NSAI Agrément

IRISH AGRÉMENT BOARD
CERTIFICATE NO. 18/0397
Joule Ireland
Kylemore Parkwest,
Ballyermot, Dublin 10
Tel: +353 (0) 1 623 7080
Fax: +353 (0) 1 626 9337
Email: info@joule.ie
Web: www.joule.ie

Joule Pulsa Solar PV Systems

Le système solaire photovoltaïque

NSAI Agrément (Irish Agrément Board) is designated by Government to carry out European Technical Assessments.

NSAI Agrément Certificates establish proof that the certified products are **'proper materials'** suitable for their intended use under Irish site conditions, and in accordance with the **Building Regulations 1997 to 2017**.

PRODUCT DESCRIPTION:
This Certificate relates to the Joule Pulsa Solar PV Systems utilising the Monocrystalline and Polycrystalline range of Photovoltaic (PV) collectors and ancillary items.
Each system is comprised of an array of photovoltaic solar collectors, DC to AC Inverter equipment and cables, on-roof fixing kit and user & installation manual.

This Certificate certifies compliance with the requirements of the Building Regulations 1997 to 2017.

USE:
The Joule Pulsa Solar PV collectors are suitable for application on new and existing buildings with a roof pitch of between 5º-70º. The collectors must be fixed to a roof that meets the requirements of SR 82:2017. In addition, all relevant aspects related to the fixing of the PV panel to the roof structure shall be designed and installed to comply with SR 50-2:2012.

The Joule Pulsa Solar PV Systems should be installed by competent persons with suitable training and practical experience of the systems and have been approved by Joule Ireland to install the system.

MARKETING, DESIGN AND MANUFACTURE:
Joule Pulsa Solar PV Systems are manufactured on behalf of:

Joule Energy Solutions.
Kylemore Parkwest,
Ballyfermot, Dublin 10.
Tel: 01 623 7080
Fax: 01 626 9337
Email: info@joule.ie
Web: www.joule.ie

Joule Energy Solutions also design, market and distribute the Joule Pulsa Solar PV systems.

1.1 ASSESSMENT

In the opinion of NSAI Agrément, the Joule Pulsa Solar PV Systems, if used in accordance with this Certificate can meet the requirements of the Building Regulations 1997 to 2017, as indicated in Section 1.2 of this Agrément Certificate.

1.2 BUILDING REGULATIONS 1997 to 2017

REQUIREMENTS:

Part D – Materials and Workmanship

D3 – Proper Materials

The Joule Pulsa Solar PV Systems, as certified in this certificate, are comprised of 'proper materials' fit for their intended use (see Part 4 of this Certificate).

D1 – Materials & Workmanship

The Joule Pulsa Solar PV Systems, as certified in this certificate, meet the requirements for workmanship.

Part A - Structure

A1 – Loading

The Joule Pulsa Solar PV Systems, once appropriately designed and installed in accordance with this certificate, have adequate strength and stability to meet the requirements of this Regulation (see Part 3 of this Certificate).

Part B – Fire Safety/Vol 2 (Dwelling Houses)

B4/B9 – External Fire Spread

The Joule Pulsa solar PV systems will not affect the external fire rating of the roof structure on which they are installed (see Part 4 of this Certificate).

Part C – Site Preparation and Resistance to Moisture

C4 – Resistance to Weather and Ground Moisture

The Joule Pulsa Solar PV Systems, once appropriately designed and installed in accordance with this certificate, will not affect a roof's resistance to the ingress of moisture (see Part 4 of this Certificate).

Part L – Conservation of Fuel and Energy

L1 – Conservation of Fuel and Energy

The Joule Pulsa Solar PV Systems can be designed to meet the minimum level of energy provision from renewable technologies stated in this Regulation (i.e. 4kWh/m^2/annum), contributing to electrical energy use for domestic buildings.

The solar PV technology referenced on this certificate can contribute to the Renewable Energy Ratio (RER) requirements of TGD Part L Non-Domestic Energy Assessment Procedure (NEAP). The RER is the ratio or primary energy from renewable energy sources to total primary energy.

2.1 PRODUCT DESCRIPTION

This Certificate relates to the Joule Pulsa solar PV systems utilising the Monocrystalline and Polycrystalline range of Photovoltaic (PV) collectors and ancillary items.

Each system is comprised of a photovoltaic solar collector, a DC to AC Inverter, solar DC cable, a branch terminator, extruded aluminium mounting rails, End and Mid Panel fixing clamps, both AC and DC electrical isolators, a roof fixing kit and user & installation manuals.

Figures 1 to 3 show the main elements of the Joule Pulsa solar PV systems. Tables 1-3 show the Joule Pulsa solar PV systems range and technical specifications.

The Joule Pulsa PV Solar modules have been tested by TÜV SÜD- München to the requirements of I.S. EN 61215-2:2005: *Crystalline silicon terrestrial photovoltaic (PV) modules – Design, qualification and type approval*, and I.S EN 61730: *Photovoltaic (PV) module safety qualification*, Part 1: *Requirements for construction* & Part 2: *Requirements for testing*.

2.1.1 Joule Pulsa PV Solar Modules

The Joule Pulsa system offers two cell-sized modules; 60 cell and 72 cell modules. The PV modules consist of six strings of PV cells 156 x 156mm square, monocrystalline and polycrystalline. The front cover consists of 3.2mm thick tempered glass and the rear coating consists of layers of specialist polymers. The frame consists of a 40mm anodized aluminium alloy. The junction box of the PV module has a minimum protection class of IP68.

The collectors operate by daylight entering the solar cells, causing movement of electrons which generates an electrical DC current.

The PV modules can be arranged into an array of variable size, depending on the requirements of the design and the available mounting space.

2.1.2 Inverters

A DC/AC inverter is required to convert the direct current (DC) generated by the PV modules into a useable alternating current (AC) so the power produced can be used by the electrical appliances in the building. There are two types of invertors approved in this certificate:

- String inverters (Omnik)
- Micro inverters (Enphase)

The inverter specified by Joule Ireland is sized according to the number of PV modules required in the design.

2.1.2.1 String Inverters

With residential string inverters, all solar collectors are connected in a series circuit to a DC electric cable, which is then connected to a single inverter.

The string inverter should be mounted at a suitable location in an accessible loft space or beside the property's main AC consumer unit. String inverters produce power at slightly higher voltage than the grid. The inverter is wired back to the consumer unit where it delivers power to the electric loads within the building or exporting.

The maximum number of panels that can be installed using a string inverter is only limited by the kW capacity of the inverter. All DC and AC cabling must be sized correctly to carry the electrical load from the panels back to the inverter, which is then wired back to the consumer board.

2.1.2.2 Micro Inverters

Micro inverters are small roof mounted inverters rated to handle the output of one to two panels. The use of micro inverters ensures that any panel that is under-performing does not affect the performance of the remaining panel.

Additional compatible panels can be added to an array at any time once all the other requirements of this certificate are met. Micro inverters produce grid-matching AC power directly at the panel. Arrays of panels are connected in parallel to each other, and then to the grid. Additional panels can be added, up to a maximum of seven micro inverters per branch. Three branches can be connected in a three-phase system (21 panels).

2.2 MANUFACTURE AND OPERATION

The Joule Pulsa solar PV collectors consist of the PS monocrystalline and polycrystalline designs, available in two different cell configurations (see tables 1 to 3).

The cells of the polycrystalline PV collectors are manufactured using thin wafers of silicon which are cut from a block of silicon crystal which are made up from multiple crystals. The cells used in the Monocrystalline PV collector are manufactured from a large single silicon crystal.

Both the monocrystalline and polycrystalline PV collectors contain cells measuring 156 x 156mm squares, which are housed in anodized aluminium alloy frame complete with 3.2mm toughened glass.

2.3 DELIVERY, STORAGE AND HANDLING

Joule Energy Solutions supply a complete package for each PV system, which includes the PV modules, inverters, electrical isolators, roof mounting kit, user & installation manual and labelling packs.

Collectors should always be stored indoors, preferably in a vertical position, otherwise on the flat (frame on frame), ensuring no weight is applied to the wafer area, with the glass facing upwards. Heavy goods should not be loaded on top of the kit boxes. Care should be taken when opening boxes to prevent scratches or sudden shocks to the flat panels.

Associated components also supplied should be stored in a clean, dry and frost-free environment until ready for installation. Parts should be inspected for damage on arrival to site.

Current health and safety legislation apply to these products with regard to safe lifting and manual handling.

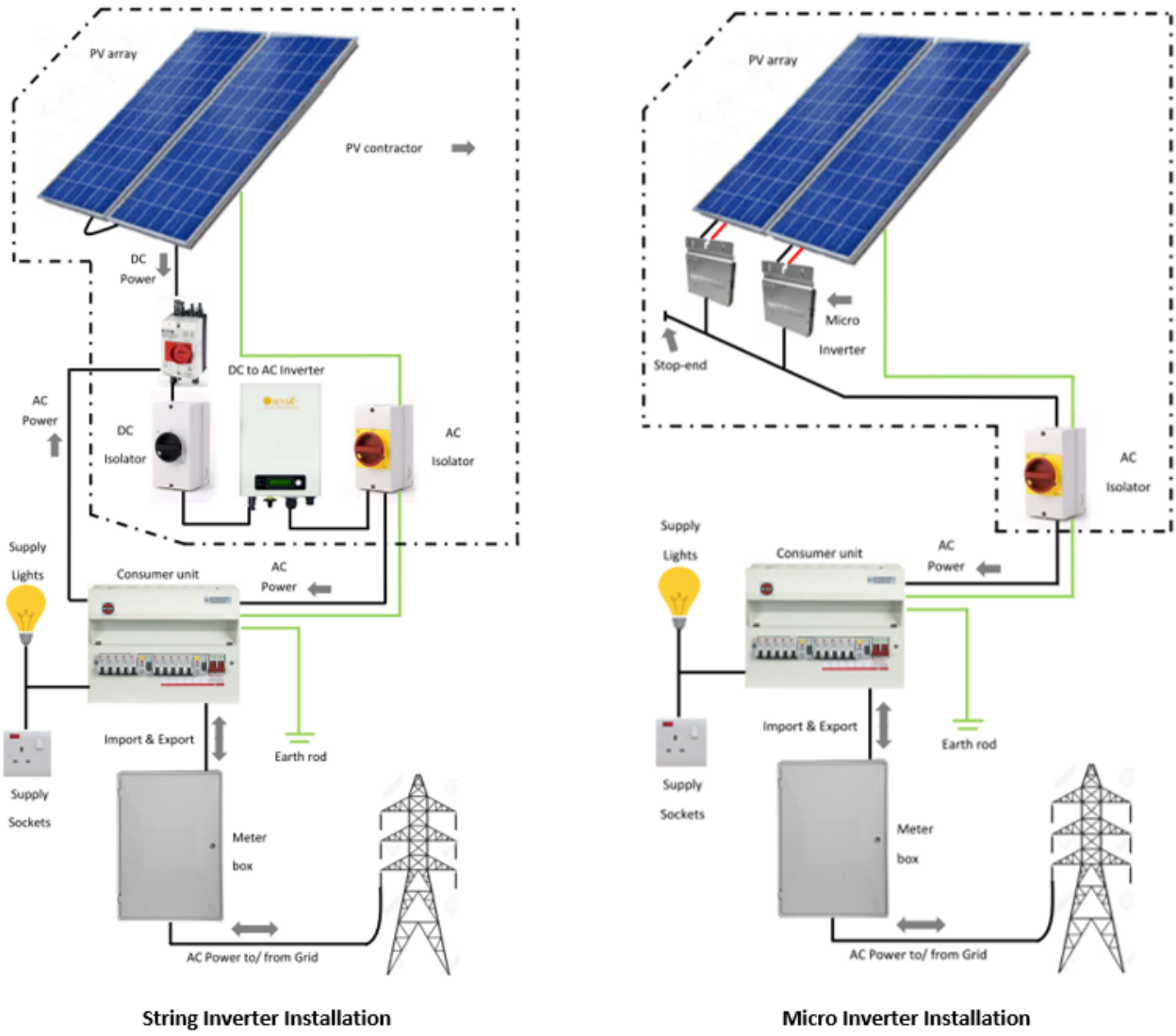


Figure 1: System Components

Table 1: PV Module Specification		
Photovoltaic panel type	**Monocrystalline & Polycrystalline**	
	60 Cell	**72 Cell**
Panel length (up roof) (m)	1.64	1.956
Panel width (across roof) (m)	0.992	0.992
Panel depth (mm)	40	40
Frame colour	Black Anodised Aluminium	Black Anodised Aluminium
Panel weight (kg)	19	22.5

Table 2: Electrical Characteristic / Performance (1) – Joule Monocrystalline Panels												
	PS255M-20/U	PS260M-20/U	PS265M-20/U	PS270M-20/U	PS275M-20/U	PS280M-20/U	PS280M-24/T	PS290M-24/T	PS300M-24/T	PS310M-24/T	PS320M-24/T	PS330M-24/T
Number of Cells	60						72					
Nominal peak power rating (W)	255	260	265	270	275	280	280	290	300	310	320	330
Tolerance (%)	±3%						±5%					
Open circuit voltage (V)	38.0	38.1	38.2	38.3	38.4	38.5	45.1	45.5	45.9	46.3	46.7	47.1
Maximum power voltage (V)	30.6	30.8	31.0	31.2	31.4	31.6	36.1	36.4	36.7	37.1	37.4	38.0
Short circuit current (A)	8.75	8.85	8.95	9.05	9.10	9.15	8.3	8.45	8.6	8.75	8.9	8.99
Maximum power current (A)	8.35	8.46	8.55	8.65	8.75	8.86	7.75	7.97	8.17	8.36	8.55	8.68
Module efficiency (%) (2)	15.67	15.98	16.29	16.60	16.90	17.20	14.45	14.96	15.47	15.98	16.49	17.00
Maximum System DC voltage (V)	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Series fuse rating (A)	15	15	15	15	15	15	15	15	15	15	15	15

Table 3: Electrical Characteristic / Performance (1) – Joule Polycrystalline Panels										
	PS250P-20/U	PS255P-20/U	PS260P-20/U	PS265P-20/U	PS270P-20/U	PS280P-24/T	PS290P-24/T	PS300P-24/T	PS310P-24/T	PS320P-24/T
Number of Cells	60					72				
Nominal peak power rating (W)	250	255	260	265	270	280	290	300	310	320
Tolerance (%)	±3%					±5%				
Open circuit voltage (V)	37.8	37.9	38.0	31.1	38.2	44.8	45.2	45.6	46.0	46.4
Maximum power voltage (V)	30.2	30.4	30.6	30.8	31.0	35.8	36.1	36.4	36.7	37.0
Short circuit current (A)	8.7	8.8	8.90	9.0	9.10	8.35	8.50	8.65	8.80	8.95
Maximum power current (A)	8.30	8.42	8.53	8.61	8.71	7.82	8.03	8.24	8.45	8.65
Module efficiency (%) (2)	15.37	15.67	15.98	16.29	16.60	14.42	14.94	15.46	15.98	16.23
Maximum System DC voltage (V)	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Series fuse rating (A)	15	15	15	15	15	15	15	15	15	15

(1) Performance of standard test conditions: irradiance 1000W^2, cell temperature 25ºC, AM 1.5 spectrum.
(2) Based on aperture area

Table 4: Annual Solar Radiation, kWh/m² [1]					
/	Orientation of collector				
Tilt of Collector	South	SE/SW	E/W	NE/NW	North
Horizontal	963				
15⁰	1036	1005	929	848	813
30⁰	1074	1021	886	736	676
45⁰	1072	1005	837	644	556
60⁰	1027	956	778	574	463
75⁰	942	879	708	515	416
Vertical	822	773	628	461	380

[1] **Taken from Table H2, DEAP Version 3.2.1**

Table 5: Overshading factors from SEAI DEAP Manual		
Over Shading	% sky blocked by obstacles	Overshading Factor
Heavy	> 80%	0.50
Significant	60% - 80%	0.65
Modest	20% - 60%	0.80
None or Very Little	< 20%	1.00

[1] **Taken from Table H2, DEAP Version 3.2.1**

Worked DEAP Example
Output (kWh) = 0.8 x kWp x S x Z_{pv}

Where:

kWp = installed peak power
S = annual solar radiation (from table 4)
Z_{pv} = overshading factor (from DEAP manual Table 7, typically a value of 1 were placed on a roof with no shading)

Example calculation
For an array of 4 monocrystalline silicon panels each with a nominal peak power of 260 Wp (i.e nominal peak power rating for the PS260M-20/U panel per Table 2), mounted on a roof with a 30˚ pitch facing directly south with no overshading, the total installed capacity would be:

Installed peak power: 0.26 x 4 = 1.04 kWp (260Wp = 0.26 kWp, x No. of panels in array).

The annual approximated output would be: 0.8 x 1.04 x 1,074 x 1 = 893.57 kWh.

**This calculation method is used in the SEAI DEAP software.*

2.4 INSTALLATION

2.4.1 General

The Joule Pulsa Solar PV Systems should be installed by competent persons with suitable training and practical experience of the systems and who have been approved by Joule to install the system. The installer shall fully understand the requirements of the customer, have completed a user and installation health & safety risk assessment and an installation health and safety risk assessment.

The necessary electrical installation should be undertaken by a qualified RECI electrical contractor. Solar PV panel installation must be performed in accordance with all Health & Safety legislation and local building/planning regulations, and must comply with ET101 for the system components, including the cables, connectors, charging controllers, inverter, etc.

Under normal conditions, a module is likely to produce more current and/or voltage than reported under Standard Test Conditions (stc). Accordingly, the values of current short circuit (Isc) and voltage open circuit (Voc) marked on the module nameplate should be multiplied by the following safety factors:

- Voltage > Voc (stc) x M x 1.15:
- Current > Isc (stc) x (N-1) x 1.25

Where M is the number of modules in a string and N is the number of strings in the array.

Example calculation

(for the PS260M -20/U panel as per table 2)

- 2 strings of 6 PV modules
- 38.1 Voc, 8.85 Isc, (PV module datasheet)

38.1 x 6 x 1.15 = 263 Vmin
8.85 x (2-1) x 1.25 = 11.06 Imin

All electrical components on the circuit must have a voltage and current rating greater than 263V DC and have a current carrying capacity of greater than 11.06 amps.

Joule Energy Solutions can be contacted for guidance when determining the component voltage ratings, conductor current ratings, fuse sizes and the size of controllers connected to the photovoltaic system.

Care is required when working with electrical cables. Electrical connectors should never be opened or unplugged while the circuit is under load (when there is direct light on the panels). Extreme care should also be exercised not to touch the end with electricity during installations when the modules are exposed to sunlight.

To protect the installer from current and voltage shock during installation, the DC cables should be fitted into a junction box in the building before connecting the PV modules.

In addition, an opaque board can be used to cover the modules while making electrical connections. Only industrial approved insulated tools shall be used during installation.

Earthing of the PV array shall be performed in accordance with IEC62540. Earthing/ bonding of the exposed conductive parts of a PV array shall be performed by bonding of an earth cable to the metal frame.

The conductor used to earth exposed metallic frames of the PV array shall have a minimum size of 6mm^2 copper or equivalent.

If the PV array requires lightning protection a 16mm^2 copper conductor shall be bonded to the array and fitted to the existing lightning protection system.

The Joule Pulsa PV modules and inverters comply with conditions specified in EN 50438: 2007 and are supplied with Irish electrical grid settings.

For safety, the inverters require a small mains current to operate, and in the event of loss of mains supplied electricity, they will not operate or generate electricity.

Fixings used with PV solar collectors must comply with clause 4.11 (fittings) and 5.9 (battens and counter-battens) of SR 82:2017. All tiles adjacent to the collectors shall be mechanically fixed in place and the fixing design shall comply with the requirements of SR 50-2: 2012.

2.4.2 Pre-Installation Product Details

The nameplate labels are affixed to the back of each module which provide the following information:

- Product description
- Rated power*
- Rated current*
- Rated voltage*
- Open circuit voltage*
- Short circuit*
- Weight, dimensions etc.
- A 15-digit barcode

(* measured under Standard Test conditions)

Note: The value of VOC (voltage at open circuit) times the number of modules in series shall not be greater than the maximum system voltage marked in the nameplate (1000V DC.).

The roof is assessed to establish the best position and orientation of the modules. To minimise uplift caused by wind loads, collectors shall not be installed within 0.5m from the edge of the roof or projection.

2.4.2.1 Risk Assessment

Before work commences on the installation, a health and safety risk assessment must be completed and recorded by the installer in the risk assessment form. Items assessed to include:

- Safe access to the roof.
- Ability of roof structure to accommodate all applied loadings.
- Working at height.
- Manual handling.
- Working in dusty/ dark/ confined spaces.
- Lifting of materials including cranes, teleporters forklifts.
- Working near or close to openings i.e. stair or loft openings.
- Use of power tools.
- Effects of wind and snow loads.
- Fire mitigation.
- Fireman safety.
- Access for routing electrical cables.
- Protection from overhead wires.
- Any other risk associated with the installation.

Cautions to include:

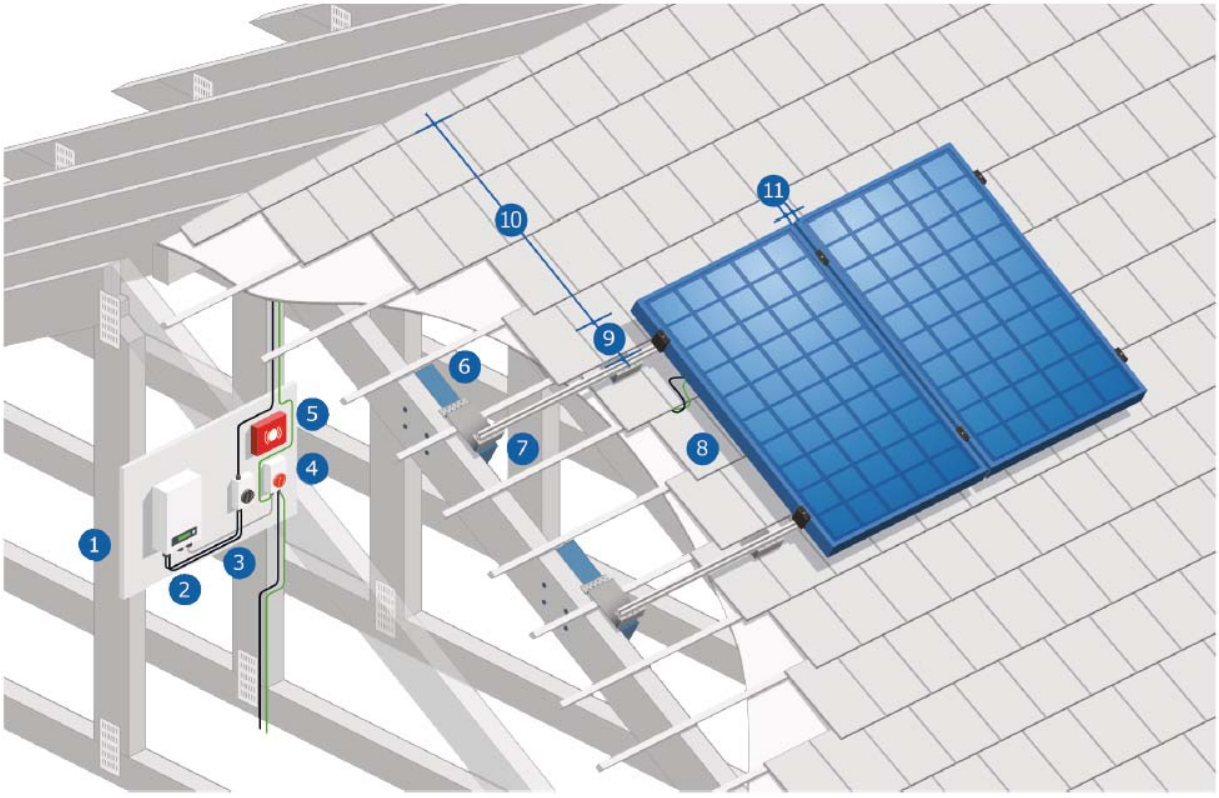
- Hardware used must be compatible with the mounting material to avoid galvanic corrosion.
- Only connectors that are designed for photovoltaic systems and that match the PV modules shall be used.
- Only specialist tools, as recommended by the connector manufacturer shall be used when making electrical connectors for panel.
- The maximum number of series connected modules, which depends on system design, the type of inverter used and environmental conditions, shall not be exceeded.
- The grounding cable must be properly fastened as referenced in 2.4.1.
- As supply from PV modules cannot be switched off, special precautions shall be made to ensure that live parts are either not accessible or cannot be touched during installation, use and maintenance.
- If the inverter is mounted in the loft it should be within 1m from the DC cable point of entry. Otherwise a fireman switch shall be fitted, again, within 1m of the DC cable entering the loft.
- PV modules are current-limiting devices, which require a non-standard approach when designing fault protection systems. Fuses are not likely to operate under short-circuit conditions. DC fuses are required when joining three or more strings of PV panels in parallel.
- If the building is deemed to require a lightning protection system (LPS), a suitably qualified lightning protection design professional shall be engaged. The advice of Joule Ireland shall be sought in such instances.

2.4.3 Site Survey

Following completion of the initial risk assessment, a site survey must be carried out by the installer using the pre-installation survey form. Copies of this should be kept by the homeowner and installer. This survey will typically cover the following points:

- Verify details from the Solar Quotation Enquiry Form.
- Identification of any special user requirements.
- Shade, such as that cast from trees or neighbouring buildings, can have a significant impact on the performance of a system. Both the current and future potential risk shall be considered.
- The buildings location and orientation of the modules will have a significant effect on the power generated by the system. A south facing elevation at 35° pitch is ideal (south-east or south-west elevations can also achieve favourable results).
- The pitch of the roof is greater than 15˚ (5˚ if a flat roof mounted system utilised).
- The pitch of the roof is less than 70˚.
- If the panels are required to go on two orientations, then each orientation should be split into two separate strings.
- Annual solar radiation for different roof pitch and orientation are given in Table 4.

- Access to collector location for both installation and maintenance.
- All DC cables should be installed to provide the shortest run possible. Positive and negative cables of the same string or main DC supply should be installed together, avoiding the creation of loops in the system. This requirement includes any associated earth/ bonding conductors.
- A suitable location for the inverter, ideally in the loft mounted on a fireproof board (provided there is a safe means of access), alternatively in the utility room or next to the main consumer board.



1- Flame retardant board
2- DC to AC Inverter
3- DC Isolator
4- AC Isolator
5- Fire alarm
6- Timber reinforcing plant
7- Roof hook
8- PV module
9- 200mm Aluminium rail offset
10- 500mm minimum edge offset
11- Minimum 20mm gap

Figure 2: Roof fixing layout

Roof Fixings

Joule Energy Solutions define the roof kit to be used, depending on the type of slate/ tile used. Only approved Schletter and K2 roof brackets supplied by Joule shall be used. These are manufactured from Stainless Steel. All roof fixings specified for types of all pitched roofs are MCS 012 certified. Isolation gaskets shall be used where necessary to ensure bi-metallic corrosion does not occur.

The PV modules and fixing bracket systems are designed to cover all Irish wind zones (as illustrated in Figure NA.1 in Irish National Annex to Eurocode 1). However, in high wind load areas, e.g. at excessive heights or very exposed areas, additional roof fixing brackets may be required. The advice of Joule Energy Solutions shall be sought in all such instances, or if doubt exists.

Two bracket sets per collector are required as a minimum, dependant on the on the site-specific wind load analysis of the building. These brackets should be directly fixed into a timber reinforcing plant (not standard rafters or battens). See Figure 2 and Figure 5 of this certificate.

The roof bracket shall be fixed to the timber reinforcing plant using a minimum of 2 no. Heco Topix wood screws Ø8x80mm, or equivalent. The installer shall ensure the wood screws are securely fixed to the timber reinforcing plant, using the midpoint holes in the bracket to satisfy edge distances. To accommodate site-specific slates/ tiles and batten heights, plastic spacers can be used in different combinations to pack the mounting brackets accordingly.

Slates/ tiles at fitting locations shall be trimmed or re-worked as required to accommodate non-transference of mechanical loads due to wind deflections. See Figures 6, 7 and 8.

Module bearing rail Schletter Solo 05, module clamps Schletter Rapid 2+ are used to secure PV modules to the roof.

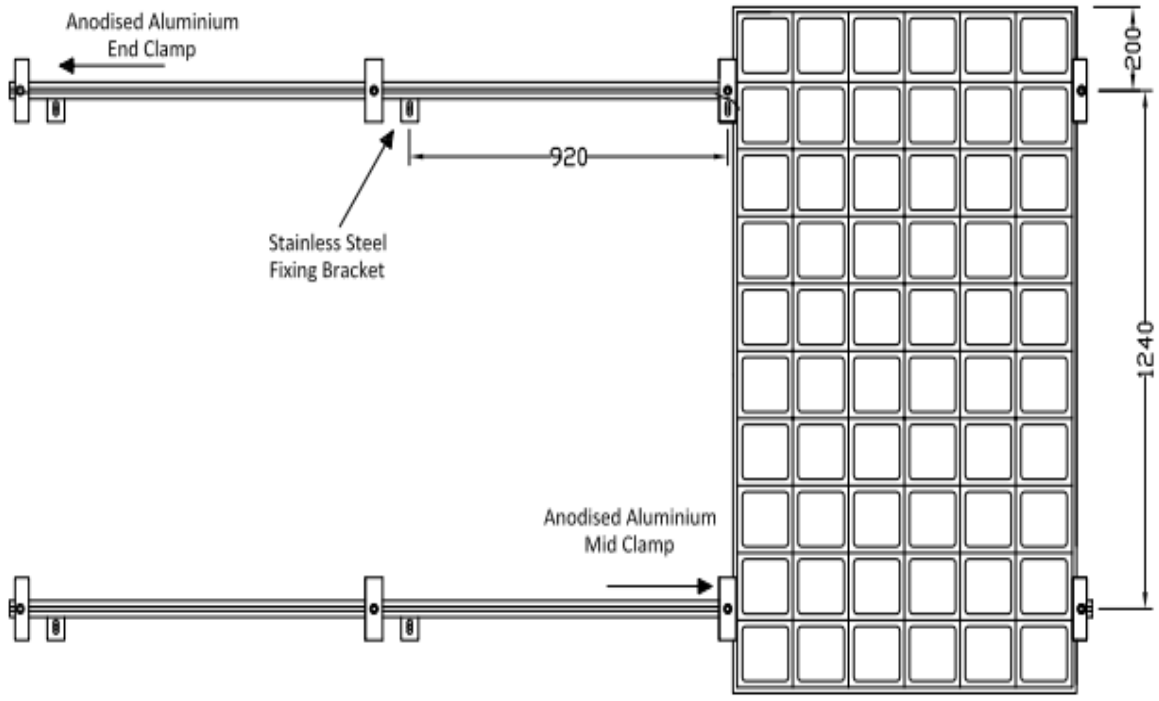


Figure 3: Joule Rail Fixing System

2.4.4 Solar PV modules, Mounting frame Installation

The complete procedure for the installation of the Joule Pulsa PV modules and mounting frames are detailed in the Joule Installation Manual.

The Joule Pulsa PV mounting frame consists of roof hooks specified to the roof finish, aluminium horizontal profile frames, anodised middle and end clamps. The aluminium horizontal mounting profiles are fixed to the roof hooks. The roof hook has a specialised clamp that fits into a slot on the lower side of the horizontal rail and clamps shut once the screw is tightened.

The Joule Pulsa PV modules are supported on upper and lower aluminium profiles as per Figure 3. The PV module is fixed to the profile with a special module clamps as shown in Figure 4.

Figure 4: Module Clamp

2.4.5.1 Timber reinforcing plant installation

Solar collectors shall not be secured directly to rafter timbers and shall only be fixed via timber reinforcing plants to meet the requirements of SR 50-2: 2012.

New build:

The main contractor shall ensure that the roof, including any support system for the PV array, is designed and constructed to comply with the relevant technical specifications for the use of structural timber: I.S. EN 1995-1-1:2005 Eurocode 5. All other relevant requirements described for retrofit installation shall also apply.

Retrofit installations:

An assessment of the condition of the rafter timbers is part of the site survey report. Any timbers showing signs of damage or rot must be replaced. A single length of timber reinforcing plant (750mm x 100mm x 75mm C24 grade) is installed as shown in Figure 5, to accommodate each roof bracket. The timber reinforcing plant shall be screwed to the existing rafter, using four Paslode Structural timber screws PSTS Ø8x85mm, or equivalent. Fixing locations can be seen in Figure 5. Additional timber reinforcing plants can be installed as required to accommodate additional roof brackets. The full details of the standard timber reinforcing plant design are available in the Joule Pulsa PV installation manual.

The timber reinforcing plant fixing design shall always be checked by a Chartered Structural Engineer for suitability in relation to the applicable point loads.

Any resulting modification required to the existing roof structure, shall form part of the structural design report and sign off documentation issued by the Structural Engineer. This should be completed prior to commencement of works.

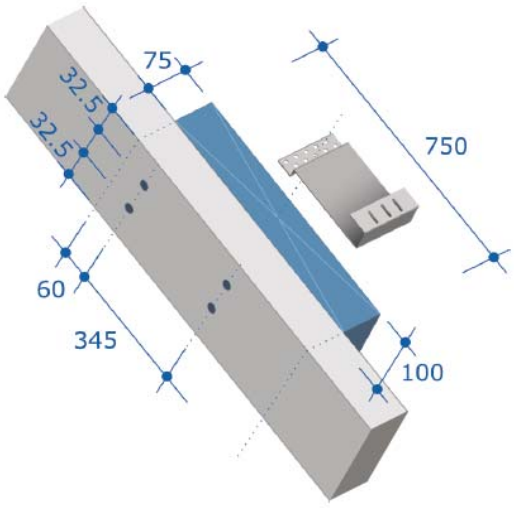


Figure 5: Timber Reinforcing Plant Detail

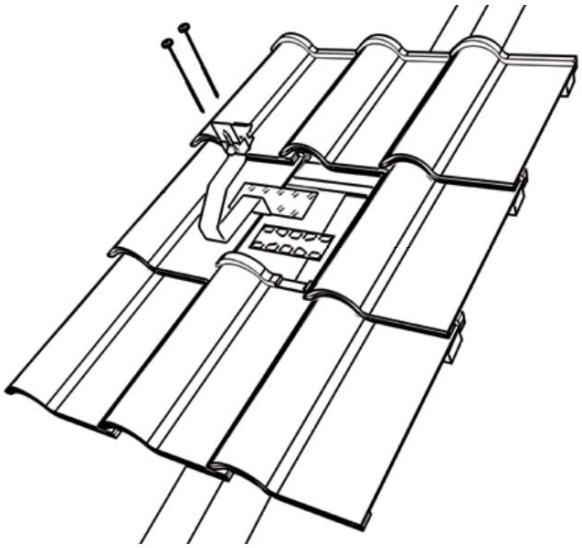


Figure 6: Schletter Roof Hook Fixing Detail

2.4.5.2 Roof Hook Fixing

Joule Energy Solutions supplies the Schletter range of MCS 012 approved roof hooks and fixings for securing the PV module mounting frame to the roof structure via the timber reinforcing plants.

The complete procedure for the installation of the solar PV roof hooks is detailed in the Joule Pulsa PV installation manual.

The roof hook is fixed directly into the timber reinforcing plant with a minimum of two wood screws into predrilled 5mm holes to prevent damaging the structure of the timber reinforcing plant, as outlined in 2.4.3- Roof Fixings, of this certificate.

To meet minimum loading requirements, a minimum number of six roof hooks is required per PV module. Because the hook fixing is subject to deflection under wind load which could result in tiles/ slates cracking, tiles/ slates should be locally notched and cut as required by the installer to accommodate the roof hooks and flashing kits, however notches should not create excessive gaps, larger than those that naturally exist between tiles. Refer to Figure 7 and Figure 8 for examples of slate tile notching and flashing.

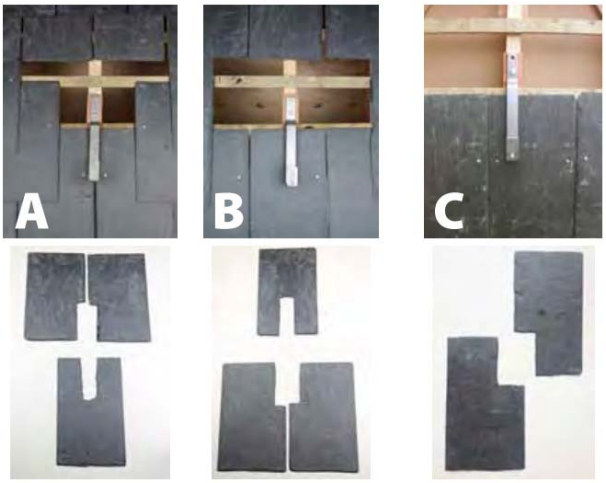


Figure 7: Slate Notching Examples

Figure 8: Finished Slate Falshing Example

For roofs incorporating single lapped or profiled tiles (Roman, Spanish, Mission etc.), consideration shall be given to the location of the hook fitting to minimise the interference/ contact between the fitting and the tile. On profiled tiles, hooks should be installed to line up with the tile trough, notching to provide clearance with the hook fixing.

Joule Energy Solutions supplies the Solarflash by Genius Roof Solutions, to cover a wide range of roof flashing requirements. See figures 7 and 8. Installation of the flashing systems to be performed in accordance with the Joule Energy Solutions installation manual.

Where existing insulation and/or plasterboard is displaced, or there is a break in the underlay, it must be replaced with similar material and made airtight. Joule Energy Solutions recommends the Siga Airtight (NSAI Certificate 08/0314) range of seals and tapes for this purpose, where required. See Figure 9.

Figure 9: Siga Cable Sealing Example

Joule Energy Solutions supplies the Dektite solar flashing to carry electrical cables through the roof into the loft space, see Figure 10. This Dektite solar flashing is manufactured from a lead base with a black EDPM cone and is AA fire rated when tested to BS 476-3:2004. The solar flashing will have a design life equivalent to the Solar PV modules and must be inspected as part of routine maintenance on the system.

Figure 10: Dektite Multiple Solar Flashing

The Dektite lead apron is fitted in the same way as a conventional lead weathering slate and positioned beneath one of the PV panels to give added protection from driven rain and UV light.
When installed in accordance with the installation instructions, this system creates a permanent seal which ensures the water-tightness of the external building envelope is maintained. Airtightness tapes can be added as required to reinstate the airtightness at all service penetrations.

2.4.6 Flat Roof Mounting system

Joule Energy Solutions shall define the roof kit to be used, depending on the number of modules required and the site-specific conditions. Only approved brackets and fixing systems supplied by Joule shall be used. All roof systems specified for use shall MCS 012 certified.

The flat roof system is held in place by ballast, as calculated by the site-specific wind load analysis in conformance with Eurocode 1. The ballast used is standard concrete blocks with a density of 960kg/m^3 placed within the ballast tray and on the base rail.

The use of ballast eliminates the need for roof penetrations. The minimum ballast weight is determined by Joule Energy Solutions and the weight of the ballast will vary depending on the roof height, geographic location and position within the array, as the edge of the array will be subject to higher wind loads.
The ballast trays shall be configured to hold a maximum load of 100kg/ module. The load shall be distributed as required by the ballast distribution plan. Kit supplied roof protection pads shall be used to prevent damage to the roof waterproofing system.

For smaller systems Joule Energy Solutions recommends the use of the Schletter CompactDirect mounting system. Joule Ireland shall specify the best suited mounting system dependant on the site-specific design. The PV panels are fixed to the support system with standard module clamps.

The complete procedure for the installation of the flat roof mount solar PV systems are detailed in the Joule Pulsa PV installation manual.

The flat roof mounting system design has been subject to simulation wind tunnel testing to determine the aerodynamic coefficients and designed with safety factors in accordance with Eurocode 0.

The calculation standards used in the design of the mounting system for the materials used include, Eurocode 9 – *Design of aluminium structure*, Eurocode 5 – *Design of timber structures* and Eurocode 3 – *Design of steel structures.*

For new builds, the dead load of a PV panel and ballast shall be included in the structural design of the roof. For retrofit of roof installations, the adequacy of the roof structure to support the PV panel and ballast shall be assessed by a Chartered Structural Engineer. If the flat roof is found to have insufficient structural capacity, remedial strengthening measures may be required before installation is commenced.

The PV system may only be mounted on sufficiently load-bearing roof surfaces and structures. The structural load-bearing capacity of the roof and the structure must be assessed at the installation site mounting the PV system. A Chartered Structural Engineer shall be used to access the report on any remedial work required on the roof structure before work commences. The advice of Joule Energy Solutions shall be sought in all such instances.

The flat roof mount system has been assessed by TUV to qualify as a mounting system for PV modules.

2.4.7 Wiring the Solar PV system

All electrical aspects of the installation should be undertaken in accordance with ETCI regulations by a qualified RECI electrical contractor.

An inverter must not be connected by means of a plug with contacts which may be live when exposed. AC cables are to be specified and installed in accordance with I.E EN50438: 2013.

The AC cable connecting the inverter(s) to the consumer unit should be sized to minimise voltage drop. The volt drop must remain within voltage drop limits as prescribed by with ET101.

The AC isolator switch shall clearly show the ON and OFF positions and be labelled as 'PV system- – main AC isolator'. The DC isolator switch shall clearly show the ON and OFF positions and be labelled as 'PV system- – main DC isolator'. Isolation and Switching of both the AC and DC side of the installation shall also comply with the requirements of with ET101.

Cable protection from the inverter(s) must be provided at the distribution board. This protective measure shall be specified and installed in accordance with the requirements of IEC 60364, ensuring there is no requirement for additional overcurrent protection to be installed at the inverter end of the AC installation.

All the DC component ratings (cables, isolators/disconnectors, switches, connectors, etc) of the system must be derived from the maximum voltage and current of the relevant part of the PV array. String cables must be rated as detailed in Cl. 2.4.1 of this certificate.

For every DC system, double insulation cabling must be applied as the method of shock protection. In this instance the use of suitably CE certified rated cables, connectors and enclosures along with controlled installation techniques are defined in ET101.

As per TGD B Cl. 5.4.5.1, where Photovoltaic (PV) panels are provided on buildings, provision should be made for the isolation of the panel array externally in accordance with ET101.

The inverters are fitted with an anti-islanding feature (automatic disconnection of circuit) and require a live grid connection to function. Therefore, if the power is switched off at the mains, there will be no current downstream of the inverter. If the DC cable is more than 1m in length within the building, a fireman's safety switch shall be fitted within 1m of the entry of the DC cables, this will interrupt the DC current should the mains electricity be shut off. See Figure 1.

Exterior cable colour coding is not required for PV systems. PV cables are black in colour to assist in UV resistance. For all cable runs, cables shall be labelled along the DC cables as follows: "Danger Live DC cable". Labels shall be fixed every 5 to 10m on straight runs, where a clear view is possible between labels. See Figure 11.

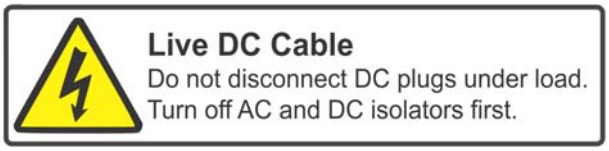


Figure 11: Cable Label

DC cables should be fitted with additional mechanical protection (installed in a kopex sleeve) between the point of entry of the DC cables and the inverter location or the fireman's safety switch.

PV DC cable runs should be kept as short as practicable. Where multiple PV sub-arrays and/or string conductors enter a junction box - they should be grouped or identified in pairs so that positive and negative conductors of the same circuit may easily be clearly distinguished from other pairs.
If there is more than one string, the DC junction box is normally the point at which they are connected together in parallel. The box may also contain string fuses and test points.

The DC junction box must be labelled as 'PV array DC junction box', and also labelled with 'Danger, contains live parts during daylight'. All labels must be clear, legible, located so as to be easily visible, and durably constructed and affixed to last the lifetime of the installation.

A PV system cannot be turned off – terminals will remain live at all times during daylight hours. It is important to ensure that anyone opening an enclosure is fully aware of this.

The short-circuit protection afforded by the cable installation throughout the rest of the DC circuit needs to be maintained in the construction, and makeup of the DC junction box. (See *IEC 61140 4th Edition, January 1, 2016*).

To protect the AC system, when required, surge suppression devices may be fitted at the main incoming point of AC supply (at the consumer's cut-out). To protect the DC system, surge suppression devices can be fitted at the inverter end of the DC cabling and at the array.

An accessible means of AC isolation shall be provided in addition to the RCBO fitted in the consumer unit. The AC isolator shall be fitted adjacent to the inverter to allow for a means of isolation should the need arise for maintenance on the PV system. See Figure 13.

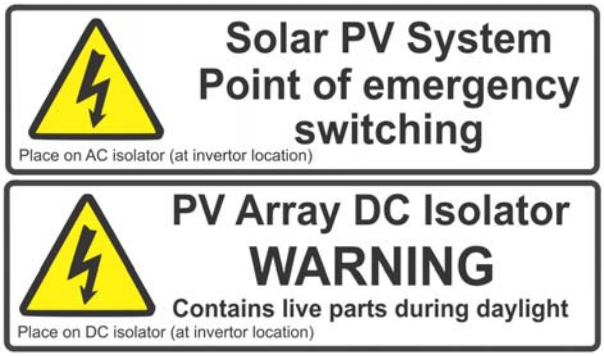


Figure 12: AC & DC Isolator Labels

Figure 13: Installed Inverter with Electrical Isolators

The isolator shall be located in close proximity to the Inverter and shall fulfil the following conditions/ requirements:

- To switch all live and neutral lines;
- To clearly show the ON and OFF positions. They shall be labelled as 'PV system – main AC isolator'. See Figure 12.

Short-circuit protection shall be achieved by:

- Fabrication of the enclosure from non-conductive material.
- Positive and negative busbars and terminals adequately separated and segregated within the enclosure and/or by a suitably sized insulating plate, or separate positive and negative junction boxes.
- Suitably designed cable and terminal layouts to ensure that short-circuits during installation and subsequent maintenance are extremely unlikely.

An approved PV generation meter (Rayleigh Instruments RI-18-45-P) is supplied by Joule Energy Solutions as part of the solar PV kit. The meter shall be installed to display and record the delivered energy(kWh) from the PV system. This is referred to as a PV generation meter. This meter shall be located where it can be readily observed by the consumer, possibly at the consumer unit.

Where there is a perceived increase in risk of direct lightning strike as a consequence of the installation of the PV system, specialists in lightning protection shall be consulted with a view to installing a separate lightning protection system in accordance with I.S EN 62305-1: 2011. *Protection against lightning: General Principles.*

2.4.8 Inspection and Testing – DC Side (PV Array)

The inspection and testing of the DC side of the PV system shall be performed in accordance with the requirements of BS 7671: 2008+A3: 2015 and I.S. EN 62446: 2016.
This inspection/ verification sequence includes:

- Following an inspection schedule.
- Continuity test of protective earthing and/or equipotential bonding conductors (if fitted).
- Polarity test.
- String open circuit voltage test.
- String short circuit current test.
- Functional tests.
- Insulation resistance of the DC circuits.

These tests shall be recorded by the installer in the Joule Pulsa Solar PV Installation checklist and the PV array test report documents provided by Joule Ireland. Full details of the inspection schedule and guidance on test procedures are contained with I.S. EN 62446.

To allow for maintenance and inspection tasks to be carried out safely, a means of isolation needs to be provided on the DC side of an inverter. The means of isolation shall:

- Be readily accessible and immediately adjacent to or incorporated into the inverter.
- The switch must isolate all live conductors (double pole to isolate PV array positive and negative conductors).
- The switch must be rated for DC operation at the system maximum voltage.
- The switch must be labelled as 'PV array DC isolator', with the ON and OFF positions clearly marked. Switch enclosures must also be labelled with 'Danger - contains live parts during daylight'. All labels must be clear, easily visible and durable. During routine maintenance, labels showing signs of degradation shall be replaced.
- An additional DC switch may be specified for systems with long DC cable runs (typically at the point of cable entry into the building) – so as to provide a means of isolating the cable for safety reasons or maintenance works.

Installations using micro-inverters may omit the DC switch disconnector where all of the following requirements are met:

- The micro inverter is located immediately to the rear of the PV modules.
- The micro inverter is plugged directly into the flying leads provided by the module manufacturer (no extensions to the flying leads may be used).
- The micro inverter and DC cables are generally inaccessible or only. accessible to trained or authorised personnel.
- The DC conductors between the module and micro inverter are adequately protected against mechanical damage.

2.5 SYSTEM EARTHING

2.5.1 DC Side Earthing

As specified in IEC/TS 62548: Edition 1.0; there are a number of possible PV array system earthing scenarios which can be summarized as follows:

- No earth connection.
- Hardwired connection of positive or negative conductor to earth.
- Centre tapped array – with/ without earth connection.
- High impedance connection of positive or negative conductor to earth (for functional reasons).

Positive and negative cables of the same string or main DC supply should be bundled together, avoiding the creation of loops in the system. This requirement includes any associated earth/bonding conductors. Long cables (e.g. PV main DC cables over about 50 m) should be installed in earthed metal conduit or trunking or be screened (armoured) cables. In addition, all panels shall be bonded in order to avoid electrical potential differences.

A number of earthing or bonding options of the PV array exists as follows:

a) Functional earthing of conductive non-current carrying parts (e.g. to allow for better detection of leakage paths to earth). Earthing/ bonding of exposed conductive parts of a PV array shall be performed with IEC 62548 requirements.
b) Earthing of lightning protection.
c) Equipotential bonding to avoid uneven potentials across an installation.
d) Functional earthing of one current carrying pole of the PV array-functionality earthed PV array.

An earth conductor may perform one or more of these functions in an installation. The dimensions and location of the conductor are dependent on its function.

2.5.2 Bonding conductor size

The conductor used to earth exposed metallic frames of the PV array shall have a minimum size of 6mm^2 copper or equivalent. For some system configurations, the minimum conductor size may need to be larger due to lightning system requirements.

2.6 INVERTER LOCATION

The inverters specified in this certificate are air cooled passively by natural convection of air on the heat dissipation fins on the rear of the inverter. It is important that the air flow is never impeded or blocked by other components or debris by adhering to the clearances stated in the inverter installation manual.

The inverter shall be mounted on a fire-resistant material, preferably on a concrete or masonry wall. If this option is not available, the inverter shall be mounted on a fire-resistant substrate fitted between the trusses in the loft and sized to extend a minimum of 150mm beyond the edge of the inverter. See Figure 13.

To comply with the requirements of TGD B to the Irish Building Regulations and ET101 a fire alarm shall be installed in the loft space where electrical installation have been installed. All installation details of the fire alarm shall comply with I.S 3218:2013.

2.7 A.C CABLE PROTECTION

Protection for the cable from the inverter(s) must be provided at the distribution board. This protective measure shall be specified and installed in accordance with the requirements of ET101. Joule Energy Solutions recommend that the AC side of the system shall be protected by a suitably sized 30mA B Type RCBO in accordance with IEC 62423:2011.

A suitable sized DC fuse will be required on each string if three or more strings of PV are connected in parallel. These fuses are normally houses within the DC junction box.

2.8 SYSTEM PERFORMANCE

Shade makes a big impact on the performance of a PV system. Even a small degree of shading on part of an array can have a very significant impact on the overall array output. Shade is one element of system performance that can be specifically addressed during system design – by careful selection of array location, equipment selection and layout and in the electrical design (string design to minimise shade effects). Shading from objects adjacent to the array (from vent pipes, chimneys, satellite dishes, trees etc) can have a very significant impact on the system performance. Where such shading is apparent, the array should be repositioned, or where possible, the object casting the shade should be relocated.

In Ireland the optimum orientation and tilt of an array is due south at 35˚. Any deviation from this will result in a lower output as outlined in Figure 14.

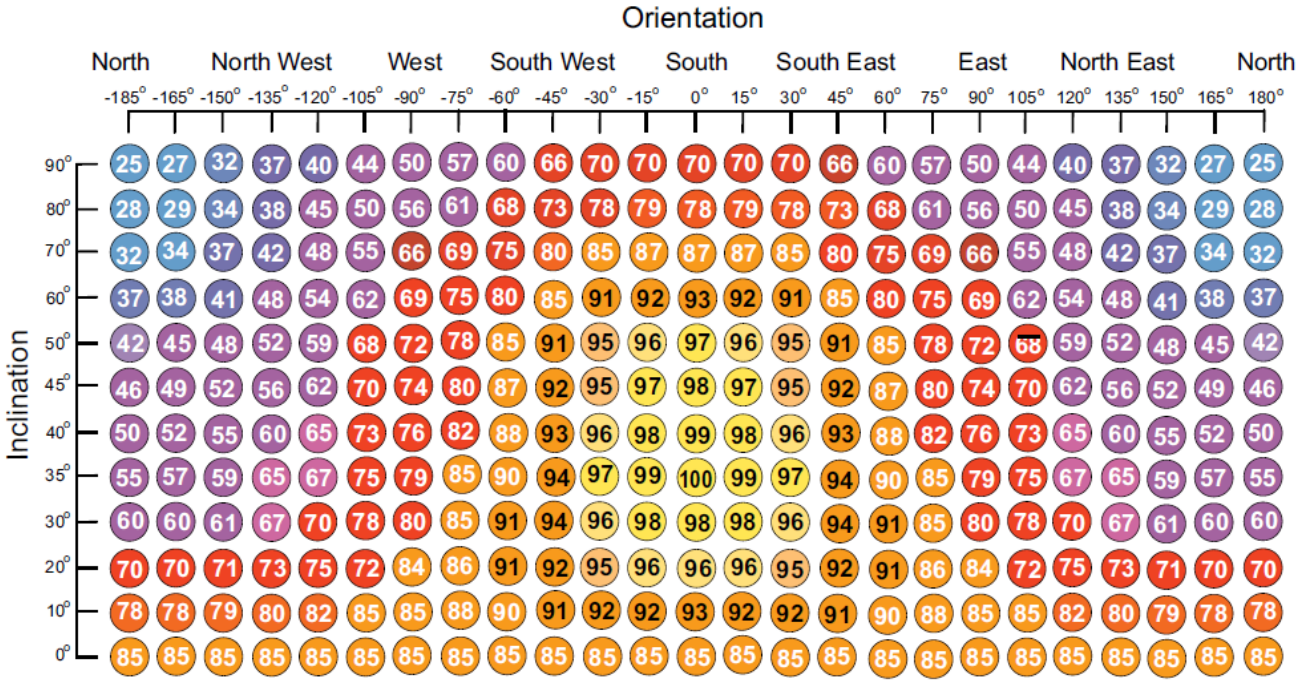


Figure 14: Performance depending on Orientation and Inclination

2.9 COMMISSIONING

The commissioning, testing and inspection of the system should comply with the requirements of IEC 62446:2016, including:

- Confirmation that all AC and DC wiring is correct and that no cable has been pinched or damaged during installation.
- Confirmation that all AC junction boxes are correctly installed and closed.
- Performing continuity test of protective earthing and/or equipotential bonding conductors (where fitted).
- Performing a polarity test.
- Performing a string open circuit voltage test.
- Performing a string short circuit test.
- Performing an insulation resistance test on the DC circuit.
- Performing an inverter Loss of Mains test.
- Recording/ Log the number of PV modules.
- Recording/ Log the make and model of the inverter.

2.9.1 Certification/ Manuals/ Warranty

- The installer must complete the Commissioning Certificate which is contained in the Installation manual.
- The installer must complete the Maintenance Log and locate it in a viewable position.
- The installer shall hand over the User Manual to owners and instruct users on all aspects of the documentation and how to effectively use the solar equipment.
- Details of the Installation and Warranty conditions are located in the installation manual. The warranty card should be completed and sent to Joule Ireland with all relevant details completed.

2.9.2 User Manual

After commissioning, the user manual is provided to the homeowner. The user manual includes a recommended maintenance schedule, commissioning certificate, full contact details of the installer and guidance on the use of the PV system.

System installer information shall contain the following:

- A checklist of what to do in case of a system failure.
- Emergency shutdown/ isolation procedures.
- Maintenance and cleaning recommendations (if any).
- Considerations for any future building works related to the PV array (e.g. roof works).
- Warranty documentation for PV modules and inverters – to include starting date of warranty and period of warranty.

2.9.3 Decommissioning the System

Due to the presence of AC and DC electrical power, only qualified persons should decommission a system.

When carrying out maintenance, the systems must be switched off using the installed AC and DC isolators. The maintenance pack provided by the installer to the homeowner shall be provided to those suitably qualified to perform maintenance on the PV system.

The Joule Pulsa PV range of PV modules can be retrofitted onto existing roofs. Reference shall be made to Cl 2.4 of this certificate and Joule Joule Energy Solutions installation manual for all conditions to be met.

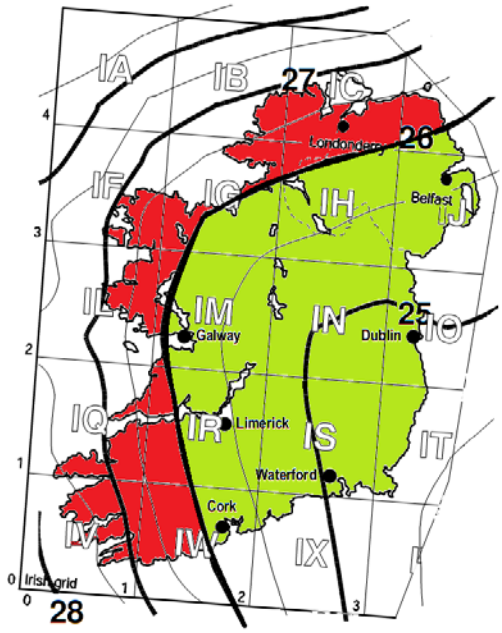


Figure 15: Basic Wind Velocity (ref. Irish National Annex to Eurocode 1)

3.1 STRENGTH AND STABILITY

When mechanical load tested in accordance with I.S. EN 61215-2. The Joule Pulsar solar PV modules achieved the maximum resistance to wind loading allowed by the standard of 5400 Pa positive pressure and 2400 Pa negative pressure without suffering any degradation in performance. Using a safety factor of 1.5 for positive pressure (SR 50-2) and a safety factor of 2 for negative pressure, Joule Pulsar solar PV modules, can be deemed to withstand a positive pressure of up to 3,600 Pa and a negative pressure of up to 1,200 Pa.

Testing performed per Microgeneration Certification Scheme (MCS) 12 and EN 61215-2, in conjunction with, I.S. EN 1995-1-1: Eurocode 5, have shown that, provided timber reinforcing plans are used as detailed in Cl. 2.4.5.1 of this certificate (also see Figure 2 and Figure 4) in conjunction with the Joule Pulsa PV supplied roof hooks, mounting rail and module clamps, will adequately fix the panels to the pitched roof and resist the positive and negative loading up to the limits.

The collectors and the correct fixing bracket systems are designed to cover Irish wind zones 2 and 3 (as illustrated in Figure NA.1 in Irish National Annex to Eurocode 1) up to an altitude of 150m, see Figure 15. However, in wind zones 0 and 1, and in high wind load areas above 150m in altitude, at excessive heights or very exposed areas, wind loads should be calculated in accordance with I.S EN 1991-1-4 Eurocode 1. The advice of Joule Energy Solutions shall be sought when the force acting on the solar collector is calculated to be greater than the aforementioned values. In such cases, Joule Energy Solutions will advise on additional fixings required.

To minimise the effect of wind load on the collectors, it is recommended that collectors are not installed within 0.5m of the roof edge, ridge, eaves or projections such as parapets, chimneys or dormer windows.

The host roof structure and any modifications necessary to accommodate the solar PV modules should be checked by a suitably qualified engineer in accordance with the Building Regulations 1997 to 2017. The main building contractor must ensure that this has been done prior to commencing installation and the timber reinforcing plant installed as detailed in Cl. 2.4.5.1 of this certificate.

3.2 DESIGN CRITERIA AND TESTING

The electrical characteristics and performance of each of the Joule Pulsa PV module design are shown in Tables 2 and 3, however reference should be made to Cl. 2.8 of this certificate for factors that affect the efficiencies and performance of the system.

Reference should be made to Cl 2.4 of this certificate for all wiring of the PV system, including lightning protection requirements where applicable.

The scope of testing as per I.S EN 61215, is to determine the electrical and thermal characteristics of the modules and to show their capability to withstand prolonged exposure to climatic conditions.

Table 6: Testing per I.S EN 61215 [1]	
Test Criteria	**Result**
Detailed inspection for visual defects	Pass
Maximum power determination	Pass
Insulation test	Pass
Measurement of temperature coefficients	Pass
Measurement of Nominal Operating Cell Temperature [NOCT, °C]	Pass
Performance at STC and NOCT	Pass
Performance at low irradiance	Pass
Outdoor exposure test	Pass
Hot spot endurance test	Pass
UV test	Pass
Thermal cycling test (200 cycles)	Pass
Humidity freeze (10 cycles)	Pass
Damp heat test 1000 hours	Pass
Robustness of terminations test	Pass
Wet leakage current test	Pass
Hail test 23m/s	Pass
Bypass diode thermal test	Pass

[1] TUV Nord test reports No. 492010435.003 and TUV SUD No. 70.406.13.574.01 refers

BEHAVIOUR IN RELATION TO FIRE

The roof covering on which the collectors are installed must have an AA, AB or AC rating as stated in Table 4.4 of TGD to Part B of the Building Regulations 1997 to 2017.

Each of the Joule Pulsa solar PV modules have also been fire tested in accordance with I.S EN 61730-2. The MST 23 fire test is performed to determine the fire resistance characteristics of the modules when exposed to a fire source originating from the outside of the building and consists of a single burning brand and spread of flame tests. All modules in the Joule Pulsa PV range achieved a Class C minimum fire resistance rating.

Multi-cable fire stops must be used to effectively seal cable bunches in electrical trunking and cable trays where they pass through fire rated walls and floors to meet the requirements of TGD Part B to the Irish Building Regulations.

See Cl. 2.6 of this certificate for issues related to the installation and location of the inverter and the requirements to install a fire alarm in the loft space of the building.

4.1 WEATHERTIGHTNESS

The Joule Pulsa range of PV modules are fixed to the roof structure using roof hook fittings as described in Cl. 2.4.5.2 of this certificate. By locally trimming the slate/ tile to accommodate the fitting all unprotected gaps caused by the mounting and installation arrangement shall be no greater than those pre-existing before their installation. The Schletter roof hook system has been tested in accordance with the requirements of CEN/ TR 15601:2012 and MCS 012.

As part of their installation kit, Joule Ireland supplies the Dektite solar flashing for the cables from the PV panels that pass through the roof, (see figure 11). This flashing is located under the installed panels for additional protection from the elements. Refer also to Cl. 2.4.5.2 of this certificate for the use of the Solarflash Genius flashings for use under slates and tiles at fixing locations.

Completed roofs will provide adequate resistance to weather ingress, when installed in accordance with this certificate and the Joule Pulsa PV installation instructions. Particular attention should be paid to correct installation of all components and to the detailing and positioning of gaskets/ grommets where cables enter the building. Refer to Cl. 2.4.5.2 of this certificate for suitable airtightness tapes.

The Joule Pulsa PV range of PV modules have also been subjected to the weather-related tests per I.S EN 61215 as listed in the table 6 of this certificate.

4.2 MAINTENANCE

All maintenance should only be carried out by a suitably qualified person approved by Joule Energy Solutions. The electrical and mechanical connections shall be periodically checked to make sure they are clean, safe, complete and secure, including the mechanical fixing to the roof structure. In the event of a problem, a suitably qualified PV design professional shall be engaged, or Joule Energy Solutions shall be contacted. High-voltage gloves and glove protectors must always be worn when working on live high-voltage DC circuits. The front surface of the modules should be covered by an opaque cloth or other material before any maintenance commences on the live portion of the circuitry. Fall-protection equipment, including harnesses, safety lines, and proper anchoring systems, shall also be used.

The inverter status should also be periodically checked including, voltage levels, frequency level and current power generation levels during daylight hours, to ensure that the system is operating correctly. If any anomalies are noted, the installer/commissioner or Joule Energy Solutions should be contacted.

The homeowner should be aware of any shading developing, i.e. from trees or vegetation growing in the vicinity. Shade from such vegetation can have a significant impact on the performance of a system.

Any build-up of dirt, dust, bird droppings etc, that is are not washed away by rain, can also affect the performance the modules. In such instances, the panel mat require washing. Joule Ireland recommend that the PV modules to be cleaned with cold water when required. Climbing onto the roof is to be avoided and the services of a qualified professional who is trained in occupational health and safety procedures to clean the PV modules is highly recommended.

4.3 DURABILITY

The PV modules have been assessed for durability in accordance with I.S EN 61215:2005. Joule Energy Solutions warrants the power output to 90% of nominal after 10 years and 80% after 25 years. The terms of the warranty are outside the scope of this certificate.

The string inverters offered by Joule Energy Solutions have a warranty that extends to ten years and may need replacing after this time period. The micro-inverters offered by Joule Ireland have a warranty that extends to 20 years and have a design/ service life comparable to the life of the PV modules.

The structural durability of the Joule Pulsa solar PV module, fixings, flashing, etc., has been assessed, and if maintained as per the maintenance schedule, should have a design life equivalent to that of the roof structure on which they are incorporated.

4.5 END OF LIFE

Disposal of any components must comply with the Waste Electrical and Electronic Equipment (WEEE) and Restriction of Hazardous Substances (RoHS) directives established in 2003.

4.6 OTHER INVESTIGATIONS

(i) Existing data on systems properties in relation to fire, electrical safety, performance, durability and the mechanical strength/ stability of the PV modules were assessed.
(ii) The manufacturing process of each of the module designs were audited and examined including the methods adopted for quality control, and details were obtained of the quality and composition of the materials used.
(iii) Site visits were conducted to assess the practicability of installation as well as the history of performance in use of the product.
(iv) An assessment was also performed on all installation control paperwork and well as training and technical support offered to installers registered with Joule Ireland.

5.1 National Standards Authority of Ireland ("NSAI") following consultation with NSAI Agrément has assessed the performance and method of installation of the product/process and the quality of the materials used in its manufacture and certifies the product/process to be fit for the use for which it is certified provided that it is manufactured, installed, used and maintained in accordance with the descriptions and specifications set out in this Certificate and in accordance with the manufacturer's instructions and usual trade practice. This Certificate shall remain valid for five years from date of issue so long as:

(a) the specification of the product is unchanged;

(b) the Building Regulations 1997 to 2018 and any other regulation or standard applicable to the product/process, its use or installation remains unchanged;

(c) the product continues to be assessed for the quality of its manufacture and marking by NSAI;

(d) no new information becomes available which in the opinion of the NSAI, would preclude the granting of the Certificate;

(e) the product or process continues to be manufactured, installed, used and maintained in accordance with the description, specifications and safety recommendations set out in this certificate;

(f) the registration and/or surveillance fees due to IAB are paid.

5.2 The NSAI Agrément mark and certification number may only be used on or in relation to product/processes in respect of which a valid Certificate exists. If the Certificate becomes invalid the Certificate holder must not use the NSAI Agrément mark and certification number and must remove them from the products already marked.

5.3 In granting Certification, the NSAI makes no representation as to:

(a) the absence or presence of patent rights subsisting in the product/process;

(b) the legal right of the Certificate holder to market, install or maintain the product/process;

(c) whether individual products have been manufactured or installed by the Certificate holder in accordance with the descriptions and specifications set out in this Certificate.

5.4 This Certificate does not comprise installation instructions and does not replace the manufacturer's directions or any professional or trade advice relating to use and installation which may be appropriate.

5.5 Any recommendations contained in this Certificate relating to the safe use of the certified product/process are preconditions to the validity of the Certificate. However, the NSAI does not certify that the manufacture or installation of the certified product or process in accordance with the descriptions and specifications set out in this Certificate will satisfy the requirements of the Safety, Health and Welfare at Work Act 2005, or of any other current or future common law duty of care owed by the manufacturer or by the Certificate holder.

5.6 The NSAI is not responsible to any person or body for loss or damage including personal injury arising as a direct or indirect result of the use of this product or process.

5.7 Where reference is made in this Certificate to any Act of the Oireachtas, Regulation made thereunder, Statutory Instrument, Code of Practice, National Standards, manufacturer's instructions, or similar publication, it shall be construed as reference to such publication in the form in which it is in force at the date of this Certification.

Bibliography

BS 476-3:2004 *Fire tests on building materials and structures – Classification and method for test for external fire exposure to roofs.*

BS 7671:2008+A3:2015: Requirements for Electrical Installations. IET Wiring Regulations.

CSN EN 50438: 2007, *Regulations for the connection of micro-generators in parallel with public low-voltage distribution networks.*

CEN/ TR 15601:2012: *Hygrothermal performance of buildings – Resistance to wind driven rain of roof coverings with discontinuously laid small elements – Test method.*

ET101: *National Rules for Electrical Installations.*

IEC 60364: *Electrical Installations for buildings.*

IEC 61140 4th Edition, January 1, 2016: Protection against electric shock – common aspects for installations and equipment.

IEC/ TS 62548: Edition 1.0. Technical specification – Photovoltaic (PV) arrays – Design Requirements.

IEC 62423:2011: *Type F and Type B residual current operated circuit-breakers with or without integral overcurrent protection for* household and similar uses.

IEC 62446:2016 *Photovoltaic (PV) systems - Requirements for testing, documentation and maintenance - Part 1: Grid connected systems - Documentation, commissioning tests and inspection.*

I.S. EN 61215-1:2016: *Terrestrial photovoltaic (PV) modules. Design qualification and type approval. Test requirements.*

I.S. EN 61215-1-1:2016: *Terrestrial photovoltaic (PV) modules. Design qualification and type approval. Special requirements for testing of crystalline silicon photovoltaic (PV) Modules.*

I.S. EN 61215-2:2017: *Terrestrial photovoltaic (PV) modules – Design qualification and type approval. Part 2: Test procedures.*

I.S. EN 61730: *Photovoltaic (PV) module safety qualification, Part 1:2014: Requirements for construction & Part 2:2012: Requirements for testing*.

I.S. EN 50438:2013: *Requirements for micro-generating plants to be connected in parallel with public low-voltage distribution networks.*

I.S. EN 62446:2016: *Photovoltaic (PV) systems. Requirements for testing, documentation and maintenance. Grid connected systems. Documentation, commissioning tests and inspection.*

I.S. 3218:2013: *Fire detection and alarm systems for buildings - system design, installation, servicing and maintenance.*

I.S. EN 1995-1-1:2005 Eurocode 5 - *Design of timber structures. General. Common rules and rules for buildings.*

I.S. EN 1991-1-4:2005 Eurocode 1 - *Actions on structures. General actions. Wind actions*

Eurocode 9 – *Design of aluminium structures*

Eurocode 5 – *Design of timber structures Eurocode 3 – Design of steel structures.*

MCS 010: Issue 1.5: *Generic Factory Production Control (FPC) requirements and* MCS 005-2.3: *Product Certification requirements for Photovoltaic modules.*

MCS 012: *Product Certification Scheme requirements- Pitched Roof installation kits.*

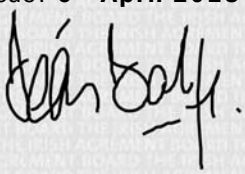
SR 82:2017, *Irish code of practise – Slating and Tiling.*

SR 50-2:2012 *Building services - Code of practice - Thermal solar systems.*

NSAI Agrément

This Certificate No. **18/0397** is accordingly granted by the NSAI to **Joule Ireland** on behalf of NSAI Agrément.

Date of Issue: **6th April 2018**

Signed 

Seán Balfe
Director of NSAI Agrément

Readers may check that the status of this Certificate has not changed by contacting NSAI Agrément , NSAI, 1 Swift Square, Northwood, Santry, Dublin 9, Ireland. Telephone: (01) 807 3800. Fax: (01) 807 3842. www.nsai.ie