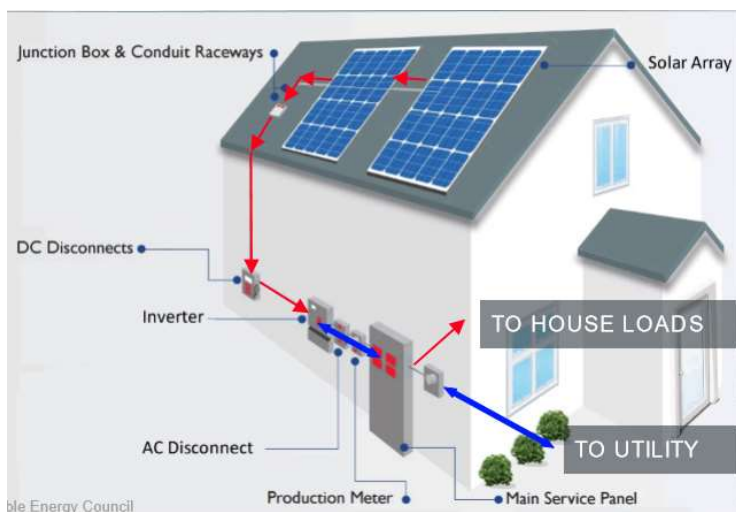


Solar Panels (Grid Tied Systems)

Examples of Photovoltaic systems (P.V. systems) i.e. solar panels. Solar energy systems are systems that are designed to harness solar energy to generate thermal and/or electrical energy through the use of photovoltaic panels and associated components.



EXAMPLE OF GRID-TIED SYSTEM (Connected directly to utility grid, no battery storage)



Photovoltaic systems (PV) or “Solar Panel systems are designed for many functions such as:

- 1). To provide space heating and/or cooling;
- 2). To provide hot water heating;
- 3). To provide swimming pool heating

The code has several requirements for each type of use. This handout is intended to provide some general guidelines.

NOTE: This system is designed to reduce the amount of power required from the utility. Depending on the size of the system the amount of power generated may exceed that of the power demand. When this happens the system will be exporting electricity back to the utility grid. Please contact your utility provider for any questions regarding compensation or benefits that may be provided.

These systems don't generate power¹ during a power outage unless the system includes a battery backup. Photovoltaic systems will shut off during grid power outages as a safety feature so as not to energize utility electric line that are assumed to be non-energized by utility staff.

¹Even though the system is shut down the panels and their leads (typically 18" in length) have the potential of being energized.

Photovoltaic systems can be designed with a battery backup (UPS system) to operate selected circuits in a building for hours or days during a utility outage. Circuits such as furnace, refrigerator, and/or a general use circuit.

SUBMITTAL REQUIREMENTS

Overview of permit submittal documents

1. Building Permit application
2. Site plan if panels are not installed on an existing structure
3. Roof system layout plan (site plan not required if system on roof)
4. Structural Engineering documents if on structure
5. Technical Data Sheets of panels, modules, inverter and rack system
6. Electrical schematic plan to include size of wires, types of wires, disconnects, etc.
7. Signage Requirements.



1. Permit Application

A Building permit is required to be submitted. The permit application required is for Additions & Alterations (Residential) and can be found at:

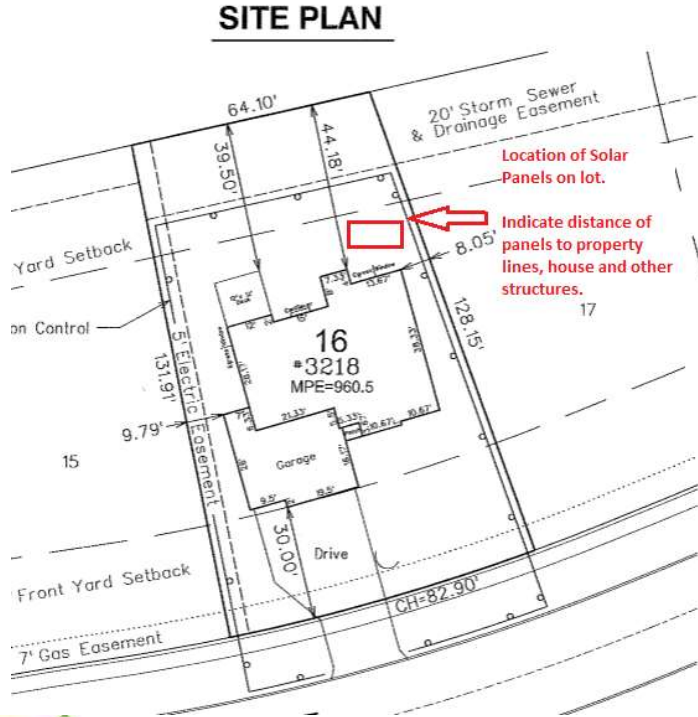
<https://www.muscatinecountyiowa.gov/DocumentCenter/View/4627/Building-Permit-Application>

Applications may also be picked up at the Muscatine County Building, Zoning, & Environmental Office, located at:
3610 Park Ave. West
Muscatine, IA 52761

Our Staff can be reached at 563-263-0482



2. Site plan if panels are not installed on an existing structure



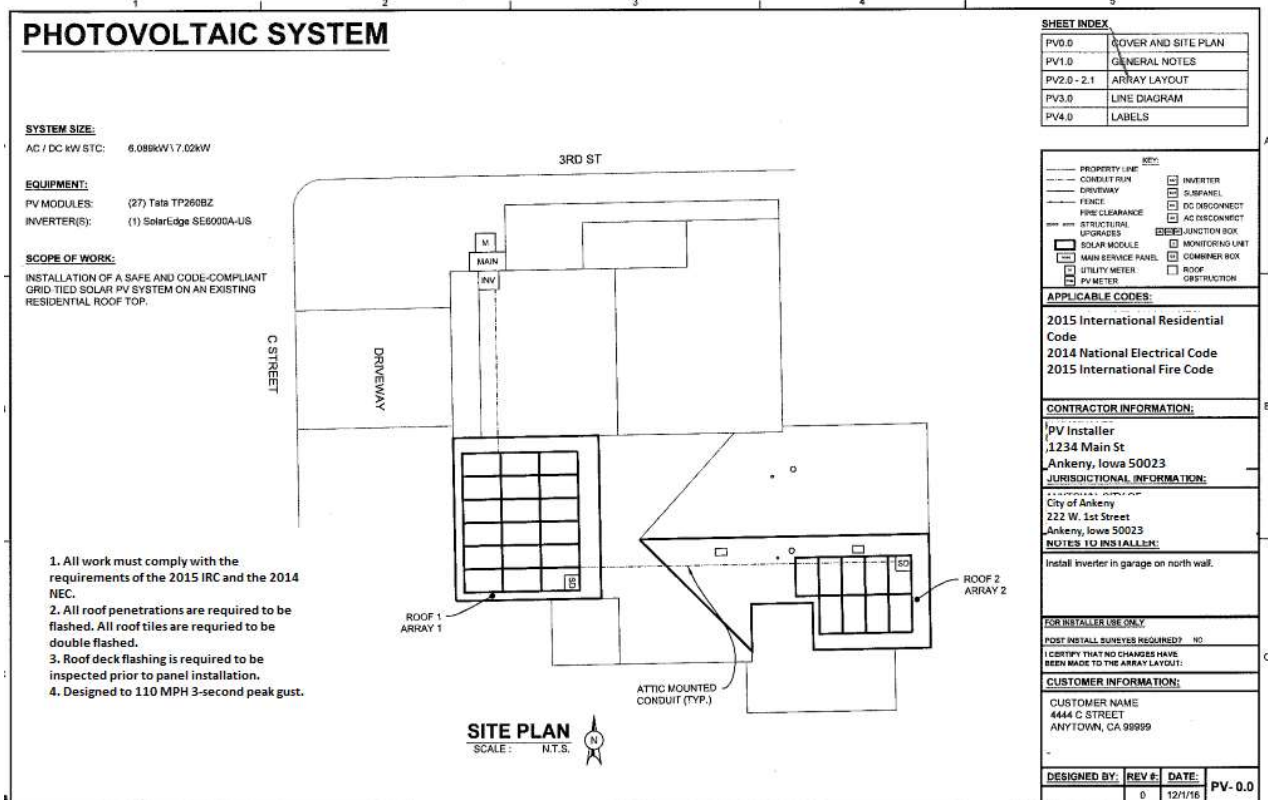
Panels located in a yard are treated as “Accessory” structures for Zoning Code purposes.

This means the panels must be:

1. In the rear yard
2. Not located in any easements
3. Be 5 feet from a property lines
4. If on corner lot must conform to the setbacks prescribed in the county zoning ordinance.



3. Roof system layout plan

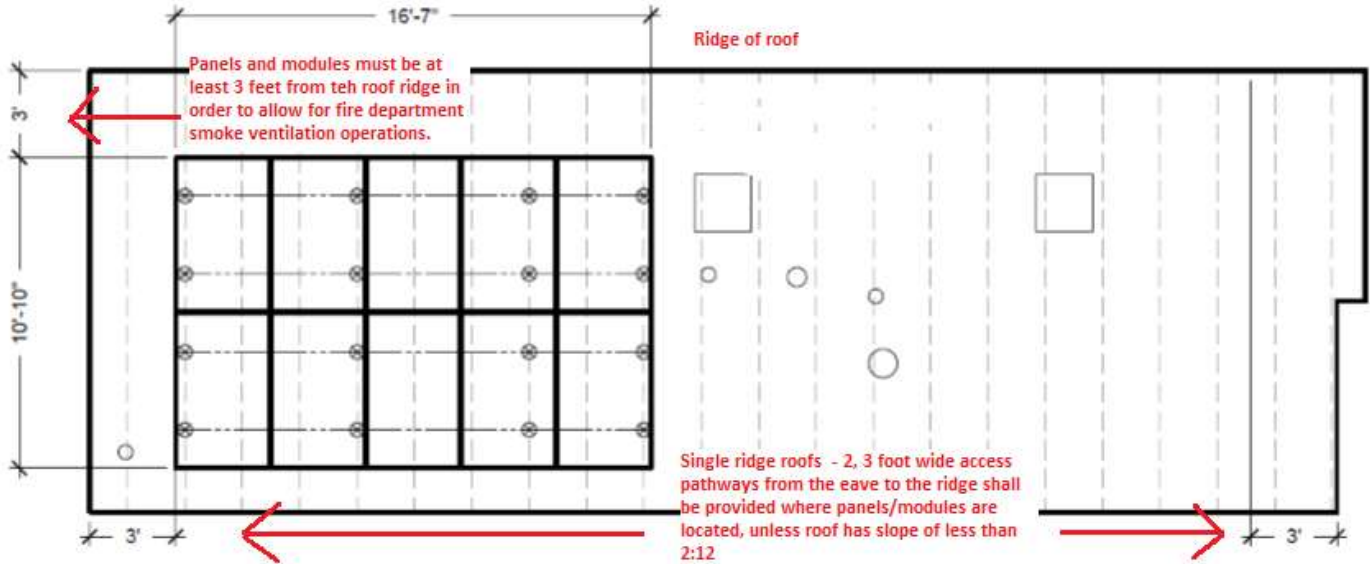


Example of Roof system layout

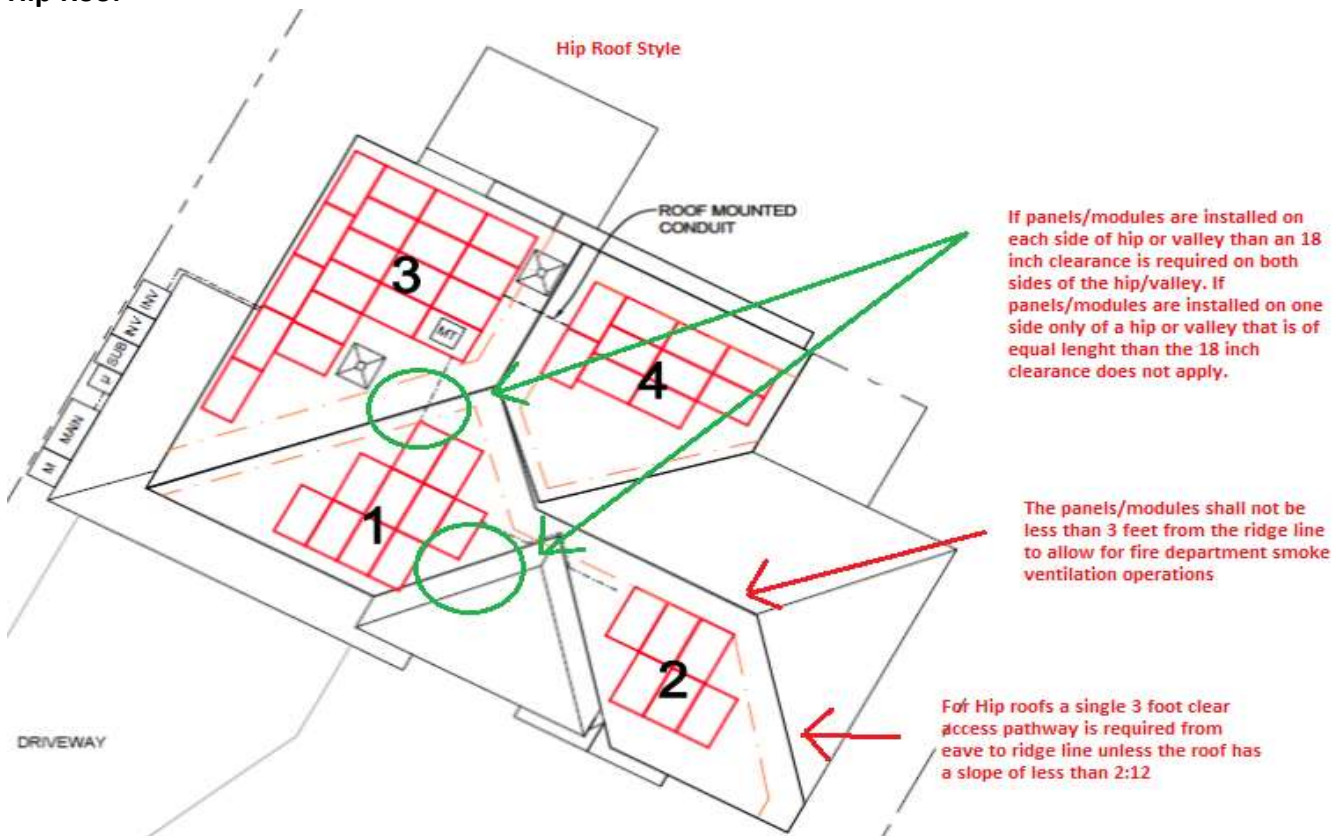
The roof system layout needs to provide the following items:

- A. The location of the solar panels on the actual roof as well as junction boxes and rapid shutdown.
- B. Location of any chimneys, plumbing vents, attic ventilation, peaks, valleys and ridge lines.
- C. Location of Inverter, a/c disconnect, combiner box, dc disconnect, main power disconnect, etc.
- D. Type of roof materials, location of DC or AC wiring (also noting if surface mounted or other method)
- E. Access pathways as required by the IRC (see the following).

Single Ridge Roof



Hip Roof



-
- NOTE:** 1. Each photovoltaic array is limited to 150 feet by 150 feet. Multiple arrays shall be separated by a clear access pathway not less than 3 feet in width.
2. Roof access points shall be located in areas that do not require the placement of ground ladders over openings such as windows or doors, located at strong points of building construction and where the access point does not conflict with overhead obstructions such as tree limbs, wires and signs.
3. Detached garages and accessory structures to one & two family dwellings are exempt from the access pathway requirements.



4. Structural Engineering

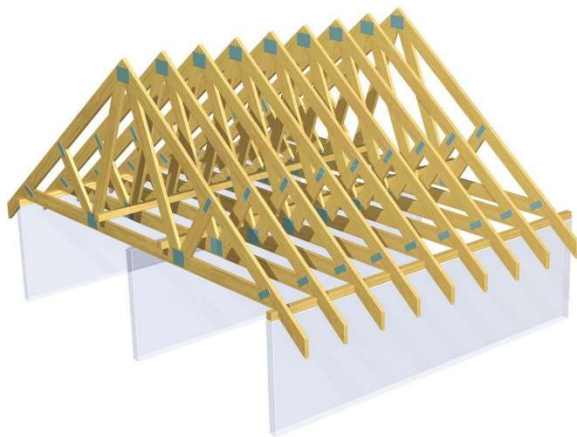
NOTE: A structural engineers report is required to be submitted with the permit application. The existing roof system is required to be analyzed by a licensed professional in order to determine whether or not the existing structure is capable of supporting the increased loads from the solar panel system.



Residential applications typically involve a pitched roof in which solar panels are mounted parallel to the roof pitch. The gravity loads of the solar panels can magnify the uniform loads existing on the roof by concentrating them as point loads. The same holds true for wind loading, as the wind uplift is accumulated through the solar array and directed to the posts that support the solar panel. Also, depending on the roof geometry, the solar panel may act as a sail and catch wind from under the panel, creating very high uplift loads. In some applications, solar panels are put on flat roofs. To achieve higher efficiency, the photovoltaic panels will be posted to the roof such that the panels are at a pitch angled toward the sun. With this geometry, snow can accumulate on the solar array, but can also slide off the panel and create a drift on the low side of the panel. Further, wind can create many different loading scenarios in roof applications.



Yet another concern is that solar panels are often attached to rafters or trusses with lag screws that must land in the center of a 1.5-inch-wide top chord. Depending on the diameter of the connector, a repair may be required due to the section loss of the wood in the top chord. It is highly recommended that all connections of solar panels be made into blocking that is run between trusses, thus avoiding potential damage to the structural integrity of the truss or rafter. This not only prevents the drilling of trusses, but also distributes any point loads between two trusses and decreases the severity of any repairs.



Different types of roof structural systems play a key in how they perform. For instance trusses are different than stick build or I-joists.

Other factors that may need to be taken into account is the number of shingle layers on the roof or the weight of the solar arrays, etc.

2015 IRC Section 802.10.4 states "... Alterations resulting in the addition of load such as HVAC equipment water heater that exceeds the design for the truss shall not be permitted without verification that the truss is capable of supporting additional loading."



5. Technical Data Sheets of Panels, Modules, Inverter and Rack system

LG NeON 2Black

Mechanical Properties

Cell Area	63.10
Cell Interconnect	1.0
Cell Type	Monocrystalline / Hetero
Cell Dimensions	162.76 x 176.75 mm
Cell Interconnect	1.0
Cell Interconnect	1.0
Dimensions (L x W x H)	1640 x 1000 x 40 mm
Front Panel	6000 mm ²
Power Load	1400 W/m ²
Weight	11.0 ± 0.1 kg
Carrier Type	General HKA 410
Carrier Size	6000 x 1000 mm (Standard, Palletized)
Carrier Box	800 x 200 x 100 mm (Standard)
Length of Cable	1.5 m (Standard)
Front cover	High temperature tempered glass
Frame	Aluminum Anodized anti-pollution black coating

Electrical Properties (STC)

Module Type	300 Wp
Maximum Power (P _{max})	300 W
MPP Voltage (V _{mp})	32.3
MPP Current (I _{mp})	9.28
Open Circuit Voltage (V _{oc})	38.7
Short Circuit Current (I _{sc})	9.70
Module Efficiency (%)	18.3
Operating Temperature (T _c)	-40 ~ +85
Maximum System Voltage (V)	1500
Maximum Series Fuse Rating (A)	20
Power Tolerance (%)	±1.0

Electrical Properties (NOCT)

Module Type	300 Wp
Maximum Power (P _{max})	273
MPP Voltage (V _{mp})	28
MPP Current (I _{mp})	9.78
Open Circuit Voltage (V _{oc})	36.3
Short Circuit Current (I _{sc})	9.83

Technical data and types

Type code	PV1-6000-OUTD-US	PV1-6000-OUTD-US
General Specifications		
DC input voltage range	500V/1	600V/1
Maximum input current	6000W	6000W
DC output voltage	200V	240V
DC output current	200A	240A
Input side (DC)		
Number of independent MPPT channels	2	2
Maximum usable power for each channel	3000W	3000W
Maximum DC input voltage (V _{oc})	600V	600V
Start-up voltage (V _{start})	200V (min.) 120-300V	240V (min.) 120-300V
DC input MPPT voltage range	140-550V/1	170-550V/1
DC input MPPT voltage range	170-550V/1	170-550V/1
Autotune and frequency range	N/A	N/A
Maximum power (output) at rated power	6000W	6000W
Maximum power (output) per channel	3000W	3000W
Maximum short circuit current per channel	9.78A	9.78A
Number of wire bonding terminals per channel	2	2
Wire bonding terminals	Terminal block, (reference to the terminal block)	Terminal block, (reference to the terminal block)
Output side (AC)		
Grid connection type	120V/60	120V/60
Autotune voltage range (Min-Max)	180-220V	210-260V
Grid frequency	50/60	50/60
Autotune and frequency range	50/60	50/60
Maximum power (output) at rated power	273W	273W
Maximum power (output) per channel	136.5W	136.5W
Maximum short circuit current per channel	2.87A	2.87A
Number of wire bonding terminals per channel	2	2
Wire bonding terminals	Terminal block, (reference to the terminal block)	Terminal block, (reference to the terminal block)
Protection		
Over-voltage protection type	Varistor, 2 for each channel	Varistor, 2 for each channel
Over-current protection type	Varistor, 2 for each channel	Varistor, 2 for each channel
Over-temperature protection type	Varistor, 2 for each channel	Varistor, 2 for each channel
Efficiency		
DC-DC efficiency	99.1%	99.1%
DC-AC efficiency	96%	96%
Overall efficiency	96%	96%
Operating performance		
Standby consumption	0W	0W
High Airflow consumption	0.8W	0.8W
Use interface	1 characters x 16 lines LCD display	1 characters x 16 lines LCD display
Dimensions	1500mm x 1000mm x 40mm (L x W x H)	1500mm x 1000mm x 40mm (L x W x H)
Environmental		
Ambient air operating temperature range	-10°C to +40°C (20°C to +100°C)	-10°C to +40°C (20°C to +100°C)

Dimensions (mm)

Temperature Characteristics

Current - Voltage characteristics at various irradiance levels

Current - Voltage characteristics at various temperatures

Additional highlights

- RS-485 communication interface (for connection to laptop or data logger)
- Available with the optional VNS300 Web Logger Card for easy and affordable wireless monitoring
- Compliant with NEC 690.12 when used with ABB's Rapid Shutdown device
- Comes standard with DC Arc Fault Circuit Interrupter (AFCI) to comply with NEC 690.11



Enphase® M215 Microinverter / DATA

INPUT DATA (DC)	M215-60-2LL-S22-IG, M215-60-2LL-S25-IG
Commonly used module pairing ¹	100-270 W
Maximum input DC voltage	48 V
Peak power tracking voltage	27 V - 30 V
Operating range	16 V - 48 V
Min/Max start voltage	22 V / 48 V
Max DC open circuit current	15 A
OUTPUT DATA (AC)	60/60 VAC
Peak output power	225 W
Rated (continuous) output power	215 W
Nominal output current	1.03 A (A rms at nominal duration) 0.8 A (A rms at nominal duration)
Nominal voltage range	208 V / 183-220 V
Nominal frequency range	60.0 / 57.81 Hz
Extended frequency range ²	57.82 Hz - 62.5 Hz
Power factor	>0.95
Maximum units per 20 A branch circuit	25 (three phase) 17 (single phase)
Maximum output fault current	850 mA rms for 6 cycles 850 mA rms for 6 cycles
EFFICIENCY	
CEC weighted efficiency, 240 VAC	96.9%
CEC weighted efficiency, 208 VAC	96.9%
Peak inverter efficiency	96.9%
Static MPPT efficiency (weighted, reference EN60503)	94.4%
Night time power consumption	65 mW max
MECHANICAL DATA	
Ambient temperature range	-40°C to +60°C
Dimensions (WxHxD)	171 mm x 173 mm x 30 mm (without mounting bracket)
Weight	1.8 kg (4.0 lbs)
Coating	Natural corrosion - No fans
Enclosure environmental rating	Outdoor - NEMA 4
Connector type	M215-60-2LL-S22-IG, M215-60-2LL-S25-IG, Amphenol H4
FEATURES	
Compatibility	Compatible with 60-cell PV modules.
Communication	Power line
Integrated ground	The DC circuit meets the requirements for ungrounded PV arrays in NEC 690.38. Equipment ground is provided in the Enphase Cable. No additional GEC or ground is required. Ground fault protection (GFP) is integrated into the microinverter.
Monitoring	Enlighten Manager and MyEnlighten monitoring options
Compliance	UL1741/IEEE1547 FOC Part 16 Class B, CAN/CSA-C22.2 NO. 0-MPI, 0.4-0.4, and 1071-01 This product is UL Listed as PV Rapid Shutdown Equipment and conforms with NEC-2014 and NEC-2017 section 690.12 and 690.12-15. It is also listed as a Rapid Shutdown PV System for AC and DC conductors, when installed according to manufacturer's instructions.

¹ Suggester only. Inverter will limit DC volts. Visit <http://enphase.com/en-us/compatibility> to determine module size compatibility.

Ex: Solar Panel

Ex: Inverter

Ex: Micro Inverter/Power Optimizer

IRONRIDGE XR Rail Family

Solar Is Not Always Sunny

Over their lifetime, solar panels experience countless extreme weather events. Not just the worst storms in years, but the worst storms in 40 years. High winds capable of ripping panels from a roof, and snowfalls weighing enough to buckle a panel frame.

XR Rails are the structural backbone preventing these results. They resist uplift, protect against buckling and safely and efficiently transfer loads into the building structure. Their superior spanning capability requires fewer roof attachments, reducing the number of roof penetrations and the amount of installation time.

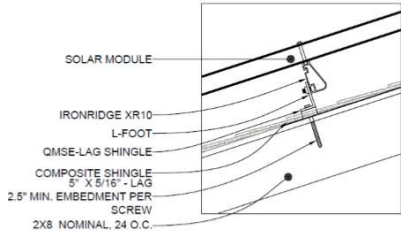
Force-Stabilizing Curve
Bridged roofs generate both vertical and lateral forces on mounting rails which can cause them to bend and twist. The curved shape of XR Rails is specially designed to increase strength in both directions while resisting the twisting. This unique feature ensures greater security during extreme weather and a longer system lifetime.

Compatible with Flat & Pitched Roofs | Corrosion-Resistant Materials

Ex: Rail System

- NOTES:**
1. Rooftop mounted panels/modules shall be tested, listed and identified with a fire classification in accordance with UL 1703.
 2. Roof penetrations shall be flashed and sealed per IRC chapter 9.
 3. Manufactures roof rail system is required to be provided along with inverters, panel arrays and power optimizer/micro inverter information.
 4. Mounting installation guidelines are required to be provided

NOTE:
MODULES SHALL NOT BE GREATER THAN 8 INCHES ABOVE ROOF COVERING



2 MOUNTING DETAIL
SCALE: NTS

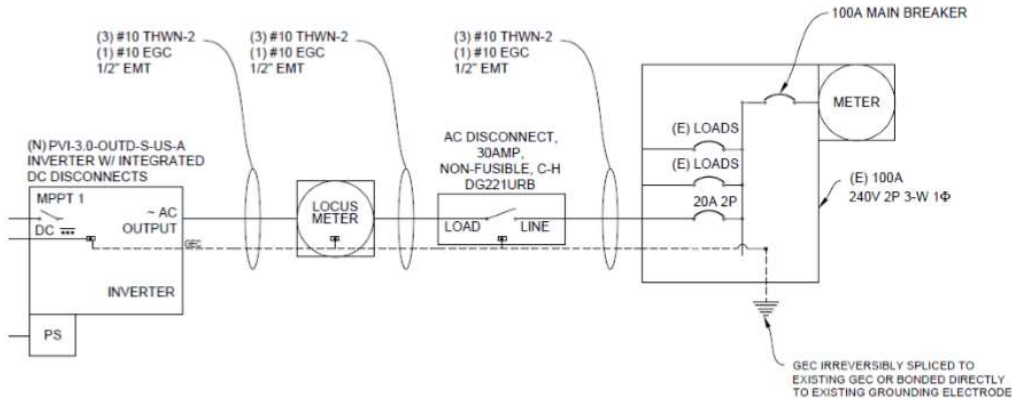
Ex: Mounting detail



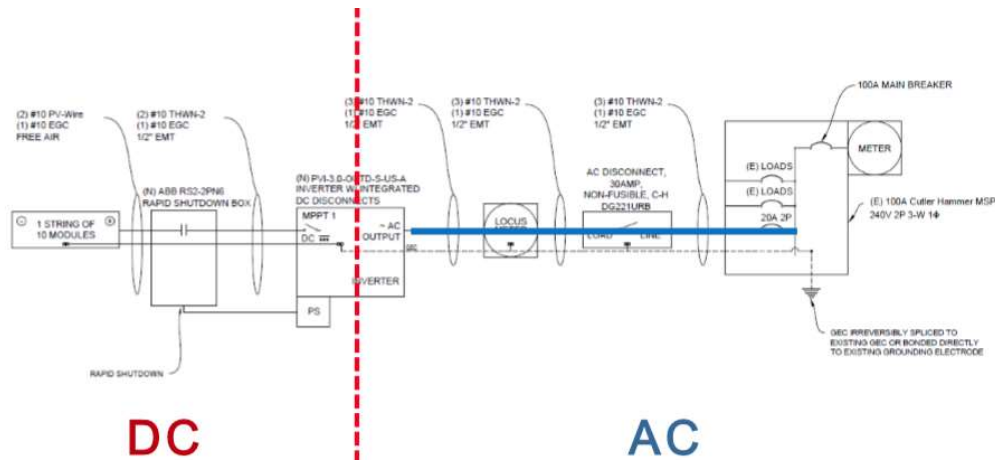
6. Electrical schematic plan to include size of wires, disconnect, types of wires, list of all equipment and components and manufacturers cut sheets of equipment/components.



A State of Iowa Licensed Electrician is required to obtain the electrical permit and perform the installation. The information provided does not reflect all code related items or requirements. The following is just a generic example with some key notes.



Example of Line diagram



DC

AC

Example of Line diagram

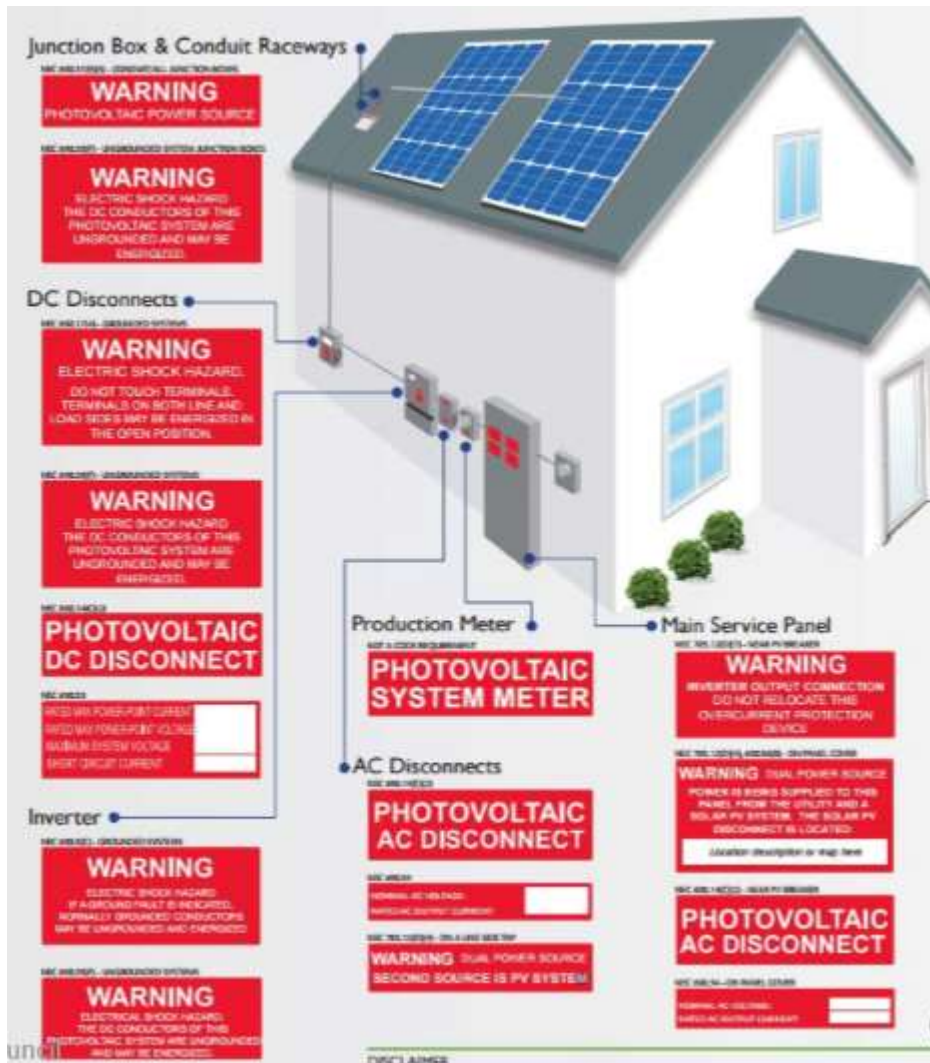
USE-2 Wire is allowed to be used however if the inverter is a transformerless inverter than PV wire must be used

GENERIC BASIC NOTES:

1. The modules and rack are required to be bonded. Two methods are allowed:
 - A. Use the rack to ground/bond the modules
 - B. Use an Equipment grounding conductor to ground/bond the modules
2. The module/rack assembly must be listed for bonding per UL 2703, if using method A
3. The equipment grounding conductor being used is connected to the modules/rack per the manufacturer's installation instructions.
4. If racking system does not meet UL 2703 then each splice is required to be bonded together.
5. If racking system is not used for bonding purposes then each module must be bonded via an Equipment Grounding Conductor or other approved method.
6. Grounding Electrode Conductor must be irreversibly spliced to existing grounding electrode conductor or bonded directly to existing grounding electrode from the Inverter to the main disconnect.



7. Signage requirements



Signage is required to be installed at:

1. Junction boxes
2. Conduit raceways
3. DC disconnects
4. Inverter
5. AC disconnects
6. Main Service panel
7. Production meter

Please refer to NEC Articles 690 & 705 for signage requirements

This handout is to serve as a guide to what the basic requirements are for PV systems. This handout does not cover all code related items. Each structure is reviewed separately and may require additional items depending on site and structure conditions.