THE RAQ INSTALLATION GUIDELINES Version 2.1 Date Created: 3-22-2015

Installation Guidelines are specific to the installation of the **The RAQ** and associated PV components mounted upon **The RAQ** only. The **The RAQ** is to be used strictly for the installation of PV Arrays installed/mounted on composition shingle roofing with Wood Structural Panel or dimension board lumber substrate.

Array Design, Structure and Substrate upon which **The RAQ** and associated Array is installed, roof condition, and any/all other variable factors which may compromise the integrity of the completed installation of the **The RAQ** are, and shall remain, the responsibility of the installer.

The **The RAQ** installation guidelines assume solar photovoltaic installers have sufficient training, knowledge, competence and experience with PV system layout and installation to understand and follow all guidelines.

This is not an exhaustive description of all standard installation practices. This document provides an overview of **The RAQ** installation, and assumes that installers follow basic protocol with regard to all wiring, combiner box installation, and other typical installation and safety practices. In addition, this manual assumes rafters or other supporting structural members are uniformly spaced at 24" on-center, per typical construction practice.

All fasteners supplied with **The RAQ** include a split-lock washer assembly, and have a 7/16" hexagon head, so that no socket changes are required.

All **The RAQ** Installation Guidelines should be thoroughly read and understood prior to commencement of **The RAQ** and PV Array installation to prevent any improper or incomplete installation.

INSTALLATION GUIDELINE INDEX

DEFINITIONS Page 2
THE RAQ MATERIALS Page 2
REQUIRED TOOLS Page 2
PRE-INSTALLATION Page 3
THE RAQ ASSEMBLY and INSTALLATION INSTRUCTIONS
18 PV Panel Array Design – 2 Rows x 9 Panels/Row Page 3
The RAQ Designation Page 4
The RAQ Initial Assembly Page 4
The RAQ Installation Page 5
18 PV Panel Array Design – 3 Rows x 6 Panels/Row Page 6
The RAQ Designation Page 7
The RAQ Initial Assembly Page 7
The RAQ Installation Page 8
FINAL ALIGNMENT and ANCHOR FLASHING Page 9
ACCESSORY INSTALLATION Page 9

PV PANEL INSTALLATION Page 9
ASYMMETRICAL and NON-STANDARD PV ARRAY DESIGNS Page 10

DEFINITIONS

The RAQ	The Racking System upon which PV Panels and associated components are attached.
PV Array	A system of PV Panels and associated components
PV Array Design	A PV Panel Lay-out designed by a suitable qualified designer
PV System	The entirety of all PV components, including Racking System, Junction Box(es), Wiring, Conduit, Disconnect(s), etc.
Anchor Base	'L' shaped bracket attached with Anchor Bolt to existing roof structure
Anchor Bolt	1/4"ø x 4-1/2" long Stainless Steel Lag Bolt and Washer assembly, as supplied with **The RAQ** for attachment of Anchor Base to existing roof structure.
Anchor Flashing	Pre-formed Flashing assembly for use with **The RAQ** installed on shingled roof
Rail Connector	Hardware to laterally connect an additional **The RAQ** for side-by-side installations
PV Clamp	Spring-loaded Clamp for attachment of PV Panels to **The RAQ**
Micro-inverters	Enphase™ Electrical components attached to Racking System at each PV Panel
Trunk Cable	Enphase™ Cable for attachment to micro-inverters
WEEB Clip	Wiley Electronics™ Grounding Clip for attachment of Bond Wire to **The RAQ**
Bond Wire	#6 Gage bare copper wire

THE RAQ Materials

Materials supplied for each 18 PV Panel Array, arranged in two Rows of nine Panels, include:

12	**The RAQ** Universal Rails
12	**The RAQ** Rail Spacer Arms
32	**The RAQ** Anchor Bases
32	**The RAQ** Anchor Bolts
32	**The RAQ** Anchor Flashings
8	**The RAQ** Rail Connectors – each consisting of 2 Connector Plates
8	**The RAQ** Terminal End Pieces
32	**The RAQ** Pre-Assembled PV Panel Mid-Clamps – for installation at rail connections
8	**The RAQ** Pre-Assembled PV Panel End-Clamps
24	Clevis Pins
32	1/4"ø x 1" long Stainless Steel Bolts with square-head nuts & washers (Anchor Bases to Rack Rails)
96	1/4"ø x 1" long Stainless Steel Bolts with washers (Rail Connectors & Terminal Ends to Rack Rails)

REQUIRED TOOLS

The following list of Required Tools is a comprehensive list of all Tools necessary for the complete installation of the The RAQ and PV Array Components directly attached to the The RAQ only.

Additional Tools will be required, including, but not limited to ladder(s), safety harness(es), hole-cutting saw(s), etc., for installation of other components / accessory components as is typically required for the complete installation of a PV System.

Tape Measure
Chalk
Chalk Line
Drill
3/16"ø x 6" "Twist" Drill Bit

Impact Driver – Preferred with adjustable torque setting
7/16" socket suitable for use with “Hex” head bolts
Roofers Flat Bar
The RAQ Spacer Tool – Preferred for efficient installation, though not essential
The RAQ PV Panel Spacer Tool – Preferred for efficient installation, though not essential

PRE-INSTALLATION

The following steps are required prior to the installation of the **The RAQ** system. Failure to comply with the following steps may unnecessarily compromise the successful installation of the **The RAQ**.

PR1) Take measurements on roof. Verify position of system and determine if PV Array layout, as designed, is compatible with Roof Geometry, Roof Obstructions / Penetrations, Rafter Spacing and any/all other Structural, Aesthetic and Geographic conditions which may affect PV Array installation.

NOTE: The Left End of Rack shall finish at 16-1/4” (+/- 1-3/4” maximum adjustability) to the Left of the center of the first rafter inboard (to the Right) from the Left End of the PV Array. Final Array location is specific to Rafter Lay-out.

PR2) Subject to verification of the PV Array design being compatible with ***all*** applicable existing conditions, proceed to step PR3. If PV Array Design is not compatible with existing roof conditions consult PV Array Designer to revise PV Array Design as required.

PR3) Locate the top of the PV Array per the PV Array Design. Measure 10-1/2” down roof slope from top of PV Array and mark across roof with chalk-line. This will be the line of Upper Row, Upper Rail Anchor Bolts.

PR4) Locate Left End of PV Array Design on Roof. The Left End of Rack shall finish between 14-1/2” and 18” to the Left of the center of the first rafter inboard (to the Right) from the Left End of the PV Array.

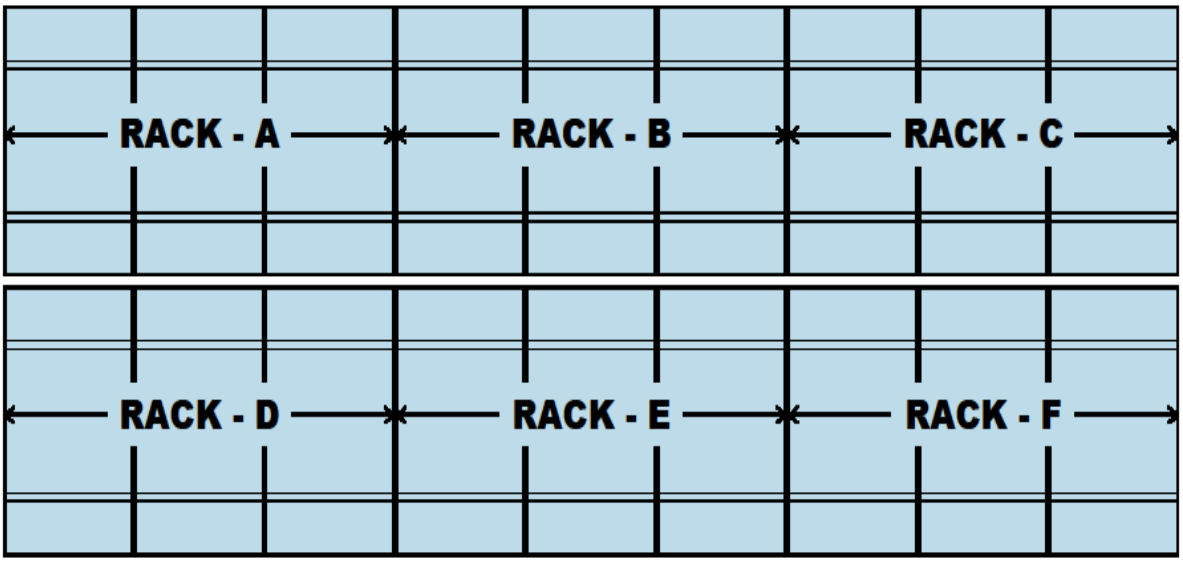
PR5) Locate center of ***ALL*** Rafters at 48”oc to the Right of the first rafter at the left end of the PV Array (per PR4) located directly under PV array and mark with chalk / chalk-line.

THE RAQ ASSEMBLY AND INSTALLATION INSTRUCTIONS

18 Panel PV Array Design – 2 Rows x 9 Panels/Row

The following Installation Steps are specific to the installation of an 18 PV Panel Array with two Rows, nine Panels/Row. The first **The RAQ** installed is to be Rack A - located as the Left rack in the Upper Row.

Installing **The RAQs** in the prescribed rack lay-out sequence is important for later steps.



THE RAQ DESIGNATION : 18 Panel PV Array Design – 2 Rows x 9 Panels/Row

For Rack Assembly and Rack Installation steps, each individual Racks shall be referred to as:

Rack A – Upper Left Rack
Rack B – Upper Middle Rack
Rack C – Upper Right Rack
Rack D – Lower Left Rack
Rack E – Lower Middle Rack
Rack F – Lower Right Rack

THE RAQ INITIAL ASSEMBLY : 18 Panel PV Array Design – 2 Rows x 9 Panels/Row

The following steps are required to assemble the **The RAQ** components prior to installation on the roof. Such initial assembly may be done at the PV Array installation site or at some other location prior to arrival at the PV Array installation site. Select a clear, level area to unload and layout all **The RAQ** components.

PA1) Layout Universal Rails, end to end, in four rows of three Rails per Row – thereby designating Top and Bottom Rails to each Rack in each of the Rows for installation on roof. Rails should be oriented in pairs, with open face of 'C' profiles facing toward each other and holes for future installation of Micro-inverters on top of Rails.

PA2) Install Terminal End Pieces at Left End of Upper and Lower Rails to Rack A with bolts provided.
PA3) Install Rails Connectors at Left and Right Ends of Upper and Lower Rails to Rack B with bolts provided.
PA4) Install Terminal End Pieces at Right End of Upper and Lower Rails to Rack C with bolts provided.
PA5) Install two Rail Spacer Arms to Lower Rails only at each of Rack A, Rack B and Rack C.

PA6) Install three Anchor Bases to both Upper and Lower Rails of Rack A and Rack C, with bolts, nuts and washers provided. Anchor Bases are to be installed at first, third and fifth horizontal slots in edge of Rails starting from Left End of Rail.

a) Orient Anchor Bases with base of Anchor 'Foot' pointing up the slope of the roof specific to final installation
b) Install bolts into vertical slots in Anchor Base, through horizontal slots in Rails.
c) Fasten to Rails with washers and nuts provided. Fastening should be snug, while allowing vertical and horizontal movement for adjustment at final installation

PA7) Install two Anchor Bases to both Upper and Lower Rails of Rack B, with bolts, nuts and washers provided. Anchor Bases are to be installed at second and fourth horizontal slots in edge of Rails, starting from Left End of Rail. Repeat steps PA6-a through PA6-b above.

PA8) Repeat steps PA2 through PA7 above for assembly to Rack D, E & F.

At this point, Initial Rack Assembly is complete and Racks are ready for Installation on roof. Horizontal slots at Rails and vertical slots at Anchor Bases will allow for final horizontal and vertical adjustment as may be required by inconsistent rafter spacing / undulating roof surface.

INSTALLATION INSTRUCTIONS : 18 Panel PV Array Design – 2 Rows x 9 Panels/Row

THE RAQ A

RA.1) Drill Anchor Bolt holes, with 3/16" Drill Bit, along Upper Anchor Bolt Row per markings established across the roof by steps PR.3 through PR.5.

RA.2) Transport Rack A Upper Rail to roof to Install at Left Side of Upper Row. Align Anchor Base Feet with holes per RA.1 and attach to roof with 1/4"ø x 4-1/2" through Anchor Base feet.

RA.3) Transport Rack A Lower Rail to roof and attach to Upper Rail. Unfold Rail Spacer Arms and connect to Upper Rail Spacer Arm bracket with Clevis Pins. Attachment of Spacer Arms to Upper Rail will "square" Lower Rail to Upper Rail.

RA.4) Align Lower Rail Anchor Base Feet with rafter markings per PR.5. Drill through Anchor Base Feet with 3/16" Drill Bit and attach to roof with 1/4"ø x 4-1/2" through Anchor Base feet.

THE RAQ B

RB.1) Transport Rack B Upper Rail to roof to install at Right of Rack A Upper Rail.

RB.2) Align Rails and attach to Rack A Upper Rail at Rail Connector with 1/4" Bolts provided.

RB.3) Transport Rack B Lower Rail to roof and attach to Rack B Upper Rail per RA.3 as related to Rack B.

RB.4) Attach Rack B Lower Rail to roof per RA.4 as related to Rack B.

THE RAQ C

RC.1) Repeat Steps RB.1 through RB.4 above for installation of Rack C attached to Right of Rack B.

THE RAQ D

RD.1) Use **The RAQ Spacer Tool** to appropriately establish the location of lower row of **The RAQ** assemblies.

RD.2) Transport Rack D Upper Rail to install below Rack A. Align Anchor Base Feet over rafter markings per PR.5. Attach per RA.4 as related to Rack D.

RD.3) Repeat steps RB.3 & RB.4 as related to Rack D.

THE RAQ E

RE.1) Repeat step RD.1 as related to Rack E.

RE.2) Repeat steps RB.1 through RB.4 as related to Rack E.

THE RAQ F

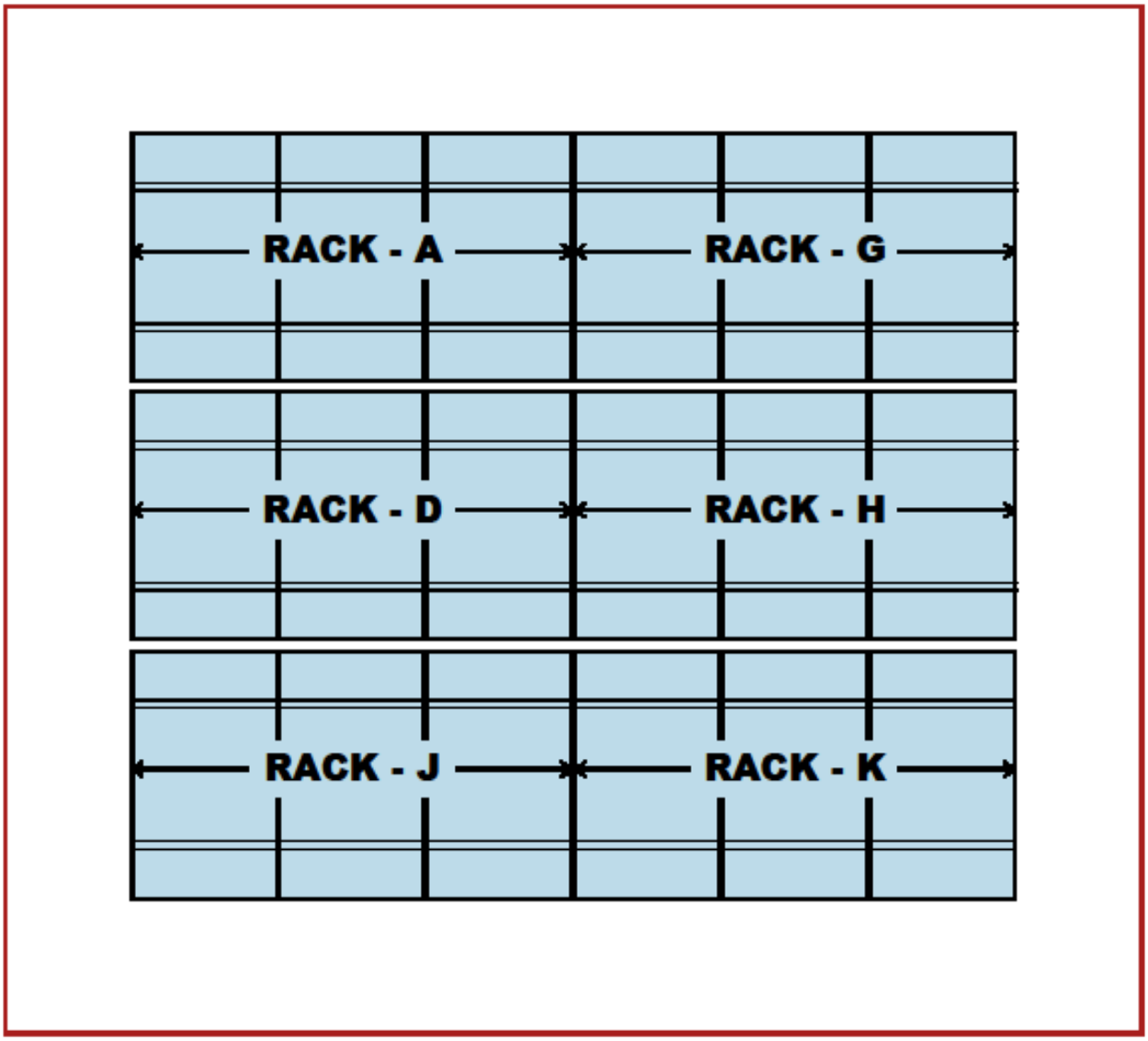
RF.1) Repeat steps RE.1 and RE.2 as related to Rack F.

THE RAQ ASSEMBLY AND INSTALLATION INSTRUCTIONS

18 Panel PV Array Design – 3 Rows x 6 Panels

The following Installation Steps are specific to the installation of an 18 PV Panel Array with three Rows, six Panels/Row. The first **The RAQ** installed is to be Rack A - located as the Left rack in the Upper Row.

Installing **The RAQs** in the prescribed rack lay-out sequence is important for later steps.



THE RAQ DESIGNATION : 18 Panel PV Array Design – 3 Rows x 6 Panels/Row

For Rack Assembly and Rack Installation steps, each individual Racks shall be referred to as:

Rack A – Upper Left Rack

Rack G – Upper Right Rack
Rack D – Middle Left Rack
Rack H – Middle Right Rack
Rack J – Lower Left Rack
Rack K – Lower Right Rack

THE RAQ INITIAL ASSEMBLY : 18 Panel PV Array Design – 3 Rows x 6 Panels/Row

The following steps are required to assemble the **The RAQ** components prior to installation on the roof. Such initial assembly may be done at the PV Array installation site or at some other location prior to arrival at the PV Array installation site. Select a clear, level area to unload and layout all **The RAQ** components.

PA1) Layout Universal Rails, end to end, in six rows of two Rails per Row – thereby designating Top and Bottom Rails to each Rack in each of the Rows for installation on roof. Rails should be oriented in pairs, with open face of 'C' profiles facing toward each other and holes for future installation of Micro-inverters on top of Rails.

PA2) Install Terminal End Pieces at Left End of Upper and Lower Rails to Rack A with bolts provided.

PA3) Install Rails Connectors at Left End and Terminal End Piece at Right End of Upper and Lower Rails to Rack G with bolts provided.

PA4) Install two Rail Spacer Arms to Lower Rails only at each of Rack A and Rack G.

PA5) Install three Anchor Bases to both Upper and Lower Rails of Rack A and Rack G, with bolts, nuts and washers provided. Anchor Bases are to be installed at first, third and fifth horizontal slots in edge of Rails starting from Left End of Rail.

a) Orient Anchor Bases with base of Anchor 'Foot' pointing up the slope of the roof specific to final installation
b) Install bolts into vertical slots in Anchor Base, through horizontal slots in Rails.
c) Fasten to Rails with washers and nuts provided. Fastening should be snug, while allowing vertical and horizontal movement for adjustment at final installation

PA6) Repeat steps PA2, PA4 and PA5 above for assembly of Rack D and Rack J.

PA7) Repeat steps PA3, PA4 and PA5 above for assembly of Rack H and Rack K.

At this point, Initial Rack Assembly is complete and Racks are ready for Installation on roof. Horizontal slots at Rails and vertical slots at Anchor Bases will allow for final horizontal and vertical adjustment as may be required by inconsistent rafter spacing / undulating roof surface.

INSTALLATION INSTRUCTIONS : 18 Panel PV Array Design – 3 Rows x 6 Panels/Row

THE RAQ A

RA.1) Drill Anchor Bolt holes, with 3/16” Drill Bit, along Upper Anchor Bolt Row per markings established across the roof by steps PR.3 through PR.5.

RA.2) Transport Rack A Upper Rail to roof to Install at Left Side of Upper Row. Align Anchor Base Feet with holes per RA.1 and attach to roof with 1/4"ø x 4-1/2” through Anchor Base feet.

RA.3) Transport Rack A Lower Rail to roof and attach to Upper Rail. Unfold Rail Spacer Arms and connect to Upper Rail Spacer Arm bracket with Clevis Pins. Attachment of Spacer Arms to Upper Rail will “square” Lower Rail to Upper Rail.

RA.4) Align Lower Rail Anchor Base Feet with rafter markings per PR.5. Drill through Anchor Base Feet with 3/16” Drill Bit and attach to roof with 1/4"ø x 4-1/2” through Anchor Base feet.

THE RAQ G

RG.1) Transport Rack G Upper Rail to roof to install at Right of Rack A Upper Rail.

RG.2) Align Rails and attach to Rack A Upper Rail at Rail Connector with 1/4" Bolts provided.

RG.3) Transport Rack G Lower Rail to roof and attach to Rack B Upper Rail per RA.3 as related to Rack G.

RG.4) Attach Rack G Lower Rail to roof per RA.4 as related to Rack G.

THE RAQ D

RD.1) Use **The RAQ Spacer Tool** to appropriately establish the location of lower rows of **The RAQ** assemblies.

RD.2) Transport Rack D Upper Rail to install below Rack A. Align Anchor Base Feet over rafter markings per PR.5. Attach per RA.4 as related to Rack D.

RD.3) Repeat steps RG.3 & RG.4 as related to Rack D.

THE RAQ H

RE.1) Repeat step RD.1 as related to Rack H.

RE.2) Repeat steps RG.1 through RG.4 as related to Rack H.

THE RAQ J

RF.1) Repeat steps RD.1 through RD.3 as related to Rack J.

THE RAQ K

RF.1) Repeat steps RH.1 and RH.2 as related to Rack K.

FINAL ALIGNMENT & ANCHOR FLASHINGS

FL1) Where possible, with suitable access, inspect accuracy of installation from inside attic to verify integrity of Anchor Bolt fastening correctly into rafters. Where such inspection mat reveal exposed Anchor Bolt threads from Bolts below, corrective actions will be required.

FL2) Verify Rails at all Racks to be level and straight. Adjust vertically as may be required. Tighten all Anchor Base to Rail bolts initially left “snug” per PA.6.c

FL3) Install Anchor Flashings at each Anchor Base.

FL4) Use Roofers Flat Bar to separate upper shingle from lower shingle above each Anchor Base. Take care not to damage roof.

FL5) Slide Anchor Flashing under upper shingle and over Anchor Base assembly.

FL6) Fold Tabs at lower vertical edge of Anchor Flashing around Anchor Base to secure flashing to **The RAQ**.

ACCESSORY INSTALLATION

AC1) Install The RAQ Pre-Assembled PV Panels Clamps Top and Bottom Rails. Insert square-headed bolt head through hole at end of clamp slot. Slide to middle of clamp slot. Adjust final location of PV Panel Clamp at time of PV Panel installations (PV1)

AC2) Install Micro-inverters into provided locations as per typical installation.

AC3) Tighten micro-inverter to rack at predetermined locations, using included mounting hardware.

AC4) Install trunk cable as per typical installation.

AC5) Install “WEEB” bonding clips at pre-drilled holes at either or both ends (if required/desired) of Terminal Ends.

AC6) Install #6 bare copper wire as per typical installation.

PV PANEL INSTALLATION

PV1) Using previously installed pre-assembled clamps, mount PV Panels from LEFT side of UPPER row. Proceed with successive PV Panel installation moving RIGHT.

PV2) Use **THE RAQ PANEL SPACER TOOL** to properly align and space PV Panels between upper row of PV Panels and lower row of PV Panels.

PV3) Tighten down pre-assembled clamps using impact driver.

Complete entire installation using typical installation protocols and procedures for Junction Box(es), Disconnect(s), Conduit(s), any/all other required accessories as may be applicable.

ASYMMETRICAL and NON-STANDARD PV ARRAY DESIGNS

Not all PV Array Designs are symmetrical – consisting of unequal numbers of PV Panels/Row, or otherwise requiring "Non-Standard" PV Panel placement – often due to roof geometry, obstructions, roof penetrations, shade conditions or other factors.

Asymmetrical and Non-Standard PV Array Designs will, in most cases, utilize the installation of one or more THE RAQ SINGLE rack systems – either as extension(s) to THE RAQ(S), "Stand Alone Single Panel" or "Stand Alone Double Panel" configurations.