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FRAMING SYSTEM FOR SOLAR PANELS

The present invention relates generally to framing systems and more particularly is concerned with systems adapted to mount panel members or laminates in an array on a supporting structure. The present invention will be exemplified with particular application to the field of mounting solar electric panels, also known as photovoltaic (PV) panels which are adapted to be mounted suitably at an angle to the horizontal and with respect to the sun.

However, the invention and the framing system is not necessarily limited to just these applications and extends to analogous applications. In this discussion we refer to use of the described system as mainly in roof mounting or roof integrating applications. However the system described can equally be suitable, with minor adjustments, for use in a vertical arrangement as an external PV wall cladding system.

In the field of solar PV panels, proposals have been made to form the PV panel to have the general characteristics of a roofing tile so that the PV laminate may be integrated into a roof, commonly but not exclusively, a tile roof. An alternative approach is to have a panel which is adapted to be mounted over a roof. However, important considerations to the design and development of PV panels are the ability of the panels to be effectively integrated architecturally into a roof design. With in-roof integrated panels there is also known to be a greater opportunity to beneficially capture solar thermal energy in addition to PV electrical energy to use within the building on which the PV tiles are installed, a field of solar energy development known as PV/Thermal or PV/T. Where the panels take the place of conventional roofing elements such as tiles or metal systems, reliable and convenient mounting within the roof and effective weather sealing is most important.

One known system relies on each solar panel or tile having a framework for mounting the PV laminate with the

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seal around the periphery of the laminate and the framework having structural features to facilitate its mounting, e.g. on conventional roof battens. However, the known framework is of fixed proportions and therefore is not necessarily desirable for some installations and will not conform with, for example, standard batten spacings. Fixed proportions also severely limit the number of commercially and commonly available PV laminates that can be incorporated into the framework. Custom size PV laminates come at a cost premium making any system using them less competitive in the market.

Other known roof integrated framing systems require additional structures below the PV laminate to ensure weather sealing, or use extruded frame sections that need additional components to attach to the roof structure, in some cases lacking a smooth external finish appearance both to the eye and external environmental conditions. These systems usually require a larger inventory of components to be manufactured, warehoused, transported and used in installation and are not inherently a PV integration system embodied in a simple frame that encapsulates the PV laminate. The ideal is a PV laminate frame system for building integration, simply fitted to the PV laminate during the usual manufacturing process.

There is therefore a need for new and useful alternatives to prior proposals including arrangements which lend themselves to being dimensioned to accommodate standard size, standard production line PV laminates, that can be easily factory assembled, that need minimum additional components to the frame and that facilitate integration into a roof structure with effective weather sealing of the panel elements.

In one aspect the present invention consists in a framing system for mounting a solar panel on a building structure, the framing system comprising:

- (a) an upper elongate frame element;
- (b) a lower elongate frame element;

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- (c) two side elongate frame elements;
 - (d) wherein;
 - i) each of said frame elements has an elongate channel for engaging in weather-sealing relationship with an associated edge of a solar panel and;
 - ii) the frame elements are adapted to be inter-connected at respective corners of the frame system,
 - (e) the upper frame element has a depending retaining element for retaining the framing system from movement in a direction down the building structure; a supporting element for supporting the frame system on a batten and upper surface portion with a slight recess for weather-sealing purposes, the recess being spaced from an inner edge portion within which the elongate channel is provided and on which a lower frame portion of a further solar panel is adapted to be supported in overlapping, weather-sealing relationship and;
 - (f) the side frame elements each having on an upper surface portion an upstanding wall element for cooperation with a capping element adapted to bridge between adjacent solar panels to form a weather seal.
- Preferably, at least one of the side wall elements on an outer upstanding edge face has means for mounting a resiliently deformable seal whereby adjacent panels engage through the seal in a manner which controls the spacing between panels, yet permits the taking-up of tolerances. Preferably, the upstanding wall element on each frame element has an undercut whereby snap-fitting engagement is achieved with the corresponding depending wall of the capping element.
- Preferably, each of the upper and lower wall elements is formed from an extrusion of generally an open box structure and includes screw shank engagement cavities whereby fixing screws applied from the exterior of the side of the side frame elements can engage to secure corner joints.
- To ensure dissipation of moisture from condensation on the

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lower face of a solar panel, preferably the upper region of the upper frame element includes an upstanding lip for directing any condensation from the next superior framed solar panel onto an upper face of the upper frame element.

5 Preferably, the lower frame element has a tip portion for engaging the upper surface of the upper frame element of the next inferior framed solar panel and extends to an overhanging lip element for engaging the inferior solar panel and shielding from the weather the elongate channel
10 in the upper frame element of the inferior framed solar panel.

Preferably the lower elongate frame element is made of two parts, one being a smaller snap fit part which forms the uppermost wall of the elongate channel for weather sealing
15 of the lower frame element to the solar laminate and which engages with a larger part in a snap-fit with undercuts at the lower end of two depending walls from the smaller part engaging with corresponding undercuts in the larger part, the smaller snap fit section having a sealant groove on
20 the lower surface of the wall for forming weather sealing for the solar laminate when snapped into place, the groove being for retaining a polymeric sealing compound that can be applied in a 'wet' or 'sticky' state to form a weather/water seal between the lower elongate frame
25 element inside upper edge and the encapsulated solar laminate.

This junction is the most critical water seal location of the solar tile. The snap fit is used as it allows easier and cleaner application of the sealing compound in
30 assembly of the frame to the solar panel with less or easier clean-up of the 'wet' sealing compound once the section is snap fitted.

Preferably, each side frame element is an extrusion having a body portion of hollow form, an outer side wall
35 accommodating an undercut groove for retaining a flange of a seal and in the opposite side an elongate glazing channel is provided to mount the solar laminate so that an

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overhanging lip is provided for protecting from the weather and in particular UV exposure the glazing channel where sealing occurs typically through the use of a polymeric sealing strip.

- 5 This arrangement permits the polymeric sealing material to extend in effective sealing arrangement beyond the outer limit of the glazing channel yet there is an overhang which covers this portion and protects it from the elements.
- 10 Preferably the extent of the overhanging lip is constrained so that minimum safe edge engagement of the solar panel glass is achieved, but that it does not encroach on the solar cells or PV element located at the outer edge of the solar panel. This permits the maximum
- 15 gap possible between the PV and the overhanging lip to avoid shading of the PV by the frame elements. Preferably the lower wall portion of the glazing channel extends further than the upper wall, and provides greater engagement and support to the underside of the solar
- 20 panel. Preferably the glazing polymeric seal has an asymmetric shape, a lip on the lower wall portion extends beyond the edge of the lower glazing channel wall providing additional support to the underside of the solar panel,
- 25 and the upper wall is constrained to fit under and inside the glazing channel overhanging lip. Preferably each side frame element incorporates in its lower surface an undercut channel e.g. of mushroom-shaped cross section for receiving either in a snap-fit
- 30 arrangement or preferably the head of metal screws for the attachment of transversely extending mounting elements for supporting the solar panel off a roofing batten. Preferably the transversely extending mounting is
- 35 of the elongate mushroom groove on the side elongate elements allowing for tolerance to variations in roof batten inter-spacing.

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The transverse batten support elements are preferably made up of an elongate element that spans from one side elongate element of the solar tile to the other and is attached to them preferably by a screw or snap fit fixing.

5 Along the spanning element there are sets of spacers that

i) fill the gap between the underside of the solar panel and the top surface of the transverse spanning element, and,

10 ii) fill the gap between the bottom of the transverse spanning element and the roof batten. The shape of these spacers is preferably a series of vertically running ribs that provide the spacing and support in a way that allows moisture such as condensation on the underside of the solar panel to run freely down without interference by the

15 transverse spanning element. Similarly the ribs allow airflow between the transverse spanning element and the underlying roof batten avoiding moisture in that location that might otherwise promote rotting of the roof batten.

20 For illustrative purposes, an embodiment of the invention will now be described with reference to the attached drawings of which;-

Figure 1 is a schematic view of a multiplicity of solar tiles mounted on a roof structure in accordance with an

25 embodiment of the invention;

Figure 2 is a side elevation along the line A-A of figure 1;

Figure 3 is a schematic plan view of two of the solar panel laminate tiles as used in figures 1 and 2 and ready

30 for installation but with the solar panel laminate not shown;

Figure 4 is an inverted plan view of a solar tile showing detail of two embodiments of transverse supports;

Figure 5 is a cross-sectional view on an enlarged scale

35 illustrating weather resistant joints between adjacent side frame elements of the solar tiles as used in figures 1 to 3; and,

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Figure 6 is a detailed cross-sectional view on an enlarged scale showing the interrelationship of an upper frame element of a first inferior solar tile which is supporting the lower frame element of a second superior solar tile.

5 Referring first to figures 1 to 3, a roof structure comprises parallel spaced rafters 10 with rectangular cross section horizontal battens 11, spaced apart by approximately half the length of a solar tile. Figure 1 shows an array of solar tiles 12 which are identical and
10 joined in weather sealing relationship by the capping elements 37.

Referring to figure 3, two solar tiles are viewed from above and each tile has an upper frame element 13, side frame elements 14 and a lower frame element 15 which
15 are secure together and hold in a weather-sealing arrangement a laminate 16 (not shown) of the nature of a solar panel. At approximately the mid position, a transverse support 17 is provided and is fixed at each end to the side frame elements 14. In larger formats of the
20 solar tile there can be more than one such transverse beam, in one typical case there may be two transverse beams. Figure 3 also shows an electrical connector box 18 which is electrically connected to the solar panel and connected into the array to provide electricity.

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Referring to figure 3 the transverse support 17 is an embodiment that may be substituted by another preferred embodiment shown in figure 4 parts 19, 20 & 20A. The embodiment 17 uses a stamped metal profile. Referring to
30 figure 4 the metal profile 17 carries an array of spaced wedge elements 21 with respective flutes 22 that extend in both the upward and downward direction from the transverse part for spacing the transverse element from a further batten, as is best shown in figure 2, and for spacing
35 between the transverse support and the back of the panel laminate. The height of the flutes 22 needed in the stamped metal transverse support depends on the relative

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position of the transverse support in the solar tile frame.

In another embodiment the transverse support 19 is an aluminium extrusion with an associated plastic moulded array of parallel flutes 20, 20A. The array of spacer flutes 20A are located under the transverse support between it and the back of the panel laminate forming vertical channels that allow condensate water on the back of the laminate to run freely past the transverse support. This can also occur with the other embodiment using downward pointing flutes 22 of the stamped metal transverse support. In the preferred embodiment an array of plastic flutes 20 is also located above the transverse support 19 for spacing from a further batten. In some formats of the solar tile a plastic spacer flute array may not be needed between the transverse support and roof batten, depending on the position of the transverse support relative to the frame. In both embodiments the flutes on both the plastic moulded array 20 and the stamped metal embodiment 22 both permit allow air flow between the roof batten and the transverse support preventing moisture build-up and rotting of the roof batten.

Referring now to figure 5, a joint between adjacent solar tiles is illustrated. The side frame element 14 in each case is an aluminium extrusion, although in other embodiments each frame element may be a plastic extrusion. The extrusion has a tubular body portion 23 and a glazing channel 24 defined between spaced walls which accommodate a solar tile laminate 25 sealingly engaged in a polymeric channel-shaped seal 26. An upper wall portion 27 has a lip 28 which overhangs a tip portion 29 of the polymeric seal and thereby protects it against the effects of the elements including rainwater and ultra violet light thereby ensuring that there is a reliable seal is established and maintained. The free upstanding edge wall 31 of the tubular section 23 has an undercut portion for

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accommodating a T-shaped rib 32 of a resiliently deformable tubular seal 33. A series of such seals are at spaced locations as best shown 33 in figure 4.

5 The tubular seals are designed to permit the solar panels to be conveniently located slightly spaced from one another and to ensure that the space between respective, upstanding retaining walls 35 is accurately controlled. Each of the walls 35 has a shoulder 36 extending upwardly for snap fitting engagement with an extruded cover strip 10 37. The cover strip 37 can conveniently be secured with a fixing screw at a location of the lower frame element of the next tile above in the system best shown 63 in figure 2. The fixing screw also passes through into the supporting batten 11, and thereby secures the entire solar 15 tile to the supporting structure against wind lift.

Figure 5 shows a mushroom cross section groove 38 integrally formed into the side element extrusion for accommodating snap fit or screw fixing securing elements of corresponding shape and are identified in figure 4 as 20 item 39 and which secure in place the transverse beam 17.

Referring now to figure 6, an upper frame element 40 for an inferior solar tile is shown together with a lower frame element made of two parts 41, 41A of a superior solar tile in overlapping relationship and illustrating 25 the installed position. As indicated in figure 3, mitre joints are formed at each corner of the rectangular frame and two screws 42 are applied through the side wall 31 of the side frame element to threadably engage in self tapping arrangement with corresponding receiving cavities 30 43 in the upper and lower frame elements 40 and 41, 41A.

The upper frame element 40 has a rear wall 45 having a depending retaining wall 46 for hooking behind the edge of a batten 61 to retain in position the solar tile and a lateral wall 47 for supporting the solar tile. The rear 35 wall 45 incorporates an upstanding lip 48 which ensures deflection of any condensation dripping off a superior solar tile laminate 49 to deflect the condensate along the

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upper surface 50 of the wall 50 from which drainage occurs to the exterior of the inferior solar panel 49A via the gap provided between upper and lower elements 41D and recess 47A provided for weather sealing purposes.

5 The wall element 50 also incorporates a glazing channel defined between a pair of walls 52 and 53 between which a U-shaped polymeric sealing element 54 is located. The lower frame element 41, 41A similarly has a U-shaped polymeric element 55 for sealing engagement with the
10 laminate 49, and has an additional 'wet' polymeric seal 55A located under a groove 41C of the snap fit part 41A. Snap fit part 41A is engaged to become a part of the lower frame element 41 by the under-cut snap fittings 41B that lock 41 and 41A together, and is set in place over the
15 solar panel 49 after the wet seal polymeric material 55A has been applied, usually dispensed in semi-liquid form from an orifice, into the groove 41C of 41A.

At its free-edge region the element 41 has a forward depending wall 56 with a base wall portion 47 configured
20 for support on the upper face of element 40 by setting into a slight recess 47A in the upper face of element 40 and an extending downwardly curved lip 58 which overhangs the sealing membrane 54 for weather protection purposes. The lower portion 41D of 41 does not directly contact the
25 upper face of element of 40 leaving a gap for moisture to drain to the exterior of inferior solar panel 49A.

Numerous points of detail in the system described above with reference to the drawing do provide distinct
30 advantages and the more important features will now be summarised:

1. External overhangs are provided on the glazing channels in order to protect polymeric sealing elements from the weather and in particular direct UV exposure. In the case
35 of the upper frame element, the sealing element is exposed but the overhanging lip of the lower frame element of the next tile unit above provides the protection.

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2. The transverse supports are readily attached by snap-or screw- fit elements to the desired position and especially in the case of retrofitting to existing roofs, position adjustment can suit the existing battens. The height of
5 this transverse support is also selectable to suit the position along the frame.

3. As shown the preferred form of the upper frame element is to incorporate a pair of grooves 46A in the depending leg thereby reducing the contact surface area between the
10 leg and the batten to minimise the potential for moisture being trapped between the two surfaces and decay resulting. For the same purpose grooves 47A and depending lumps 62 are provided in the preferred form of the upper frame element.

15 4. The resilient deformable tubular elements 33, as shown in figure 5, provide for suitable spacing between adjacent units and the spacing function permits uniform distances to be established but also there is an allowance for movement by thermal expansion and contraction.

20 5. The preferred embodiment uses plastic spacer elements 20 and 20A as best shown in figure 4 and the profile permits air circulation and avoids moisture being trapped as this would be deleterious to wooden roof battens. Furthermore these plastic elements when set in place on the aluminium
25 extruded transverse support 19 ensure that the desired angle of inclination is established. Depending lumps 62 on upper frame element 40 also introduce a pitch angle of element 40 relative to the roof batten. The pitch profile is defined by these elements to ensure that the lower
30 frame element 41 is at the correct elevation above the underlying batten so that when the lower tile is in position the spacing between the batten and the frame element 41 is taken up by the frame element 40. Thus inter-engaging tile members corresponding to a roof tile
35 system are obtained.

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CLAIMS

1. A framing system for mounting a solar laminate to form a solar panel which is to be mounted at an inclination to horizontal on a building structure, the framing system
5 having:
(a) an upper elongate frame element;
(b) two side elongate frame elements;
(c) wherein;
i) each of said frame elements has an elongate channel
10 for engaging in weather-sealing relationship with an associated edge of the solar laminate and;
ii) the frame elements are adapted to be inter-connected at respective corners of the frame system,
d) the upper frame element has a depending retaining
15 element for retaining the framing system from movement in a direction down the building structure, a supporting element for supporting the frame system on a batten of the building structure and an upper portion for weather-sealing purposes, the upper portion being spaced from
20 the elongate channel and being adapted to support in overlapping, weather-sealing relationship a lower portion of a further solar panel, and;
(e) the side frame elements each having, in an upper surface portion, an upstanding wall element for
25 cooperation with a capping element adapted to bridge between adjacent solar panels to form a weather seal.
2. A framing system as claimed in claim 1, and wherein the system further includes a lower frame element having an elongate channel for engaging in weather sealing
30 relationship with an associated edge of the solar laminate.
3. A framing system as claimed in claim 1 or claim 2, and wherein the upper frame element also has an upstanding lip for catchment and subsequent direction to external
35 drainage of internal condensate moisture.
4. A framing system as claimed in any one of the preceding claims, and further including transverse

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supporting elements adjustable in position in the framing system.

5. A framing system as claimed in any one of the preceding claims, and wherein at least one of the side wall elements on an outer upstanding edge face has means for mounting a resiliently deformable seal whereby adjacent panels engage through the seal in a manner which controls the spacing between panels, yet permits the taking-up of tolerances.
6. A framing system as claimed in any one of the preceding claims, and wherein the upstanding wall element on each frame element has an undercut whereby snap-fitting engagement is achieved with the corresponding depending wall of the capping element.
7. A framing system as claimed in any one of the preceding claims, and wherein each of the upper and lower wall elements is formed from an extrusion of generally an open box structure and includes screw shank engagement cavities whereby fixing screws applied from the exterior of the side of the side frame elements can engage to secure corner joints.
8. A framing system as claimed in any one of the preceding claims, and wherein the lower frame element has a tip portion for engaging the upper surface of the upper frame element of the next inferior framed solar panel and extends to an overhanging lip element for engaging the inferior solar panel and shielding from the weather the elongate channel in the upper frame element of the inferior framed solar panel.
9. A framing system as claimed in any one of the preceding claims, and wherein the lower elongate frame element is made of two parts, one being a smaller snap-fit part which forms the uppermost wall of the elongate channel for weather sealing of the lower frame element to the solar laminate and which engages with a larger part in a snap-fit with undercuts at the lower end of two depending walls from the smaller part engaging with

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corresponding undercuts in the larger part, the smaller snap fit section having a sealant groove on the lower surface of the wall for forming weather sealing for the solar laminate when snapped into place, the groove being
5 for retaining a polymeric sealing compound that can be applied in a 'wet' or 'sticky' state to form a weather/water seal between the lower elongate frame element inside upper edge and the encapsulated solar laminate.

10 10. A framing system as claimed in any one of the preceding claims, and wherein each side frame element is an extrusion having a body portion of hollow form, an outer side wall accommodating an undercut groove for retaining a flange of a seal and in the opposite side an
15 elongate glazing channel is provided to mount the solar laminate so that an overhanging lip is provided for protecting from the weather and in particular UV exposure the glazing channel where sealing occurs typically through the use of a polymeric sealing strip.

20 11. A framing system as claimed in any one of the preceding claims, and wherein the glazing polymeric seal has an asymmetric shape, a lip on the lower wall portion extends beyond the edge of the lower glazing channel wall providing additional support to the underside of the solar
25 panel, and the upper wall is constrained to fit under and inside the glazing channel overhanging lip.

12. A framing system as claimed in any one of the preceding claims, and wherein each side frame element incorporates in its lower surface an undercut channel e.g.
30 of mushroom-shaped cross section for receiving either in a snap-fit arrangement or preferably the head of metal screws for the attachment of transversely extending mounting elements for supporting the solar panel off a roofing batten.

35 13. A framing system as claimed in any one of the preceding claims, and wherein the transverse supporting element mounting is adjustable in its relative position on

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the frame by virtue of the elongate mushroom groove on the side elongate elements

14. A framing system as claimed in any one of the preceding claims, and wherein the transverse batten
- 5 support elements are preferably made up of an elongate element that spans from one side elongate element of the solar tile to the other and is attached to them by a screw or snap fit fixing. Along the spanning element there are sets of spacers that;
- 10 i) fill the gap between the underside of the solar panel and the top surface of the transverse spanning element, and,
- ii) fill the gap between the bottom of the transverse spanning element and the roof batten.
- 15 The shape of these spacers is a series of vertically running ribs that provide the spacing and support in a way that allows moisture such as condensation on the underside of the solar panel to run freely down without interference by the transverse supporting element. Similarly the ribs
- 20 allow airflow between the transverse supporting element and the underlying roof batten of the building structure.