Installation, Operation and Maintenance

Solar Panels

Photovoltaic (PV) Modules, Thermal Collectors, and Hybrid Photovoltaic/Thermal Collectors (PVT)

⚠ SAFETY WARNING

Only qualified personnel should install and service the equipment. The installation, starting up, and servicing of heating, ventilating, and air-conditioning equipment can be hazardous and requires specific knowledge and training. Improperly installed, adjusted or altered equipment by an unqualified person could result in death or serious injury. When working on the equipment, observe all precautions in the literature and on the tags, stickers, and labels that are attached to the equipment.

April 2020 **SOL-SVX01B-EN**

Introduction

Warnings, Cautions, and Notices

Safety advisories appear throughout this manual as required. Your personal safety and the proper operation of this machine depend upon the strict observance of these precautions.

The three types of advisories are defined as follows:

⚠WARNING	Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
⚠CAUTION	Indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury. It could also be used to alert against unsafe practices.
NOTICE	Indicates a situation that could result in equipment or property-damage only accidents.

Important Environmental Concerns

Scientific research has shown that certain man-made chemicals can affect the earth's naturally occurring stratospheric ozone layer when released to the atmosphere. In particular, several of the identified chemicals that may affect the ozone layer are refrigerants that contain Chlorine, Fluorine and Carbon (CFCs) and those containing Hydrogen, Chlorine, Fluorine and Carbon (HCFCs). Not all refrigerants containing these compounds have the same potential impact to the environment. Trane advocates the responsible handling of all refrigerants-including industry replacements for CFCs and HCFCs such as saturated or unsaturated HFCs and HCFCs.

Important Responsible Refrigerant Practices

Trane believes that responsible refrigerant practices are important to the environment, our customers, and the air conditioning industry. All technicians who handle refrigerants must be certified according to local rules. For the USA, the Federal Clean Air Act (Section 608) sets forth the requirements for handling, reclaiming, recovering and recycling of certain refrigerants and the equipment that is used in these service procedures. In addition, some states or municipalities may have additional requirements that must also be adhered to for responsible management of refrigerants. Know the applicable laws and follow them.

⚠WARNING

Proper Field Wiring and Grounding Required!

Failure to follow code could result in death or serious injury. All field wiring MUST be performed by qualified personnel. Improperly installed and grounded field wiring poses FIRE and ELECTROCUTION hazards. To avoid these hazards, you MUST follow requirements for field wiring installation and grounding as described in NEC and your local/state electrical codes. Failure to follow code could result in death or serious injury.

⚠WARNING

Personal Protective Equipment (PPE) Required!

Failure to wear proper PPE for the job being undertaken could result in death or serious injury. Technicians, in order to protect themselves from potential electrical, mechanical, and chemical hazards, MUST follow precautions in this manual and on the tags, stickers, and labels, as well as the instructions below:

- **Before installing/servicing this unit, technicians MUST put on all PPE required for the work being undertaken (Examples; cut resistant gloves/sleeves, butyl gloves, safety glasses, hard hat/bump cap, fall protection, electrical PPE and arc flash clothing). ALWAYS refer to appropriate Safety Data Sheets (SDS) and OSHA guidelines for proper PPE.**
- **When working with or around hazardous chemicals, ALWAYS refer to the appropriate SDS and OSHA/GHS (Global Harmonized System of Classification and Labeling of Chemicals) guidelines for information on allowable personal exposure levels, proper respiratory protection and handling instructions.**
- **If there is a risk of energized electrical contact, arc, or flash, technicians MUST put on all PPE in accordance with OSHA, NFPA 70E, or other country-specific requirements for arc flash protection, PRIOR to servicing the unit. NEVER PERFORM ANY SWITCHING, DISCONNECTING, OR VOLTAGE TESTING WITHOUT PROPER ELECTRICAL PPE AND ARC FLASH CLOTHING. ENSURE ELECTRICAL METERS AND EQUIPMENT ARE PROPERLY RATED FOR INTENDED VOLTAGE.**

⚠WARNING

Follow EHS Policies!

Failure to follow instructions below could result in death or serious injury.

- **All Trane personnel must follow the company's Environmental, Health and Safety (EHS) policies when performing work such as hot work, electrical, fall protection, lockout/tagout, refrigerant handling, etc. Where local regulations are more stringent than these policies, those regulations supersede these policies.**
- **Non-Trane personnel should always follow local regulations.**

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Overview

Note: *One copy of this document ships inside the solar panel packaging and is the property of the customer. It must be retained by the maintenance personnel and stored in a safe place.*

A solar thermal panel is normally referred to as a *collector*. A solar photovoltaic module is made up of solar cells and is either referred to as a solar panel or as a solar module.

Note: *Throughout this manual the term collector describes a solar thermal collector and the terms panel or module describes a PV module.*

Important: *Carefully review the information within this manual and follow the instructions to avoid the risk of improper operation and/or minimize component damage. Review the installation and components with the building owner and representatives to explain the system operation and maintenance requirements.*

This manual provides information about the following:

- Installation and maintenance considerations
- Model number description and unit nameplate
- Handling and inspecting solar products
- First-aid measures
- Care and maintenance
- Photovoltaic (PV) modules
- Solar thermal collector systems
- Hybrid photovoltaic/thermal (PVT) collectors

Model Number Description

All solar panels are identified by a multiple-character model number that precisely identifies a particular type. An explanation of the alphanumeric identification code is provided at the beginning of the section for each panel type that follows. The model number enables the owner/operator, installing contractors, and service engineers to define the operation, specific components, and other options for any specific unit.

When requesting service, refer to the specific model and serial numbers printed on the panel nameplate.

Unit Nameplate

A unit nameplate is affixed to each panel. It includes the unit model and serial numbers as well as other pertinent specifications.

Handling, Inspecting, and Storing Solar Products

As soon as the solar panels arrive at the job site:

- Handle with care, all system components and accessories during storage, transport and installation.
- Inspect packaging and components as soon as possible after delivery and before storing any of the items.
- If concealed damage is discovered, notify the carrier terminal about any damage immediately by phone and by mail. Concealed damage must be reported within fifteen (15) days. Request an immediate joint inspection of the damage by the carrier and the consignee. Do not remove damaged material from the receiving location. Take photos of the damage, if possible.
- Notify the appropriate sales representative before installing or repairing a damaged collector.

- Verify that the nameplate data matches the data on the sales order and bill of lading *(including electrical data)*.
- After installation, dispose of all packing materials appropriately and according to relevant waste disposal requirements.
- The following applies to *Thermal* and *Hybrid PVT* collectors:
  - When handling solar solutions *(for example, propylene glycol and corrosion inhibitors)*, avoid contact with the skin or eyes.
  - During handling, wear long-sleeved, loose-fitting clothing, gloves, and eye protection.
  - Solar solutions can reach high temperatures. Exercise caution around hot solutions and surfaces.
- Wash clothes separately from other clothing; rinse thoroughly.
- Take precautions when storing panels before installation. Utilize the shipping crates/containers and keep them in a safe and dry location before installation.
- The manufacturer will not assume any responsibility for equipment damage resulting from storage or handling neglect.

First Aid Measures (Applies to Thermal and Hybrid PVT Collectors)

Eye Contact:

Flush eyes thoroughly with water to remove contaminants. If symptoms persist, seek medical attention.

Skin Contact

Refer to the Material Safety Data Sheet (MSDS) for the exact products employed and carefully review and follow recommended safe handling and usage procedures.

Care and Maintenance

Periodic Maintenance Schedule

There are several periodic maintenance requirements for the PV, Thermal, and PVT systems. The follow sections describe the care and maintenance of this system. In addition, use the table below to inspect and maintain these systems for maximum performance.

Maintenance and Inspection Schedule	
Activity	**Recommended Frequency**
Clean glass surfaces	Quarterly or in weather events
Solar solution testing	Quarterly or in replacement events
Pump service	Per manufacturer requirements
Pump motor service	Per Manufacturer Requirements
Controls	Observe Settings and adjust as needed
Electrical System	Annual inspection
Piping system inspection	Quarterly inspection

Exterior System Cleaning

⚠WARNING

Hazardous Voltage!

Disconnect all electric power, including remote disconnects before servicing. Follow proper lockout/tagout procedures to ensure the power can not be inadvertently energized. Failure to disconnect power before servicing could result in death or serious injury.

Frequent cleaning of the glass surface is important for performance output. A build up of dust or dirt on the module(s) front face will result in a decreased energy output. The following are exterior cleaning guidelines:

- Exercise caution when carrying water buckets, hoses, squeegees, and cleaning solutions/ supplies.
- The surface cleaning should be done at least quarterly, after dust storms, or after other weather events that may cause a limiting of the solar absorption.
- Use a mild soap solution in a spray bottles, a squeegee, and soft cloths to clean modules.

  Important: *Read the MSDS for the cleaning solution and follow proper handling procedures.*
- Never use abrasive material under any circumstances.
- Examine the PV module(s) for signs of deterioration. Check all wiring for possible rodent damage, weathering, and ensure that all connections are tight and corrosion free. Check electrical leakage to ground.
- Check screws and mounting brackets and tracking systems to ensure they are tight.
- Tie-off if near a roof edge or on a wet or icy roof.
- Inspect the panels for cracked glass, cracked wiring and loose wires or conduit.

Exterior System Inspection

It is important to check for solar solution leaks quarterly. Leaks can indicate a dilution of the solar thermal solution which, if not tested and maintained, could allow freezing. Furthermore, make-up water can cause hardness build up on the inside of the heat transfer tubes which can deteriorate the system performance.

Solar Solution Testing

It is recommended that the solar solution be tested twice per year as a preventative measure. The freeze prevention is essential to prevent a system failure or damage to the collectors or system piping. With an automatic water make-up system, a pipe leak can cause exterior and interior building damage that is costly to repair. It is best to hire a professional to perform a closed circuit *(solar solution)* water chemistry testing. They will test for biological fouling, freeze protection, pH, and a few other chemical properties.

Mechanical Maintenance

Follow the pump and pump motor manufacturer recommendations for scheduled maintenance services and inspections. These inspections check the pump seals and casings for leaks, ensuring that any flexible couplings are in good order, and that bearing lubrication is performed, as needed or required.

Expansion tanks should also be inspected to ensure that the bladder and pressure control system is functioning. The pressure relief valves should be inspected to ensure that they are in good working condition, that the air vent valves are inspected for leaks, and that all storage tanks and their fittings checked for leaks.

For domestic hot water systems, some authorities having jurisdiction may require that periodic disinfection of the systems in contact with drinking water or food preparation be inspected and/or tested.

Electrical Maintenance

Follow the manufacturer recommendations for preventive maintenance and inspections of the controls system and power system for the pumping system and automatic glycol feed system *(if installed)*. It is important to also validate the controls settings during these inspections.

Ensure that all safety disconnects, junction boxes, connection points, string connectors, and other electrical connections are weatherproof and in good working condition.

Warranty

Trane PV Modules are guaranteed to be free of manufacturing defects for a period of 10 years from the date of collector delivery.

Performance Guarantee

The electrical output performance will guarantee the following:

- During the first ten (10) years from the date of sale, produce at least 92% of the minimum power output rating.
- During the first twenty (20) years from the date of sale, produce at least 84% of the minimum power output rating.
- During twenty-five (25) years from the date of sale, produce at least 80% of the minimum power output rating, where the minimum power output rating is the rated power minus the applicable tolerance.

Photovoltaic (PV) Modules Solar Panel System

Solar photovoltaic systems consist of the following:

- Solar PV modules
- String connectors
- Manual disconnect switches and monitors *(larger systems)*
- Direct current (DC) to alternating current (AC) inverters
- Electrical power metering and monitoring equipment.

Each installation has a unique number and configuration of solar modules, inverters, and disconnects for its particular application and could contain automatic solar tracking systems.

The system designer has intentionally configured the solar photovoltaic system to fulfill its intended purpose.

Recommendations

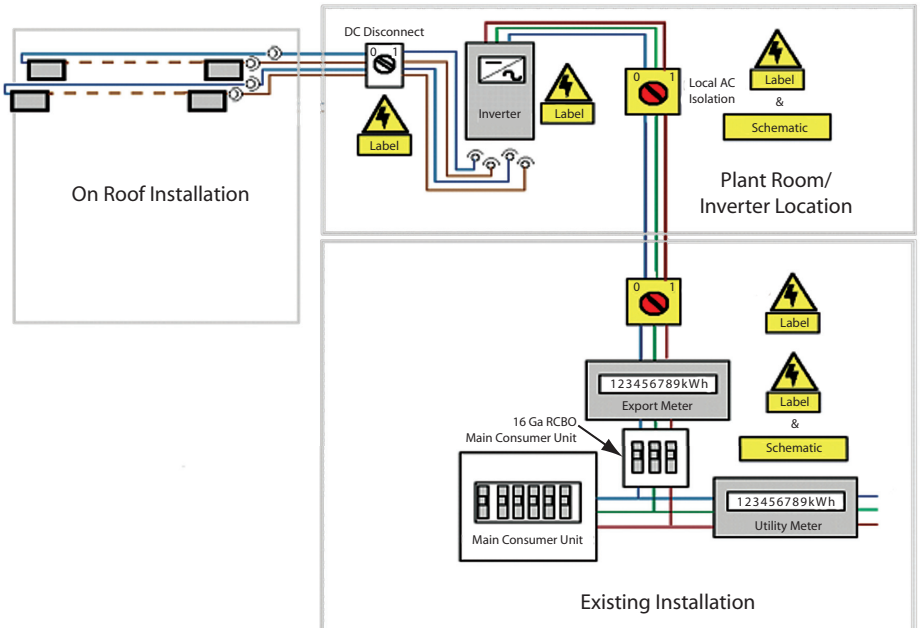
- The installer, operations personnel, and maintenance/repair personnel or contractors should become familiar with the design drawings, system specifications, and product submittals. In particular, this personnel should become familiar with the controls design and *as-built* controls drawings so that the designer's intentions and actual installation characteristics are well understood.
- The system designer or installer should provide operator training to the individuals responsible for the day-to-day operations and maintenance of the systems.
- A licensed contractor and/or certified solar installer should be employed to properly install and commission solar photovoltaic systems.

In most applications, PV modules should be installed in a location where they will receive maximum sunlight throughout the year. In the Northern Hemisphere, the modules should typically face south, and in the Southern Hemisphere, the modules should typically face north. Modules facing 30 degrees away from true South *(or North)* will lose approximately 10 to 15 percent of power output. If the module faces 60 degrees away from true South *(or North)*, the power loss will be 20 to 30 percent. When choosing a site, avoid trees, buildings or obstructions, which could cast shadows on the array.

Once the system is commissioned *(tested, properly adjusted, and proven to be installed safely to fulfill its intended purpose)*, the electrical safety disconnects are closed and the system begins to allow the energy from the sun to produce electrical current. The system will automatically direct the power produced to the power distribution system within the operating range of the array and inverter.

Monitoring systems should be used so that operators can be made aware of system malfunctions. When alarm conditions arise, trained personnel should be engaged to perform trouble-shooting and system repairs. Figure 1 shows an example of a typical PVT installation.

Figure 1. Example of typical PV installation



Precautions

⚠WARNING

Risk of Electrocution!

• Before undertaking work on the general electrical arrangements within the building, you must isolate the PV system to prevent double feeding and potential electric shock.

• In the event of an emergency, isolate the AC electrical supply situated next to the inverter and in the plant room and the DC supply at the main DC disconnect point situated next to the inverter. All persons working on the live DC cabling of a PV system must be experienced/ trained in working with such a system and fully acquainted with the voltages present on that system in particular.

Failure to follow the instructions above could result in death or serious injury!

Important: *DC cables connected to a PV module or array are live at all times during daylight. Consequently, DC cable runs should be kept as short as possible and cables carefully routed and secured.*

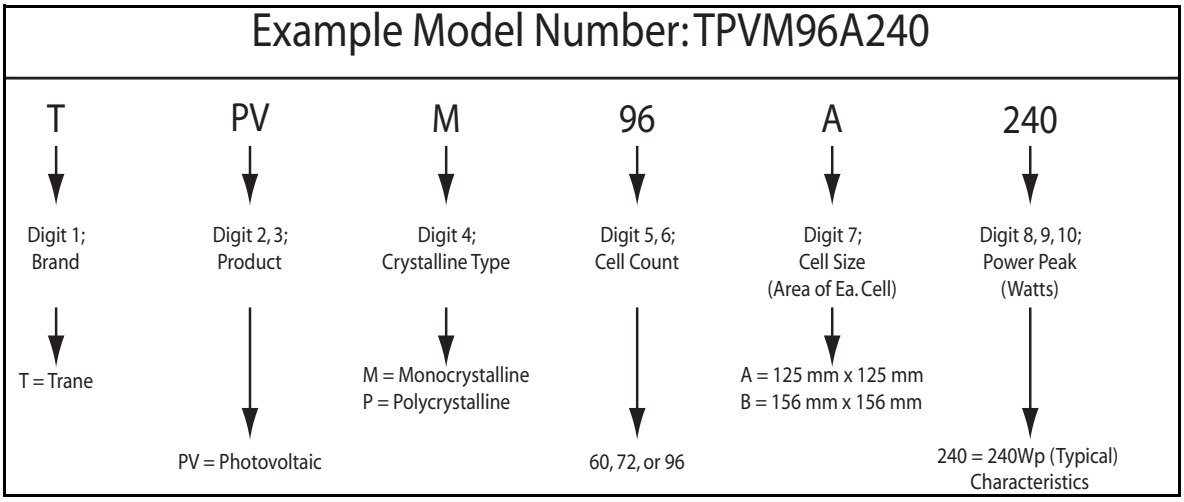
Observe the following precautions:

- Do not direct artificially concentrated sunlight onto the module or panel.
- During installation, protect PV modules from sunlight because when solar radiation comes in contact with the module(s) surface, they will produce electrical power. Only qualified technicians should install or perform maintenance work on PV modules.
- Do not touch live terminals with bare hands. Use insulated tools for electrical connections.
- To reduce the risk of electrical shock or burns, cover the modules with an opaque material during installation.
- If batteries are used with modules, follow manufacturer recommendations.

- Under normal conditions, a photovoltaic module is likely to experience conditions that produce more current and/or voltage than reported at standard test conditions. Accordingly, the value of Isc *(short circuit current)* and Voc *(open circuit voltage)* marked on this module should be multiplied by of 1.25 when determining component voltage ratings, conductor current ratings, fuse sizes, and the size of controls connected to the PV output.
- Do not attach any other devices *(antennae, piping, conduit, and so on)* to the collector racks

Model Number Description

Below is an illustration that describes the model number.



Characteristics

Standard Test Condition: Tc = 25°C, AM = 1.5, E = 1000W/m^2

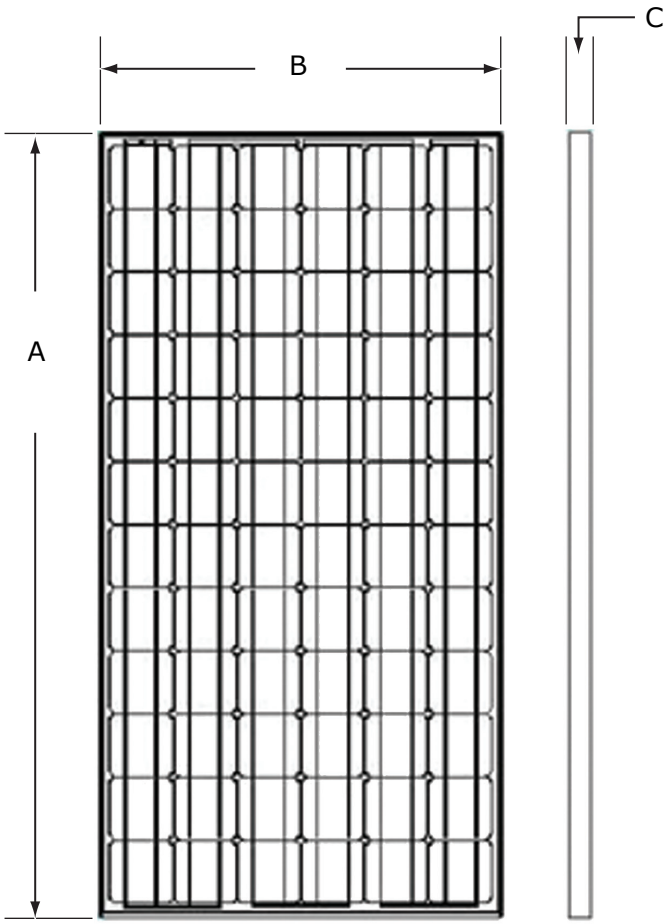
The electrical characteristics are within ±10 percent of the indicated values of I_{sc}, V_{oc}, and P_{max} under standard test conditions *(irradiance of 100 mW/cm^2, AM 1.5 spectrum, and a cell temperature of 25°C [77 °F])*.

PV

PV Panel Dimensions and Series

The following figure and tables provide information about PV system series.

Figure 2. Module dimensions



TPVM72A Series

Dimension A:	62.2 in. (1580 mm)		
Dimension B:	31.8 in. (808 mm)		
Dimension C:	1.8 in. (45 mm)		
Max. power [W]:	180	185	190
Power tolerance:	±10%		
Open-circuit voltage [V]:	43.2	43.2	43.8
Voltage at max. power [V]:	36.0	36.0	36.5
Current at max. power [A]:	5.00	5.14	5.20
Short-circuit current [A]:	5.60	5.76	5.83
Max. system voltage:	600VDC		
Series fuse rating [A]:	10		

TPVP60B Series

Dimension A:	65.0 in. (1650 mm)	
Dimension B:	39.1 in. (992 mm)	
Dimension C:	2.0 in. (50 mm)	
Max. power [W]:	225	230
Power tolerance:	±10%	
Open-circuit voltage [V]:	35.4	36.0
Voltage at max. power [V]:	29.5	30.0
Current at max. power [A]:	7.63	7.67
Short-circuit current [A]:	8.55	8.59
Max. system voltage:	600VDC	
Series fuse rating [A]:	10	

TPVP72B Series

Dimension A:	77.0 in. (1956 mm)								
Dimension B:	39.1 in. (992 mm)								
Dimension C:	2.0 in. (50 mm)								
Max. power [W]:	240	245	250	255	260	265	270	275	280
Power tolerance:	±10%								
Open-circuit voltage [V]:	42.0	42.0	42.4	42.4	42.6	42.6	43.0	43.0	43.2
Voltage at max. power [V]:	35.0	35.0	35.3	35.3	35.5	35.5	35.8	35.8	36.0
Current at max. power [A]:	6.86	7.00	7.08	7.22	7.32	7.46	7.54	7.68	7.78
Short-circuit current [A]:	7.68	7.84	7.93	8.09*	8.2	8.36	8.45	8.60	8.72
Max. system voltage:	600VDC								
Series fuse rating [A]:	10								

TPVM96A Series

Dimension A:	62.0 in (1575 mm)								
Dimension B:	42.6 in. (1082 mm)								
Dimension C:	2.0 in. (50 mm)								
Max. power [W]:	200	205	210	215	220	225	230	235	240
Power tolerance:	±10%								
Open-circuit voltage [V]:	56.4	56.4	57.0	57.0	57.6	57.6	57.6	58.2	58.2
Voltage at max. power [V]:	47.0	47.0	47.5	47.5	48.0	48.0	48.0	48.5	48.5
Current at max. power [A]:	4.26	4.36	4.42	4.53	4.58	4.69	4.79	4.85	4.95
Short-circuit current [A]:	4.77	4.88	4.95	5.07	5.13	5.25	5.36	5.43	5.55
Max. system voltage:	600VDC								
Series fuse rating [A]:	10								

TPVM72B Series

Dimension A:	77.0 in (1956 mm)					
Dimension B:	39.1 in. (992 mm)					
Dimension C:	2.0 in. (50 mm)					
Max. power [W]:	270	275	280	285	290	295
Power tolerance:	±10%					
Open-circuit voltage [V]:	44.3	44.3	43.5	43.8	44.2	44.2
Voltage at max. power [V]:	35.7	35.7	35.3	35.6	36.2	36.5
Current at max. power [A]:	7.56	7.70	7.97	8.00	8.02	8.08
Short-circuit current [A]:	8.16	8.31	8.40	8.45	8.52	8.59
Max. system voltage:	600VDC					
Series fuse rating [A]:	10					

TPVM60B Series

Dimension A:	65 in. (1650 mm)						
Dimension B:	39.1 in. (992 mm)						
Dimension C:	2.0 in (50 mm)						
Max. power [W]:	220	225	230	235	240	245	250
Power tolerance:	±10%						
Open-circuit voltage [V]:	36.2	36.8	36.8	37.4	37.4	38.0	38.0
Voltage at max. power [V]:	29.2	29.7	29.7	30.2	30.2	30.7	30.7
Current at max. power [A]:	7.5	7.58	7.74	7.78	7.94	7.98	8.14
Short-circuit current [A]:	8.11	8.18	8.3	8.4	8.58	8.62	8.79
Max. system voltage:	600VDC						
Series fuse rating [A]:	10						

Installation Guidelines

⚠WARNING

Hazardous Service Procedures!

The maintenance and troubleshooting procedures recommended in this manual could result in exposure to electrical, mechanical or other potential safety hazards. Always refer to the safety warnings provided throughout this manual concerning these procedures. Unless specified otherwise, disconnect all electrical power including remote disconnect and discharge all energy storing devices such as capacitors before servicing. Follow proper lockout/tagout procedures to ensure the power can not be inadvertently energized. When necessary to work with live electrical components, have a qualified licensed electrician or other individual who has been trained in handling live electrical components perform these tasks. Failure to follow all of the recommended safety warnings provided, could result in death or serious injury.

- Systems should be installed only by qualified personnel and at least by two competent technicians. The system involves electricity, and can be dangerous if the personnel are not familiar with the appropriate safety procedures.
- Do not step on the modules—although modules are quite rugged, the glass can be broken *(and the module will no longer work properly)* if it is dropped or hit by tools or other objects.
- Carefully set the modules next to the mounting frames. Mount and fasten the solar modules on the frame. The chassis of the solar module is anodized aluminum. If the mounting frame is not aluminum, isolate the module from the frame with gaskets or other suitable material *(for*

example, PVC or stainless steel washers) to protect against galvanic corrosion caused by contact of dissimilar materials.

- The solar module chassis should be attached to a support structure at a minimum of four (4) locations and up to eight (8) places symmetrically on the solar module. Stainless steel hardware used for securing the module chassis should be torqued to 6 foot-pounds *(8 Newton-meters)*. When installing a support structure *(see the graph)*, the structure should be approximately 8 inches *(20 cm)* above ground level and the incline angle to be adjusted according to design conditions.
- The roof installation of solar modules may affect the fireproofing of the structure.

⚠WARNING

Hazard Heights!

The on-roof installation of PVT panels requires working at hazardous heights, and should ONLY be carried out by technicians that have been trained to work in such conditions. ALWAYS wear appropriate fall restraint systems during installation and maintenance of these panels. NEVER attach fall restraint system to the installation system. Failure to follow these instructions could result in death or serious injury.

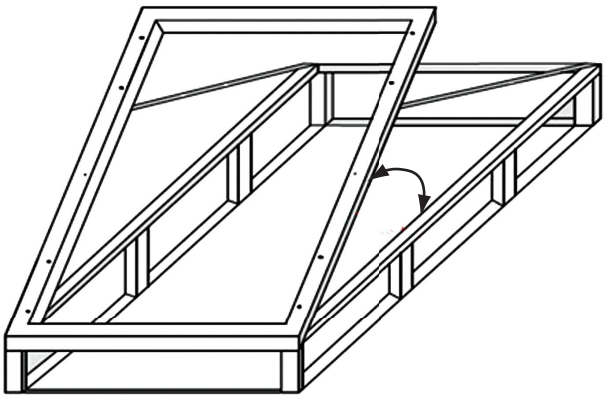
⚠WARNING

Risk of Roof Collapse!

Confirm with a structural engineer that the roof structure is strong enough to support the combined weight of the panels, framework, and weights used to secure the collectors. Failure to ensure proper structural roof support could cause the roof to collapse, which could result in death or serious injury and property damage.

- The structures that are to be used to support modules should be wind rated and approved for use by the appropriate local codes prior to installation. When installing the modules on a roof or building, for safety, install in calm winds or no wind conditions.
- Provide a suitable protective grill in the event that large snow quantities accumulate behind the panel towards the roof ridge.

Figure 3. Installing modules



PV

Wiring and Connection

⚠WARNING

Proper Field Wiring and Grounding Required!

All field wiring MUST be performed by qualified personnel. Improperly installed and grounded field wiring poses FIRE and ELECTROCUTION hazards. To avoid these hazards, you MUST follow requirements for field wiring installation and grounding as described in NEC and your local/state electrical codes. Failure to follow code could result in death or serious injury.

The electrical installation shall be in accordance with CSA C22.1, Safety Standard for Electrical Installations, National Electric Codes, Part 1.

Note: *Refer to Section 690-8 of the National Electrical Code™ (NEC) for an additional multiplying factor of 125 percent (80 percent derating) which may be applicable. For field connections, use minimum 12 AWG copper wires insulated for a minimum of 90°C.*

Connect conductors between the PV modules in series or parallel connection. This is determined by the user configuration requirement for system power, current, and voltage. In a single component array, the maximum allowable number of modules connected in series is determined by local electrical codes. The total voltage of the array must not exceed the rated working voltage of the selected controller and inverter.

Installation

⚠WARNING

Hazardous Voltage!

Disconnect all electric power, including remote disconnects before servicing. Follow proper lockout/tagout procedures to ensure the power can not be inadvertently energized. Failure to disconnect power before servicing could result in death or serious injury.

If possible, all DC wiring should be completed prior to installing a PV array. This will allow effective electrical isolation of the DC system *(via the DC disconnect switch and PV module cable connectors)* while the array is installed and effective electrical isolation of the PV array while the inverter is installed.

Typically this would require an installation of the following:

- DC disconnect switch and DC junction boxes.
- String/array positive and negative cables - from the DC disconnect/junction box to either end of the PV string/array.
- PV array main cables from DC switch to inverter.

  This should be carried out in such a way that it should never be necessary for an installer to work in any enclosure or situation featuring simultaneously accessible live PV string positive and negative parts.
- Each module should be electrically tested individually and then interconnected as they are laid. Each module has a positive and negative connector on the back of the module. Modules should be interconnected into a series string as per the circuit diagram.

Note: *A string is a number of PV modules (the glazed portion of the PV modules) wired together in series (modules interconnected such that positive on one module connects to negative on next, and so on down the string).*

Commercial systems are normally wired in series to increase voltage. There are some commercial systems that are wired in parallel.

The positive and negative end of each string has to be connected back to the inverter, using the cables as laid earlier (when fastening to the inverter connections).

- The DC cables should be securely cable tied to the mounting rail to prevent any loose cabling hanging below the modules.
- The DC cables should enter the roof adjacent to a roof bracket.
- DC cables should be visible and securely and neatly cable clipped to the point of connection with the inverter or DC switch.

Note: *Reference the current version of NEC or applicable electrical code to determine cable wire size and type.*

To install:

1. Open the connection box of the control system and connect the cables from the PV arrays to the connection box in accordance with the electrical installation drawings.
2. Properly mount and wire all isolators *(safety disconnects)* for DC and AC circuits as well as the inverter, junction boxes and pull boxes.

   Note: *Follow the manufacturer requirements for installing the inverter.*
3. Install and properly mount all control devices for the energy monitoring and control system.

   Note: *Follow the engineered wiring diagrams for connection to the existing power service.*
4. Properly lock-out and tag-out live circuits prior to terminating the new PV array to the service panel. The disconnects should be locked out and tagged out until the system is completely ready to be energized.

   Note: *Follow the requirements of applicable local and national electrical codes.*
5. Once the system is fully wired and installed, it is important to check the installation to ensure all lugs are tight, conduits are sealed.

Grounding

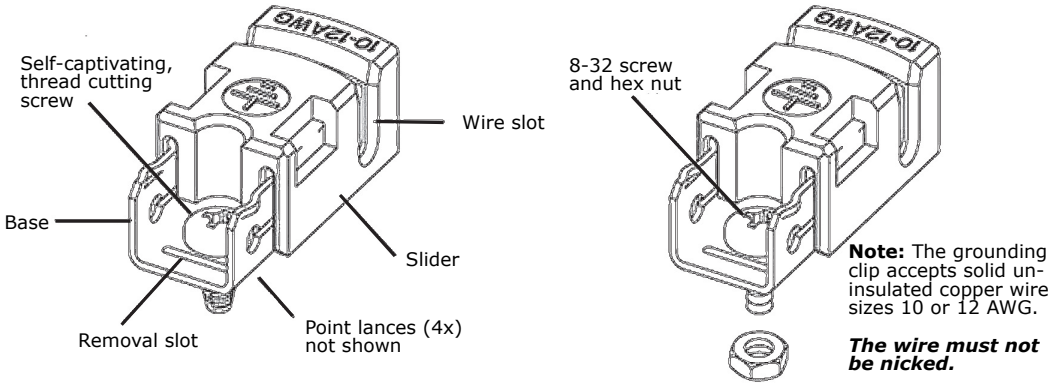
⚠WARNING

Proper Field Wiring and Grounding Required!

All field wiring MUST be performed by qualified personnel. Improperly installed and grounded field wiring poses FIRE and ELECTROCUTION hazards. To avoid these hazards, you MUST follow requirements for field wiring installation and grounding as described in NEC and your local/state electrical codes. Failure to follow code could result in death or serious injury.

- The module must be wired in accordance with the NEC. The grounding method of the frame of arrays shall comply with the National Electrical Code.
- Grounding is achieved through fastening the module chassis to the array frame. The array frame shall be grounded in accordance with National Electrical Code.
- All module frames should be grounded for safety. The grounding connections between modules must be approved by a qualified electrician, the grounding itself must be made by a qualified electrician.

Figure 4. Grounding clip

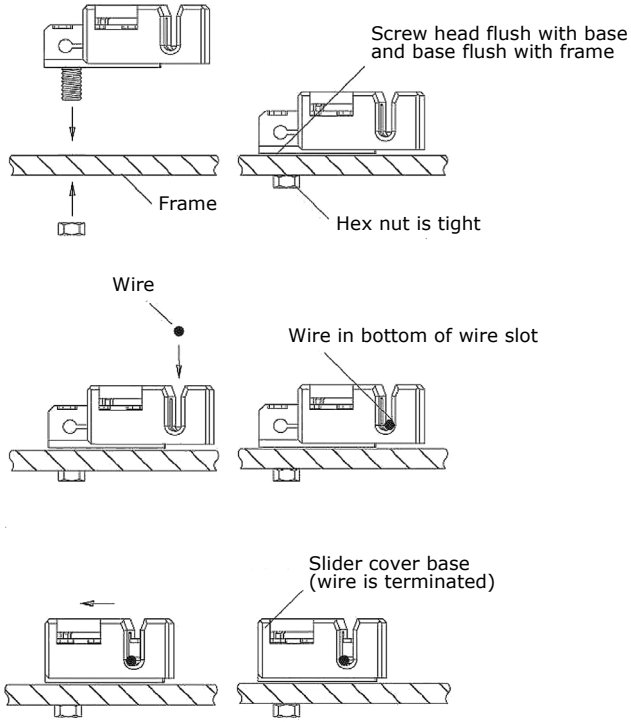


Mounting Grounding Clip to Frame

Mount the grounding clip by first, removing the coating on the frame and then placing the clip onto the frame so that the screw straddles the pre-drilled hole. It is recommended that the screw be tightened to a torque between 1.7 and 2.1 foot pounds (2.3 and 2.8 Nm). The head of the screw must be flush with the base and the base must be flush with the frame. Refer to Figure 4 and Figure 5.

- The wire must be in the bottom of the wire slot which will cause the wire to form a sleighed curve.
- The slider must be engaged *(slider covers the base)*.
- Perform High Potential (Hi-Pot) Grounding Test to ensure the integrity of the grounding system.

Figure 5. Mounting grounding clip to frame



Charge Controllers and Batteries

⚠WARNING

Hazard of Explosion!

Most batteries generate hydrogen gas when charging, which can be explosive. Do not light matches or create sparks near the battery bank. When a battery is installed outdoors, it should be placed in an insulated and ventilated battery case specifically designed for the purpose. Failure to follow instructions could result in death or serious injury.

When charging batteries with solar modules, the charge controller and batteries must be installed in a way that will protect the performance of the system and the safety of its users. Follow battery manufacturer guidelines concerning installation, operation, and maintenance recommendations. In general, the battery *(or battery bank)* should be away from the main flow of people and animal traffic. Select a battery site that is protected from sunlight, rain, snow, debris, and is well ventilated.

Tracking Systems

Most tracking systems are specifically designed for the application. Carefully follow the tracking system manufacturer installation instructions and drawings.

Array - Initial Tests

Before completion, it is very important to ensure the array has been correctly interconnected. The purpose of this initial first check is to ensure:

- All modules/cables have been interconnected
- The correct number of modules are connected in a string *(refer to the schematic)*
- Correct polarity

NOTICE

Inverter Damage!

The modules must be wired correctly and terminated in the inverter at the proper terminal. If not, the inverter could be damaged and require replacement. Follow the inverter manufacturer instructions for properly connecting the wiring from the array to the inverter.

Important: *Use a multimeter to check polarity before the PV array is connected to the inverter. This is best done at the inverter board to ensure all connections are correct.*

Check the open circuit voltage *(Voc)* to ensure it is in line with the values provided by Trane. Where two or more identical strings are installed, the values of Voc shall be compared to ensure that all strings contain the same number of modules.

Array - Full Tests

Full array tests are out of the scope of this document. Refer to Trane for more information.

⚠WARNING

Live Electrical Components!

PV modules are live at all times when a light source is present. Failure to follow all electrical safety precautions when exposed to live electrical components could result in death or serious injury.

Important: *Following installation, the PV modules must be covered to stop solar radiation reaching them until completion of commissioning.*

System Operation

Solar PV systems normally operate automatically when the minimum voltage is sensed by the inverter. The inverter automatically senses when the voltage exceeds the minimum threshold requirement, closes the disconnects, and enables power to flow into the building electrical service. The monitoring systems operate continuously throughout the day. Audible alarms and visual strobe lights should be employed to notify operators when a malfunction or trouble with the system exists. The tracking systems will automatically sense the best position for the array.

Commissioning and Warranty

The system must be installed and commissioned by competent technicians and in accordance with these instructions. Additionally, NEC compliance must be ensured and certified.

The Commissioning Checklist (refer to Table 1) must be completed at the time of commissioning. One copy of the checklist must be retained with this manual and one part returned to Trane. This requirement forms part of the manufacturer warranty.

Table 1. PV commissioning checklist

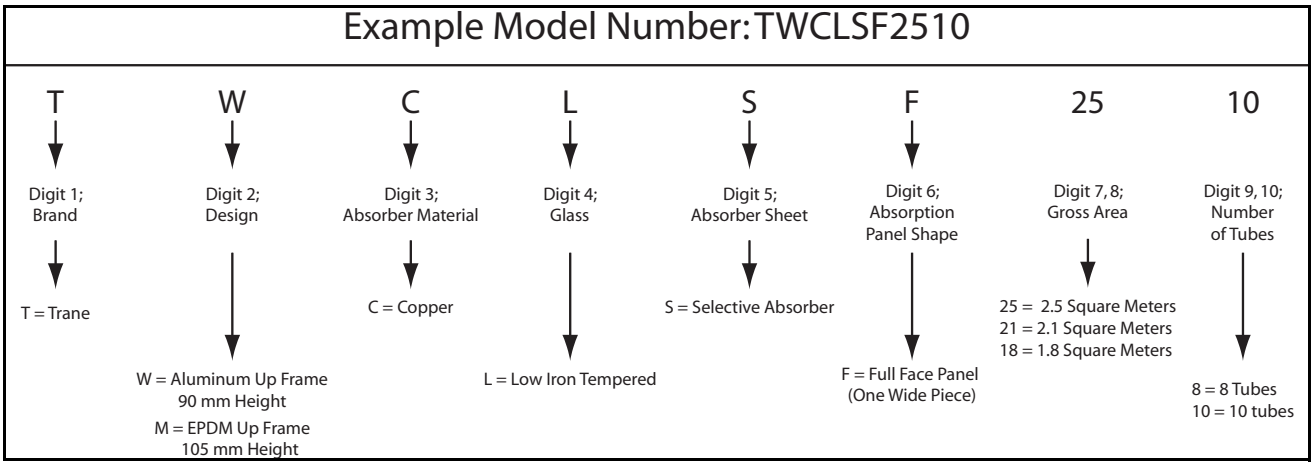
General	
Has the Installation, Operation, and Maintenance (IOM) document been provided to the owner?	Yes/No
Has owner training been completed?	Yes/No
Has the maintenance schedule *(including frequency, maintenance and list of parts to be replaced during normal maintenance)* been left on site?	Yes/No
Commissioning certificate been completed and signed, if required?	Yes/No
Name of location where documentation is kept:	
Important: *All documentation to be kept in proximity of installation, protected from heat, water and dust.*	
General Installation (Electrical)	
Equipment compliant with standards, correctly selected and not damaged?	Yes/No
Equipment accessible for operation, inspection, and maintenance?	Yes/No
Equipment and accessories correctly connected?	Yes/No
Conductors connected and identified?	Yes/No
Conductors selected for voltage rating, current carrying capacity, and voltage drop?	Yes/No
Conductors routed in safe zone or protected against mechanical damage?	Yes/No
Presence of seals and protection against thermal effects *(weather tight conduit, fittings, and boxes used in mechanical rooms and outdoors)*?	Yes/No
General Installation (Mechanical)	
Ventilation provided behind array to prevent overheating/fire risk?	Yes/No
Array frame and material corrosion proof?	Yes/No
Array frame correctly fixed and stable? Roof penetrations weatherproof?	Yes/No
Cable entry weatherproof?	Yes/No
Protection Against Overvoltage/Electric Shock	
Live parts insulated, protected by barrier/enclosure, placed out of reach, or Class II as required?	Yes/No
Array frame equipotential *(grounding)* bonding present, if required?	Yes/No
Surge protection devices present, if required?	Yes/No
Remote Control Devices provided, if required?	Yes/No

Frame correctly integrated with existing lightning protection system installation?	Yes/No
DC System	
Physical separation of AC and DC cables?	Yes/No
DC disconnect switch installed *(per NEC and local codes)*?	Yes/No
DC cables - protective and reinforced insulation, if required?	Yes/No
All DC components rated for operation at max DC system voltage *(Voc STC x 1.25)*?	Yes/No
PV array strings fused or blocking diodes fitted, if required?	Yes/No
AC System	
AC isolator lockable in off position only?	Yes/No
Inverter protection settings to local regulations?	Yes/No
Labeling & Identification	
General labeling of circuits, protective devices, switches, and terminals?	Yes/No
PV system schematic displayed on site?	Yes/No
Protection settings & installer details displayed on site?	Yes/No
Emergency shutdown procedure displayed on site?	Yes/No
AC disconnect switch clearly labeled?	Yes/No
DC isolator/junction boxes suitably labeled?	Yes/No
Signs & labels suitably affixed and durable?	Yes/No
Commissioning Details	
Expected annual delivered PV electrical energy:	
Expected annual PV fraction of electrical:	
Method of performance calculation:	
Annual electrical load assumptions:	
Commissioned By	
On behalf of:	
Date system commissioned and handed over:	
Signature of commissioning engineer *(electrical)*:	
Signature of user to confirm receipt and understanding *(optional)*:	

Solar Thermal Collector Systems

A thermal collector solar panel system is designed to collect heat by absorbing sunlight. Thermal collectors are typically used for supplemental heating of potable water, living spaces or swimming pools in residential and commercial buildings. Water or a glycol solution is used to transfer solar thermal energy to a heat exchanger.

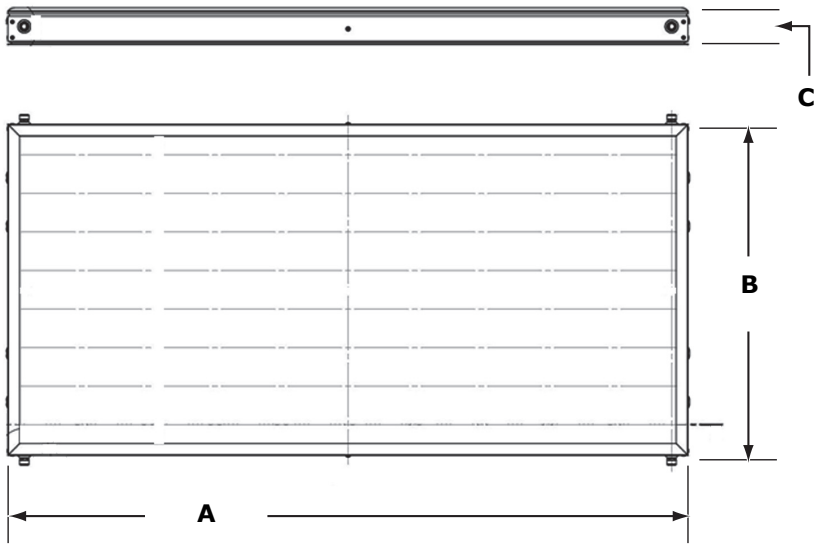
Model Number Description



Thermal Panel Dimensions and Series

The following figure and table provide information about the thermal collector dimensions.

Figure 6. Thermal Collector Dimensions



Model No.	A	B	C
TMCLSF 1808	76.6 in. (1945 mm)	37.2 in (945 mm)	4.1 in. (105 mm)
TMCLSF 2510	79 in. (2006 mm)	48.7 in. (1236 mm)	4.1 in. (105 mm)
TWCLSF 18087	5.9 in. (1927 mm)	36.5 in. (927 mm)	3.5 in (90 mm)
TWCLSF 21087	8.3 in. (1988 mm)	41 in. (1041 mm)	3.5 in (90 mm)
TWCLSF 2510	78.3 in (1988 mm)	48 in (1218 mm)	3.5 in (90 mm)

System Design Considerations

For questions or advice on the design, contact your local Trane sales district for technical assistance.

Installation

Before Installation

A Trane thermal collector system must be installed by a qualified contractor in compliance with all local planning requirements, building regulations and codes, health and safety legislation, and any relevant local by-laws and regulations in force at the time.

Mounting Solar Thermal Collectors

Roof Kits

"On-roof System Installation," p. 26 and *"In-roof System Installation," p. 29* mounting kits are designed for use on roof slopes of between 20° and 65° and must be installed in accordance with these instructions. The *"Flat-roof System Installation," p. 29* mounting kit can be used on any flat surface capable of carrying the weight of the collectors and any dead weighting used.

If necessary, the installation can be modified to suit the site conditions. However, any changes must be approved by Trane and must meet building regulations, codes of practice, and any relevant local bylaws and regulations in force at the time. Failure to comply with this requirement will invalidate the product warranty.

Wind Uplift and Roof Safety

When installed, solar thermal collectors can experience uplift due to the wind. It is also important to consider the safety of servicing a roof-mounted solar installation. Therefore, collectors must be installed an appropriate distance from the edge of the roof to comply with applicable OSHA regulations and building codes.

Note: *Applicable wind pressure and its impact on the structure are determined by the Licensed Professional Structural Engineer.*

⚠WARNING

Hazard Heights!

The on-roof installation of PVT panels requires working at hazardous heights, and should ONLY be carried out by technicians that have been trained to work in such conditions. ALWAYS wear appropriate fall restraint systems during installation and maintenance of these panels. NEVER attach fall restraint system to the installation system. Failure to follow these instructions could result in death or serious injury.

⚠WARNING

Risk of Roof Collapse!

Confirm with a structural engineer that the roof structure is strong enough to support the combined weight of the panels, framework, and weights used to secure the collectors. Failure to ensure proper structural roof support could cause the roof to collapse, which could result in death or serious injury and property damage.

Mounting Types

The following sections describe the installation of collectors in both the *portrait* and *landscape* format using all three mounting types:

- On-roof
- Flat-roof
- In-roof

Note: *The connection to the hydraulic solar circuit is identical for all the mounting options and is covered elsewhere in this manual.*

Important: *Install components only on roofs with sufficient strength and capacity. Take into consideration the additional load per flat roof rack, including solar panels, wind and snow. All installations should be reviewed by a Registered Structural Engineer to ensure that the supporting structure is adequate for supporting the installed components and system.*

Provide a suitable protective grill in the event that large snow quantities accumulate behind the panel towards the roof ridge.

On-roof System Installation

When using on-roof or in-roof mounting kits, refer to the manufacturer kit instructions. The instructions given here are only intended to be a typical guide. The illustrations that follow show the installation components and procedures that are suitable to a cement tile roof.

Note: *Asphalt or fiberglass shingle type roofs will have similar procedures.*

The standard installation kit allows panels to be fitted onto horizontal mounting rails. Each row of modules is held to the roof using two aluminium mounting rails. These are attached to the roof structure using appropriate brackets for the roof covering.

Roof Bracket and Rail Installation Guidelines

To ensure sufficient strength and resilience to wind loads, all the roof brackets supplied with the kit must be used. The brackets need careful positioning to ensure that the rails lie in the correct location as follows:

- Collectors should not be installed closer than 20 in. (500mm) *(or according to the local Building Code) to the perimeter of the roof (including the ridge line and eaves)*.
- Each mounting rail needs a roof bracket no more than 12 inches (300mm) from the end of the rail.
- Intermediate brackets along the rail should be no more 47 inches (1200mm) apart. With rafters of 23.6 inches (600mm) spacing every other rafter is sufficient.
- Single rails should not be more than 56 feet (17m) in length *(an expansion gap then needs to be allowed)*.

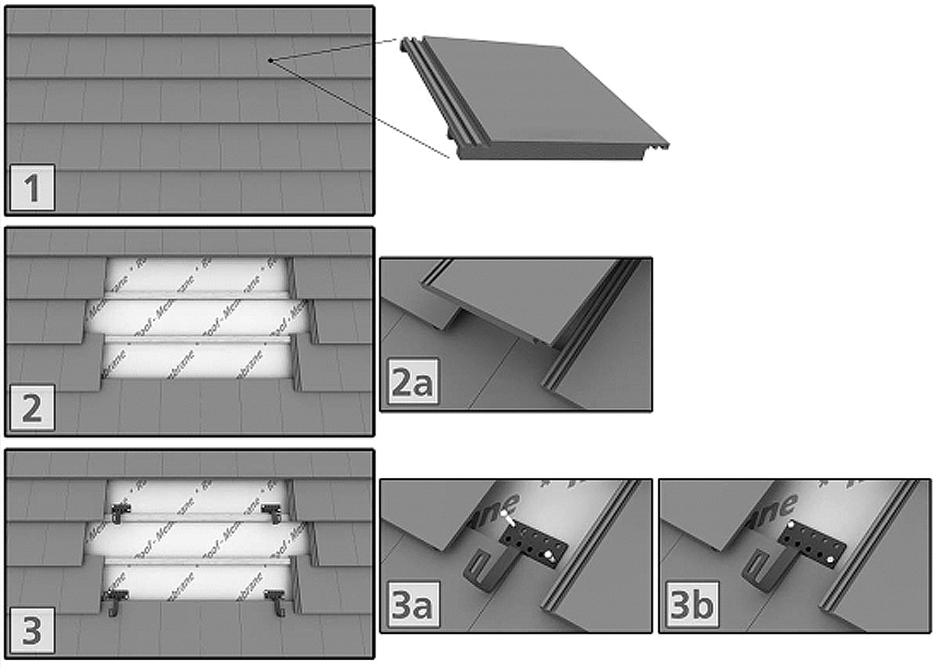
Figure 7. Roof bracket and rail installation, Steps 1 through 6d

Steps 1, 2: Move sufficient roof tiles to determine rafter positioning and to gain access for installing brackets.

Step 2a: Position the leg of the bracket in the furrow of the roof tile *(profiled tiles only)* and ensure a gap of approximately 0.2 in. (5mm) between the underside of the leg and the top face of the roof tile *(using spacers, if necessary)*.

Secure each roof bracket to the rafter using at least two points, preferably using those closest to the center of the flange.

Step 3: Screw securely into position on the rafter using the coach screws provided.



Steps 4—4b, and 5: Reposition the roof tiles over the bracket. A small section of tile may need to be removed using an angle grinder to ensure the tiles
re-seat correctly.

Step 6—6d: Bolt the mounting rails to the brackets using the supplied *M10 T-Head* bolts.

Note: *Rails must be orientated so the lower rail is the one with the mounting profile and cable channel. The cable channel should face up the slope of the roof towards the ridge.*

A straight edge should be used to ensure that the ends of rails are all perfectly in line. Tighten the *M10 T-Head* bolts to a torque of 33 ft-lbs (45 Nm).

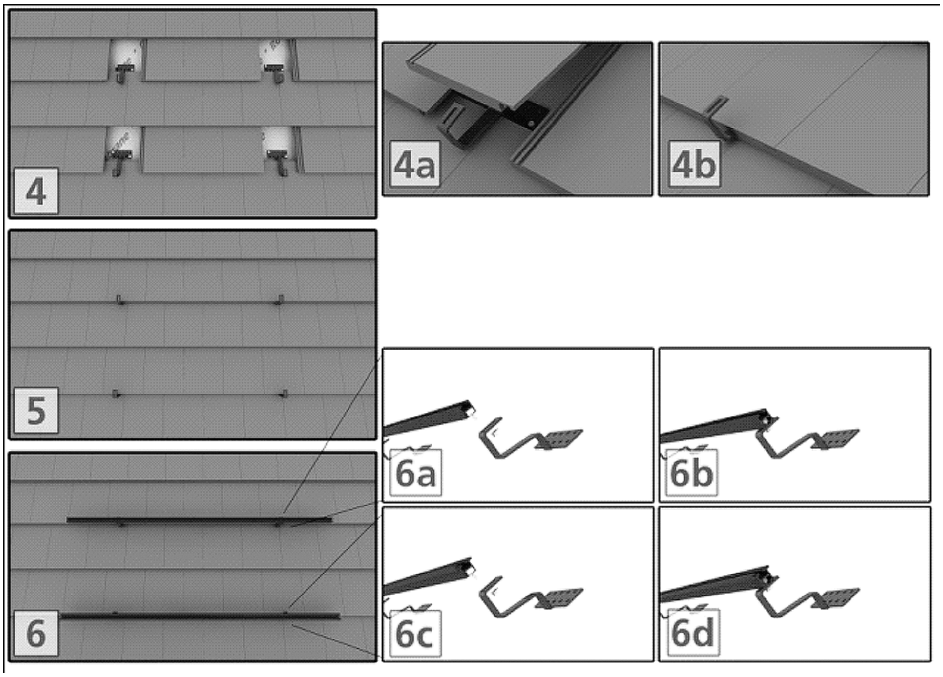


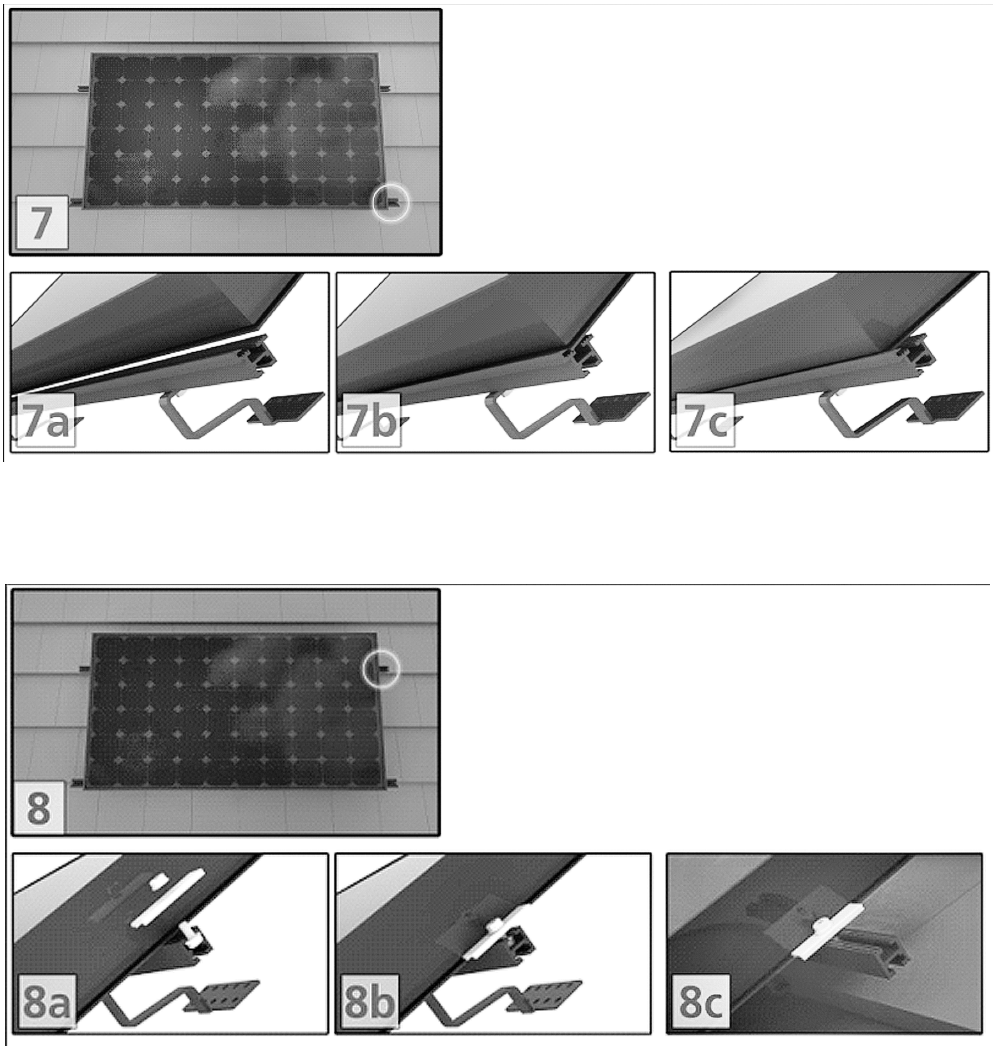
Figure 8. Collector Fastening, Steps 7 - 8c

Step 7: Collectors are fastened onto the PVT mounting rails using special clamps. The lower edge of the panel is slotted into the lower bracket.

Step 8: The upper rail accepts one of two clamp types provided; mid clamps, which go between modules and end clamps, which go at the ends of each row). Clamps are attached to the rail by sliding the square nut into the channel.

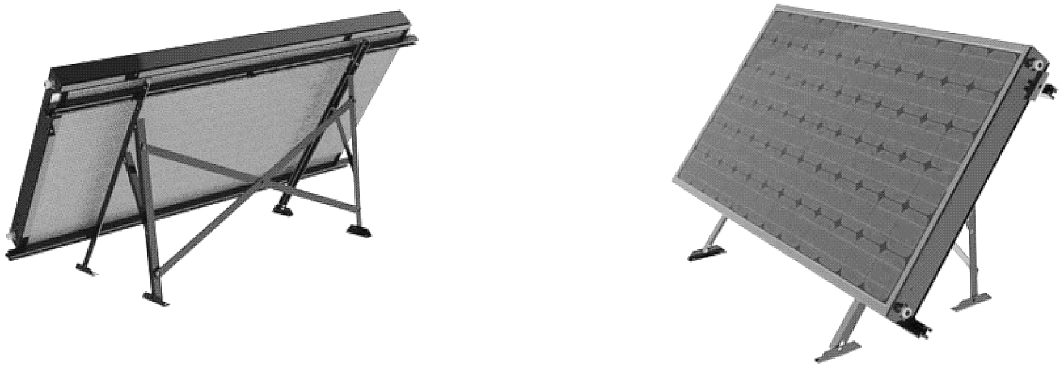
Important: A collector at one end of the row should be fastened first. Ensure that this collector is located square *(using string line, roofing square or similar)*, as the alignment of this collector affects the location of all other collectors laid subsequently. It is also important to ensure that the orientation is correct. This is marked on each collector.

Once the first collector is installed, continue laying the rest of the row. Ensure they are closely butted up to each other *(no gaps under clamps)*. Clamps should be secured by hand during this stage. Once it is clear that all collectors are correctly located, all clamps should be re-tightened to a torque of 15 ft-lbs (20 Nm). Collectors should be hydraulically connected *(piped)* as they are mounted (refer to the section, "Piping Connections," p. 30).



Flat-roof System Installation

Figure 9. Flat-Roof System Installation



When securing the framework by weights rather than screwing down, the weights must conform to the following specifications for a wind pressure zone up to 26' (8 m) building height and a snow load zone up to 11 psi (0.75k N/m^2). If any part of the existing roof structure has been penetrated, it must be carefully re-sealed in accordance with technical standards/building regulations.

Dead Weight Load for Thermal Collectors	
Collector Model	**Dead Weight Load per Collector[a]**
TMCLSF 1808	79.4 lb. (36 kg)
TMCLSF 2510	105 lb. (47.5 kg)
TWCLSF 18087	75 lb. (34 kg)
TWCLSF 21087	82 lb. (37.2 kg)
TWCLSF 2510	297 lb. (44 kg)

(a) Add approx. 2.9 lb.(1.3 kg) to each collector for the weight of the solar solution. In addition, add weights for the mounting structure, piping and accessories for your particular installation.

In-roof System Installation

A waterproof membrane must be used on all roofs. On older roofs, *sarking felt* is acceptable. If sarking felt is not available, then a breathable waterproof membrane must be fitted and it should end at the eaves *(roof guttering)*.

During extreme weather conditions *(such as driving rain, snow covering or ice formation)* dampness can occur beneath the roof covering *(tiles or slates)* on roof slopes of less than 20°, greater than 65°, or where there are long rafters or joined roofs. This can be avoided by using additional wedge section sealing strips. However, adequate ventilation of the roof must still be provided.

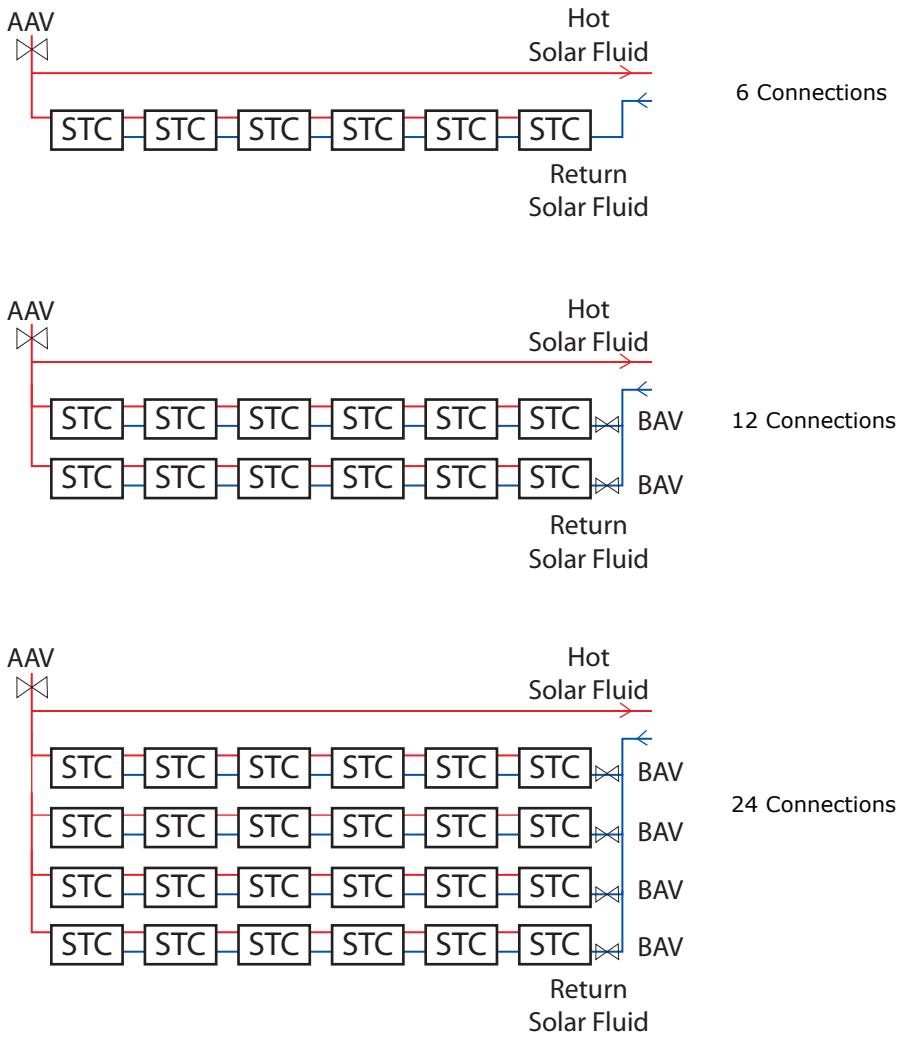
Piping Connections

Connect the collectors hydraulically, one by one, as they are mounted. Flexible connecting unions are supplied for this purpose. Careful attention to the pipe circuiting is needed.

The maximum recommended number of modules per row is six (6) before a manifold is required - the layout will be made clear in the design specification.

The following illustration shows the typical hydraulic connections for 6, 12, and 24 collector installations.

Figure 10. Typical hydraulic connections—6, 12, 24



Legend: AAV = Auto Air Vent / BAV = Balancing Valves / STC = Solar Thermal Collector

Important: *It is recommended that all external pipe work is insulated. Plastic pipe must not be used. All joints must use compression fittings with brass olives. Soldered joints are not permitted.*

Roof Penetrations

NOTICE

Proper Sealing!

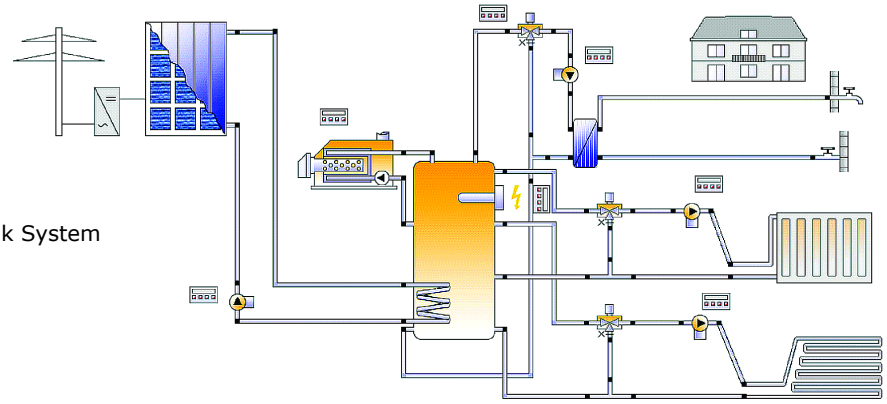
Ensure that all roof penetrations are weather tight. Off-the-shelf flashing kits are available, or these can be fabricated on site. Failure to proper seal penetrations could result in property damage.

Solar Pumping Stations

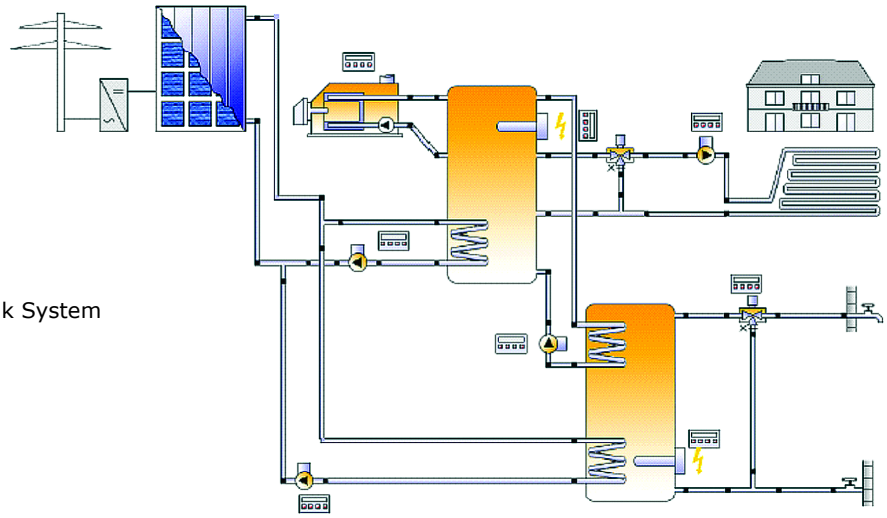
The pump selection is critical to the effectiveness of the system and is determined at the design stage. For installation details refer to the manufacturer manual that is supplied with the pumping station.

Panel connections are indicated in the submittals; this determines the minimum pipe size diameter and therefore minimum pump size. It is recommended that larger installations using pumps with higher flow rates use pipe and cylinder connections of the same size as the connections to the pump. In turn, this will determine the manifold sizes. The size of connections between the manifold and collectors should be determined by collector connection size. The following illustration shows the hydraulic schematics for a 1- or 2-tank system.

1 Tank System



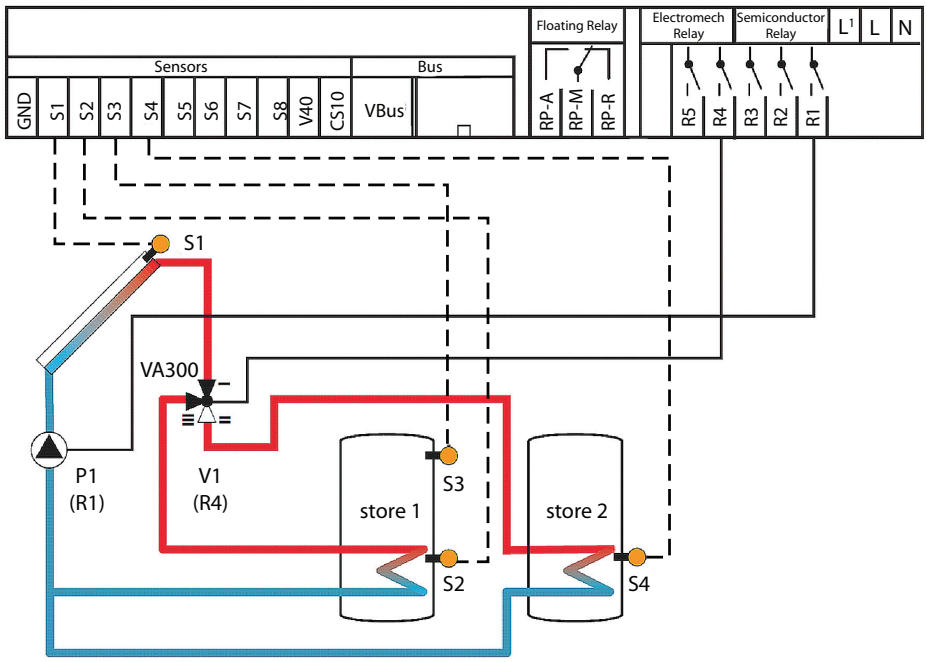
2 Tank System



Solar Solution Controller (SSC)

There are many manufacturers of solar thermal controllers. Refer to the specific manufacturer manual. The following illustration shows *(RESOL® controller)* the wiring to the controller of a typical 2-tank system.

Figure 11. Wiring to controller, typical two tank system



Commissioning and Warranty

Important: *The system must be installed and commissioned by competent persons and in accordance with these instructions. Additionally, NEC compliance must be ensured and certified.*

The Commissioning Checklist must be completed at the time of commissioning. One copy of the checklist must be retained with this manual and one part returned to Trane. This requirement forms part of the manufacturer's warranty.

This section provides information about the following:

- Thermal system startup
- Operation, repair, and troubleshooting
- Commissioning Checklist
- Mechanical and electrical maintenance
- Warranty

Thermal System Startup

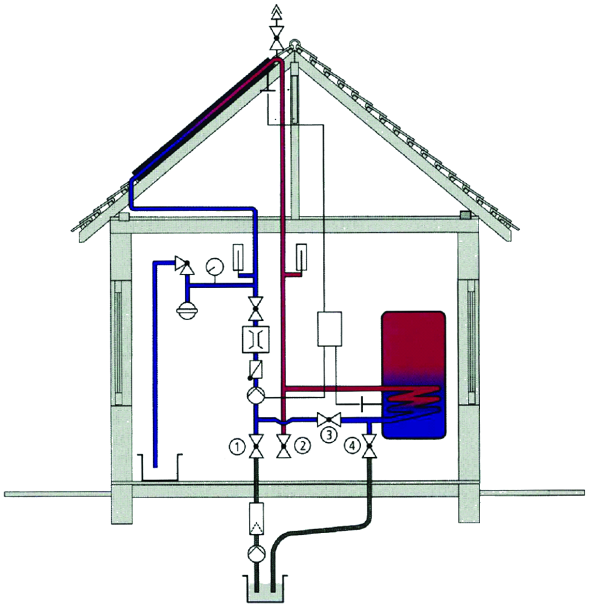
To startup the solar thermal system:

Note: *Follow steps 2 through 4 after any shutdown for routine maintenance or due to a fault condition.*

1. Flushing out the solar circuit *(refer to the illustration below)*;

   A thorough flushing process removes dirt and residual flux from the solar circuit. Flushing should not be carried out in full sunshine or during frost due to risk of evaporation or freezing. The flushing process initially takes place by means of valves 1 and 2.

   Valve 1 is connected to the cold water line by a hose; a further hose on valve 2 is laid to drain. All fittings in the solar circuit should be set to through-flow *(gravity brake, shut-off tapes)*. Finally, in order to flush out the heat exchanger, valve 2 is closed. Then, after attaching a hose to valve 4, valve 4 is opened, and valve 3 is closed. The flushing process should last at least 10 minutes.



2. Leak testing;

   The pressure test takes place after first flushing. For this purpose, valve 4 is closed and the system is filled with water through valve 1. The system pressure is then raised to a value just below the response pressure of the safety valve - as required by local codes. Then valve 1 is closed. If the system pressure is reduced due to bleeding, repeat the process of pressurizing the system by through valve 1 until the pressure stabilizes. The system is now ready to be visually observed for leaks.

   A leak test *(using the pressure gauge)* is not possible because of irradiation-caused pressure variations over the course of the day. At the end of the leak test, the function of the safety valve can be tested by increasing the pressure further. The solar circuit should be fully emptied again by opening valves 1 and 2. By measuring the amount of water that runs out, it is possible to establish the amount of antifreeze required to make up a water-antifreeze mixture *(for example 60:40)*. As some water always remains in the solar circuit, the measured amount of water should be correspondingly increased.

3. Filling with solar liquid.

   After mixing the antifreeze concentrate with water to achieve the desired level of frost protection *(or using pre-mixed antifreeze)*, the solar liquid is pumped into the solar circuit through valve 1. Purge air from the solar liquid as follows:

   – When pumping the solar liquid in the system and the mixing container, a large part of the air is already removed. To be effective the ends of the hoses must be completely submerged in the liquid. When no more air bubbles are released, valve 4 can be closed.

   – Reduce the pressure to system pressure *(= static pressure + 7 psig [0.5 bar})* plus an allowance for pressure loss through further bleeding.

   – Switch on the circulating pump. Switch it on and off several times at 10 minute intervals.

   – To bleed the circulating pump, unscrew the brass screw on the face.

   If the pressure falls below the system pressure as a result of bleeding, solar liquid should be added accordingly.

4. Setting the pump and controller;

   The volumetric flow in the system should be about 0.3 gal. *(1.2 liters)* per minute, per collector *(medium flow operation)*. The pump should be capable of generating the pressure required in the medium performance range. With full irradiation, this leads to a temperature differential between the feed and return lines of about 20°F to 40°F (11°C to 22°C) in medium flow operation.

   The switch-on temperature difference of 41°F to 50°F (5°C to 10°C) and the switch-off difference *(hysteresis)* of about 3.6°F (2°C), should be set on the controller. In this way, the heat generated in the collector is transferred to the storage tanks at a useful temperature level while no unnecessary pump energy is used. Refer to the specific system controller manufacturer manual for additional information.

Operation, Repair, and Troubleshooting

Solar thermal systems can consist of a variety of storage and drain-back tanks, solar solution feed stations, heat exchangers and pumps, and usually have a unique set of controls for the particular application. Solar thermal systems should be designed with redundant heating systems in the event that the sun does not help the system produce an adequate amount of heating for building heating or for one of the many applications for solar thermal systems. They need to be configured to supplement the heating supplied by the solar thermal system in the most efficient manner for maximum energy efficiency.

The system designer has intentionally configured the system to fulfill its intended purpose. It is highly recommended that:

- The installer, operations personnel, and maintenance/repair personnel or contractors familiarize themselves with the design drawings, system specifications, product submittals, and particularly the controls design, sequence of operations, and *as-built* controls drawings.
- The system designer or installer provide operator training to the individuals responsible for the day to day operations and maintenance of the systems.
- A licensed contractor and/or certified solar installer should be employed to properly install and commission solar thermal systems.

Solar Thermal systems can be operated in a several different modes, including the normal heating mode and heat-rejection mode. The system should have been designed to either fully reject all of the heat that can be generated by the system to the heat recipient or should have the provisions for rejecting excess heat in the event that the heat generated cannot not be fully used by the intended recipient. While the collectors are designed to withstand a *stagnation temperature condition*, it is highly recommended to avoid this condition.

Stagnation is a condition in which the solar solution pump is not causing water flow through the collector array and the heated solution continues to absorb heat. Excess heat can cause the solar solution to deteriorate and be rendered ineffective at freeze protection. Temperature sensors and alarms should have been designed into the system so that the heat rejection equipment can be automatically operated. Monitoring systems should be used so that operators can be made aware of system malfunctions. When alarm conditions arise, trained personnel should be engaged to perform troubleshooting and system repairs.

The solar thermal system is fully automated. Once correctly setup, the system should require no input from the user. The controller continuously monitors the temperature differential between the solar cylinder and the panels, the panels must be warmer than the water in the cylinder before the pump is switched on. Any fault condition will be indicated on the controller.

Table 2. Thermal System Commissioning Checklist

General	
Has the Installation, Operation and Maintenance (IOM) document been provided to the owner?	Yes/No
Have the system submittals been provided to the owner *(collectors, pumps, expansion tanks, controls, drawings, wiring diagrams, sequence of operations, etc.)*?	Yes/No
Has owner training been completed?	Yes/No
Has the maintenance schedule *(including frequency, maintenance and list of parts to be replaced during normal maintenance)* left on site?	Yes/No
Has the hydronic system been pressure tested *(leak checked)* and all leaks been repaired satisfactorily?	Yes/No
Commissioning certificate completed and signed, if required?	Yes/No
Important: *All documentation to be kept in proximity of installation, protected from heat, water and dust.*	
Name of location where documentation is kept:	
What is design operating temperature?	
Pressure relief valve installed on system?	Yes/No
Is PRV piped to collection tank or to drain?	Yes/No
Has the freeze protection solution test been completed to ensure that the solar solution has adequate protection?	Yes/No
Maximum stagnation temperature of PVT collector:	
Maximum design pressure of PVT collector:	145 psig (10 bar)
Maximum design pressure of exchanger:	125 psig (8.6 bar)
Primary pressure limit of weakest component:	
System pressure setting adjusted when cold:	22 psig (1.5 bar)

Minimum allowable primary system pressure/level before user action required from pressure switch low limit *(make-up water pressure regulating valve set at 13 psig [0.9 bar])*:	12 psig (0.8 bar)
Procedure for user to follow if primary pressure/level is below limit:	Contact installer/maintainer (check for visible leaks)
Location of primary system pressure gauge:	Solar pump station
Frequency of regular test of pressure safety device:	Yearly
Location of pressure safety device:	Solar pump station
Location of electrical fused isolating switch:	Solar pump station
Fuse rating:	3 Amps
Electrical controls and temperature sensors operating correctly?	Yes/No
Non-solar DWH heating fitted with a thermostat responding to the solar system operating temperature?	Yes/No
Controller Temperature Setting (120°F to 190°F)/(49° to 88°C):	
Expansion vessel pre-charge (15 to 18psig)/(1.0 to 1.2 bar):	
Expansion vessel capacity:	
Expansion capacity suitable to be inherently secure?	Yes/No
Written warning left on site if there is potentially no automatic resumption of normal operation after stagnation *(manual reset on high temperature limit reached)*?	
Lowest ambient temperature of primary system without freezing damage:	___ °F (____ °C)
The heat transfer fluid provides freeze protection to:	___ °F (____ °C)
Type of transfer fluid:	Water/Glycol
Maximum ambient temperature for pump:	
Minimum ambient temperature for pump:	
Circulation rate setting. Gallons (Liters) per minute:	
Direction of circulation through collector heat exchanger matched to sensor positions?	Yes/No
Location of DHW isolation valve:	
Location of pump control/thermostatic mixing valve:	
Location of digital temperature gauge fitted to monitor risk of DHW overheating:	
Lime scale risk to heat exchanger *(make-up water system hardness test completed)*?:	Yes/No
Lime scale control in heat exchanger *(is there a softened water make-up to the solar solution system)*?:	Yes/No
Non-solar DWH heating equipped with a thermostat responding to the solar water heating temperature?	Yes/No
General installation (electrical)	
Equipment compliant with standards, correctly selected, and not damaged?	Yes/No
Equipment accessible for operation, inspection, and maintenance?	Yes/No
Equipment and accessories correctly connected?	Yes/No
Particular protective measures for special locations?	Yes/No
Conductors connected and labeled?	Yes/No
Conductors selected for voltage rating, current carrying capacity, and voltage drop?	Yes/No
Conductors routed in safe zone or protected against mechanical damage?	Yes/No
Presence of seals and protection against thermal effects *(weather tight conduit, fittings, and boxes used in mechanical rooms and outdoors)*?	Yes/No
General installation (mechanical)	
Ventilation provided behind array to prevent overheating/fire risk?	Yes/No

Array frame & material corrosion proof?	Yes/No
Array frame correctly fixed and stable? Roof penetrations weatherproof?	Yes/No
Protection against overvoltage/electric shock	
Live parts insulated, protected by barrier/enclosure, placed out of reach, or Class II as required?	Yes/No
Array frame equipotential bonding present, if required?	Yes/No
Surge protection devices present, if required?	Yes/No
Remote Control Devices provided, if required?	Yes/No
Frame correctly integrated with existing lightning protection system installation?	Yes/No
Labelling & identification	
General labelling of circuits, protective devices, switches, and terminals?	Yes/No
Protection settings and installer details displayed on site?	Yes/No
Emergency shutdown procedure displayed on site?	Yes/No
Signs & labels suitably affixed and durable?	Yes/No
Commissioning details	
Expected annual delivered solar thermal energy to domestic hot water system/space heating:	
Expected annual solar collector fraction of DHW:	
Expected annual PVT fraction of DHW:	
Method of performance calculation:	
Daily DHW/space heating load assumption	
Date of site visits for bacterial, water quality and access risk assessments:	
Commissioned by	
On behalf of:	
Date system commissioned and handed over:	
Signature of commissioning engineer *(Electrical)*:	
Signature of commissioning engineer *(Solar Thermal)*:	
Signature of user to confirm receipt and understanding *(optional)*:	

Hybrid PVT Collectors

A hybrid PVT collector is the combined assembly of a photovoltaic (PV) module, for the conversion of electrical energy, with a high efficiency flat-plate solar collector to convert thermal energy. Photovoltaic cells are semiconductors which have one drawback— degradation in performance due to temperature and aging.

On a sunny day and expecting the most output of the PV system, the outputs will be significantly reduced. This is because the high ambient temperature of the silicon wafers within the PV panel impedes current flow and degrades the output. By removing the heat from the panel, the PV efficiency does not degrade, whereby, and beneficial use of the solar heat can be produced. Using this principle, it is possible to obtain a higher electrical yield, coupled with enough free heat to offset low energy annual heating requirements. A hybrid PVT is a step-change technology that maximizes the energy return from a given area.

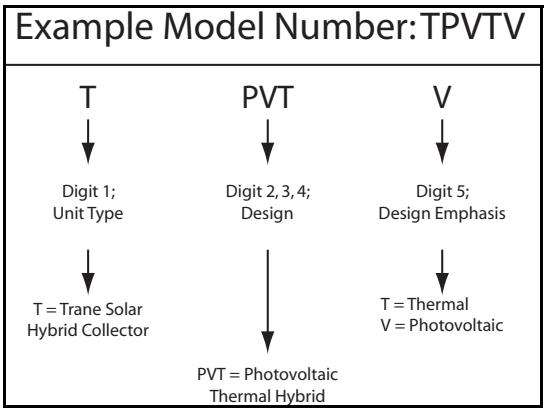
Effective PV Performance and Operation Temperature

All photovoltaics are tested under standard test conditions (STC) at an irradiance level of 1000W/m2 and a temperature of 24°C. PV performance and temperature are inextricably linked. For every 1°C rise temperature there is a drop of 0.5% of electrical output. When under direct sunlight, the temperature of a standard PV module may be as high as 230°F (110°C), resulting in a 43% loss in efficiency due to heat, leading to a subsequent reduction in annual performance.

The Benefits of Cooling a PV Module

If the PV module can be actively cooled, reducing its nominal temperature closer to that of standard test conditions, the overall annual output of the module will be improved. A hybrid PVT collector panel, stabilized at an average temperature of 113°F (45°C), will produce roughly 20% more output over a 12 month period *(when compared to a PV system with the same peak output)*.

Model Number Description



PVT

Product Selection

There are two types of PVT collectors determined by the project:

- PVT- thermal (TPVT-T);

  The TPVT-T collector is designed to maximize on the thermal return of the panel, making it an enhanced thermal collector capable of electrical production. The peak outputs of this panel are 170 electrical watts and 610 thermal watts *(2321 BTUh)*. It will produce roughly 80% of the output of the equivalent area of solar thermal and it also produces electricity. This is an excellent solution if the project has restricted space while trying to maximize the energy return.

  This system is ideal for use with swimming pools, whereby, the collector operates at lower temperatures. This supplies year-around heat to the pool and the electrical energy needed to offset the running of the pool equipment.

  In conjunction with ground source heat pumps, excess summer energy is fed into the ground which is recovered during colder periods to heat a building. PVT can contribute to producing a zero-carbon building as part of an integrated solution.

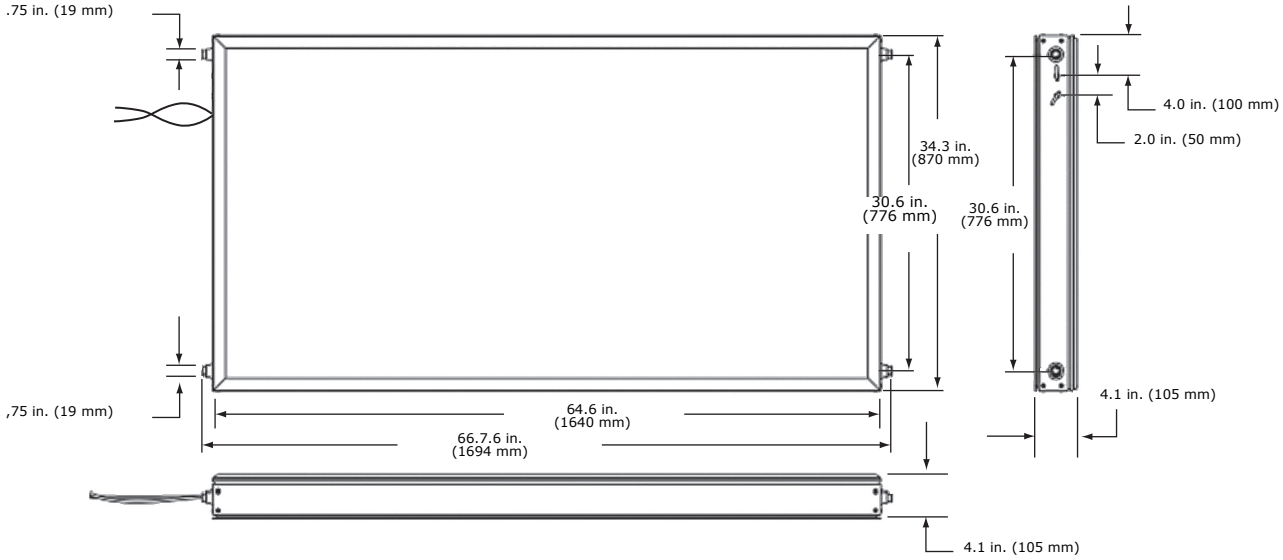
- PVT - photovoltaic (TPVT-V)

  The TPVT-V collector is designed to maximize on the electrical return of the panel, making it an enhanced PV collector, capable of producing a reasonable amount of heat production in the summer. The peak outputs of this panel are 170 electrical watts and 460 thermal watts *(1,570 BTUh)*. When correctly installed, the collector will produce roughly 30% more electricity than conventional PVs and provide a contribution to the thermal requirements of a building.

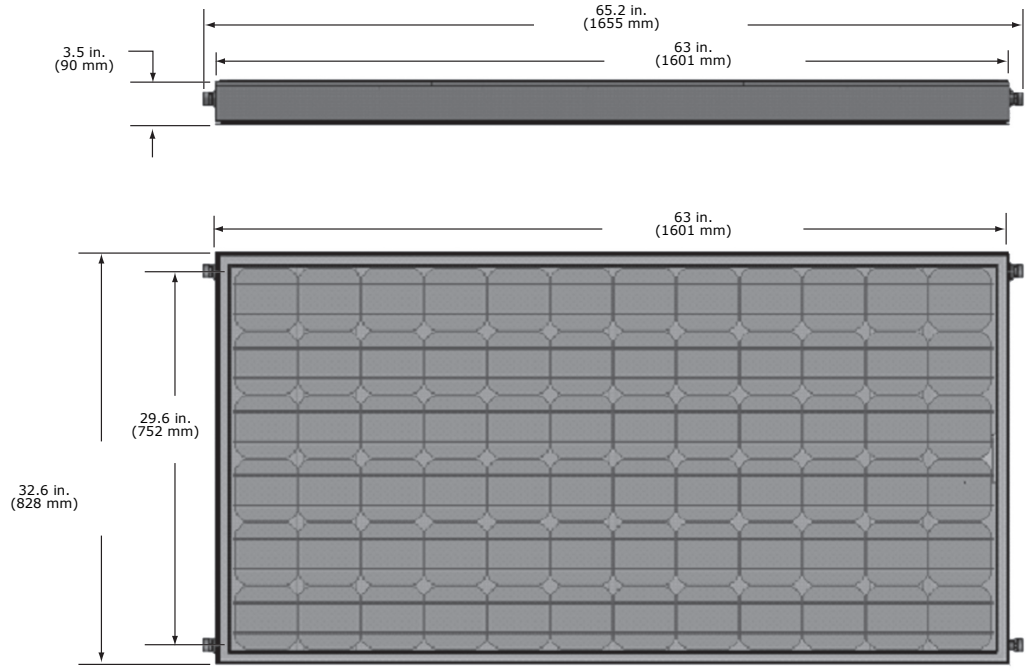
  This system is ideal for maximizing electrical energy returns from a given area. Any buildings with 175 feet or more of available south-facing roof area can use the TPVT- V collector to produce the equivalent annual output of 224 feet of conventional monocrystalline photovoltaic panels. The same area of TPVT-V collectors will offset around the same amount of thermal energy as 46feet of conventional solar thermal collectors. This means that separate systems over 270 feet of roof area would be required to produce the same thermal and electrical energy. In addition, the TPVT-V collector has numerous commercial applications and when actively cooled can produce impressive electrical energy outputs

TPVT-T and TPVT-V Panel Dimensions

TPVT-T Dimensions



TPVT-V Dimensions



PVT

Product Specifications

Description	TPVT-V Hybrid Collectors	TPVT-T Hybrid Collectors
Dimensions:	32.6 in. x 63 in. x 3.5 in. (82.8 cm x 160.0 cm x 8.9 cm)	34.3 in. x 64.6 in. x 4.1 in. (87.12 cm x 164.08 cm x 10.41 cm)
Weight:	53.8 lb. (24.4 kg)	75.8 lb. (34.4 kg)
Liquid content:	40.6 oz. (1.2 L)	40.6 oz. (1.2 L)
Cell efficiency (STC):	17.5%	17.5%
Module efficiency (STC):	14.88%	10.9%
Ratio (e/th) at 60C:	1:1	1:3
Absorber panel:	Monocrystalline	Monocrystalline
Number of cells:	72	72
Cell dimensions:	4.9 in. x 4.9 in. (12.45 cm x 12.45 cm)	4.9 in. x 4.9 in. (12.45 cm x 12.45 cm)
WP (W) nominal power:	190	175
Imp (A) normal current:	5.2	5.2
Isc (V) short circuit current:	5.6	5.6
Vmp (V) normal current:	36.5	32.7
Voc (V) open circuit voltage:	45.2	45.2
Heat exchanger:	Copper strip	Copper strip
Internal piping:	Copper	Copper
Flow:	17 gal/h (65L/h)	17 gal/h (65L/h)
Test pressure bar:	290 psig (20 bar)	290 psig (20 bar)
Operating pressure bar:	145 psig (10 bar)	145 psig (10 bar)
Cover glass:	PV glass	Extra solar glass
Sealing:	EPDM & silicon	EPDM & silicon
Maximum temperature:	<230°F (110°C)	<230°F (110°C)
Housing:	Aluminum	Aluminum
Rear side:	Aluminum	Aluminum
Product warranty:	10 years	10 years
Quality guarantee:	90% < 10 years	90% < 10 years
	80% < 20 years	80% < 20 years

TPVT-T

Radiation ΔT = 10°C	1000 Q = 55 1/h/m²	W/m²	n
T out	Wth/m²	We/m²	W/m²
10°C	>680	161.3	>83%
20°C	680	153.8	82%
40°C	557	138.8	68%
60°C	475	123.8	58%
80°C	370	108.8	46%

TPVT-V

Radiation ΔT = 10°C	1000 Q = 551/h/m²	W/m²	n
T out	Wth/m²	We/m²	W/m²
10°C	>600	178.7	>77%
20°C	510	171.2	68%
40°C	317	156.2	47%
60°C	113	141.2	25%
80°C	-71	126.2	6%

System Design Considerations

Due to the nuances of PVT hybrid, correct system design, installation, and operational setup are important to the efficient operation. Temperature is an important way of limiting maximum temperature. Before installing PVT hybrid collectors, consider the advantage of using lower grade heat. For maximum return and best advantage, it is recommended that maximum panel temperatures be kept below 131°F (55°C) for TPVT-T and 91°F (35°C) for TPVT-V.

In addition, consider the weight of the collectors, piping, and fluid analyzing the loading impact on the structure. Use the chart below to determine the dead weight load of hybrid collectors:

Dead Weight Load for TPVT-V/TPVT-T[(a)]		
	TPVT-V	TPVT-T
	Dead Weight Required	Dead Weight Required
1	53.8 lb. (24.4 kg)	75.8 lb. (34.4 kg)
2	107.6 lb. (48.8 kg)	152 lb. (68.8 kg)
3	162 lb. (73.2 kg)	228 lb. (103.2 kg)
4	216 lb. (97.6 kg)	304 lb. (137.6 kg)
5	270 lb. (122.0 kg)	380 lb. (172 kg)

(a) Dry weight of collector is shown in chart. Add approx. 2.6 lb.(1.2 kg) to each collector for the weight of the solar solution. In addition, add weights for the mounting structure, piping, and accessories for each specific installation. For questions or advice on the design, contact your local Trane sales district for technical assistance.

PVT

Installation Guidelines

⚠WARNING

Proper Field Wiring and Grounding Required!

All field wiring MUST be performed by qualified personnel. Improperly installed and grounded field wiring poses FIRE and ELECTROCUTION hazards. To avoid these hazards, you MUST follow requirements for field wiring installation and grounding as described in NEC and your local/state electrical codes. Failure to follow code could result in death or serious injury.

- The Trane PVT hybrid system installation must only be carried out by a competent installer in compliance with all local planning requirements, building regulations and codes, health and safety legislation, and any relevant local by-laws and regulations in force at the time.
- All electrical installation work must be carried out by a qualified electrician. All wiring and earth bonding must comply with current NEC wiring regulations.
- For information about unpacking and handling components, refer to the section, "Handling, Inspecting, and Storing Solar Products," p. 6.
- For information about mounting solar PVT panels, refer to the section, "Mounting Solar Thermal Collectors," p. 25.

  The most common orientation for Hybrid PVT collectors is *horizontal* or *landscape*. However, PVT collectors can be installed in a *vertical* or *portrait* orientation by using an external pipe design that permits the correct flow of solar fluid in the system.

  Both types of hybrid collectors *(TPVT-T and TPVT-V)* can be installed as *on-roof*, *in-roof*, and *flat-roof*. Mounting procedures for PVT and thermal collectors are identical.
- For information about solar thermal installation, start-up, operation, and maintenance, refer to the section, "Commissioning and Warranty," p. 33.
- For more information about solar PV installation, start-up, operation and maintenance, refer to the section, "Photovoltaic (PV) Modules Solar Panel System," p. 10.

Important: *Following installation, the PVT collectors must be covered to stop solar radiation reaching them until completion of commissioning.*

⚠WARNING

Live Electrical Components!

DC cables connected to PVT collectors are live at all times when a light source is present. Failure to follow all electrical safety precautions when exposed to live electrical components could result in death or serious injury.

⚠WARNING

Risk of Roof Collapse!

Confirm with a structural engineer that the roof structure is strong enough to support the combined weight of the panels, framework, and weights used to secure the collectors. Failure to ensure proper structural roof support could cause the roof to collapse, which could result in death or serious injury and property damage.

Commissioning and Warranty

The system must be installed and commissioned by competent persons and in accordance with these instructions. Additionally, NEC compliance must be ensured and certified.

The Commissioning Checklist (refer to Table 3, p. 44) must be completed at the time of commissioning. One copy of the checklist must be retained with this manual and one part returned to Trane. This requirement forms part of the manufacturer warranty.

Table 3. PVT commissioning check list

General	
Has the Installation, Operation, and Maintenance (IOM) document been provided to the owner?	Yes/No
Have the system submittals been provided to the owner *(collectors, pumps, inverters, expansion tanks, controls, drawings, wiring diagrams, sequence of operations, and so on)*?	Yes/No
Has owner training been completed?	Yes/No
Has the maintenance schedule *(including frequency, maintenance and list of parts to be replaced during normal maintenance)* been left on site?	Yes/No
Has the hydronic system been pressure tested *(leak checked)* and all leaks been repaired satisfactorily?	Yes/No
Commissioning certificate completed and signed, if required?	Yes/No
All documentation to be kept in proximity of installation, protected from heat, water and dust.	
Name of location where documentation is kept:	
What is design operating temperature?	
Pressure relief valve installed on system?	Yes/No
Is PRV piped to collection tank or to drain?	Yes/No
Has the freeze protection solution test been completed to ensure that the solar solution has adequate protection?	Yes/No
Maximum stagnation temperature of PVT collector:	
Maximum design pressure of PVT collector:	145 psig (10 bar)
Maximum design pressure of exchanger:	125 psig (8.6 bar)
Primary pressure limit of weakest component:	
System pressure setting adjusted when cold:	22 psig (1.5 bar)
Minimum allowable primary system pressure/level before user action required from pressure switch low limit *(make-up water pressure regulating valve set at 13 psig [0.9 bar])*:	12 psig (0.8 bar)
Procedure for user to follow if primary pressure/level is below limit:	Contact installer/maintainer *(check for visible leaks)*
Location of primary system pressure gauge:	Solar pump station
Frequency of regular test of pressure safety device:	Yearly
Location of pressure safety device:	Solar pump station
Location of electrical fused disconnect switch:	Solar pump station
Fuse rating:	3 Amps
Electrical controls and temperature sensors set and operating correctly?	Yes/No
Non-solar DWH heating fitted with a thermostat responding to the solar system operating temperature?	Yes/No
Controller temperature setting (120°F to 190°F)/(49° to 88°C):	
Expansion vessel pre-charge (15 to 18psig)/(1.0 to 1.2 bar):	
Expansion vessel capacity:	
Expansion capacity suitable to be inherently secure?	Yes/No

Written warning left on site if there is potentially no automatic resumption of normal operation after stagnation *(manual reset on high temperature limit reached)*?	
Lowest ambient temperature of primary system without freezing damage:	___ °F (____ °C)
The heat transfer fluid provides freeze protection to:	___ °F (____ °C)
Type of transfer fluid:	Water/Propylene Glycol
Maximum ambient temperature for pump:	
Minimum ambient temperature for pump:	
Circulation rate setting. Gallons *(Liters)* per minute:	
Direction of circulation through collector heat exchanger matched to sensor positions?	Yes/No
Location of DHW isolation valve:	
Location of pump control/Thermostatic mixing valve:	
Location of digital temperature gauge fitted to monitor risk of DHW overheating:	
Lime scale risk to heat exchanger *(make-up water system hardness test completed)*?:	Yes/No
Lime scale control in heat exchanger *(is there a softened water make-up to the solar solution system)*?:	Yes/No
General Installation (Electrical)	
Equipment compliant with standards, correctly selected and not damaged?	Yes/No
Equipment accessible for operation, inspection, and maintenance?	Yes/No
Equipment and accessories correctly connected?	Yes/No
Particular protective measures for special locations?	Yes/No
Conductors connected and labeled?	Yes/No
Conductors selected for voltage rating, current carrying capacity, and voltage drop?	Yes/No
Conductors routed in safe zone or protected against mechanical damage?	Yes/No
Presence of seals and protection against thermal effects *(weather tight conduit, fittings, and boxes used in mechanical rooms and outdoors)*?	Yes/No
General Installation (Mechanical)	
Ventilation provided behind array to prevent overheating/fire risk?	Yes/No
Array frame and material corrosion proof?	Yes/No
Array frame correctly installed and stable? Roof penetrations weatherproof?	Yes/No
Cable entry weatherproof?	Yes/No
Protection Against Overvoltage/Electric Shock	
Live parts insulated, protected by barrier/enclosure, placed out of reach or Class II as required?	Yes/No
Array frame equipotential bonding present, if required?	Yes/No
Surge protection devices present, if required?	Yes/No
Remote control devices provided, if required?	Yes/No
Frame correctly integrated with existing lightning protection system installation?	Yes/No
DC System	
Physical separation of AC and DC cables?	Yes/No
DC disconnect switch installed *(per NEC and local codes)*?	Yes/No
Are the DC cables protective and reinforced insulation, if required?	Yes/No
All DC components rated for operation at maximum DC system voltage *(Voc STC x 1.25)*?	Yes/No

PV array strings fused or blocking diodes fitted, if required?	Yes/No
Non-solar DWH heating equipped with a thermostat responding to the solar water heating temperature?	Yes/No
AC System	
AC isolator lockable in **OFF** position only?	Yes/No
Inverter protection settings to local regulations?	Yes/No
Labeling and Identification	
General labelling of circuits, protective devices, switches, and terminals?	Yes/No
PV system schematic displayed on site?	Yes/No
Protection settings & installer details displayed on site?	Yes/No
Emergency shutdown procedure displayed on site?	Yes/No
AC disconnect switch clearly labelled?	Yes/No
DC disconnect switch/junction boxes suitably labelled?	Yes/No
Signs & labels suitably affixed and durable?	Yes/No
Commissioning Details	
Expected annual delivered PVT thermal energy to domestic hot water system/space heating:	
Expected annual delivered PVT electrical energy:	
Expected annual PVT fraction of DHW:	
Expected annual PVT fraction of electrical:	
Method of performance calculation:	
Daily DHW/space heating load assumption	
Annual electrical load assumptions	
Date of site visits for bacterial, water quality and access risk assessments:	
Commissioned By	
On behalf of:	
Date system commissioned and handed over:	
Signature of commissioning engineer *(electrical)*:	
Signature of commissioning engineer *(solar thermal)*:	
Signature of user to confirm receipt and understanding *(optional)*:	

PVT System Start-up

Important: *After any shutdown, it is important to restart the AC side of the installation before switching on the main DC disconnect switch.*

To restart the system, in sequence:

1. Turn on the RCBOs connected to each phase.
2. Turn on the 3-phase rotary disconnect switch located next to the inverter.
3. Turn on the main DC disconnect switch.

   Once all disconnect switches are in the **ON** position, the inverter will go into start mode.

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