

## SYMBOLS LIST

- ① SHEET NOTE
- ② EQUIPMENT TAG
- ③ STRING NUMBER
- ~ FUSE
- DISCONNECT
- CIRCUIT BREAKER

## SYSTEM DESCRIPTION

ENCLOSED DOCUMENTS DESCRIBE CONSTRUCTION REQUIREMENTS FOR A NEW 2.5 KW STC PHOTOVOLTAIC (PV) SYSTEM ON METAL ROOFING PANELS. ALL PV MODULES ARE FACTORY INSTALLED OR MOBILE ROLL-FORM INSTALLED ON METAL ROOFING PANELS. PV EQUIPMENT LOCATION SHALL BE COORDINATED WITH CONTRACTOR AND/OR OWNER.

PV MODULES SHALL BE WIRED IN A SERIES OF STRINGS OF 14 PV MODULES EACH, FOR A 231 VDC NOMINAL OUTPUT AND A 323 VDC OPEN CIRCUIT VOLTAGE. ALL WIRES TO TRANSITION BOXES SHALL BE ROUTED AND CONCEALED UNDER RIDGE CAP OR WITHIN METALLIC CABLE TRAY SYSTEM. LENGTH AND GAUGE OF USE-2/RHW-2 WIRE FOR EACH HOME-RUN PAIR (PV-STRING) SHALL MATCH LENGTH AND GAUGE INDICATED ON "CABLE TRAY & ROOF TRAVERSING CHART" (SEE PV2.12). LENGTH AND GAUGE OF ALL WIRING, ROUTING FROM ANY CABLE TRAY OR TRANSITION BOX, TO AN INVERTER SHALL NOT EXCEED DISTANCES INDICATED ON "ROOF TO INVERTER WIRE SIZE CHART" (SEE PV2.12). OUTPUT FROM GRID-TIE INVERTERS SHALL BE COMBINED IN THE AC COMBINER PANEL THEN INTERCONNECTED WITH THE GRID POWER (IN ACCORDANCE WITH NEC 690.64 (B)).

THE COMPLETE PV SYSTEM DESCRIBED HEREIN SHALL BE INSTALLED AND COMMISSIONED SUCH THAT IT OPERATES AUTOMATICALLY AS FOLLOWS:

1. WHEN GRID POWER IS PRESENT, SOLAR POWER RUNS LOADS ON SITE DURING THE DAY.
2. WHEN GRID POWER FAILS, THE PV SYSTEM SHALL AUTOMATICALLY DISCONNECT FROM THE GRID.
3. THE PV SYSTEM SHALL AUTOMATICALLY RESUME SUPPLYING POWER TO THE GRID WHEN THE PROPER VOLTAGE AND FREQUENCY (AS MANDATED BY IEEE STANDARDS) IS RESTORED AND THERE IS SUFFICIENT SUNLIGHT.

## GENERAL NOTES

1. ALL ELECTRICAL WORK SHALL BE IN ACCORDANCE WITH THE 2005 or 2008 NATIONAL ELECTRIC CODE (NEC), LOCAL MUNICIPAL CODE, AND LOCAL FIRE DISTRICT REGULATIONS.
2. ALL EQUIPMENT SHALL BE LISTED AND LABELED PER RECOGNIZED ELECTRICAL TESTING LABORATORY AND INSTALLED PER THE LISTING REQUIREMENTS AND THE MANUFACTURER'S INSTRUCTIONS.
3. ALL INVERTERS SHALL BE IEEE 929 COMPLIANT AND SHALL BE INSPECTED BY LOCAL UTILITY BEFORE COMMISSIONING, TESTING, AND OPERATION OF THE SYSTEM.
4. ALL OUTDOOR EQUIPMENT SHALL BE MINIMUM NEMA 3R, INCLUDING OUTDOOR MOUNTED TRANSITION BOXES, COMBINER BOXES, AND SWITCHES.
5. ALL EQUIPMENT SHALL BE PROPERLY GROUNDED PER THE REQUIREMENTS OF NEC ART. 250, 690.
6. NEC ART. 690.9 (A). ALL CIRCUITS CONNECTED TO MORE THAN ONE SOURCE SHALL HAVE OVERCURRENT DEVICES LOCATED SO AS TO PROVIDE OVERCURRENT PROTECTION FROM ALL SOURCES.
7. NEC ART. 690.18. DUE TO THE FACT THAT PV MODULES ARE ENERGIZED WHENEVER THEY ARE EXPOSED TO LIGHT, PV CONTRACTOR SHALL DISABLE THE ARRAY DURING INSTALLATION AND SERVICE BY SHORT CIRCUITING, OPEN CIRCUITING, OR COVERING THE ARRAY WITH AN OPAQUE COVERING.
8. PHOTOVOLTAIC SYSTEM SHALL BACKFEED THE DISTRIBUTION SYSTEM ON SITE PER THE REQUIREMENTS OF NEC ART. 690.64 (B). ALL BACKFEED BREAKERS SHALL BE IDENTIFIED AS SUCH AND SHALL BE SECURED IN PLACE BY AN ADDITIONAL FASTENER PER THE REQUIREMENTS OF NEC 408.16 (F) (408.36 (F) IN 2005 NEC.
9. FALL ARREST PROTECTION PER OSHA REQUIREMENTS SHALL BE PROVIDED FOR ALL ROOF WORK.
10. ALL CONDUCTORS AND TERMINATIONS SHALL BE RATED FOR 75°C MINIMUM.
11. NEC ART. 690.56 (B). A PLACARD SHALL BE PROVIDED ON THE EXTERIOR AND INTERIOR OF THE UTILITY MAIN SERVICE DISCONNECT LOCATION WITH THE FOLLOWING TEXT: "CAUTION: SOLAR PHOTOVOLTAIC (PV) SYSTEM INSTALLED. WHEN POWER DISCONNECTED, SOLAR PV MODULES AND WIRING IN CONDUIT TO INVERTER MAY REMAIN ENERGIZED DURING DAYLIGHT HOURS. PHOTOVOLTAIC SYSTEM DISCONNECTS ARE LOCATED IN THE PV EQUIPMENT ROOM.
12. NEC ART. 690.14. EACH DC DISCONNECT SHALL BE LABELED WITH: "SOLAR PHOTOVOLTAIC POWER SYSTEM EMERGENCY DC DISCONNECT." LABEL SHALL BE 1" X 4" MINIMUM WITH UV RESISTANT BLACK LETTERS ON YELLOW BACKGROUND.
13. NEC ART. 690.53. A PLACARD, MINIMUM 3" X 3", UV RESISTANT, AND INCLUDING BLACK LETTERS AND YELLOW BACKGROUND, SHALL BE PROVIDED BESIDE THE DC DISCONNECT LOCATION WITH THE FOLLOWING TEXT

DC PHOTOVOLTAIC POWER SOURCE:  
OPERATING CURRENT = 12.3 AMPS  
OPERATING VOLTAGE = 231 VDC  
MAXIMUM SYSTEM VOLTAGE = 403.5 VDC  
SHORT CIRCUIT CURRENT = 19.1 AMPS

14. NEC ART. 690.14 EACH AC DISCONNECT SHALL BE LABELED WITH: "SOLAR PHOTOVOLTAIC POWER SYSTEM AC DISCONNECT". LABEL SHALL BE 1" X 4" MINIMUM WITH UV RESISTANT BLACK LETTERS ON YELLOW BACKGROUND.
15. NEC ART. 690.17. EACH AC DISCONNECT SHALL ALSO BE LABELED WITH: "WARNING! - ELECTRICAL SHOCK HAZARD - DO NOT TOUCH TERMINALS. TERMINALS ON BOTH LINE AND LOAD SIDE MAY BE ENERGIZED IN THE OPEN POSITION". LABEL SHALL BE 1" X 4" MINIMUM WITH UV RESISTANT BLACK LETTERS ON YELLOW BACKGROUND.
16. DC DISCONNECT AT THE INVERTER WILL BE READILY ACCESSIBLE AFTER THE INSTALLATION IS COMPLETE PER 2002 NEC ART.690.17 WHERE TERMINALS OF THE DISCONNECTING MEANS MAY BE ENERGIZED IN THE OPEN POSITION. PROVIDE A WARNING SIGN OF THE HAZARDS PER 2002 NEC ART. 690.17
17. CONTRACTOR TO PROVIDE GROUND FAULT PROTECTION FOR ROOF MOUNTED PHOTOVOLTAIC ARRAYS LOCATED ON DWELLINGS PER 2002 NEC ART.690.5
18. WHERE MORE THAN ONE NOMINAL VOLTAGE SYSTEM EXISTS, THE DIFFERENT SYSTEMS SHALL BE IDENTIFIED BY PHASE AND SYSTEM PER 2002 NEC ART.210.4D
19. PROVIDE AN ACCESSIBLE DISCONNECT DEVICE THAT IS LOCKABLE IN OPEN POSITION AND IS LOCATED WITHIN 10'-0" OF THE METER PER LOCAL ELECTRICAL UTILITY REGULATIONS.
20. PHOTOVOLTAIC SOURCE CURRENTS MUST BE RATED AT BOTH 125% OF THE PARALLEL MODULE AND AT A CONTINUOUS LOAD OF ANOTHER 125% FOR A TOTAL OF 156% OF THE LOAD
21. PROVIDE PERMANENT PLAQUE OR DIRECTORY PROVIDING THE LOCATION OF THE SERVICE DISCONNECTING MEANS AND THE PHOTOVOLTAIC SYSTEM DISCONNECT MEANS IF THEY ARE NOT IN THE SAME LOCATION PER 2002 NEC ART. 690.56
22. INSTALLATION OF PV PANEL ARRAYS SHOULD RESIST SLIDING AND POP-UP RESULTING FROM SEISMIC EVENTS AND SHOULD COMPLY WITH CBC SECTION 1613A AND ASCE STANDARD 7-05, CHAPTER 13.
23. DESIGN INDICATES USE OF COPPER WIRE. IF THE CONTRACTOR PREFERS TO USE ALUMINUM WIRE, HE NEEDS SELECT CORRECT WIRE GAUGE AND CONDUIT SIZE. CONTRACTOR TO USE THE ANTI-OXIDANT SPRAY / GREASE ON ALUMINUM WIRE ENDS THAT GET TERMINATED INTO PROPER LUGS. CONTRACTOR ALSO NEED TO COMPLY WITH THE VOLTAGE DROP REQUIREMENTS PER NEC.
24. IT IS RECOMMENDED TO INSTALL THE PV ARRAY SUCH THAT GENERAL SHADING OF THE PV MODULES BETWEEN 9:00AM - 3:00PM SOLAR TIME IS MINIMIZED AND LOCALIZED SHADING DUE TO PLUMBING OR AIR VENTS IS MINIMIZED.
25. PV SYSTEM INSTALLAER WILL BE RESPONSIBLE FOR FURNISHING AND INSTALLATION OF ALL RELATED EQUIPMENT, CABLES, ADDITIONAL CONDUITS, BOXES WIREWAYS AND OTHER ACCESSORIES NECESSARY FOR COMPLETE AND OPERATIONAL PHOTOVOLTAIC SYSTEM.
26. PV SYSTEM CONTRACTOR SHALL COORDINATE ALL THE WORK WITH THE ENGINEER, THE CONSTRUCTION MANAGER AND ALL OTHER CONTRACTORS TO INSURE THAT PV SYSTEM IS INSTALLED AS SPECIFIED IN THESE DRAWINGS.
27. DRAWINGS IN GENERAL ARE DIAGRAMATIC AND INDICATE GENERAL ARRANGEMENT OF THE EQUIPMENT AND WORK INCLUDED. THE INTENSION OF THE DRAWINGS IS TO INDICATE SIZE, CAPACITY, APPROXIMATE LOCATION AND GENERAL RELATIONSHIP, BUT NOT EXACT DETAIL OR PHYSICAL PLACEMENT.
28. FIELD VERIFY EXACT AIC RATING REQUIRED OF THE MAIN SWITCHBOARD FROM LOCAL UTILITY COMPANY.

JOB NO. \_\_\_\_\_ PM. \_\_\_\_\_  
 DESIGNERS JFF  
 DRAWN BY JFF



### REVISIONS

SHEET TITLE  
**2.5KW PV SYSTEM  
 GENERAL NOTES &  
 SYMBOLS LIST**

ENGINEER: -

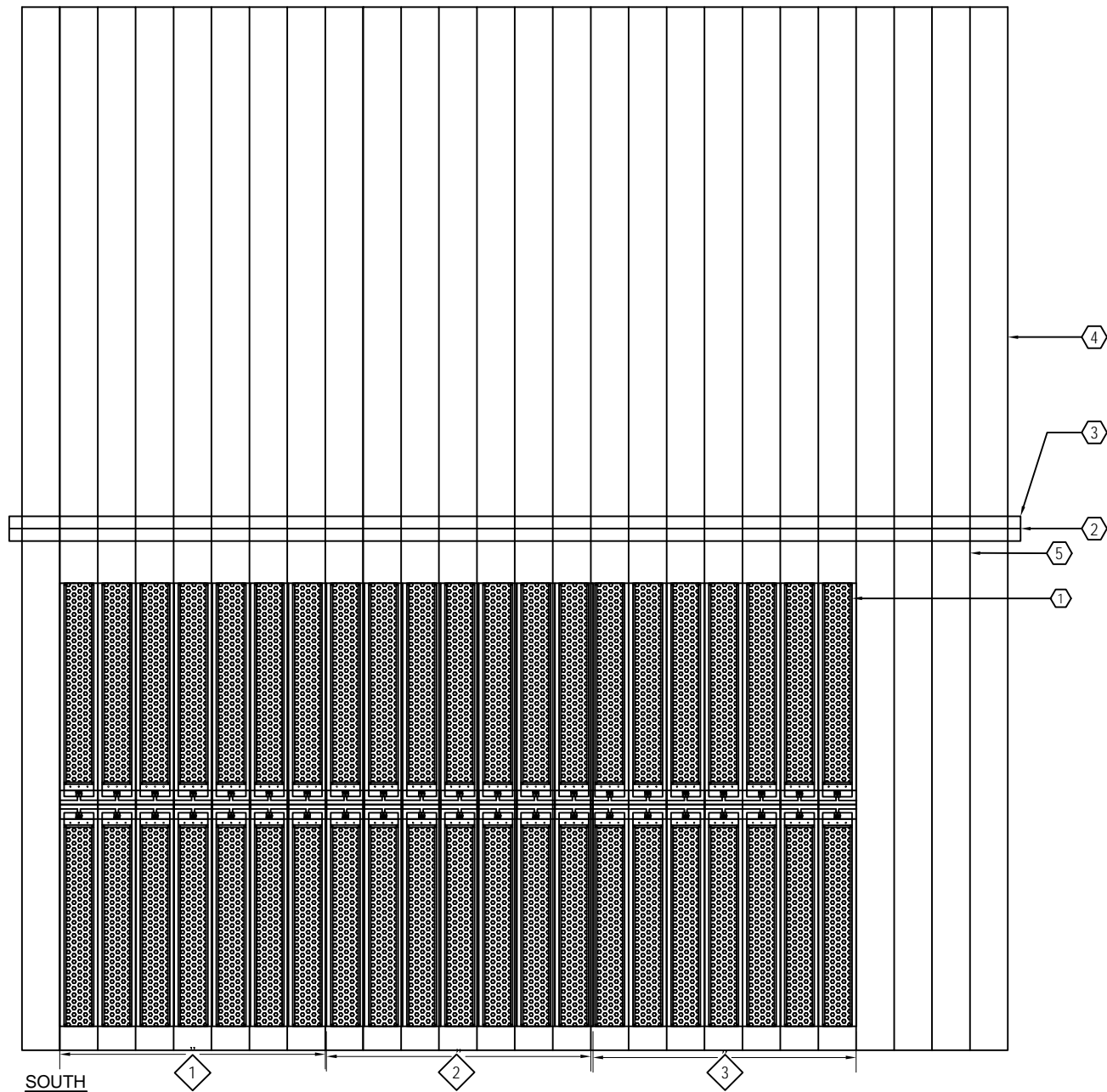
JOB NO. -

DATE 2-23-2009

SHEET

# PVO.12

NORTH



### SHEET NOTES

- ① UNISOLAR PVL-68, TYP.
- ② RIDGE LINE.
- ③ RIDGE CAP.
- ④ METAL ROOFING PANEL, TYP.
- ⑤ METALLIC CABLE TRAY, MIN. 2" OFFSET FROM RIDGE CAP.

### NEC CALCULATIONS

ALL AMPACITIES CALCULATED AT 75°C FOR TERMINATIONS

**DC VOLTAGE**  
 PV MODULE  $V_{oc}$  = 23.1 VDC STC  
 MAXIMUM PV MODULES PER STRING = 14  
 CORRECTION FACTOR PER NEC 690.7 (A) FOR -40°C =  $-0.088 \times (-40°C - 25°C) = 5.72$  VDC  
 MAXIMUM DC VOLTAGE =  $14 \times (23.1 + 5.72) = 403.48$  VDC

**PV SOURCE CIRCUIT**  
 PV MODULE  $I_{sc}$  = 5.1 A  
 PV MODULE  $I_{mp}$  = 4.1 A  
 # OF MODULES IN PARALLEL PER SOURCE CIRCUIT = 1  
 MAX  $I_{sc}$  =  $1 \times 5.1 \text{ A} \times (1.25 \times 1.25) = 7.97 \text{ A}$

SOURCE CIRCUIT OUTDOOR WIRING TO TRANSITION BOX = #10 AWG USE-2/RHW-2, 90°C RATED  
 TEMPERATURE CORRECTION FACTOR FOR 60°C AMBIENT = 0.58  
 CORRECTED AMPACITY =  $35 \text{ A} \times 0.58 \times 0.80 = 16.2 \text{ A} > 7.97 \text{ A}$

**PV OUTPUT CIRCUIT**  
 # OF STRINGS IN PARALLEL PER OUTPUT CIRCUIT = 3  
 MAX  $I_{sc}$  =  $3 \times 5.1 \text{ A} \times (1.25 \times 1.25) = 23.91 \text{ A}$

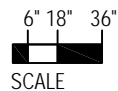
OUTPUT CIRCUIT OUTDOOR WIRING TO INVERTER = #10 AWG USE-2 / RHW-2 OR THWN-2, 90°C RATED  
 TEMPERATURE CORRECTION FACTOR FOR 40°C AMBIENT = 0.88  
 CORRECTED AMPACITY =  $36 \text{ A} \times 0.88 \times 0.80 = 25.34 \text{ A} > 23.91 \text{ A}$

OUTPUT CIRCUIT OVERCURRENT PROTECTION = 3 X 8 A FUSE = 24 A  
 80% OF OVER CURRENT PROTECTION RATING =  $24 \times 0.80 = 19.2 \text{ A}$   
 OUTPUT CIRCUIT CONTINUOUS CURRENT =  $4.1 \text{ A} \times 3 = 12.3 \text{ A} < 19.2 \text{ A}$

**INVERTER OUTPUT CIRCUIT**  
 MAX CONTINUOUS CURRENT = 11.25 A

INVERTER OUTPUT CIRCUIT OVERCURRENT PROTECTION = 20 A BREAKER  
 80% OF OVERCURRENT PROTECTION RATING = 16 A  
 OUTPUT CIRCUIT CONTINUOUS CURRENT = 11.25 A < 16 A

INVERTER OUTPUT WIRING TO POINT OF INTERCONNECTION = #12 THWN-2, 90°C RATED  
 TEMPERATURE CORRECTION FACTOR FOR 40°C AMBIENT = 0.88  
 TOTAL INVERTER CONTINUOUS OUTPUT CURRENT = 11.25 A  
 CORRECTED AMPACITY =  $27 \text{ A} \times 0.88 \times 0.80 = 19.01 \text{ A} > 11.25 \text{ A}$



① 2.5KW PHOTOVOLTAIC SYSTEM ROOF PLAN

JOB NO. \_\_\_\_\_ PM. \_\_\_\_\_  
 DESIGNERS JFF \_\_\_\_\_  
 DRAWN BY JFF \_\_\_\_\_



#### REVISIONS

NO.	DESCRIPTION

SHEET TITLE  
 2.5KW PV SYSTEM  
 ROOF PLAN

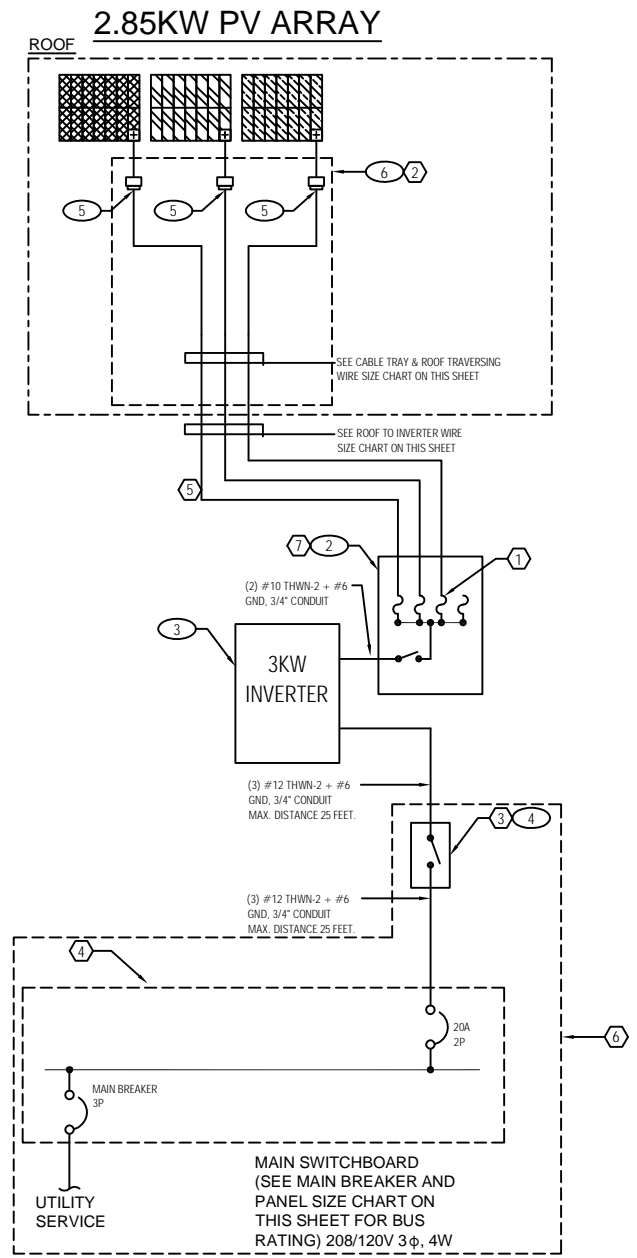
ENGINEER: -

JOB NO. -

DATE 2-23-2009

SHEET

# PV1.12



1 2.5KW PHOTOVOLTAIC SYSTEM ONE LINE DIAGRAM  
NO SCALE

**SHEET NOTES**

- ① TYPICAL, 8 AMP FUSE - DC RATED.
- ② CABLE TRAY SYSTEM ROUTES USE-2 / RHW-2 WIRE ACROSS THE ROOF. AT THE TERMINAL END-CAP OF THE CABLE TRAY, USE-2 / RHW-2 TRANSFERS INTO CONDUIT, AND PROCEEDS TO THE DC DISCONNECT. ALTERNATIVELY, IF USE-2 IS NOT RHW-2 RATED, THEN USE-2 WIRE SHALL BE TRANSITIONED TO THWN-2 IN CONDUIT (UPON EXISTING THE CABLE TRAY) VIA SEPARATE TRANSITION BOX.
- ③ PROVIDE NON-FUSED 30 AMP DISCONNECT IF REQUIRED BY LOCAL CODES. VERIFY SWITCH SPECIFICATION AND LOCATION WITH LOCAL UTILITY.
- ④ LOAD BREAKERS ARE GENERALLY NOT SHOWN IN ELECTRICAL PANELS ON THIS SHEET. SEE ELECTRICAL DRAWINGS FOR PANEL SCHEDULES. ALL BACKFED PANELS SHALL INCLUDE A MAIN BREAKER AND THE MAIN BREAKER SHALL BE PHYSICALLY LOCATED AT THE OPPOSITE END OF THE BUS FROM ALL OTHER BREAKERS WHICH CAN FEED POWER TO THE SAME BUS (PV BREAKERS, GENERATORS, ETC.). ALL SINGLE DIRECTION LOAD BREAKERS SHALL BE LOCATED BETWEEN THE MAIN BREAKER AND THE OTHER BACKFEED BREAKERS IN ORDER TO MINIMIZE OVERALL BUS LOAD.
- ⑤ LOCAL FIRE DEPARTMENT MAY REQUIRE DC DISCONNECT(S) AT THIS LOCATION. IF REQUIRED, PROVIDE "SQUARE D H361RB".
- ⑥ SEE PV2.11 FOR INTERCONNECTION ALTERNATES.
- ⑦ LOCATE BESIDE OR BENEATH INVERTER.

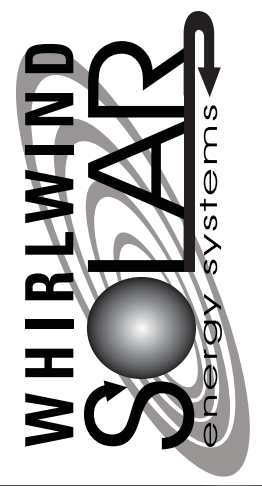
EQUIPMENT SCHEDULE			
TAG	EQUIPMENT MANUFACTURE	EQUIPMENT DESCRIPTION	MODEL
①	UNISOLAR	PV MODULE	PVL-68
②	SQUARE D	DC DISCONNECT	H361RB
③	FRONIUS	3 KW INVERTER	IG 3000
④	SQUARE D	3-POLE NON FUSED DISCONNECT	HU361NRB
⑤	MULTI-CONTACT	USE-2/RHW-2 HOME-RUNS	MC EXTENSIONS W/ QUICK CONNECTS
⑥	ENERGYPEAK	CABLE TRAY SYSTEM	PROVIDED BY: BIPV MANUFACTUER

CABLE TRAY & ROOF TRAVERSING WIRE SIZE CHART			
USE-2 / RHW-2 (AWG)	CABLE TRAY LENGTH (FT.)	STRING # / HOME-RUN PAIR #	COMBINER UNIT
10	0 --> 53	1 --> 3	DIRECT TO ②

ROOF TRANSITION TO INVERTER WIRE SIZE CHART		
THWN-2 OR USE-2 / RHW-2 WIRE (AWG)	MAX DISTANCE (FT.)	EMT CONDUIT (INCH)
12	196	3/4
10	312	3/4
8	497	1
6	789	1 1/4
4	1254	1 1/2

MAIN BREAKER AND PANEL SIZE CHART	
BUS SIZE	MAIN BREAKER
100	80
225	200
400	350
600	500
800	700
1200	1000
1600	1400

JOB NO. \_\_\_\_\_ PM. \_\_\_\_\_  
DESIGNERS JEFF  
DRAWN BY JEFF



REVISIONS

SHEET TITLE  
2.5 KW PV SYSTEM  
ONE LINE DIAGRAM

ENGINEER: -  
JOB NO. -  
DATE 2-23-2009  
SHEET

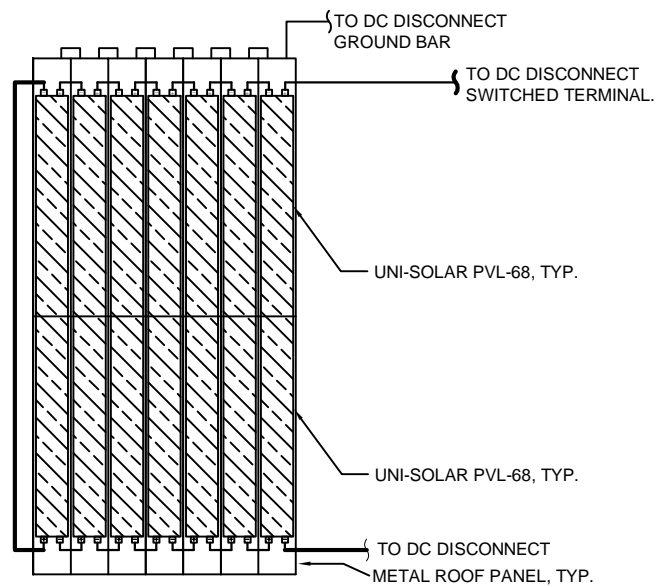
**PV2.12**

### SHEET NOTES

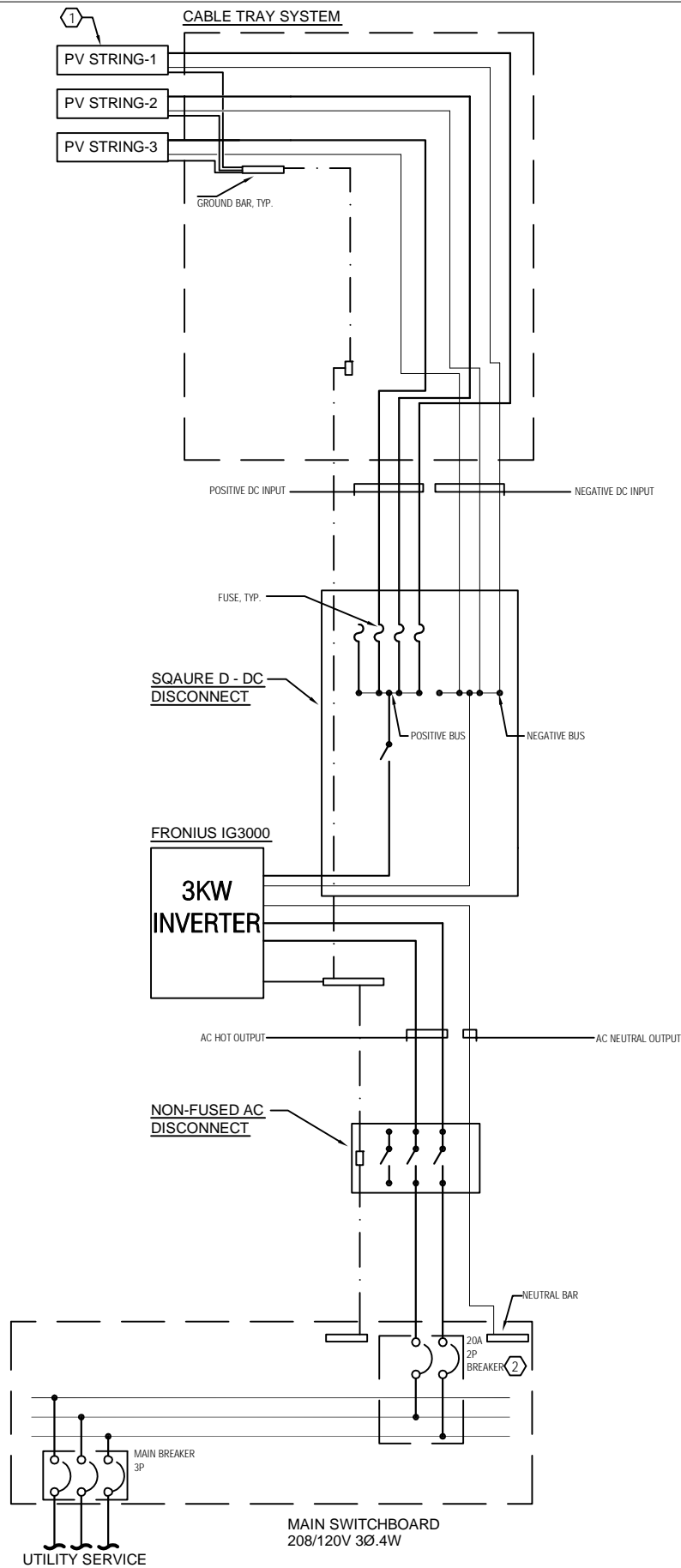
- ① SEE DETAIL 1, TYP.
- ② PROVIDE BREAKER AIC RATING COMPATIBLE WITH AVAILABLE FAULT CURRENT FROM ELECTRIC POWER COMPANY.

### LEGEND

- DC POSITIVE AND AC HOT
- - - DC NEGATIVE AND AC NEUTRAL
- · — GROUND

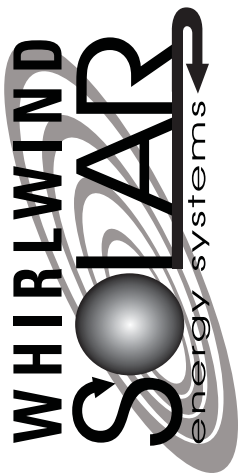


① TYPICAL STRING WIRING FOR UNI-SOLAR PVL-68  
NO SCALE



② 2.5 KW PHOTOVOLTAIC SYSTEM WIRING DIAGRAM  
NO SCALE

JOB NO. — PM. —  
DESIGNERS JEF  
DRAWN BY JEF



#### REVISIONS

SHEET TITLE  
2.5KW PV SYSTEM  
WIRING DIAGRAM

ENGINEER: -

JOB NO. -

DATE  
5-20-09

SHEET

PV3.12