	SOURCE CIRCUIT JUNCTION BOX INSTALLED?: YES / NO
4	COMBINER BOX (STEPS 11 & 12 REQUIRED)
5	SEPARATE DC DISCONNECT INSTALLED?: YES / NO
6	INTERNAL INVERTER DC DISCONNECT: YES / NO
7	CENTRAL INVERTER
8	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)
REFER TO STEP 16 FOR RAPID SHUTDOWN DETAILS ☐ 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.



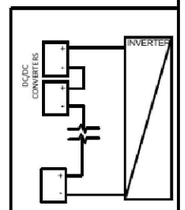
COMBINER CONDUCTOR/CONDUIT SCHEDULE

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

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

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

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

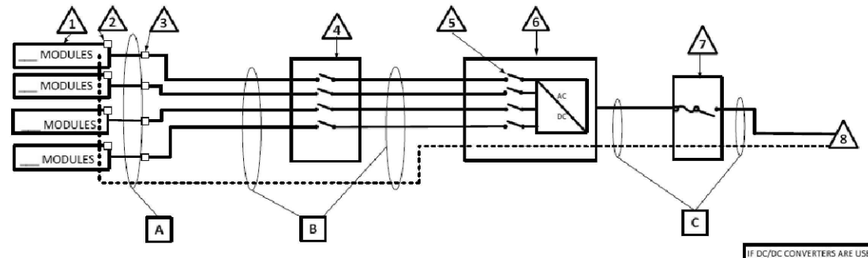
* Consult with your local AHJ and /or Utility

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

INVERTER # 2

CHECK A BOX FOR WHETHER SYSTEM IS GROUNDED OR UNGROUNDED: ☐ GROUNDED (INCLUDE GEC)
REFER TO STEP 16 FOR RAPID SHUTDOWN DETAILS ☐ 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.

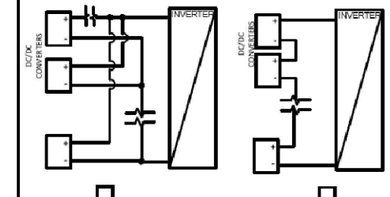


CONDUCTOR/CONDUIT SCHEDULE

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

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

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)

SAMPLE SINGLE LINE DIAGRAM
SCALE:

COMPANY LOGO

SIGNATURE & LICENSE NUMBER

KW RATING OF THE SYSTEM

PROJECT NAME
PROJECT ADRESS
LEGAL DESCRIPTION / ASSESSOR'S PARCEL NUMBER

REVISION	DATE

DRAWN BY:
PROJECT NO.
DATE:

SHEET
PV–3.1A

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)

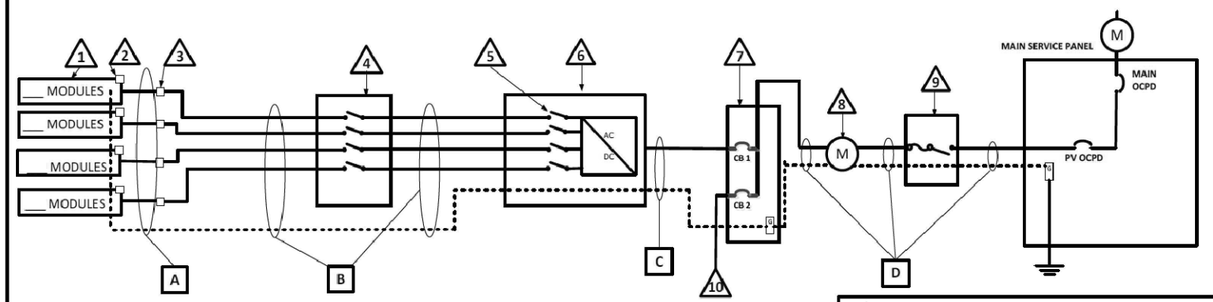
* Consult with your local AHJ and /or Utility

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

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

REFER TO STEP 16 FOR RAPID SHUTDOWN DETAILS

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.

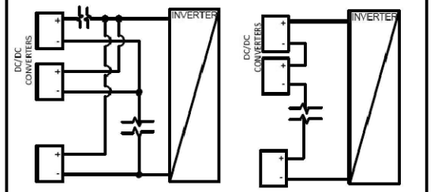


CONDUCTOR/CONDUIT SCHEDULE

☐ TAG	DESCRIPTION AND CONDUCTOR TYPE	CONDUCTOR SIZE	NUMBER OF CONDUCTORS	CONDUIT/CABLE TYPE	CONDUIT SIZE
A	USE-2 ☐ OR PV-WIRE ☐				
	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

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)

General Notes

1. ALL PLAQUES AND SIGNAGE REQUIRED BY THE LATEST EDITION OF CALIFORNIA ELECTRICAL CODE AND THE SAN DIEGO AREA ELECTRICAL NEWSLETTER, WILL BE INSTALLED AS REQUIRED.
2. ALTERNATE POWER SOURCE PLACARD SHALL BE METALLIC OR PLASTIC, ENGRAVED OR MACHINE PRINTED LETTERS IN A CONTRASTNG COLOR TO THE PLAQUE. THIS PLAQUE WILL BE ATTACHED BY POP RIVETS OR SCREWS OR OTHER APPROVED METHOD. IF EXPOSED TO SUNLIGHT, IT SHALL BE UV RESISTANCE.
3. PHOTOVOLTAIC DC CONDUCTORS ENTERING THE BUILDING SHALL BE INSTALLED IN METAL CONDUIT AND THE CONDUIT SHALL BE LABELED, "CAUTION DC CIRCUIT" OR EQUIVALENT EVERY 10 FT."
4. EXPOSED NON-CURRENT CARRYING METAL PARTS OF MODULE FRAMES, EQUIPMENTS, AND CONDUCTOR ENCLOSURES SHALL BE GROUNDED IN ACCORDANCE WITH 250.134 OR 250.136 (A) REGARDLESS OF VOLTAGE.
5. EACH MODULE SHALL BE GROUNDED USING THE SUPPLIED CONNECTION POINT IDENTIFIED ON THE MODULE AND THE MANUFACTURER'S INSTRUCTIONS.
6. IF THE EXISTING GROUNDING ELECTRODE SYSTEM CAN NOT BE VERIFIED OR IS ONLY METALIC WATER PIPING, IT IS THE CONTRACTOR'S RESPONSIBILITY TO INSTALL A SUPPLEMENTAL GROUNDING ELECTRODE.
7. THE INVERTER SHALL BE LISTED AS A UTILITY INTERACTIVE
8. UNIT INSTALLED ON THE SAME BUILDING AS THE MODULES BUT NOT ON THE ROOF.
9. THE INVERTER OUTPUT CIRCUIT CONDUCTORS SHALL TERMINATE WITHIN THE SERVICE PANEL IN ACCORDANCE WITH CEC 690.64(B)(7).
10. BACKFEED BREAKERS IN THE SERVICE PANEL SHALL BE SUITABLE AS SUCH.
11. ALL EQUIPMENT SHALL BE INSTALLED IN ACCORDANCE WITH THE MANUFACTURER'S APPROVED INSTALLATION INSTRUCTIONS. A COPY OF THESE INSTRUCTIONS ARE INCLUDED AS PART OF THIS PLAN.
12. ALL EQUIPMENT AND WIRING SHALL BE LISTED BY NATIONAL RECOGNIZED TESTING AGENCY
13. USE MINIMUM 8 AWG EQUIPMENT GROUNDING CONDUCTOR (EGC) WHEN IT IS SUBJECT TO PHYSICAL DAMAGE, OR INSTALL THE EGC IN AN APPROVED RACEWAY.
14. ALL WIRING SHALL BE OF COPPER MATERIAL, AND KEPT OUTSIDE OF THE BUILDING.
15. ALL ELECTRICAL EQUIPMENT INCLUDING THE SERVICE SHALL HAVE A LEGIBLE, VISIBLE, AND DURABLE MARKING INDICATING THE MANUFACTURER NAME, CURRENT, VOLTAGE, FREQUENCY, AND NUMBER OF PHASES.
16. EACH INSTALLED EQUIPMENT, WIRING AND OVERCURRENT PROTECTIVE DEVICE (OCPD) SHALL HAVE A SHORT CIRCUIT RATING NOT LESS THAN THE AVAILABLE SHORT CIRCUIT CURRENT AT THEIR INPUT TERMINALS.
17. THE INVERTER SHALL COMPLY ACCORDANCE WITH CEC 690.11.

SAMPLE SINGLE LINE DIAGRAM
SCALE:

SCOPE: Use this plan ONLY for electrical review of utility-interactive central/string inverter systems not exceeding a combined system AC inverter output of 10kW on the roof of a single or duplex family dwelling or accessory building. The specific structural and fire requirements are covered under a separate permit. The photovoltaic system must interconnect to the load side of a single-phase AC service panel of 240Vac or less with a busbar rating of 225A or less. This plan is not intended for bipolar systems, hybrid systems or systems that utilize storage batteries, charge controllers, trackers, ac modules, more than two inverters or more than one DC combiner (non-inverter-integrated) per inverter. Systems must be in compliance with current California Building Standards Codes and all applicable STOCKTON Codes. Other Articles of the California Electrical Code (CEC) shall apply as specified in 690.3.

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)).

COMPANY LOGO

SIGNATURE & LICENSE NUMBER

KW RATING OF THE SYSTEM

PROJECT NAME

PROJECT ADRESS

LEGAL DESCRIPTION / ASSESSOR'S PARCEL NUMBER

REVISION	DATE

DRAWN BY:

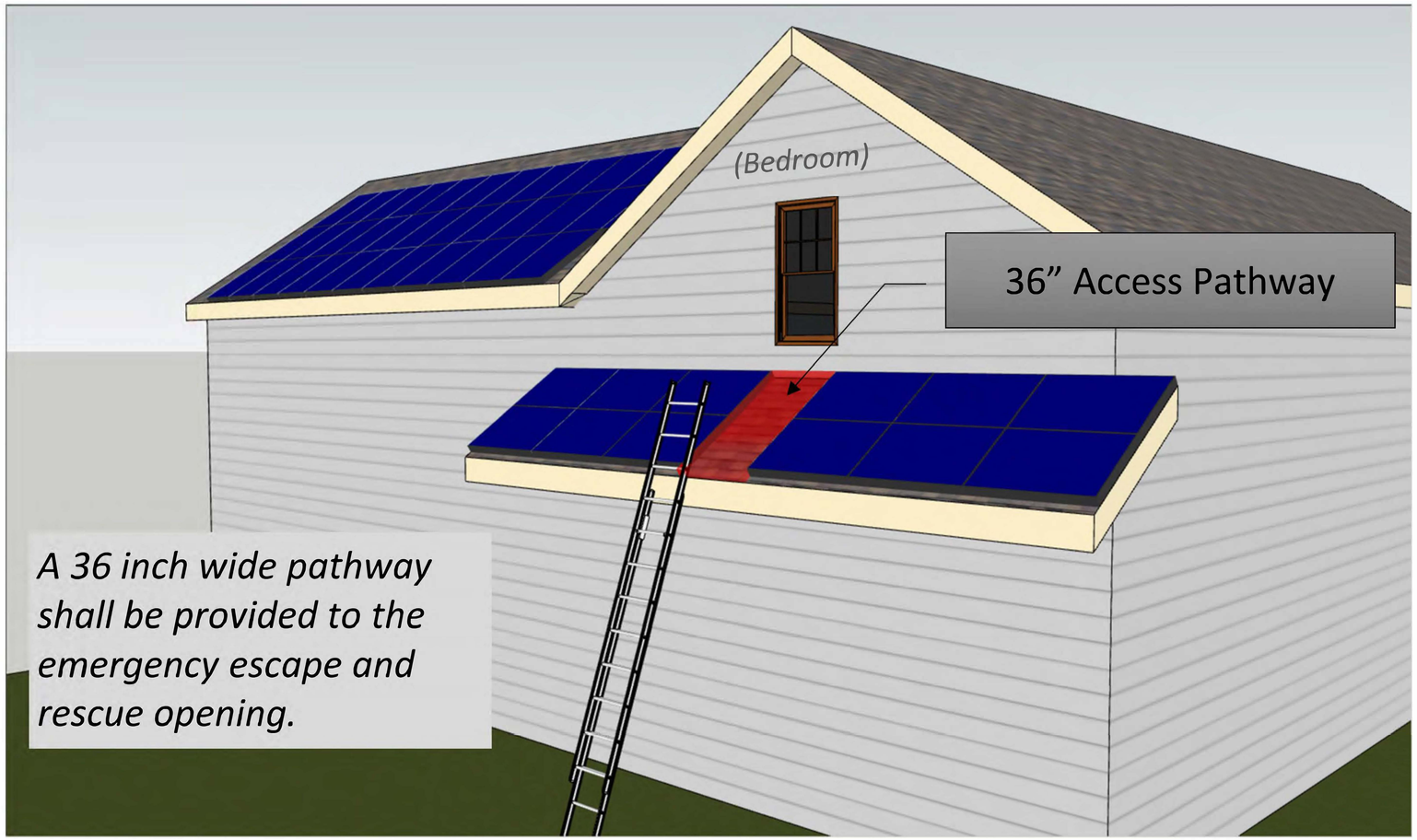
PROJECT NO.

DATE:

SHEET

PV–3.2A

Emergency Escape and Rescue Opening Access



EMERGENCY ESCAPE & RESCUE OPENING
SCALE:

COMPANY LOGO

SIGNATURE & LICENSE NUMBER

KW RATING OF THE SYSTEM

PROJECT NAME

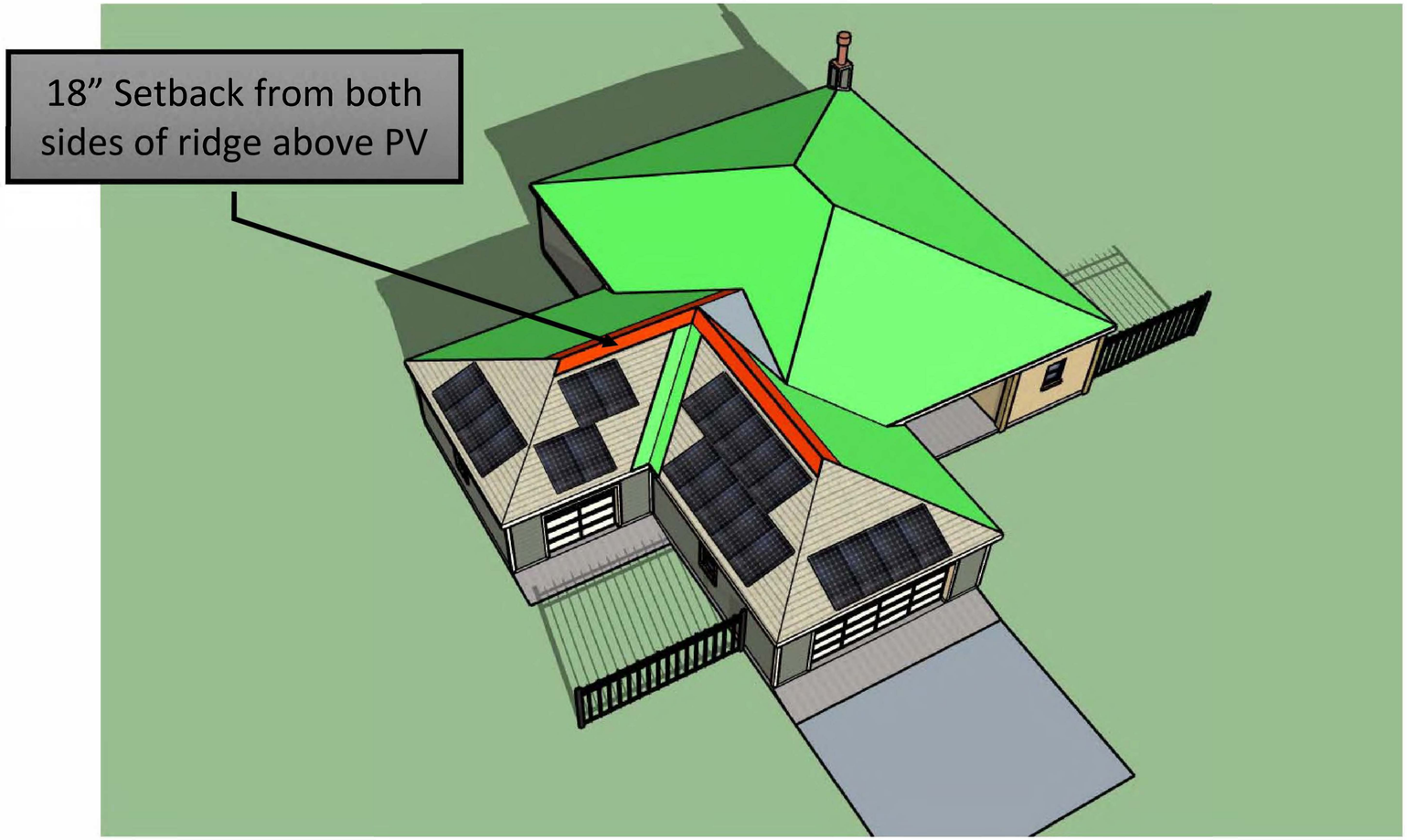
PROJECT ADRESS

LEGAL DESCRIPTION / ASSESSOR'S PARCEL NUMBER

REVISION	DATE

DRAWN BY:
PROJECT NO.
DATE:
SHEET
PV–4.1

Ridge Setbacks – <33% Total Roof Area



COMPANY LOGO

SIGNATURE & LICENSE NUMBER

KW RATING OF THE SYSTEM

PROJECT NAME

PROJECT ADRESS

LEGAL DESCRIPTION / ASSESSOR'S PARCEL NUMBER

REVISION	DATE

DRAWN BY:

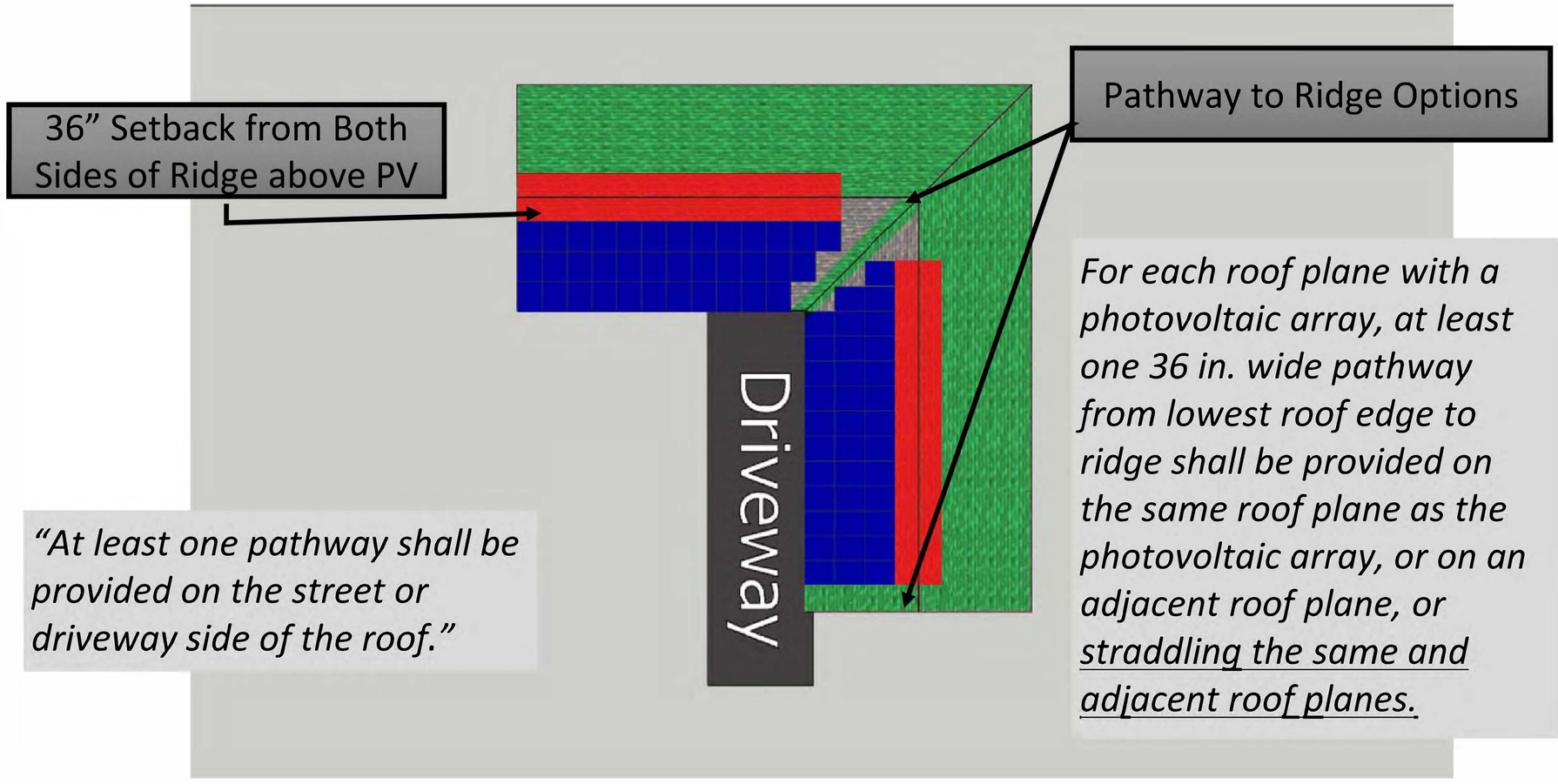
PROJECT NO.

DATE:

SHEET

PV–4.1

Setbacks & Pathways w/ Hips, Valleys & Driveways



CROSS GABLE WITH HIP & VALLEY ROOF
SCALE:

COMPANY LOGO

SIGNATURE & LICENSE NUMBER

KW RATING OF THE SYSTEM

PROJECT NAME
PROJECT ADRESS
LEGAL DESCRIPTION / ASSESSOR'S PARCEL NUMBER

REVISION	DATE

DRAWN BY:
PROJECT NO.
DATE:
SHEET
PV–4

SOLAR PV STANDARD PLAN - SIMPLIFIED

Central/String Inverter Systems for One and Two Family Dwellings

SCOPE: Use this plan ONLY for electrical review of utility-interactive central/string inverter systems not exceeding a combined system AC inverter output of 10kW on the roof of a single or duplex family dwelling or accessory building. The specific structural and fire requirements are covered under a separate permit. The photovoltaic system must interconnect to the load side of a single-phase AC service panel of 240Vac or less with a busbar rating of 225A or less. This plan is not intended for bipolar systems, hybrid systems or systems that utilize storage batteries, charge controllers, trackers, ac modules, more than two inverters or more than one DC combiner (non-inverter-integrated) per inverter. Systems must be in compliance with current California Building Standards Codes and all applicable San Diego Codes. Other Articles of the California Electrical Code (CEC) shall apply as specified in 690.3.

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" starting on page 8 & "Load Center Calculations" on page 13 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**

Site Conditions:

Ambient Temperature Adjustment Factors: select the box for the expected lowest ambient temperature (T_L) with the corresponding Ambient Temperature Correction Factor (C_F):

1) ☐ If T_L is greater than or equal to -5°C, C_F = 1.12
☐ If T_L is between -6°C and -10°C, C_F = 1.14
Average ambient high temperature (T_H) ≤ 47° C
Note: For a lower T_L or a higher T_H, this plan is not applicable.

DC Information:

Module Manufacturer: ______________________ **Model:** ______________
2) Module V_{OC} (from module nameplate): ____Volts
3) Module I_{SC} (from module nameplate): ____ Amps **Is Module I_{SC} below 9.6 Amps? ☐Yes ☐ No (If No, this plan is not applicable.)**
4) Module DC output power under standard test conditions (STC) = ________ Watts (STC)

SOLAR PV STANDARD PLAN - SIMPLIFIED

Central/String Inverter Systems for One and Two Family Dwellings

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:		

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**
Max DC Output Current: ______________ **Amps** | **DC Output Current:** ________________ **Volts DC/DC**
Max # of DC/DC Converters in an Input Circuit: ______ | **Converter Max DC Input Power:** _______ **Watts**

7) Maximum System DC Voltage
Use for systems without DC/DC converters.

A. Module V_{OC} (STEP 2) ________x # of modules in series (STEP 5) ______x C_F (STEP 1) ________ = ____V

Table 1. Maximum Number of PV Modules in Series Based on Module Rated V_{OC} for 600Vdc Rated Equipment (CEC 690.7)

Max. Rated Module V_{OC} if C_F = 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} if C_F = 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 systems with DC/DC converters. The value calculated below must be less than DC/DC converter max DC input voltage (STEP 6).

B. Module V_{OC} (STEP 2) ______ x # of modules per converter (STEP 6) ____x C_F (STEP 1) ________ = ____V

Table 2. Largest Module V_{OC} for Single-Module DC/DC Converter Configurations (With 80V AFCI Cap) (CEC 690.7 and 690.11)

Max. Rated Module V_{OC} if C_F = 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} if C_F = 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: For over 8 conductors in the conduit or mounting height of lower than ½" from the roof, this plan is not applicable.

SOLAR PV STANDARD PLAN - SIMPLIFIED

Central/String Inverter Systems for One and Two Family Dwellings

10) Are PV source circuits combined prior to the inverter? ☐ Yes ☐ No
If No, use Single Line Diagram 1 and proceed to Step 12.
If Yes, use Single Line Diagram 2 and proceed to Step 11 after this step.
Is source circuit OCPD required? ☐ Yes ☐ No
Source circuit OCPD size (if needed): 15 Amps
Are the source circuits combined on the roof? ☐ Yes ☐ No
If "Yes," the DC output of the combiner shall have a load break disconnecting means located in the combiner or within 1.8m (6ft) of the combiner (CEC 690.15(C)).

11) Sizing PV Output Circuit Conductors — If strings are combined (answered "Yes" in Step 10), Output Circuit Conductor Size = Min. #6 AWG copper conductor.

12) Inverter DC Disconnect
Does the inverter have an integrated DC disconnect? Yes No If Yes, proceed to step 13.
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, this plan is 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 3. Minimum Inverter Output OCPD and Circuit Conductor Size

Inverter Continuous Output Current Rating (Amps) (Step 13)	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

15) Point of Connection to Utility
Note: Only load side connections are permitted with this plan.
Is the PV OCPD positioned at the opposite end from input feeder location or main OCPD location?
☐ Yes, use Table 4, row 3 and circle the Max Combined PV System OCPD(s) at 120% based on the bus bar rating and main OCPD values.
☐ No, use Table 4, row 4 and circle the Max Combined PV System OCPD(s) at 100% based on the bus bar rating and main OCPD values.
Per 705.12(D)(2)(3): The value circled in Table 4 should be equal to or greater than the OCPD value selected from Table 3 (for a single inverter) or the OCPD value from Step S18 (for two inverters).

Table 4. Maximum Combined Supply OCPDs Based on Bus Bar Rating (Amps) per CEC 705.12(D)(2)(3)(b)

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 and/or interconnection to center-fed panelboards are not permitted with this plan.

SOLAR PV STANDARD PLAN - SIMPLIFIED

Central/String Inverter Systems for One and Two Family Dwellings

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: ______________________

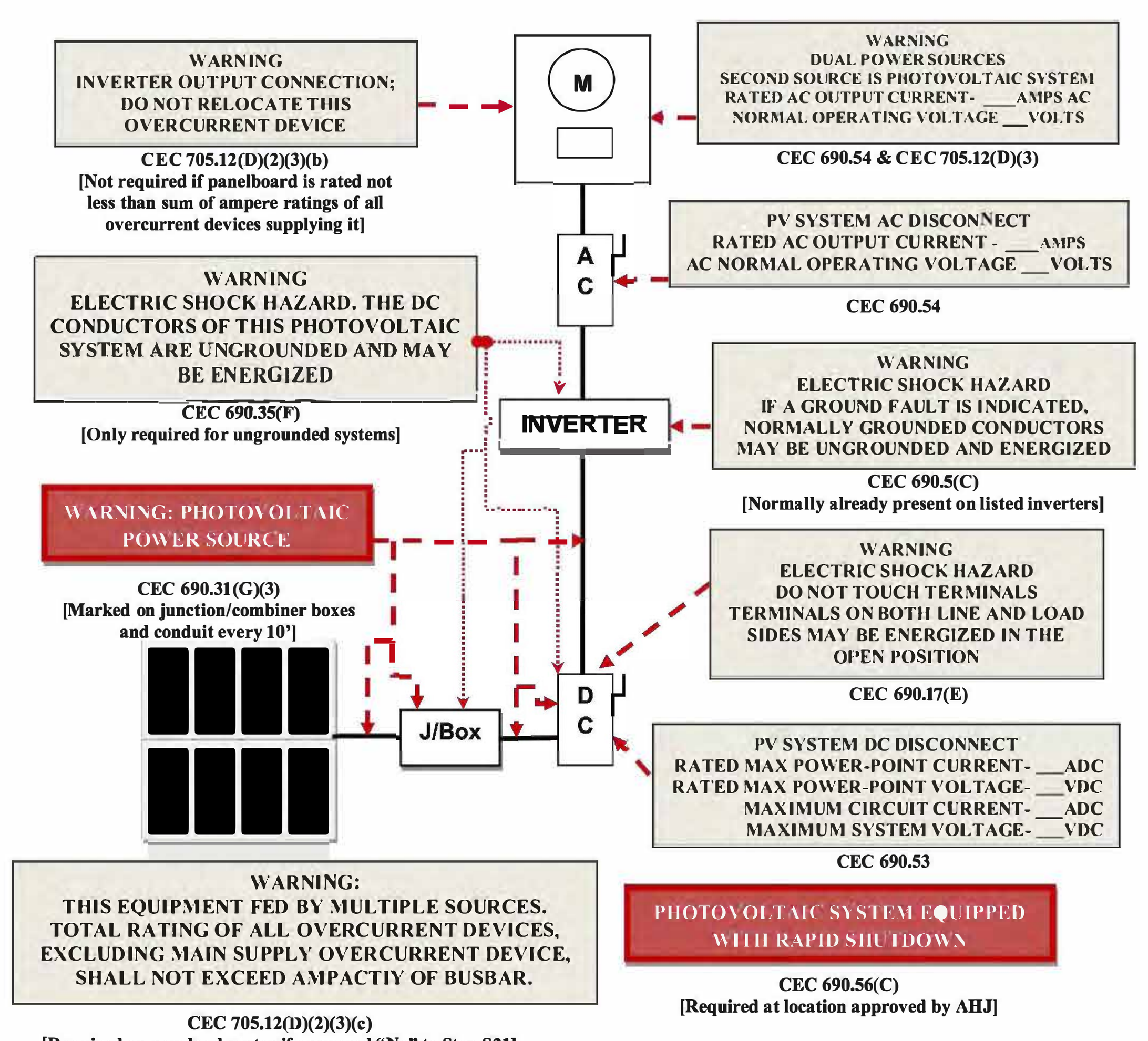
17) Grounding and Bonding of Modules and Racking System (select one):
☐ Racking system listed to UL 2703 using modules identified in the listing.
☐ Other method subject to AHJ approval

SOLAR PV STANDARD PLAN - SIMPLIFIED

Central/String Inverter Systems for One and Two Family Dwellings

Markings

CA Electrical Code (CEC) Articles 690 and 705 and CA Residential Code (CRC) Section R331 require the following labels or markings be installed at these components of the photovoltaic system:



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 and the rapid shutdown initiation device.

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 Is Module I_{SC} below 9.6 Amps? ☐Yes ☐ No (If No, this plan is not applicable.)
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? ☐Yes ☐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
Max DC Output Current: ______________ Amps | Current: ______________ Volts DC/DC Converter Max DC Input
Max # of DC/DC Converters in an Input Circuit: ________ | Power: ______ Watts

SOLAR PV STANDARD PLAN - SIMPLIFIED

Central/String Inverter Systems for One and Two Family Dwellings

S7) Maximum System DC Voltage

Use for systems without DC/DC converters.

A. Module V_{OC} (STEP S2) = __________x # of modules in series (STEP S5) ______x C_F (STEP 1) ________ = __________V

Table S1. Maximum Number of PV Modules in Series Based on Module Rated V_{OC} for 600Vdc 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	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 systems with DC/DC converters. The value calculated below must be less than DC/DC converter max DC input voltage (STEP 6).

B. Module V_{OC} (STEP S2) = ________x # of modules per converter (STEP S6) ______x C_F (STEP 1) ________ = __________V

Table S2. Largest Module V_{OC} for Single-Module DC/DC Converter Configurations (With 80V 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

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

S9) 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, this plan is not applicable.

S10) Are PV source circuits combined prior to the inverter? ☐Yes No
If No, use Single Line Diagram 1 with Single Line Diagram 3 and proceed to Step S12.
If Yes, use Single Line Diagram 2 with Single Line Diagram 4 and proceed to Step S11 after this step.
Is source circuit OCPD required? ☐ Yes ☐ No
Source circuit OCPD size (if needed): 15 Amps
Are the source circuits combined on the roof? ☐Yes ☐ No
If "Yes," the DC output of the combiner shall have a load breaker disconnecting means located in the combiner or within 1.8m (6ft) of the combiner.

S11) Sizing PV Output Circuit Conductors — If strings are combined (answered "Yes" in Step S10), Output Circuit Conductor Size = Min. #6 AWG copper conductor.

S12) Inverter DC Disconnect
Does the inverter have an integrated DC disconnect? ☐Yes ☐No If Yes, proceed to Step S13.
If No, the external DC disconnect to be installed is rated for ______Amps (DC) and _______ Volts (DC)

SOLAR PV STANDARD PLAN - SIMPLIFIED

Central/String Inverter Systems for One and Two Family Dwellings

S13) Inverter Information
Manufacturer: ______________ Model: ______________
Max. Continuous AC Output Current Rating: __________Amps
Integrated DC Arc-Fault Circuit Protection? ☐ Yes ☐ No (If No is selected, this plan is not applicable.)
Grounded or Ungrounded System? ☐Grounded ☐ Ungrounded

AC Information:

S14) Sizing Inverter Output Circuit Conductors and OCPD
Inverter Output OCPD rating = _________Amps (Table 3)
Inverter Output Circuit Conductor Size = __________AWG (Table 3)

Table S3. 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)

S18) Load Center Output:
Calculate the sum of the maximum AC outputs from each inverter.
Inverter #1 Max Continuous AC Output Current Rating [STEP S13] __________ × 1.25 = ______ Amps
Inverter #2 Max Continuous AC Output Current Rating [STEP S13] __________ × 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
Can the load center accept more than two breakers? Yes ☐ No ☐

If Yes, the sum of 125% of the inverter output circuit currents and the rating of the overcurrent device protecting the busbar shall not exceed 120% of the ampacity of the busbar.
If No, the sum of ampere rating of the two PV overcurrent devices shall not exceed the rating of the busbar.

SAMPLE STRING INVERTER CALCULATION

COMPANY LOGO

SIGNATURE & LICENSE NUMBER

KW RATING OF THE SYSTEM

PROJECT NAME

PROJECT ADRESS

LEGAL DESCRIPTION / ASSESSOR'S PARCEL NUMBER

REVISION	DATE

DRAWN BY:
PROJECT NO.
DATE:
SHEET

PV-5A

SOLAR PV MICROINVERTER/ACM STANDARD PLAN - COMPREHENSIVE

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

SCOPE: Use this plan ONLY for systems using utility-interactive Microinverters or AC Modules (ACM) not exceeding a combined system ac inverter output rating of 10 kW on a roof of a one or two family dwelling or accessory structure. The photovoltaic system must interconnect to a single-phase ac service panel of 120/240 Vac with service panel busbar rating of 225 A or less. This plan is not intended for bipolar systems, hybrid systems, or systems that utilize storage batteries, charge controllers, or tracker or more than 4 branch circuits. 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 section 690.3.

MANUFACTURER'S SPECIFICATION SHEETS MUST BE PROVIDED for proposed inverters, 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)).

Applicant and Site Information

Job Address: _____ **Permit #:** _____

Contractor/ Engineer Name: _____ **License # and Class:** _____

Signature: _____ **Date:** _____ **Phone Number:** _____

1 General Requirements and System Information

□ **Microinverter**
Number of PV modules installed: _____
Number of Microinverters installed: _____

□ **AC Module (ACM)**
Number of ACM's installed: _____
Note: Listed Alternating-Current Module [ACM] is defined in ***CEC 690.2*** *and installed per* ***CEC 690.6***

Number of Branch Circuits, 1, 2, 3, or 4: _____
Total ac system power rating = (Number of Microinverters or ACMs) * (ac inverter power output) = _____ **Watts**

1.1 **Lowest expected ambient temperature for the location: (T_L) =** _____ **°C**

1.2 **Average ambient high temperature for the location: (T_H) =** _____ **°C**

Provide the name of the source used to determine T_L and T_H: _____

2 Microinverter or ACM Information and Ratings

Microinverters with ungrounded dc inputs shall be installed in accordance with CEC 690.35.
Microinverter or ACM Manufacturer: _____
Model: _____

2.1 **Rated (continuous) ac output power:** _____ **Watts**

2.2 **Nominal ac Voltage Rating:** _____ **Volts**

2.3 **Rated (continuous) ac output current:** _____ **Amps**

If installing ACMs, skip [STEPS 2.4 and 2.5)

2.4 **Maximum dc Input Voltage Rating:** _____ **Volts**

2.5 **Maximum dc Input Current Rating:** _____ **Amps**

2.6 **Maximum dc Input Short Circuit Current Rating:** _____ **Amps (if provided by manufacturer)**

3 PV Module Information

(If installing ACMs, skip to [STEP 6])

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**

4 PV Module Maximum DC Voltage

(If installing ACMs, skip to [STEP 6])

Maximum dc voltage shall not exceed inverter manufacturer's maximum input voltage rating **[STEP 2.4]** _____ Volts. If the open-circuit voltage (V_{OC} from **[STEP 3.1]**) temperature coefficients (β or ε) are provided by the module manufacturer, use the calculation in **Method 1.** If V_{OC} temperature coefficient is not provided by the module manufacturer, use the calculation in **Method 2**.

4.1 **Method 1:**
V_{OC} temperature coefficient (β)= _____ **%/°C**
Max number of modules per inverter _____ **× {V_{OC} + [(T_L-25) × (β × V_{OC})/100)] =** _____ **Volts**

If module manufacturer provides a voltage temperature coefficient (ε) in mV/°C, use the formula below.
V_{OC} temperature coefficient (ε)= _____ **mV/°C**
Max number of modules per inverter _____ **× {V_{OC} + [(T_L-25) × (ε/1000)]} =** _____ **Volts**

4.2 **Method 2:**
Maximum number of modules per inverter _____ **x V_{OC}** _____ **x K_T =** _____ **Volts,**
Where K_T= _____ is a correction factor for ambient temperatures below 25 °C. See **Table 690.7**.

Verify the Low Temperature V_{OC} is less than the Microinverter maximum input voltage from **[STEP 2.4]**: □ Yes □ No

5 PV Short Circuit Current

(If installing ACMs, skip to [STEP 6])

5.1 **Calculate the Maximum Short Circuit Current for the PV module**
Adjust the PV current for peak sunlight (x 1.25) and compare it to the microinverter Maximum dc Input Short Circuit Current Rating. (If Max dc Input Short Circuit Current rating is not provided by manufacturer, use 1.5 x Max dc Input rating (per UL 1741)):

5.1.1 Maximum Short Circuit Current = (PV Short Circuit Current, I_{SC}, from **[STEP 3.2]**) * 1.25 = _____ Amps

5.1.2 Verify Maximum Short Circuit Current **[STEP 5.1.1]** is equal to or less than the Maximum dc Input Short Circuit Current **[STEP 2.6]** = _____ Amps or the Maximum dc Input Current **[STEP 2.5]** * 1.5 = _____ Amps

6 Branch and Combined Inverter Output Circuit Information and Calculations

Fill in **[Table 1]** to describe the Branch and Combined System circuits.

Circuit Power = (Number of Microinverters or ACMs) * (Rated ac output power **[STEP 2.1]**) = _____ Watts
Circuit Current = (Circuit Power) / (Nominal ac voltage **[STEP 2.2]**)) = _____ Amps

Table 1 - OCPD and Ampacity Current Calculations

	Branch 1	Branch 2	Branch 3	Branch 4	Combined Inverter Output Circuit
Number of Microinverters or ACMs					
AC Power for each unit **[STEP 2.1]**, Watts					
Circuit Power, Watts					
Nominal ac Voltage **[STEP 2.2]**, Volts					
Circuit Current, Amps					

7 Sizing Branch and Combined Inverter Output Circuit Conductors

Calculate the current using both **Method A [STEP 7.1]** and **Method B [STEP 7.2]** for each Branch and the Combined Inverter Output Circuit from **[Table 1]**. Enter the results in **[Table 2]**.

7.1 **Method A:**

7.1.1 **Each Branch Circuit Current, Method A**
(Number Microinverters/ACMs) * (AC power **[STEP 2.1]**) / (Nominal ac voltage **[STEP 2.2]**) x 1.25 = _____ Amps

7.1.2 **Combined Inverter Output Circuit Current, Method A**
(Total Number Microinverters/ACMs) * (AC power **[STEP 2.1]**) / (Nominal ac voltage **[STEP 2.2]**) x 1.25 = _____ Amps

7.2 **Method B:**
Number of current-carrying branch and combined output circuit conductors in each raceway: _____.
Each Raceway height above the roof: _____ **inches (if not applicable indicate N/A)**
The correction factors for each raceway:
C_R = _____ C_R is the conduit fill coefficient found by referencing **Table 310.15(B)(3)(a)**
C_T = _____ C_T is a coefficient dependent on the highest continuous ambient temperature and raceway height above roof (if applicable) and is found by referencing **Table 310.15(B)(3)(c)** and **Table 310.15(B)(2)(a).**

7.2.1 **Each Branch Circuit Current, Method B**
(Number Microinverters/ACMs) * (AC power **[STEP 2.1]**) / (Nominal ac voltage **[STEP 2.2]**) / (C_R x C_T) = _____ Amps

7.2.2 **Combined Inverter Output Circuit Current, Method B**
(Total Number Microinverters/ACMs) * (AC power **[STEP 2.1]**) / (Nominal ac voltage **[STEP 2.2]**) / (C_R x C_T) = _____ Amps

7.3 **Determine Conductor Size**
Using the greater ampacity as calculated in **Method A** or **Method B**, use **Table 310.15(B)(16)** to identify the ac circuit conductor size. The conductor ampacity shall not exceed the ampacity of chosen conductor rated at the lowest temperature rating of any connected termination, conductor, or device (typically 60°C or 75°C).

Table 2 – Branch and Combined Circuit Currents, Correction Factors, and Conductor Sizes

	Branch 1	Branch 2	Branch 3	Branch 4	Combined Inverter Output Circuit
7.1 Method A: Branch and Combined Circuit Current					
7.2 Method B: Number of current carrying conductors for Branch and Combined Circuit Current					
7.2 Method B: Raceway height above the roof					
7.2 Method B: C_R					
7.2 Method B: C_T					
7.2 Method B: Branch and Combined Circuit Current					
Minimum Conductor Size, AWG					

8 Branch and Combined Inverter Output Circuit OCPD Size

Determine the OCPD size for each Branch Circuit and for the Combined Inverter Output Circuit. Use **CEC 690.8(B)(1)** to determine the OCPD size. Calculate the circuit current for each branch circuit. Enter the results in **[Table 3]**.

8.1.1 **Each Branch Circuit Current for OCPD Sizing**
(Number Microinverters/ACMs) * (AC power **[STEP 2.1]**) / (Nominal ac voltage **[STEP 2.2]**) x 1.25 = _____ Amps

8.1.2 **Combined Inverter Output Circuit for OCPD Sizing**
(Total Number Microinverters/ACMs) * (AC power **[STEP 2.1]**) / (Nominal ac voltage **[STEP 2.2]**) x 1.25 = _____ Amps

Size the inverter output OCPD based on the value calculated above. Where the figure is between two standard values of fuse/breaker sizes (see **CEC 240.6(A)**), the next higher size may be used provided the conductors are sufficiently sized. The OCPD's rating may not exceed the conductor ampacity or the inverter manufacturer's max OCPD rating for the inverter.

Where supplementary grounding electrodes are installed, a bonding jumper to the existing grounding electrode must be installed. Bonding jumpers must be sized to the larger grounding conductor that it is bonded to, 250.58

11.2 **Grounded Systems:**
The dc **grounding electrode conductor (GEC)** from the inverter terminal must be unbroken or irreversibly spliced and sized minimum **#8** AWG copper per article 250.166. The **dc** GEC from the inverter terminal to the existing grounding electrode system must tie to the existing grounding electrode or be bonded to the existing ac GEC using an irreversible means, per 250.64(C)(**1**).

A combined dc GEC and ac EGC may be run from the inverter dc grounding terminal to the grounding busbar in the associated ac equipment. This combined grounding conductor must be sized to the larger of the GEC and EGC sizes, with the bonding requirements of EGCs and remaining continuous as a GEC, per 690.47(C)(3).

11.3 **Ungrounded Systems:**
A dc GEC shall not be required from the inverter **dc** grounding terminal to the building grounding electrode system. The EGC shall run from the inverter to the grounding busbar in the associated ac equipment, sized per 690.45, using Table 250.122. Ungrounded conductors must be identified per 210.5(C). White-finished conductors are not permitted.

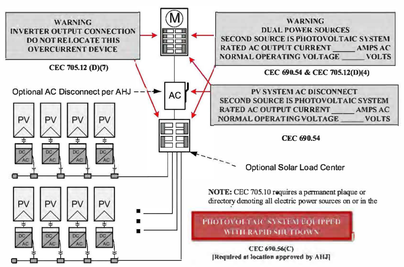
12 Markings

Per Section **CEC 690.54**, a permanent label shall be installed at an accessible location at the PV ac disconnecting means that shall indicate the following:

12.1 Rated ac Output current (total Combined System Current from **[Table 1]**) _____ Amps

12.2 Nominal Operating ac Voltage **[STEP 2.2]**_____ Volts

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



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.

Table 3 - Branch and Combined Inverter Output Circuit OCPD Sizing

	Branch 1	Branch 2	Branch 3	Branch 4	Combined Inverter Output Circuit
Branch and Inverter Output OCPD, Amps					

9 Solar Load Center

The sum of the ampere ratings of overcurrent devices in circuits supplying power to a busbar or conductor shall not exceed 120 percent of the rating of the busbar or conductor **[CEC 705.12(D)(2)]**.

9.1 Solar Load center busbar rating: _____ Amps

9.2 Using **[Table 3]**, (Sum of all inverter output Branch OCPDs) _____ Amps + (Combined Systems OCPD) _____ Amps = _____ Amps ≤ 120% of **[STEP 9.1]** Amps.

10 Point of Connection to Utility:

One of the following methods of interconnection must be utilized.

10.1 **Supply Side Connection: □ Yes □ No**
Check with your local jurisdiction to determine if this connection is allowed.

Supply side connections shall only be permitted where the service panel is listed for the purpose. The sum of the ratings of all overcurrent devices connected to power production sources shall not exceed the rating of the service. The connection shall not compromise listing or integrity of any equipment.

10.2 **Load Side Connection: □ Yes □ No**
Is the PV OCPD positioned at the opposite end from input feeder location or main OCPD location? □ Yes □ No

If No to the statement above, the sum of OCPD(s) supplying the panel cannot exceed 100% of the bus circle 100% as the multiplier in calculation. Otherwise, circle 120% and use that as the multiplier.

Per **705.12(D)(2)**: [Inverter output OCPD size **[Table 3]** + Main OCPD Size] ≤ [Bus size x (100% or 120%)]

Table 4 - Maximum Combined Inverter Output Circuit OCPD, CEC 705.12(D)(2)

Busbar 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 busbar rating (Amps)	20	50	25	60†	60†	40	60†	60†	45
Maximum Combined Inverter OCPD with 100% of busbar 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. If the main breaker is reduced, a load calculation per Article 220 must accompany the Standard Plans to show that the reduction is allowed.

All upstream panelboard busbar ratings must also comply with **CEC 705.12(D)(2)**.

11 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).

11.1 **All Systems:**
Modules and racking must be bonded by a method listed to the respective UL standard and recognized by the respective equipment manufacturers. Bonding method is subject to AHJ approval. DC and ac **equipment grounding conductor (EGC)** shall be sized based on source and output circuit conductors per 690.45 using Table 250.122. Where exposed to physical damage, it is required to be #6 AWG copper per 690.46. A dc EGC is required for both grounded and ungrounded systems. If an existing premises grounding electrode system is not present, a new grounding electrode system must be established per 250.53.

SAMPLE MICRO INVERTER CALCULATION

COMPANY LOGO

SIGNATURE & LICENSE NUMBER

KW RATING OF THE SYSTEM

PROJECT NAME
PROJECT ADRESS
LEGAL DESCRIPTION / ASSESSOR'S PARCEL NUMBER

REVISION	DATE

DRAWN BY:
PROJECT NO.
DATE:
SHEET
PV-5B

SOLAR PV STANDARD PLAN - SIMPLIFIED

Central/String Inverter Systems for One and Two Family Dwellings

SCOPE: Use this plan ONLY for electrical review of utility-interactive central/string inverter systems not exceeding a combined system AC inverter output of 10kW on the roof of a single or duplex family dwelling or accessory building. The specific structural and fire requirements are covered under a separate permit. The photovoltaic system must interconnect to the load side of a single-phase AC service panel of 240Vac or less with a busbar rating of 225A or less. This plan is not intended for bipolar systems, hybrid systems or systems that utilize storage batteries, charge controllers, trackers, ac modules, more than two inverters or more than one DC combiner (non-inverter-integrated) per inverter. Systems must be in compliance with current California Building Standards Codes and all applicable San Diego Codes. Other Articles of the California Electrical Code (CEC) shall apply as specified in 690.3.

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" starting on page 8 & "Load Center Calculations" on page 13 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

Site Conditions:

Ambient Temperature Adjustment Factors: select the box for the expected lowest ambient temperature (T_L) with the corresponding Ambient Temperature Correction Factor (C_F):

1) ☐ If T_L is greater than or equal to -5°C, C_F = 1.12
☐ If T_L is between -6°C and -10°C, C_F = 1.14
Average ambient high temperature (T_H) ≤ 47° C
Note: For a lower T_L or a higher T_H, this plan is not applicable.

DC Information:

Module Manufacturer: ______________________ Model: ______________________

2) Module V_{OC} (from module nameplate): ____Volts

3) Module I_{SC} (from module nameplate): ____ Amps
Is Module I_{SC} below 9.6 Amps? ☐Yes ☐No (If No, this plan is not applicable.)

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

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SOLAR PV STANDARD PLAN - SIMPLIFIED

Central/String Inverter Systems for One and Two Family Dwellings

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:		

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**
Max DC Output Current: ______________ Amps — **DC Output Current: ______________ Volts DC/DC**
Max # of DC/DC Converters in an Input Circuit: ______ — **Converter Max DC Input Power: _______ Watts**

7) Maximum System DC Voltage
Use for systems without DC/DC converters.

A. Module V_{OC} (STEP 2) ________x # of modules in series (STEP 5) ______x C_F (STEP 1) ________ = ____V

Table 1. Maximum Number of PV Modules in Series Based on Module Rated V_{OC} for 600Vdc Rated Equipment (CEC 690.7)

Max. Rated Module V_{OC} if C_F = 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} if C_F = 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 systems with DC/DC converters. The value calculated below must be less than DC/DC converter max DC input voltage (STEP 6).

B. Module V_{OC} (STEP 2) ______ x # of modules per converter (STEP 6) ____x C_F (STEP 1) ________ = ____V

Table 2. Largest Module V_{OC} for Single-Module DC/DC Converter Configurations (With 80V AFCI Cap) (CEC 690.7 and 690.11)

Max. Rated Module V_{OC} if C_F = 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} if C_F = 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: For over 8 conductors in the conduit or mounting height of lower than ½" from the roof, this plan is not applicable.

2

SOLAR PV STANDARD PLAN - SIMPLIFIED

Central/String Inverter Systems for One and Two Family Dwellings

10) Are PV source circuits combined prior to the inverter? ☐ Yes ☐ No
If No, use Single Line Diagram 1 and proceed to Step 12.
If Yes, use Single Line Diagram 2 and proceed to Step 11 after this step.
Is source circuit OCPD required? ☐ Yes ☐ No
Source circuit OCPD size (if needed): 15 Amps
Are the source circuits combined on the roof? ☐ Yes ☐ No
If "Yes," the DC output of the combiner shall have a load break disconnecting means located in the combiner or within 1.8m (6ft) of the combiner (CEC 690.15(C)).

11) Sizing PV Output Circuit Conductors — If strings are combined (answered "Yes" in Step 10), Output Circuit Conductor Size = Min. #6 AWG copper conductor.

12) Inverter DC Disconnect
Does the inverter have an integrated DC disconnect? Yes No If Yes, proceed to step 13.
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, this plan is 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 3. Minimum Inverter Output OCPD and Circuit Conductor Size

Inverter Continuous Output Current Rating (Amps) (Step 13)	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

15) Point of Connection to Utility
Note: Only load side connections are permitted with this plan.
Is the PV OCPD positioned at the opposite end from input feeder location or main OCPD location?
☐ Yes, use Table 4, row 3 and circle the Max Combined PV System OCPD(s) at 120% based on the bus bar rating and main OCPD values.
☐ No, use Table 4, row 4 and circle the Max Combined PV System OCPD(s) at 100% based on the bus bar rating and main OCPD values.
Per 705.12(D)(2)(3): The value circled in Table 4 should be equal to or greater than the OCPD value selected from Table 3 (for a single inverter) or the OCPD value from Step S18 (for two inverters).

Table 4. Maximum Combined Supply OCPDs Based on Bus Bar Rating (Amps) per CEC 705.12(D)(2)(3)(b)

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 and/or interconnection to center-fed panelboards are not permitted with this plan.

3

SOLAR PV STANDARD PLAN - SIMPLIFIED

Central/String Inverter Systems for One and Two Family Dwellings

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 AHJ approval

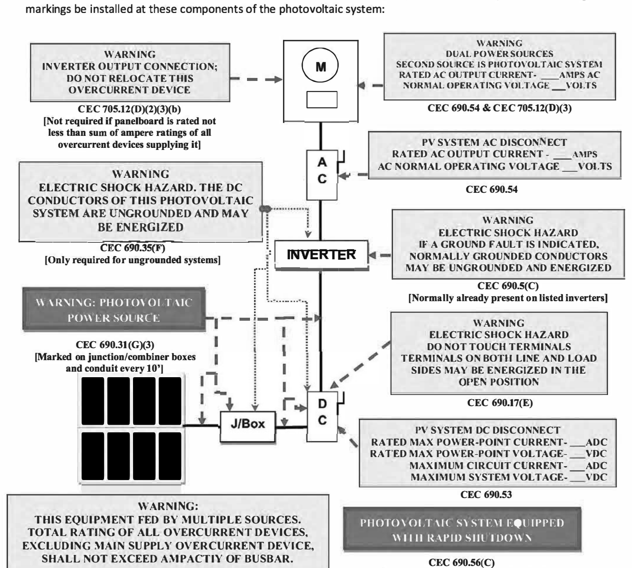
4

SOLAR PV STANDARD PLAN - SIMPLIFIED

Central/String Inverter Systems for One and Two Family Dwellings

Markings

CA Electrical Code (CEC) Articles 690 and 705 and CA Residential Code (CRC) Section R331 require the following labels or markings be installed at these components of the photovoltaic system:



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 and the rapid shutdown initiation device.

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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
Is Module I_{SC} below 9.6 Amps? ☐Yes ☐No (If No, this plan is not applicable.)

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? ☐Yes ☐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
Max DC Output Current: ______________ Amps — Current: ______________ Volts DC/DC Converter Max DC Input
Max # of DC/DC Converters in an Input Circuit: ______ — Power: _______ Watts

8

SOLAR PV STANDARD PLAN - SIMPLIFIED

Central/String Inverter Systems for One and Two Family Dwellings

S7) Maximum System DC Voltage

Use for systems without DC/DC converters.

A. Module V_{OC} (STEP S2) = __________x # of modules in series (STEP S5) ______x C_F (STEP 1) ________ = ____________V

Table S1. Maximum Number of PV Modules in Series Based on Module Rated V_{OC} for 600Vdc 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	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 systems with DC/DC converters. The value calculated below must be less than DC/DC converter max DC input voltage (STEP 6).

B. Module V_{OC} (STEP S2) = ________x # of modules per converter (STEP S6) ______x C_F (STEP 1) ________ = ____________V

Table S2. Largest Module V_{OC} for Single-Module DC/DC Converter Configurations (With 80V 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

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

S9) 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, this plan is not applicable.

S10) Are PV source circuits combined prior to the inverter? ☐Yes No
If No, use Single Line Diagram 1 with Single Line Diagram 3 and proceed to Step S12.
If Yes, use Single Line Diagram 2 with Single Line Diagram 4 and proceed to Step S11 after this step.
Is source circuit OCPD required? ☐ Yes ☐ No
Source circuit OCPD size (if needed): 15 Amps
Are the source circuits combined on the roof? ☐Yes ☐ No
If "Yes," the DC output of the combiner shall have a load breaker disconnecting means located in the combiner or within 1.8m (6ft) of the combiner.

S11) Sizing PV Output Circuit Conductors — If strings are combined (answered "Yes" in Step S10), Output Circuit Conductor Size = Min. #6 AWG copper conductor.

S12) Inverter DC Disconnect
Does the inverter have an integrated DC disconnect? ☐Yes ☐No If Yes, proceed to Step S13.
If No, the external DC disconnect to be installed is rated for ______Amps (DC) and _______ Volts (DC)

9

SOLAR PV STANDARD PLAN - SIMPLIFIED

Central/String Inverter Systems for One and Two Family Dwellings

S13) Inverter Information
Manufacturer: ______________________ Model: ______________________
Max. Continuous AC Output Current Rating: ____________Amps
Integrated DC Arc-Fault Circuit Protection? ☐Yes ☐No (If No is selected, this plan is not applicable.)
Grounded or Ungrounded System? ☐Grounded ☐Ungrounded

AC Information:

S14) Sizing Inverter Output Circuit Conductors and OCPD
Inverter Output OCPD rating = __________Amps (Table 3)
Inverter Output Circuit Conductor Size = ___________AWG (Table 3)

Table S3. 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)

S18) Load Center Output:
Calculate the sum of the maximum AC outputs from each inverter.
Inverter #1 Max Continuous AC Output Current Rating [STEP S13] ___________ × 1.25 = ______ Amps
Inverter #2 Max Continuous AC Output Current Rating [STEP S13] ___________ × 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
Can the load center accept more than two breakers? Yes ☐ No ☐

If Yes, the sum of 125% of the inverter output circuit currents and the rating of the overcurrent device protecting the busbar shall not exceed 120% of the ampacity of the busbar.
If No, the sum of ampere rating of the two PV overcurrent devices shall not exceed the rating of the busbar.

10

SAMPLE STRING INVERTER CALCULATION

COMPANY LOGO

SIGNATURE & LICENSE NUMBER

KW RATING OF THE SYSTEM

PROJECT NAME
PROJECT ADRESS
LEGAL DESCRIPTION / ASSESSOR'S PARCEL NUMBER

REVISION	DATE

DRAWN BY:
PROJECT NO.
DATE:
SHEET
PV-5A

SOLAR PV MICROINVERTER/ACM STANDARD PLAN - COMPREHENSIVE

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

SCOPE: Use this plan ONLY for systems using utility-interactive Microinverters or AC Modules (ACM) not exceeding a combined system ac inverter output rating of 10 kW on a roof of a one or two family dwelling or accessory structure. The photovoltaic system must interconnect to a single-phase ac service panel of 120/240 Vac with service panel busbar rating of 225 A or less. This plan is not intended for bipolar systems, hybrid systems, or systems that utilize storage batteries, charge controllers, or tracker or more than 4 branch circuits. 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 section 690.3.

MANUFACTURER'S SPECIFICATION SHEETS MUST BE PROVIDED for proposed inverters, 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)).

Applicant and Site Information

Job Address: _____ **Permit #:** _____

Contractor/ Engineer Name: _____ **License # and Class:** _____

Signature: _____ **Date:** _____ **Phone Number:** _____

1 General Requirements and System Information

□ **Microinverter** □ **AC Module (ACM)**

Number of PV modules installed: _____ **Number of ACM's installed:** _____

Number of Microinverters installed: _____ *Note: Listed Alternating-Current Module (ACM) is defined in* ***CEC 690.2*** *and installed per* ***CEC 690.6***

Number of Branch Circuits, 1, 2, 3, or 4: _____

Total ac system power rating = (Number of Microinverters or ACMs) * (ac inverter power output) = _____ **Watts**

1.1 Lowest expected ambient temperature for the location: (T_L) = _____ **°C**

1.2 Average ambient high temperature for the location: (T_H) = _____ **°C**

Provide the name of the source used to determine T_L and T_H: _____

2 Microinverter or ACM Information and Ratings

Microinverters with ungrounded dc inputs shall be installed in accordance with CEC 690.35.

Microinverter or ACM Manufacturer: _____

Model: _____

2.1 Rated (continuous) ac output power: _____ **Watts**

2.2 Nominal ac Voltage Rating: _____ **Volts**

2.3 Rated (continuous) ac output current: _____ **Amps**

If installing ACMs, skip [STEPS 2.4 and 2.5]

2.4 Maximum dc Input Voltage Rating: _____ **Volts**

2.5 Maximum dc Input Current Rating: _____ **Amps**

2.6 Maximum dc Input Short Circuit Current Rating: _____ **Amps (if provided by manufacturer)**

3 PV Module Information

(If installing ACMs, skip to [STEP 6])

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**

SOLAR PV MICROINVERTER/ACM STANDARD PLAN - COMPREHENSIVE

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

4 PV Module Maximum DC Voltage

(If installing ACMs, skip to [STEP 6])

Maximum dc voltage shall not exceed inverter manufacturer's maximum input voltage rating **[STEP 2.4]**_____ Volts. If the open-circuit voltage (V_{OC} from **[STEP 3.1]**) temperature coefficients (β or ε) are provided by the module manufacturer, use the calculation in **Method 1.** If V_{OC} temperature coefficient is not provided by the module manufacturer, use the calculation in **Method 2**.

4.1 Method 1:

V_{OC} temperature coefficient (β)= _____ **%/°C**

Max number of modules per inverter _____ **× {V_{OC} × [(T_L-25) × (β × V_{OC})/100]} =** _____ **Volts**

If module manufacturer provides a voltage temperature coefficient (ε) in mV/°C, use the formula below.

V_{OC} temperature coefficient (ε)= _____ **mV/°C**

Max number of modules per inverter _____ **× {V_{OC} + [(T_L-25) × (ε/1000)]} =** _____ **Volts**

4.2 Method 2:

Maximum number of modules per inverter _____ **x V_{OC}** _____ **x K_T =** _____ **Volts,**

Where K_T= _____ is a correction factor for ambient temperatures below 25 °C. See **Table 690.7.**

Verify the Low Temperature V_{OC} is less than the Microinverter maximum input voltage from **[STEP 2.4]**: □ Yes □ No

5 PV Short Circuit Current

(If installing ACMs, skip to [STEP 6])

5.1 Calculate the Maximum Short Circuit Current for the PV module

Adjust the PV current for peak sunlight (x 1.25) and compare it to the microinverter Maximum dc Input Short Circuit Current Rating. (If Max dc Input Short Circuit Current rating is not provided by manufacturer, use 1.5 x Max dc Input rating (per UL 1741)):

5.1.1 Maximum Short Circuit Current = (PV Short Circuit Current, I_{SC}, from **[STEP 3.2]**) * 1.25 = _____ Amps

5.1.2 Verify Maximum Short Circuit Current **[STEP 5.1.1]** is equal to or less than the Maximum dc Input Short Circuit Current **[STEP 2.6]** = _____ Amps or the Maximum dc Input Current **[STEP 2.5]** * 1.5 = _____ Amps

6 Branch and Combined Inverter Output Circuit Information and Calculations

Fill in **[Table 1]** to describe the Branch and Combined System circuits.

Circuit Power = (Number of Microinverters or ACMs) * (Rated ac output power **[STEP 2.1]**) – _____ Watts

Circuit Current = (Circuit Power) / (Nominal ac voltage **[STEP 2.2]**)) = _____ Amps

Table 1 - OCPD and Ampacity Current Calculations

	Branch 1	Branch 2	Branch 3	Branch 4	Combined Inverter Output Circuit
Number of Microinverters or ACMs					
AC Power for each unit **[STEP 2.1]**, Watts					
Circuit Power, Watts					
Nominal ac Voltage **[STEP 2.2]**, Volts					
Circuit Current, Amps					

7 Sizing Branch and Combined Inverter Output Circuit Conductors

Calculate the current using both **Method A [STEP 7.1]** and **Method B [STEP 7.2]** for each Branch and the Combined Inverter Output Circuit from **[Table 1]**. Enter the results in **[Table 2]**.

SOLAR PV MICROINVERTER/ACM STANDARD PLAN - COMPREHENSIVE

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

7.1 Method A:

7.1.1 Each Branch Circuit Current, Method A
(Number Microinverters/ACMs) * (AC power **[STEP 2.1]**) / (Nominal ac voltage **[STEP 2.2]**) x 1.25 = _____ Amps

7.1.2 Combined Inverter Output Circuit Current, Method A
(Total Number Microinverters/ACMs) * (AC power **[STEP 2.1]**) / (Nominal ac voltage **[STEP 2.2]**) x 1.25 = _____ Amps

7.2 Method B:

Number of current-carrying branch and combined output circuit conductors in each raceway: _____.

Each Raceway height above the roof: _____ **inches (if not applicable indicate N/A)**

The correction factors for each raceway:

C_R = _____ C_R is the conduit fill coefficient found by referencing **Table 310.15(B)(3)(a)**

C_T = _____ C_T is a coefficient dependent on the highest continuous ambient temperature and raceway height above roof (if applicable) and is found by referencing **Table 310.15(B)(3)(c)** and **Table 310.15(B)(2)(a).**

7.2.1 Each Branch Circuit Current, Method B
(Number Microinverters/ACMs) * (AC power **[STEP 2.1]**) / (Nominal ac voltage **[STEP 2.2]**) / (C_R x C_T) = _____ Amps

7.2.2 Combined Inverter Output Circuit Current, Method B
(Total Number Microinverters/ACMs) * (AC power **[STEP 2.1]**) / (Nominal ac voltage **[STEP 2.2]**) / (C_R x C_T) = _____ Amps

7.3 Determine Conductor Size

Using the greater ampacity as calculated in **Method A** or **Method B**, use **Table 310.15(B)(16)** to identify the ac circuit conductor size. The conductor ampacity shall not exceed the ampacity of chosen conductor rated at the lowest temperature rating of any connected termination, conductor, or device (typically 60°C or 75°C).

Table 2 – Branch and Combined Circuit Currents, Correction Factors, and Conductor Sizes

	Branch 1	Branch 2	Branch 3	Branch 4	Combined Inverter Output Circuit
7.1 Method A: Branch and Combined Circuit Current					
7.2 Method B: Number of current carrying conductors for Branch and Combined Circuit Current					
7.2 Method B: Raceway height above the roof					
7.2 Method B: C_R					
7.2 Method B: C_T					
7.2 Method B: Branch and Combined Circuit Current					
Minimum Conductor Size, AWG					

8 Branch and Combined Inverter Output Circuit OCPD Size

Determine the OCPD size for each Branch Circuit and for the Combined Inverter Output Circuit. Use **CEC 690.8(B)(1)** to determine the OCPD size. Calculate the circuit current for each branch circuit. Enter the results in **[Table 3]**.

8.1.1 Each Branch Circuit Current for OCPD Sizing
(Number Microinverters/ACMs) * (AC power **[STEP 2.1]**) / (Nominal ac voltage **[STEP 2.2]**) x 1.25 = _____ Amps

8.1.2 Combined Inverter Output Circuit for OCPD Sizing
(Total Number Microinverters/ACMs) * (AC power **[STEP 2.1]**) / (Nominal ac voltage **[STEP 2.2]**) x 1.25 = _____ Amps

Size the inverter output OCPD based on the value calculated above. Where the figure is between two standard values of fuse/breaker sizes (see **CEC 240.6(A)**), the next higher size may be used provided the conductors are sufficiently sized. The OCPD's rating may not exceed the conductor ampacity or the inverter manufacturer's max OCPD rating for the inverter.

SOLAR PV MICROINVERTER/ACM STANDARD PLAN - COMPREHENSIVE

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

Table 3 - Branch and Combined Inverter Output Circuit OCPD Sizing

	Branch 1	Branch 2	Branch 3	Branch 4	Combined Inverter Output Circuit
Branch and Inverter Output OCPD, Amps					

9 Solar Load Center

The sum of the ampere ratings of overcurrent devices in circuits supplying power to a busbar or conductor shall not exceed 120 percent of the rating of the busbar or conductor **[CEC 705.12(D)(2)]**.

9.1 Solar Load center busbar rating: _____ Amps

9.2 Using **[Table 3]**, (Sum of all inverter output Branch OCPDs) _____ Amps + (Combined Systems OCPD) _____ Amps = _____ Amps ≤ 120% of **[STEP 9.1]** Amps.

10 Point of Connection to Utility:

One of the following methods of interconnection must be utilized.

10.1 Supply Side Connection: □ Yes □ No

Check with your local jurisdiction to determine if this connection is allowed.

Supply side connections shall only be permitted where the service panel is listed for the purpose. The sum of the ratings of all overcurrent devices connected to power production sources shall not exceed the rating of the service. The connection shall not compromise listing or integrity of any equipment.

10.2 Load Side Connection: □ Yes □ No

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

If No to the statement above, the sum of OCPD(s) supplying the panel cannot exceed 100% of the bus circle 100% as the multiplier in calculation. Otherwise, circle 120% and use that as the multiplier.

Per **705.12(D)(2)**: [Inverter output OCPD size **[Table 3]** + Main OCPD Size] ≤ [Bus size x (100% or 120%)]

Table 4 - Maximum Combined Inverter Output Circuit OCPD, CEC 705.12(D)(2)

Busbar 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 busbar rating (Amps)	20	50	25	60†	60†	40	60†	60†	45
Maximum Combined Inverter OCPD with 100% of busbar 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. If the main breaker is reduced, a load calculation per Article 220 must accompany the Standard Plans to show that the reduction is allowed.

All upstream panelboard busbar ratings must also comply with **CEC 705.12(D)(2)**.

11 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).

11.1 All Systems:

Modules and racking must be bonded by a method listed to the respective UL standard and recognized by the respective equipment manufacturers. Bonding method is subject to AHJ approval. DC and ac **equipment grounding conductor (EGC)** shall be sized based on source and output circuit conductors per 690.45 using Table 250.122. Where exposed to physical damage, it is required to be #6 AWG copper per 690.46. A dc EGC is required for both grounded and ungrounded systems. If an existing premises grounding electrode system is not present, a new grounding electrode system must be established per 250.53.

SOLAR PV MICROINVERTER/ACM STANDARD PLAN - COMPREHENSIVE

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

Where supplementary grounding electrodes are installed, a bonding jumper to the existing grounding electrode must be installed. Bonding jumpers must be sized to the larger grounding conductor that it is bonded to, 250.58

11.2 Grounded Systems:

The dc **grounding electrode conductor (GEC)** from the inverter terminal must be unbroken or irreversibly spliced and sized minimum #8 AWG copper per article 250.166. The dc GEC from the inverter terminal to the existing grounding electrode system must tie to the existing grounding electrode or be bonded to the existing ac GEC using an irreversible means, per 250.64(C)(1).

A combined dc GEC and ac EGC may be run from the inverter dc grounding terminal to the grounding busbar in the associated ac equipment. This combined grounding conductor must be sized to the larger of the GEC and EGC sizes, with the bonding requirements of EGCs and remaining continuous as a GEC, per 690.47(C)(3).

11.3 Ungrounded Systems:

A dc GEC shall not be required from the inverter dc grounding terminal to the building grounding electrode system. The EGC shall run from the inverter to the grounding busbar in the associated ac equipment, sized per 690.45, using Table 250.122. Ungrounded conductors must be identified per 210.5(C). White-finished conductors are not permitted.

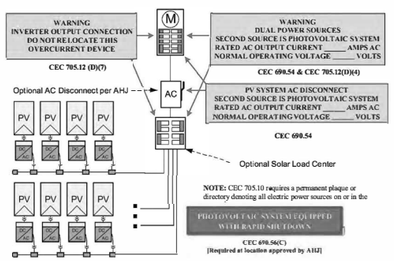
12 Markings

Per Section **CEC 690.54**, a permanent label shall be installed at an accessible location at the PV ac disconnecting means that shall indicate the following:

12.1 Rated ac Output current (total Combined System Current from **[Table 1]**) _____ Amps

12.2 Nominal Operating ac Voltage **[STEP 2.2]** _____ Volts

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



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.

SAMPLE MICRO INVERTER CALCULATION

COMPANY LOGO

SIGNATURE & LICENSE NUMBER

KW RATING OF THE SYSTEM

PROJECT NAME

PROJECT ADRESS

LEGAL DESCRIPTION / ASSESSOR'S PARCEL NUMBER

REVISION	DATE

DRAWN BY:

PROJECT NO.

DATE:

SHEET

PV–5B