Asia-Pacific Economic Cooperation

Rooftop Solar PV System Designers and Installers

Training Curriculum

APEC Secretariat

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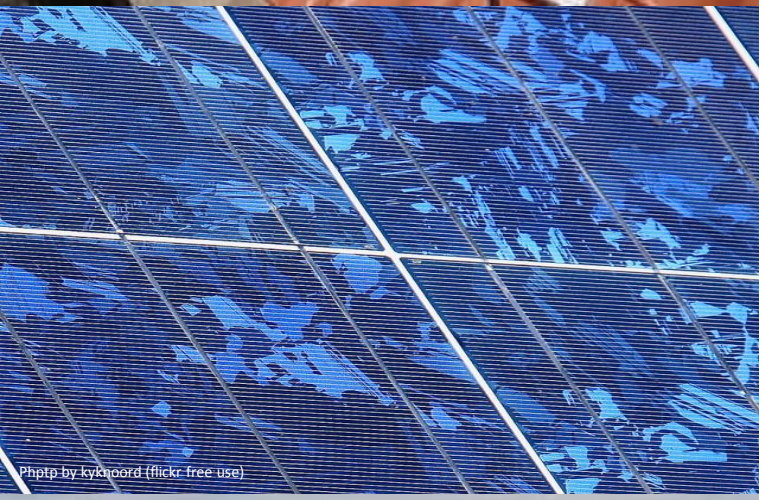
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1-LINE AND 3-LINE ELECTRICAL DIAGRAMS

Training of PV Designer and Installer

APEC
Asia-Pacific Economic Cooperation

Cu International Copper Association
Copper Alliance

castlerock consulting

Purpose

To introduce the concept of 1-line and 3-line diagrams as a means to communicate the solar PV system design to others involved in the project

What is a 1-line diagram?

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A 1-line diagram or a single-line diagram (SLD) is a diagram to show information about the circuit system but the details of the connections and the operations of the system are not required.

Normally used to communicate how a system works in general and which components are connected to another. It uses single lines to connect graphic symbols representing the different components to indicate the path and components of an electrical circuit.

Not all of the components may be shown in a 1-line diagram, but only the relevant components.

What is a 1-line diagram?

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The symbols on the diagram do not represent the size or location of the electrical equipment. But the diagram should be organized based on some kind of logic. In most cases it makes sense to organize the diagram based on the general locations of the components (ie indoor/outdoor).

The diagram should provide a fast, easy understanding of the connections and use of components

In some cases it may make more sense to organize the diagram based on the circuit flow from component to component rather than locations.

The design engineer should consider the stakeholders who need to read the information and draw them accordingly

What is a 1-line diagram?

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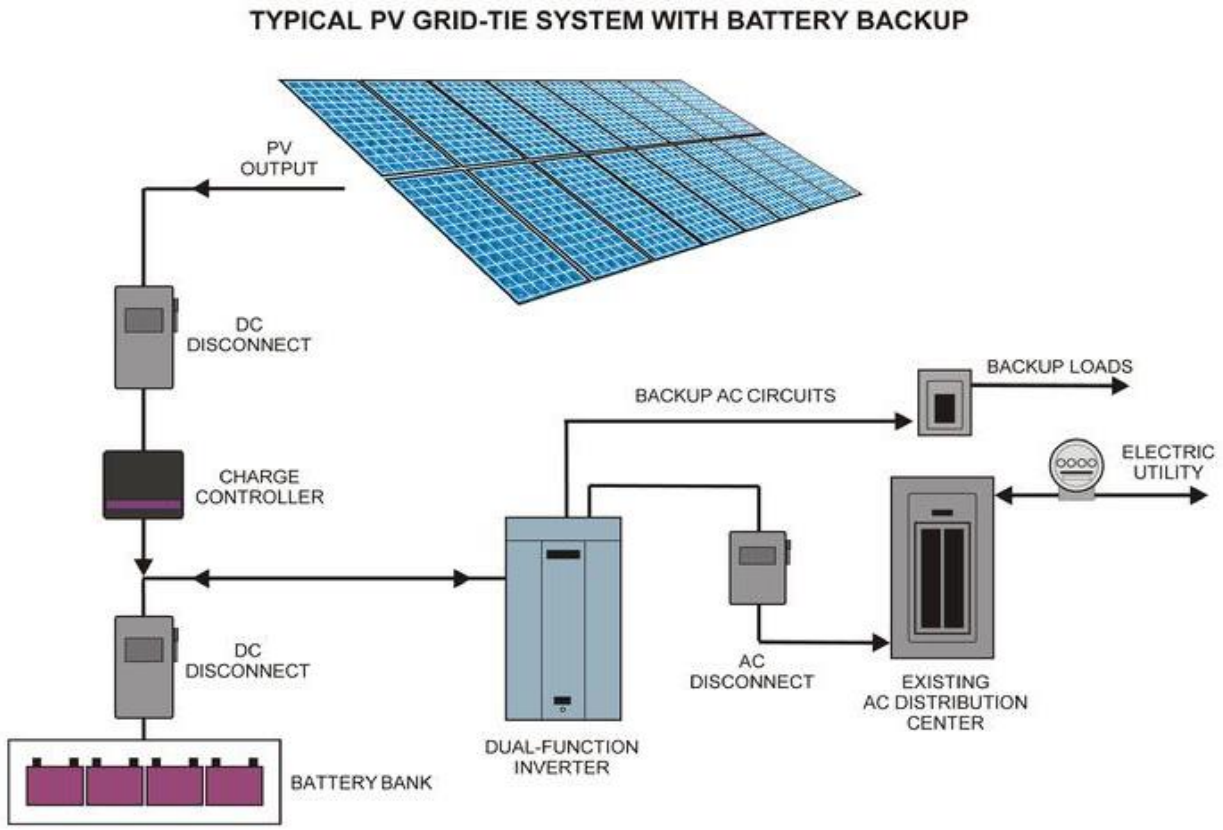
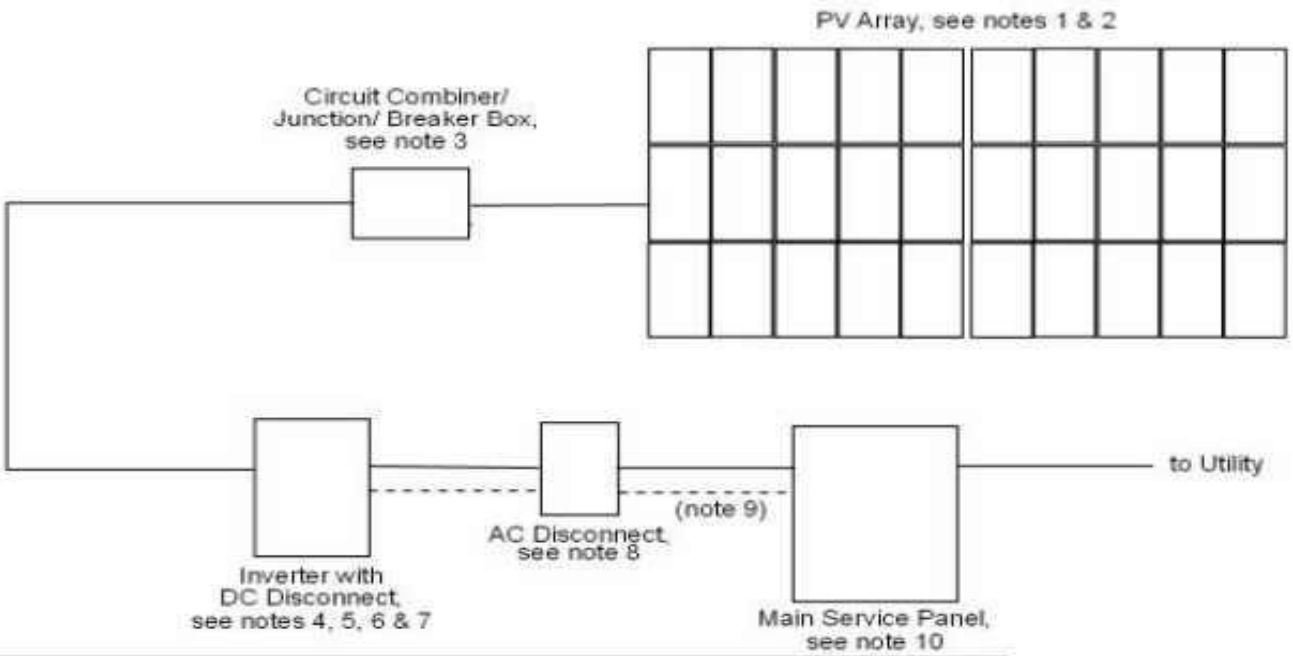


http://soverieegntysolar.files.wordpress.com/2012/07/809_typicalgridtiebatterybackup_web.jpg

1 Line diagram



Notes:
1. PV array contains two parallel strings of 15 210-watt Kyocera modules in series (30 modules).
2. PV array wiring to junction box is #10 AWG USE-2 with factory-installed MC connectors. Panel frames are grounded with #10 AWG solid copper wire.
3. Combiner/junction box provides transition from array wiring to conduit wiring. This box houses two 15 amp breakers, one for each string.
4. The inverter/DC disconnect is enclosed in a weatherproof NEMA 3R housing.
5. Inverter is Fronius IG Plus 6.0-1 rated at 6.0 kW AC output and is rated to provide 25 amps at 240-volts.
6. Inverter complies with the requirements for the following standards "Inverters, converters and controllers for use in independent power systems": UL1741-2005, IEEE 1547-2003.
7. The Fronius IG Plus is equipped with a ground fault detection and interruption circuit as required by UL 1741 and the National Electrical code.
8. The inverter output AC disconnect is rated at 60-amps, 240 VAC, NEMA 3R.
9. Negative pole of PV array referenced to ground at the inverter.
10. 100-amp service panel with 35-amp two-pole breaker for point of connection.

One-Line Diagram for PV System

What is a 3-line diagram?

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Also called a circuit diagram, it shows the connections to each component and every circuit is shown. Also, every electrical component relevant to the system is drawn in this diagram.

As a result, a complete 3-line diagram can be used to create a bill of materials for the system. All components included in the 3-line diagram can be assigned a property that corresponds to a particular line item on the bill of materials.

For materials inventory, non electrical components can be drawn and assigned a property as well. Examples are enclosures, fasteners, or other installation materials.

3-line diagram

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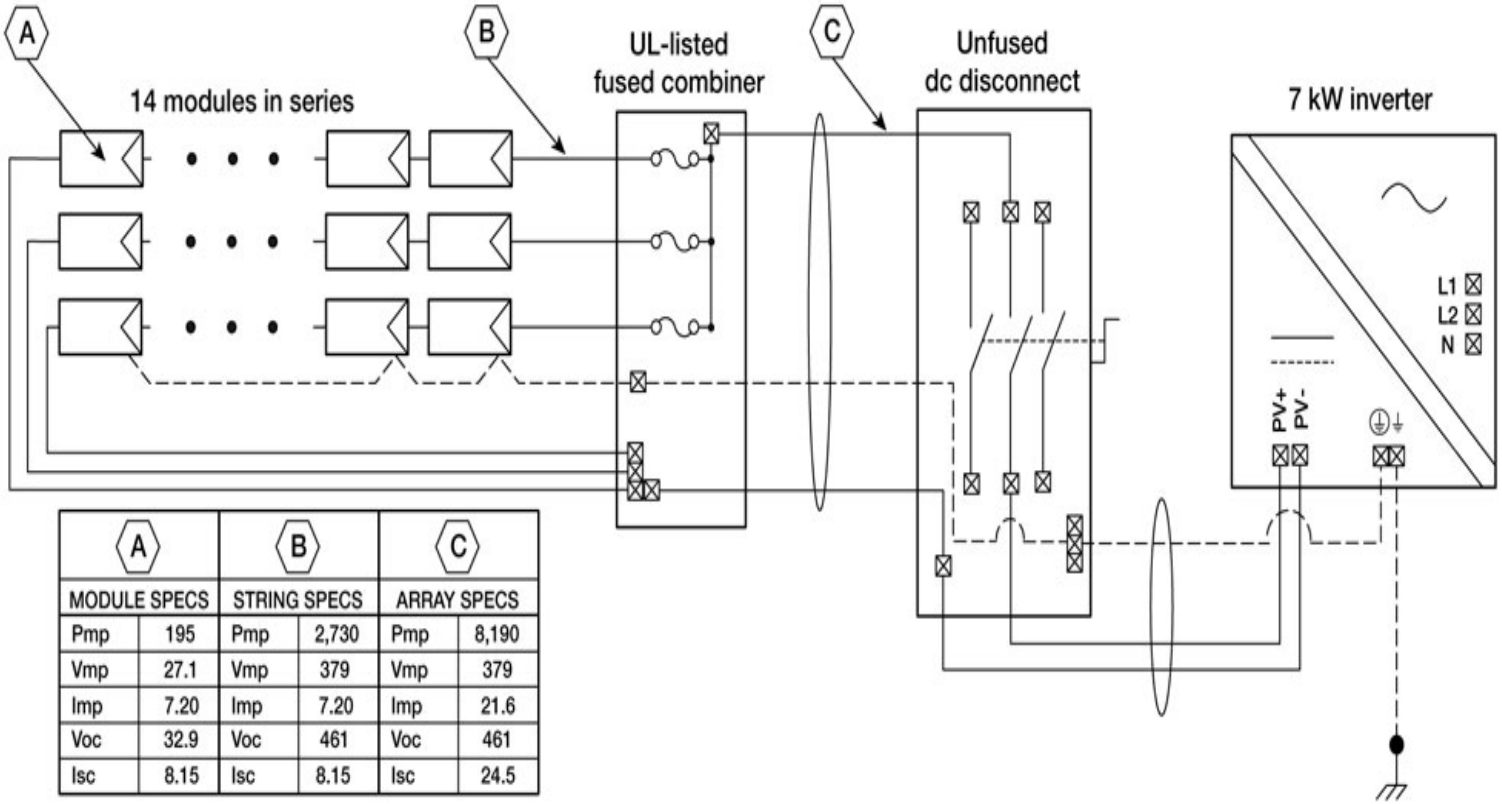
Please build a BOQ for the system below



A		B		C	
MODULE SPECS		STRING SPECS		ARRAY SPECS	
Pmp	195	Pmp	2,730	Pmp	8,190
Vmp	27.1	Vmp	379	Vmp	379
Imp	7.20	Imp	7.20	Imp	21.6
Voc	32.9	Voc	461	Voc	461
Isc	8.15	Isc	8.15	Isc	24.5

Example diagram This three-line wiring diagram includes electrical specifications for an 8,190 W array on a 7 kW inverter.

Exercise

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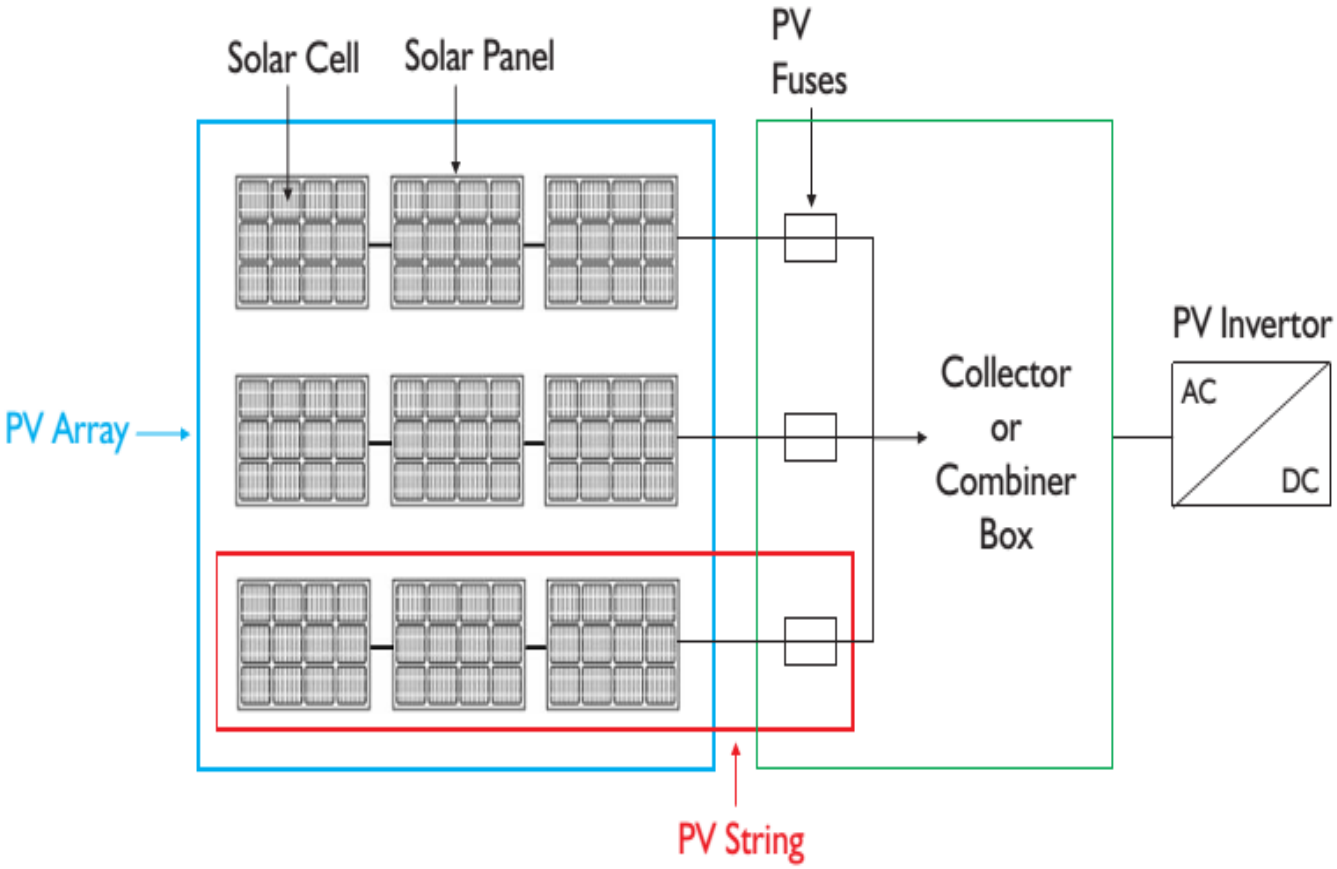
Please build a three line diagram and BOQ from single line diagram below



General Drafting Practices

- Electrical systems should be drawn separate from other drawings such as architectural, structural, mechanical.
- Electrical symbols should be drawn darker than the background drawing showing other systems and/or building structure
- It is preferable that the solar PV electrical system drawing is done separately from other electrical systems but referencing them if it helps with clarity
- Electrical plans are generally drawn to scale, but graphic symbols only indicate the approximate locations of electrical equipment

General Drafting Practices

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- CAD electrical construction drawings should be created at full scale as this will help to make the scale and print size uniform when printed with other drawings
- Use locally accepted standard practices when possible, otherwise a good standard to use is *CAD Layer Guidelines* published by the American Institute of Architects
- A complete set of electrical construction drawings include the following:
  - Plan for each structure and location/site with electrical installation
  - Site plan(s) showing incoming utility services and substations, exterior transformers, feeders, trunk lines, cables between buildings, etc
  - Symbol list and abbreviation list
  - Bill of materials for electrical systems
  - One line diagram for the solar PV system

Note to trainers

Please add example drawings that are common to the industry standards in your country.

Follow the common procedures and best practices that are widely available

The goal is for the design engineers to be able to effectively communicate their design to All stakeholders such as the installers, other contractors, facility owners, etc

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