

SOLAR PV STANDARD PI SIMPLIFIED CENTRAL / STRING INVERTER

Permit #:

390 Towne Centre Dr, Lathrop, CA 95330 Phone: (209) 941-7270

SOLAR PV STANDARD PLAN SIMPLIFIED CENTRAL / STRING INVERTER Systems for One- / Two- Family Dwellings

Use this plan ONLY for utility-interactive central/string inverter systems not exceeding a system AC inverter output rating of 10kW on the roof of a one- or two- family dwelling, or accessory structure. The photovoltaic system must interconnect to the load side of a single-phase AC service panel of nominal 120/240Vac with a bus bar rating of 225A or less. This plan is not intended for bipolar systems, hybrid systems, or systems that utilize storage batteries, charge controllers, trackers, more than two inverters, or more than one DC combiner (non-inverter integrated) per inverter. Systems must comply with current California Building Standards Codes (CBC) and local amendments of the authority having jurisdiction (AHJ). Other Articles of the California Electrical Code (CEC) shall apply as specified in 690.3.

Manufacturer's Specification Sheets must be provided for proposed inverter, modules, combiner/junction boxes, and racking systems. Installation instructions for bonding and grounding equipment shall be provided, and local AHJs may require additional details. Listed and labeled equipment shall be installed and used in accordance with any instructions included in the listing or labeling (CEC 110.3). Equipment intended for use with PV system shall be identified and listed for the application. (CEC 690.4d).

Pro	oject Address:			Permit #:							
Со	ntractor/Engineer Name:			License #: Class:							
Ph	one #:	Email: _									
	Signature			Date							
	tal # of Inverters Installed: nore than one inverter, complete and attach the "Supplemen	tal Calculatio	on sheets	" and the "Load Center Calcu	lations" if a new load center is to be	e used)					
Inv	verter 1 AC Output Power Rating:	_Watts	Invert	er 2 AC Output Powe	r Rating (if applicable):	Watts					
	Combined Inverter Ou	tput Pow	ver Rat	ing:≤	10,000 Watts						
[Se	nbient Temperature Adjustment Factors:		with the	corresponding Ambient T	emperature Correction Factor	(C _F)]					
1.	☐ If T_L is greater than or equal to -5°C, C_F = ☐ If T_L is between -6°C to -10°C, C_F = 1.14	: 1.12									
	Average ambient high temperate (T_H) = 47°C Note: For a lower T_L or a higher T_H , this plan is not appl										
DC	Information:										
Mo	odule Manufacturer:			Mo	odel:						
2.	Module V _{oc} (From Module Nameplate):	Vol	lts 3	B. Module I _{SC} (from r	nodule nameplate):	Amps					



	Is Module I_{SC} less than 13 Amps? \square Yes \square No \square If No, this plan is not applicable.																
4.	Module DC output power under Standard Test Conditions (STC) =Watts (STC)																
5.	5. DC Module Layout																
Id	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						
	al number of sou										<u> </u>	1614					
6.	Are DC/DC Conv	erters	used?	'	'es		0	ı	f NO, sl	kip to	Step 7.	If Yes,	enter	rinto	below	'.	
DC/	DC Converter M	odel #	:					I	DC/DC	Conv	erter N	1ax DC	Input	: Volta	age:		Volts
	x DC Output Curr							os			Converter Max DC Input Voltage:Volts Output Voltage:Volts						
Ma	x # of DC/DC Con	verter	rs in an	Input	Circuit	:					erter N					\	Vatts
7.	Max System DC	Voltag	ge					•									
0 1			. 50	/D.C													
	y use for systems							/C+	\		. C (C+	1\			,	,	
□ /	A. Module V _{oc} (St	tep 2)	=	_ x#c	or moa	uies ii	n seri	es (St	ep 5) _		x C _F (St	ep 1) _		=		/	
	Table 1. Maximum	Numb	er of P	V Modu	les in S	eries E	Based	on Mo	odule Ra	ited VC	C for 6	00 Vdc	Rated	Equip	ment (CEC 69	0.7)
	Max Rated Modul	le V _{oc}	29.76					38.27	41.21	44.64					56.96	76.53	89.29
	if C _F = 1.12 (Max Rated Modul		23.70	31.31	33.10	, 55.	, `	,0.27	11.21		10.70	33.3	, 33.	J2 0	50.50	7 0.33	05.25
	if $C_F = 1.14$ (29.24	30.96	32.89	35.	09 3	37.59	40.49	43.86	47.85	52.63	3 58.	48 6	55.79	75.19	87.72
	Max # of Module	es for	18	17	16	1:	5	14	13	12	11	10	9)	8	7	6
	60	0 Vdc															
Onl	y use for systems	s with	חכ/חכ	conve	rters. T	The va	alue c	alcula	ated be	low m	ust he	less th	an DC	3DC c	onver	ter ma	x DC
	ut voltage (Step 6		20,20					arcare			use se		u D C				X 2 0
	B. Module V _{oc} (St	tep 2)	=	_ x # o	f modu	ıles p	er coi	nverte	er (Step	6)	x (C _F (Ste _l	o 1) _		=	V	
	Table 2. Largest Max Rated Module	odule '	VOC for	r Single-	Module	e DC/[OC Coi	nverte	r Config	uratio	าร (with	80V A	-CI Cap	o) (CEC	C 690.7	' & 690.	11)
	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
М	ax Rated Module	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
	OC (*1.14) (Volts)	25.0	32.3	33.1	37.7	70.7	75.0	45.0	70.2	30.3	33.3	30.1	50.0	01.4	04.0	00.7	05.5
	DC/DC Converter Max DC Input	34	37	40	43	46	49	52	55	58	61	64	67	70	73	76	79
	(STEP 6) (Volts)			-			-										
													_				
8.	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 current-carrying conductors in roof-mounted conduit exposed to sunlight at least ½" from the roof covering (CEC 310) Note: For over 8 current-carrying conductors in the conduit or mounting height of lower than ½" from the roof, this plan is not applicable.									
10. Inverter DC Disconnect									
	Does the inverter have an integrated DC disconnect? Yes No If Yes, proceed to Step 14 If no, the external DC disconnect to be installed is rated forAmps (DC) andVolts (DC)								
11. Inverter Information									
Manufacturer: Model:									
Max Continuous AC Output Current Rating:A	mps								
	Max Short Circuit Current per Input:Amps								
Does PV Module I_{SC} (Step 3) exceed value above? \square Yes \square No If No, this plan is not applicable. Integrated DC Arc-Fault Circuit Protection? \square Yes \square No If No, this plan is not applicable.									
Grounded or Underground System? Grounded Undergrounded									
Grounded of Officerground System: 🗀 Grounded 🗀 Officergrounded									
AC Information:									
12. Sizing Inverter Output Circuit Conductors and OCPD									
Inverter Output OCPD rating =Amps (Table 3	-								
Inverter Output Circuit Conductor Size =AW	G (Tabl	e 3							
Table 2 Minimum lauretes Onto	0.65	D 1 C	::-		C:				
Table 3. Minimum Inverter Out Inverter Continuous Output Current Rating (Amps) (Step 11)	12	D and C	ircuit C	onducto 24	or Size 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
					•			•	
13. Point of Connection to Utility – Inverter(s) must be co	nnecte	ed to ei	ther lo	ad or s	upply s	ide of	service		
disconnecting means. Only one of the sub-sections be	elow ar	nd <u>eithe</u>	<u>er </u> Singl	e Line l	Diagrar	n #1 or	· Single	Line D	iagram
#2 should be filled out.									
Only use this section for connections on the <u>load side</u> of t	he sen	ice dis	connec	ting m	eans.				
la the DV OCDD resitioned at the constitution of form:					OCDI	.	2		
Is the PV OCPD positioned at the opposite end from i	•	eaer io	cation	or mai	n OCPL) locati	on?		
☐ Yes ☐ No If No, then use 100% row in Table 4									
Load side connections (Per 705.12(D)(2)(3)(c)):									
(Combined inverter output OCPD size + Main OCPD si	ze) ≤ [I	ous bar	size x l	100%	or 1209	%)]			
	-, — L·				3,	,,			



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% of Bus Bar Rating	0	25	0	50	25	0	50	25	0

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

Reduction of the main breaker is not permitted with this plan. Interconnection to center-fed panel boards may be permitted per California Building Standards Commission - Informational Bulletin.

Only use this section for connections on the <u>supply side</u> of the service disconnecting means (between the utility meter and the service disconnecting means).

Select one:

☐ Utility- and AHJ-approved meter socket adapter.
Adapter Name / Model:
\square Service equipment listed for the purpose of PV interconnection.
Description / Model Number(s):

14. 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):

\Box 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.



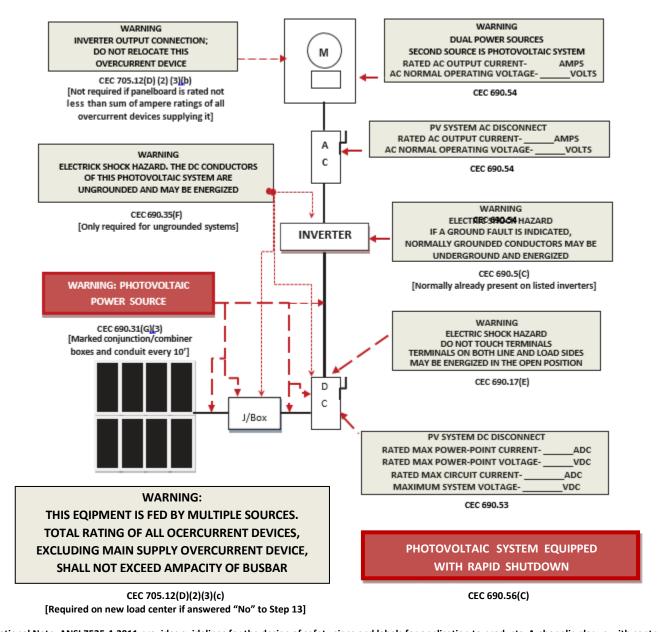
	□ Remotely-controlled DC disconnecting means are located within 10 feet of the PV array and DC input of the inverter(s), and the locations of the disconnecting means are such that uncontrolled PV system conductors are no greater than 5 feet of length within the building. Reduction of the voltage for 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.
	\square 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:
15.	Grounding and Bonding of Modules and Racking System (Select One):
	\square 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- / TWO- FAMILY DWELLINGS

MARKINGS

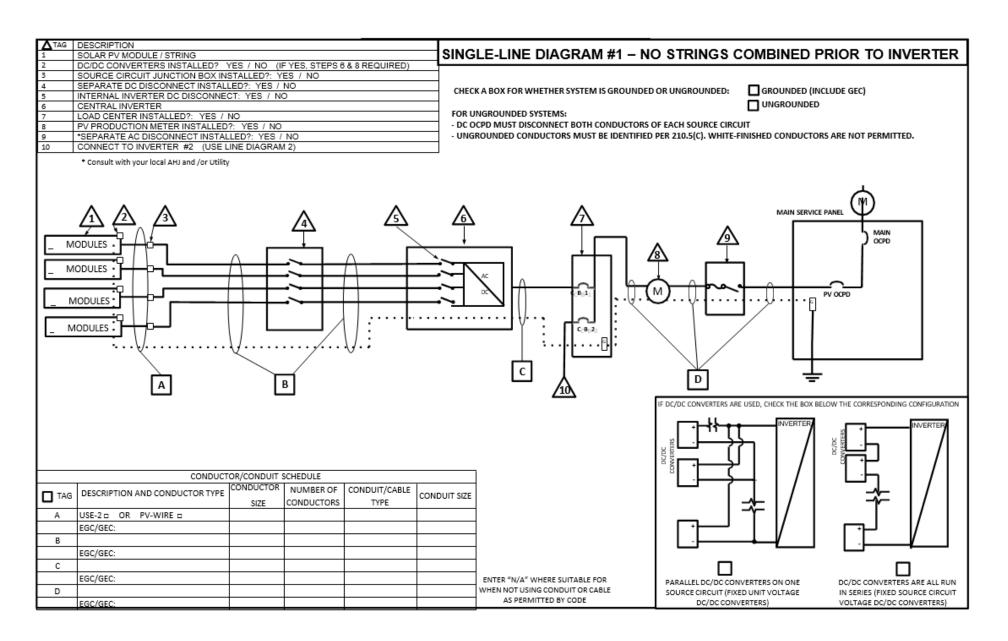
CEC Articles 690 and 705 and CA Residential Code Section R324 require the following labels or markings be installed at these components of the photovoltaic system:



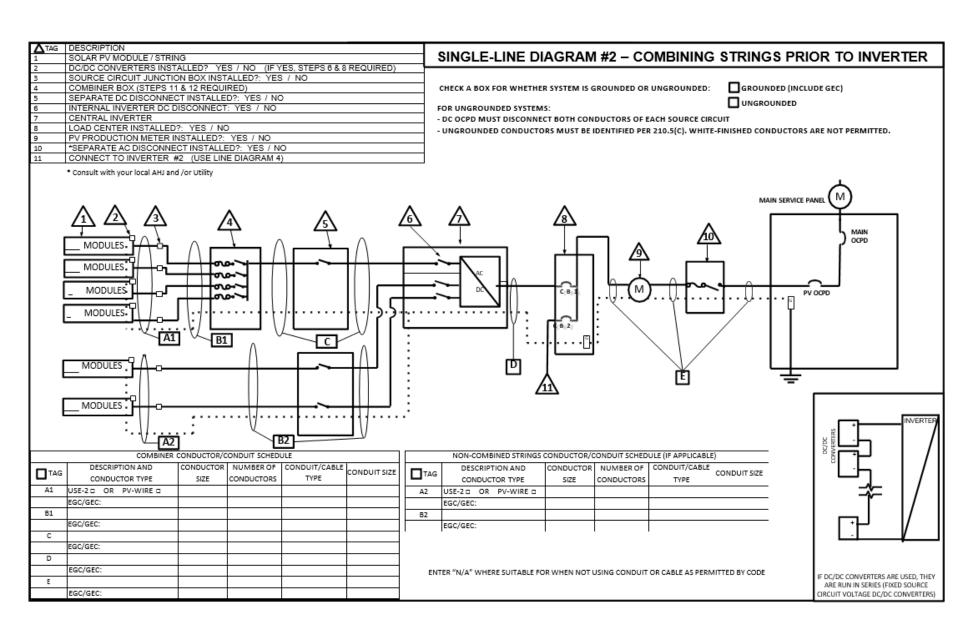
Informational Note: ANSI Z535.4-2011 provides guidelines for the design of safety signs and labels for application to products. A phenolic plaque with contrasting colors between the text and background would meet the intent of the code per permanency. No type size is specified, but 20 point (3/8") should be considered the minimum.

CEC 705.12 requires a permanent plaque or directory denoting all electric power sources on or in the premises or rapid-fire shutdown equipment.











SOLAR PV STANDARD PLAN SIMPLIFIED CENTRAL / STRING INVERTER SYSTEMS FOR ONE- / TWO- FAMILY DWELLINGS

SUPPLEMENTAL CALCULATION SHEETS FOR INVERTER #2 (ONLY INCLUDE IF SECOND INVERTER IS USED)

DC Information:

Module Manufacturer:	Model:						
S1. Module V _{OC} (From Module Nameplate):Volts	S2. Module I _{SC} (from module nameplate):Amps						
Is Module I _{SC} less than 13 Amps?							
S3. Module DC output power under Standard Test Conditions (STC) =Watts (STC)							
S4. DC Module Layout							
Identify each source circuit (string) for inverter 1 shown on the with a Tag (e.g. A, B, C)	ne roof plan Number of modules per source circuit for Inverter 1						
Total number of source circuits for inverter 1:							
S5. Are DC/DC Converters used? ☐ Yes ☐ No	If NO, skip to Step 7. If Yes, enter info below.						
DC/DC Converter Model #:	DC/DC Converter Max DC Input Voltage:Volts						
Max DC Output Current: Amps	Max DC Output Voltage: Volts						
Max # of DC/DC Converters in an Input Circuit:	DC/DC Converter Max DC Input Power:Watts						



S6. Max System DC Voltage																
		, •														
Only use for systems	with	out DC	/DC co	nverte	rs.											
\square A. Module V_{OC} (St	ep 2)	=	_ x#0	of mod	ules i	n seri	es (St	ep 5) _	x	C _F (Ste	ep 1) _		=	'	V	
	Table 1. Maximum Number of PV Modules in Series Based on Module Rated VOC for 600 Vdc Rated Equipment (CEC 690.7)															
Max Rated Modul if $C_F = 1.12$ (29.76	31.51	33.48	35	.71 3	38.27	41.21	44.64	48.70	53.57	59.	52 6	6.96	76.53	89.29
Max Rated Modul if $C_F = 1.14$ (29.24	30.96	32.89	35	.09	37.59	40.49	43.86	47.85	52.63	58.	48 6	55.79	75.19	87.72
Max # of Module	es for O Vdc	18	17	16	1	.5	14	13	12	11	10	9)	8	7	6
				1					1		1			<u> </u>		
Only use for systems	with	DC/DC	conve	rters.	The v	alue c	alcula	ated be	low mu	ust be l	ess tha	an DC	?DC c	onve	rter ma	x DC
input voltage (Step 6	5)															
\square B. Module V_{OC} (St	ep 2)	=	_ x # o	f mod	ıles p	er co	nverte	er (Step	6)	x C	F (Step	1)		=	V	
Table 2. Largest Module VOC for Single-Module DC/DC Converter Configurations (with 80V AFCI Cap) (CEC 690.7 & 690.11)																
Max Rated Module	odule	VUC for	Single	-Modul	e DC/I	DC CO	nverte	r Config	guration	is (with	8UV AF	CI Cap) (CEC	. 690. /	/ & 690.	.11)
VOC (*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	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
VOC (*1.14) (Volts)	23.0	32.3	33.1	37.7	70.7	75.0	45.0	70.2	30.3	33.3	30.1	56.6	01.4	04.0	00.7	05.5
DC/DC Converter Max DC Input	34	37	40	43	46	49	52	55	58	61	64	67	70	73	76	79
(STEP 6) (Volts)	34	37	40	43	40	43	32	33	36	01	04	07	70	/3	/0	79
(= = -/(= ==/									ı						1	
S7. Maximum Syster	m DC \	Voltage	from	DC/D0	Con	verte	rs to I	nverter	– Only	/ requi	ed if Y	es in	Step	6		
Maximum Syster	m DC \	Voltage	e =	V	'olts											
S8. Sizing Source Cir	cuit C	onduct	ors													
									20							a =:::
Source Circuit Co	onduc	tor Size	e = Mir	ո. #10 /	AWG	coppe	er con	ductor	, 90°C \	wet (US	E-2, P\	/ Wire	e, XHH	IW-2,	IHWN-	2, RHW-
2)		•					م. ـ ـ ـ اـ	al:ta a				1/	// E		.	
For up to 8 currer	nt-carr	ying co	naucto	ors in ro	or-m	ounte	a con	auit exp	osea to	o suniig	nt at le	ast ½	Tron	n the r	OOT COV	ering
(CEC 310) Note: For over 8 curre	ent-carr	ving con	ductors i	n the co	nduit o	r moun	ting hei	ght of lov	wer than	½" from	the roof	this pl	an is no	ot appli	cable.	
S9. Inverter DC Disco								0		, , , , , , , , , , , , , , , , , , , ,				-		
Does the inverte			_					Yes	□ No	lf If	Yes, p	roce	ed to	Step :	14	
If no, the externa	If no, the external DC disconnect to be installed is rated forAmps (DC) andVolts (DC)															



S10. Inverter Information										
310. inverter information										
Manufacturer: Model:										
Max Continuous AC Output Current Rating:Amps										
Max Short Circuit Current per Input:Amps	• ———									
Does PV Module I_{SC} (Step 3) exceed value above? \square Yes \square No If No, this plan is not applicable.										
Integrated DC Arc-Fault Circuit Protection?										
Grounded or Underground System? ☐ Grounded ☐ Undergrounded										
<u> </u>										
AC Information:										
S11. Sizing Inverter Output Circuit Conductors and OCF	D									
Inverter Output OCPD rating =Amps (Table 3)									
Inverter Output Circuit Conductor Size =AWG	(Table	e 3								
Table 3. Minimum Inverter Output OCPD and Circuit Conductor Size										
Inverter Continuous Output Current Rating (Amps) (Step 11)	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	



SOLAR PV STANDARD PLAN SIMPLIFIED CENTRAL / STRING INVERTER SYSTEMS FOR ONE- / TWO- FAMILY DWELLINGS

SUPPLEMENTAL CALCULATION SHEETS FOR INVERTER #2 (ONLY INCLUDE IF SECOND INVERTER IS USED)

S12. Load Center Output								
Calculate the sum of the maximum AC outputs from each inverter.								
Inverter #1 Max Continuous AC Output Current Rating (Step 11)	x 1.25 =Amps							
Inverter #2 Max Continuous AC Output Current Rating (Step S10)	x 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 bus bar shall not exceed 120% of the ampacity of the bus bar.								
If No, the sum of ampere rating of the two PV overcurrent devices shall no	ot exceed the rating of the busbar.							



▲TAG DESCRIPTION				CINCLE LINE DIACDAM #2 ADDITIONAL INVEDTED				
	SOLAR PV MODULE / STRING			SINGLE-LINE DIAGRAM #3 – ADDITIONAL INVERTER				
2 1	DC/DC CONVERTERS INSTALLED? YES / NO (IF YES, STEPS 6 & 8 REQUIRED)			INVERTER # 2				
	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				CHECK A BOX FOR WHETHER SYSTEM IS GROUNDED OR UNGROUNDED: GROUNDED (INCLUDE GEC)				
	SEPARATE AC DISCONNECT INSTALLED?: YES / NO		СН	ECK A BOX FOR WHETHER	R SYSTEM IS GROUND	ED OR UNGROUNDED:	GROUNDED (INCLUDE GEC)	
8	TO LOAD CENTER ON LINE DIAGRAM 1		REI	FER TO STEP 14 FOR RAPII	D SHUTDOWN DETAIL	ls 🗖	UNGROUNDED	
* Consult with your local AHJ and /or Utility				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.				
			- 0	JNGROUNDED CONDUCTO	IN S INIO S I DE IDENTIFI	ED PER 210.5(C). WHITE-FINIS	HED CONDOCTORS ARE NOT PERIVITTED.	
	Λ Λ Λ		Λ	Δ				
	/1\ <u>/2</u> \ /3\	Λ	∕ 5∖	<u> </u>			ı	
_	 ^	4	$\overline{}$	\top	/ \		ı	
	MODULES . T———————————————————————————————————			_	4		ı	
					1		ı	
Г	MODULES . / \	- > - /	 :				ı	
		- ~	-	AC II A	1 1.	۸	ı	
		->-	 -	<u>~-</u> ∑ - /-	╼╼	\	ı	
l I.	MODULES • +	•>	`	→ "\	1 11	11 A		
_		1 1 1				8	ı	
Г	MODULES 1	1///	· · · · · · · · · · · · · · · · · · ·			y · · · · · · · · · · · · · · · · · · ·		
L	 \	 /\\	: —		/			
	·\/\/\/	, / \ /	Inverter M	lake:				
	_		Inverter M	lodel:	\ /			
					· ~			
	ΓĀ Î	В			c			
	COMPLICA	OD /CONDINE	CHEBLUE			1		
	CONDUCT	OR/CONDUIT S	CHEDULE				ı	
		CONDUCTOR	NUMBER OF	CONDUIT/CABLE			ı	
□ TA	G DESCRIPTION AND CONDUCTOR TYPE			_	CONDUIT SIZE			
		SIZE	CONDUCTORS	TYPE				
Α	USE-2 □ OR PV-WIRE □							
А								
	EGC/GEC:					ENTER N/A WHERE SUITA		
В						NOT USING CONDUIT (
В						PERMITTED BY	JODE	
	EGC/GEC:						ı	
	•							
С								
	EGC/GEC:						l	



SOLAR PV STANDARD PLAN

Roof Layout Diagram for One- and Two-Family Dwellings	

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