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# Grant Solar Photovoltaic

## Grid Connected PV Systems

# Installation & User Instructions

APPROVED PRODUCT

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GRANT

EFFICIENT HEATING SOLUTIONS

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# 1 Introduction

## 1.1 Principle of operation

Solar photovoltaic (or Solar PV) systems produce electricity from silicon cells in the presence of daylight. The amount of electricity produced depends on a number of factors including the intensity of the solar irradiation (sunlight), the orientation/angle of the PV modules, and the number of PV modules used.

Grant Solar PV systems are designed to be used as a 'Grid-connected' installations and as such the electricity produced by the PV modules is DC (Direct Current) and is converted to AC (Alternating Current) by a DC/AC Inverter for use in domestic properties and other buildings.

The AC output from the inverter is connected into the Consumer unit for that property – usually via a 16A circuit breaker. Refer to Section 7 – wiring/connection diagrams.

A kWh electricity meter (usually referred to and an 'Export' or 'Generation meter') is fitted between the Inverter and Consumer unit to record the amount of electricity produced by the solar PV installation. Refer to Section 3.6.

Important: A grid-connected system, such as a Grant Solar PV system, will be automatically disconnected from the mains supply within 0.5 second in the event of a power failure on the supply grid and will not thus provide protection against power cuts.

Grant Solar PV systems utilise Monocrystalline PV modules. Refer to Section 2 for technical details on the modules.

## 1.2 Safety

Solar PV cells produce electricity whenever exposed to daylight. Therefore care must be taken when working on any solar PV installation during daylight hours.

**Figure 1-1:** Solar PV system diagram

# 1 Introduction

## 1.3 Installation requirements

All electrical installation work must comply with the requirements of the Electricity at Work Regulations 1989 and BS.7671:2008 – IEE Wiring Regulations 17th Edition (including any amendments). All installations must also comply with all applicable parts of The Building Regulations - Part P in particular.

All 'grid-connected' Solar PV installations must conform to the requirements of the 'Engineering Recommendations for the connection of a small scale embedded generator (SSEG) in parallel with public low voltage distribution networks' published by the Energy Networks Association, as follows:

G83/1-1 – for systems up to 16A per phase

G59/1 – for systems exceeding 16A per phase

To comply with G83/1-1, for single installations up to 16A per phase, the local Distribution Network Operator (DNO) has to be notified of the installation on or before the commissioning and a commissioning pro-forma (refer to G83/1-1 Appendix 3) has to be submitted within 30 days of commissioning.

For planned/multiple installations in the same geographic area the DNO must be notified on or before commissioning and an application pro-forma (refer to G83/1 - Appendix 2) must be submitted for the DNO to assess the impact of the proposed connection.

To comply with G59/1, the local DNO must be contacted and the installation discussed prior to starting the installation.

Further guidance on the design and installation of solar PV systems can be found in the DTI publication URN 06/1972: Photovoltaics in Buildings – Guide to the installation of PV systems 2nd edition.

## 1.4 Labelling

Labels indicating the presence of an SSEG (in this case a Solar PV system) should be displayed at the following locations on the electrical installation for the property – at all meters, consumer unit, all isolators and at the supply terminals (suppliers fused cut-out). This labelling is to warn that there are TWO sources of electrical supply present in the installation.

Warning labels used should be sufficiently robust and fixed in place such that it remains legible and secure for the lifetime of the installation. Refer to BS7671:2008 (IEE Wiring Regulations 17th Edition) and G83/1-1 for further details.

A sheet of suitable labels for DC cables, isolators, inverters, meters, consumer units, etc. Is supplied with every Grant Solar PV system.

A typical label format and content is as follows:

## 1.5 Start up and shut down procedure

Care should be taken in the way the system is started up, i.e. switched on, and also how it is shut down.

**Important:**
**NEVER disconnect a DC connection (i.e. between the PV modules and DC/AC Inverter) whilst the system is under load (i.e. with the AC output connected to the inverter).**

**ALWAYS isolate the AC side of the system (AC supply to inverter) BEFORE isolating the DC output from the PV modules.**

**ALWAYS isolate the DC output from modules before disconnecting or connecting any DC connections.**

The DC output from the PV modules should not be shut down or disconnected whilst the AC side of the installation is operational.

The DC isolator switch – whether fitted in the inverter or a separate isolator – must be in the OFF position throughout the entire installation process.

DC cables for PV module strings should be connected to the isolator first and then the individual modules connected together. Refer to Section 3 for further details on the installation procedure.

**Figure 1-2:** Warning label

# 2 Technical Information

## 2.1 Solar PV kits – contents: On-roof kits for portrait modules

| | GPVKIT0 – 0.54kWp 3 modules | GPVKIT? – 1.08?kWp 6 modules | GPVKIT1 – 1.44kWp 8 modules | GPVKIT2 – 1.80kWp 10 modules | GPVKIT3 – 2.10kWp 12 modules | GPVKIT4 – 2.52kWp 14 modules | GPVKIT5 – 2.88kWp 16 modules | GPVKIT6 – 3.24kWp 18 modules | GPVKIT7 – 3.60kWp 20 modules |
|---|---|---|---|---|---|---|---|---|---|
| Type MPE180 MS05 Monocrystalline PV module (Pack of 2) | 1 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Type MPE180 MS05 Monocrystalline PV module (Pack of 1) | 1 | - | - | - | - | - | - | - | - |
| Type GPV 180M Monocrystalline PV module (Pack of 2) | 1* | 3* | 4* | 5* | 6* | 7* | 8* | 9* | 10* |
| Type GPV 180M Monocrystalline PV module (Pack of 1) | 1* | - | - | - | - | - | - | - | - |
| Mastervolt Soladin 600 Inverter | 1 | 2 | - | - | - | - | - | - | - |
| Mastervolt Sunmaster XS2000 | - | - | 1** | 1** | - | - | - | - | - |
| Mastervolt Sunmaster XS3200 | - | - | - | - | 1** | 1** | 1** | - | - |
| SMA Sunny Boy SB1200 Inverter c/w DC Isolator | - | 1** | - | - | - | - | - | - | - |
| SMA Sunny Boy SB1700 Inverter c/w DC isolator | - | - | 1** | 1** | - | - | - | - | - |
| SMA Sunny Boy SB2500 Inverter c/w DC isolator | - | - | - | - | 1** | 1** | - | - | - |
| Grant AS 1.0 Inverter | - | 1 | - | - | - | - | - | 1 | 1 |
| Grant AS 1.5 Inverter | - | - | 1 | - | - | - | - | - | - |
| Grant AS 2.0 Inverter | - | - | - | 1 | 1 | - | - | 1 | 1 |
| Grant AS 3.0 Inverter | - | - | - | - | - | 1 | 1 | - | - |
| DC Isolator – single string (600V 25A) | 1 | 2(1) | 1 | 2 | 2 | 2 | 2 | 2 | 2 |
| Solar DC cable 4mm² c/w MC type 4 plugs (10 metres) | 2 | 4(2) | 2 | 4 | 4 | 4 | 4 | 4 | 4 |

| | |
|---|---|
| Aluminium mounting rails (2.1metres) | Refer to packing list supplied with kit for quantities of fixing components |
| PV module stop bracket | |
| Module retaining end clip – type 9-1 | |
| Module retaining mid clip – type 9-2 | |
| Fixing screw (M8 x 14) | |
| Anchor block | |
| Roof Anchors – one option selected to suit roof covering | |
| Profile concrete tile (pack of 2) | |
| Flat concrete tile (pack of 2) | |
| Slate tile (pack of 2) | |

*Alternative Monocrystalline PV modules
**SMA Sunny Boy, Mastervolt Sunmaster XS or Grant AS inverters may be supplied as alternatives

# 2 Technical Information

## 2.2 PV modules – technical specification

| | 180Wp Monocrystalline Module | 180Wp Monocrystalline Module |
|---|---|---|
| **Electrical Data** | | |
| Module type reference | MPE180 MS05 | GPV 180M |
| Cell type | Monocrystalline | Monocrystalline |
| Rated output @ STC* - Pmpp | 180 Wp | 180 Wp |
| Power tolerance - ΔPmpp | +0.5%/-0% | ± 3% |
| Open circuit voltage – Voc (nominal) | 45V | 44.2V |
| Short circuit current – Isc (nominal) | 5.2A | 5.13A |
| Maximum power voltage – Vmpp (nominal) | 36V | 36.4V |
| Maximum power current – Impp (nominal) | 5A | 4.95A |
| Cell efficiency | 17.2% | 16.2% |
| Module efficiency | 14.1% | 14.3% |
| Temperature Coefficient α (Pmpp) | -0.4%/°C | -0.55%/°C |
| Temperature Coefficient β (Isc) | +0.04%/°C | +0.3%/°C |
| Temperature Coefficient χ (Voc) | -0.38%/°C | -0.22mV/°C |
| Temperature Coefficient δ (Impp) | +0.04%/°C | +0.03%/°C |
| Temperature Coefficient ϵ (Vmpp) | -0.38%/°C | -0.53%/°C |
| Maximum permissible system voltage | 1000V DC | 1000V DC |
| Normal operating cell temperature (NOCT)** | 45°C ± 3% | 45°C ± 3% |
| Number of cells | 72 | 72 |
| Cell size | 125 x 125 mm | 125 x 125 mm |
| | | |
| **Physical Data** | | |
| Dimensions | 1581 x 809 x 42 mm | 1580 x 808 x 45 mm |
| Weight | 15kg | 15.5kg |
| Frame material | Anodised Aluminium | HD Anodised Aluminium |
| Frame Colour | Silver (similar to RAL 7035) | Silver |
| Glass | Toughened Safety Glass | 3.2mm tempered Glass |
| Connector - positive | MC type 4 - Male plug | MC type 4 - Male plug |
| Connector – negative | MC type 4 - Female plug | MC type 4 - Female plug |
| Connection cable type | 4mm² 1000V | 4mm² 1000V |
| Connection lead length – positive | 800 mm | 900 mm |
| Connection lead length – negative | 800 mm | 900 mm |
| | | |
| **Warranty Data** | | |
| Electrical Safety Classification | Safety Class 2 | Safety Class 2 |
| Maximum snow and wind load (EN61215) | 3.6 kN/m² | 5.4 kN/m² |
| Output Guarantee to 90% Pmpp min | 12 years | 10 years |
| Output Guarantee to 80% Pmpp min | 25 years | 25 years |
| Product Standards | IEC61215 & EN61730 | IEC61215 & EN61730 |

* Module output is measured at STC of 1000W/m² and 25°C ambient temperature
**With Solar radiation 800W/m², ambient temperature 20°C & Wind speed 1 m/s

## 2.3 PV modules – dimensions

180Wp Monocrystalline modules

| Dimensions (mm) | A | B | C |
|---|---|---|---|
| | Height | Width | Thick |
| Module Type MPE180 MS05 | 1581 | 809 | 42 |
| Module Type GPV 180M | 1580 | 808 | 45 |

**Figure 1-2:** 180Wp Monocrystalline module dimensions

# 2 Technical Information

## 2.4 DC/AC inverters – technical specification

| | Mastervolt Soladin 600 | Mastervolt Sunmaster XS2000 | Mastervolt Sunmaster XS3200 | SMA Sunny Boy SB1700 | SMA Sunny Boy SB2500 | Grant AS 1.0 | Grant AS 1.5 | Grant AS 2.0 | Grant AS 3.0 |
|---|---|---|---|---|---|---|---|---|---|
| **Solar Input (DC)** | | | | | | | | | |
| Max open circuit string voltage Voc (V DC) | 155 | 450 | 600 | 400 | 600 | 400 | 400 | 400 | 400 |
| Max PV power (Wp) | 700 | 2100 | 3500 | 1850 | 2700 | 1250 | 1875 | 2500 | 3500 |
| Mpp Voltage (V DC) | 45-125 | 145-360 | 180-480 | 139-320 | 224-480 | 165-300 | 165-300 | 165-300 | 165-300 |
| Ambient temperature range (°C) | -20 to +50 | -20 to +60 | -20 to +60 | -25 to +60 | -25 to +60 | -25 to +50 | -25 to +50 | -25 to +50 | -25 to +50 |
| Protection class | Indoor only | IP44 | IP44 | IP65 | IP65 | IP65 | IP65 | IP65 | IP65 |
| Weight (kg) | 1.5 | 10.0 | 10.0 | 25.0 | 30.0 | 22.5 | 27.0 | 36.5 | 42.5 |
| DC connectors | 1 pair MC type 4 | 2 pairs MC type 4 | 2 pairs MC type 4 | 2 pairs MC type 4 | 2 pairs MC type 4 | 1 pair MC type 4 | 1 pair MC type 4 | 2 pairs MC type 4 | 2 pairs MC type 4 |
| **Grid Output (AC)** | | | | | | | | | |
| Voltage* (V AC 1ph) | 230 | 230 | 230 | 230 | 230 | 230 | 230 | 230 | 230 |
| Frequency* (Hz) | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 |
| Nominal output power * (W) | 540 | 1500 | 2500 | 1550 | 2300 | 1000 | 1500 | 2000 | 3000 |
| Maximum power (W) | 600 | 1575 | 2625 | 1700 | 2500 | 1100 | 1650 | 2200 | 3300 |
| Rated output current (A) | 2.4 | 7.0 | 11.0 | 6.7 | 10.0 | 4.3 | 6.5 | 8.7 | 13.0 |
| Maximum output current (A) | 3.0 | 9.0 | 15.0 | 8.6 | 12.5 | 5.0 | 7.0 | 10.0 | 15.0 |
| AC connection | Pre-wired cable | PG-13.5 Gland & 3-way terminal block | PG-13.5 Gland & 3-way terminal block | Plug with PG-13.5 gland | Plug with PG-13.5 gland | Plug with PG-13.5 gland | Plug with PG-13.5 gland | Plug with PG-13.5 gland | Plug with PG-13.5 gland |

*Dependant on country of use – refer to manufacturers information supplied with the Inverter

**Important:**
**Refer to the manufacturers' Installation and User instructions supplied with each respective inverter for full technical specification, details of Installation, connection, operation and fault diagnosis/rectification.**

**Non-standard Grant solar PV systems may use other inverters not shown in the above table. Refer to manufacturers' Installation and User instructions supplied with the inverter for full technical specification, details of Installation, connection, operation and fault diagnosis/rectification.**

All the above mentioned inverters incorporate an 'Anti-Islanding' safety feature – to comply with requirements of G/83 -1. This ensures that the inverter is shut down within 0.5 seconds of the mains electrical supply to the inverter being interrupted, either deliberately or due to a mains power failure.

**These Inverters are only suitable for use as part of a 'Grid connected' solar PV installation and should not be used for any other type of system.**

The Mastervolt Sunmaster XS and SMA Sunny Boy inverters listed above all incorporate an integral DC isolation device. However, local regulations may require an external DC isolator to be fitted when using on of these Inverters. If this is the case please contact Grant UK for details of an appropriate DC isolator to be used.

The Mastervolt Soladin 600 and Grant AS inverters are NOT fitted with an integral isolator and thus must be installed with a suitable DC isolator – as supplied in the Grant Solar PV kits using these inverters.

All the above inverters have a maximum power point tracker (MPP) fitted and configured to suit the kit. This ensures that the system is configured to optimise the efficiency of the PV installation.

CAUTION!
Polarity must be observed correctly. Connections made to the inverter are polarity sensitive and damage to the inverter may result if the connections are incorrect.

**Important:**
**Short-circuiting or connection with reversed polarity on the DC side can damage the inverter.**

## 2.5 DC cable & connectors

The cable supplied for connection of the PV modules to the Inverter, and also that used for the connection leads on the PV modules, is 4mm² double insulated cable – rated at 1000V. Cable resistance is 5.09mΩ/metre.

The 10 metre lengths of DC cable supplied in the Grant Solar PV kits come fitted with Multi Connector (MC) Type 4 DC connectors – one male connector and one female connector pre-fitted on either end.

These connectors are rated at 20A and 1000V. The degree of protection is IP2X when separated and IP67 when correctly connected together. Operating temperature range is -40°C to 90°C.

Note: Once fitted, the MC Type 4 connectors cannot be removed and re-fitted to the DC cable.

## 2.6 DC isolators – technical specification

The DC isolators supplied in the Grant Solar PV kits have the following specification:

Operational current: 32A

Operational voltage: 690V

Operational power (1ph): 3kW

Class II insulation (double insulated)

Lockable in OFF position

Switch interlocked with cover – cover cannot be removed when in ON position

IP66/67 protection

Operating temperature 35°C (average over 24 hour period with peaks of 40°C)

Screw down terminals - Maximum wire gauge 6mm² (stranded wire).

# 3 Solar PV Systems

## 3.1 Solar PV modules

The Solar PV modules are connected together in series, with the positive output connector of one module connected to the negative output connector of the next, to form a 'STRING'.

The total peak output of such a string = module peak output x number of modules in the string

e.g. For a string comprising 8 x 180Wp modules:

**Total peak power output** = 180 x 8 = 1440Wp or 1.44kWp for the string

**The total Open Circuit voltage (Voc) of a string** = module Voc x number of modules

**For a module Voc of 44.2V:** Total Voc = 44.2 x 8 = 353.6V DC for the string

**The total Short Circuit current (Isc) of a string** = module Isc (as it is a series connection)

**For a module Isc of 5.13A:** Total Isc = 5.13A for the string

Depending on the total number of PV modules and the rating of the inverter used, modules may be connected as PARALLEL strings - each consisting of an equal number of modules.

e.g. For 2 strings each comprising 4 x 180wp modules:

**Total peak power output** = 180 x 8 = 1440Wp or 1.44kWp for the string

**The total Open Circuit voltage (Voc) across both strings** = string Voc = module Voc x number of modules

**For a module Voc of 44.2V:** Total Voc = string Voc = 44.2 x 4 = 176.8V DC for the 2 parallel strings

**The total Short Circuit current (Isc) of both strings** = 2 x string Isc = module Isc (it is a series connection)

**For a module Isc of 5.13A:** Total Isc = 2 x 5.13A = 10.26A for the 2 parallel strings

Thus, depending on the number of PV modules involved and the rating of the Inverter rating used in a Grant Solar PV system, the modules may be connected as a single string OR as parallel strings. Refer to Section 3.2 for connection details and Section 2.1 for further details on the standard Grant solar PV kits.

## 3.2 DC circuit

The Solar PV modules are connected together in series to form a string (or strings), with the positive output connector of one module connected to the negative output connector of the next. Refer to Figure 3-1.

**Figure 3-1:** Male and Female MC Type 4 plugs

The positive connection (male connector) and negative connection (female connector) from the PV module string are connected to the DC/AC inverter using the DC extension cables supplied in the system kit. For a single string of modules, two DC extension cables are supplied for connection to one pair of connections on the inverter. Refer to Figure 3-2.

For two parallel strings, four DC extension cables are supplied for connection to both pairs of connectors on the inverter. Refer to Figure 3-3.

These DC extension cables are supplied with MC Type 4 connectors already fitted - with male connector at one end and a female connector at the other.

Note:
These connectors cannot be removed and re-fitted to the DC cable.

One end of each DC cable is connected to the corresponding connectors on the positive and negative connection leads at either end of the module string. The remaining ends of the two DC cables are connected to the corresponding MC Type 4 connectors on the Inverter. Refer to Figures 3-2 and 3-3.

**Figure 3-2:** Single string of PV modules connected to Inverter

**Figure 3-3:** Two parallel strings of PV modules connected to one Inverter

# 3 Solar PV Systems

The smaller Grant AS 1.0, AS 1.5 and Soladin 600 Inverters are fitted with only one pair of MC Type 4 connectors. They are therefore suitable for connection of a single module string only. Refer to Figures 3-4 and 3-5.

**Figure 3-4:** Mastervolt Soladin 600 Inverter with one pair of MC Type 4 connectors

**Figure 3-5:** Grant AS 1.0 and AS 1.5 Inverters with one pair of MC Type 4 connectors

The larger Grant AS, SMA and Mastervolt Inverters are fitted with two pairs of MC Type 4 connectors and can be used for the connection of two module strings in parallel with each other. It is therefore important that the correct 'matching' pair of connectors is used when connecting the DC cables from the module string.

Please refer to the manufacturers' Installation and User instructions supplied with each Inverter to determine which pairs of connectors should be used for connection of each module string. Refer to figures 3-6, 3-7 and 3-8.

**Figure 3-6:** SMA Sunny Boy Inverter with two pairs of MC Type 4 connectors

**Figure 3-7:** Mastervolt Sunmaster Inverter with two pairs of MC Type 4 connectors

**Figure 3-8:** Grant AS 2.0 and AS 3.0 Inverters with two pairs of MC Type 4 connectors

Note:
Depending on the number of PV modules involved and the rating of the Inverter rating used in a Grant Solar PV system, the modules may have to be connected as a single string OR as parallel strings. Refer to Figure 3-9 for further details on the standard Grant solar PV kits.

## 3.3 Sunclix DC cable connectors

**Some SMA Sunnyboy inverters** are not supplied with the MC Type 4 connectors, but are fitted with an alternative type of connector. These inverters use the SMA 'Sunclix' connectors and these are NOT compatible with the MC Type 4 connectors. Hence, an MC Type 4 male connector on a DC cable will not fit into a Sunclix female connector and vice versa.

In order to overcome this mismatch between the connectors, all SMA Sunnyboy inverters fitted with Sunclix connectors, supplied as part of a Grant Solar PV system, will come with a pack of loose Sunclix connectors for fitting to the DC cables. The MC Type 4 connectors on the end of the DC cables can be removed (cutting the cable just before the connector) and the corresponding male or female Sunclix connector fitted in its place. NB. Ensure that a Female MC Type 4 connector is replaced with a Sunclix female connector and the same for male connectors.

Sunclix connectors are easy to fit, require no special tools and can be easily removed from a cable and re-fitted, if necessary. Refer to the illustrated fitting instructions provided with each pack of Sunclix connectors.

## 3.4 DC Isolators

**The Mastervolt Sunmaster XS and SMA Sunny Boy Inverters** used in the Grant Solar PV kits all incorporate an integral DC isolation device. Refer to Figures 3-10 and 3-11 for details of the Isolators fitted to these Inverters.

However, local regulations may require an external DC Isolator to be fitted when using on of these Inverters. If this is the case please contact Grant UK for details of an appropriate DC Isolator to be used.

| Grant Kit Ref | Number of Modules | Output kWp | Inverter | Strings |
|---|---|---|---|---|
| GPVKIT0 | 3 | 0.54 | 1 x Soladin 600 | 1 x 3 modules |
| n/a | 6 | 1.08 | 1 x SMA SB1200 | 1 x 6 modules |
| | | | 2 x Soladin 600 | 2 x 3 modules |
| | | | 1 x Grant AS 1.0 | 1 x 6 modules |
| GPVKIT1 | 8 | 1.44 | 1 x SMA SB1700 | 1 x 8 modules |
| | | | 1 x Mastervolt XS2000 | 1 x 8 modules |
| | | | 1 x Grant AS 1.5 | 1 x 8 modules |
| GPVKIT2 | 10 | 1.80 | 1 x SMA SB1700 | 2 x 5 modules |
| | | | 1 x Mastervolt XS2000 | 2 x 5 modules |
| | | | 1 x Grant AS 2.0 | 2 x 5 modules |
| GPVKIT3 | 12 | 2.16 | 1 x SMA SB2500 | 1 x 12 modules |
| | | | 1 x Mastervolt XS3200 | 1 x 12 modules |
| | | | 1 x Grant AS 2.0 | 2 x 6 modules |
| GPVKIT4 | 14 | 2.52 | 1 x SMA SB2500 | 2 x 7 modules |
| | | | 1 x Mastervolt XS3200 | 2 x 7 modules |
| | | | 1 x Grant AS 3.0 | 2 x 7 modules |
| GPVKIT5 | 16 | 2.88 | 1 x Mastervolt XS3200 | 2 x 8 modules |
| | | | 1 x Grant AS 3.0 | 2 x 8 modules |
| GPVKIT6 | 18 | 3.24 | 1 x Grant AS 1.0<br>1 x Grant AS 2.0 | 1 x 6 modules<br>2 x 6 modules |
| GPVKIT7 | 20 | 3.60 | 1 x Grant AS 1.0<br>1 x Grant AS 2.0 | 1 x 8 modules<br>2 x 6 modules |

**Figure 3-9:** Table of modules, inverters and strings

**Figure 3-10:** DC isolator fitted to SMA Sunny Boy Inverter

**Figure 3-11:** DC isolator fitted to Mastervolt Sunmaster Inverter

**The Mastervolt Soladin 600** is NOT fitted with an integral Isolator and thus must be installed with a suitable DC isolator – as supplied in the Grant Solar PV kits using this Inverter.

**The Grant AS Inverters** are NOT fitted with an integral Isolator and thus must be installed with a suitable DC isolator – as supplied in the Grant Solar PV kits using this Inverter.

# 3 Solar PV Systems

## 3.5 DC/AC inverters

**Important:**
**The Inverters supplied in the Grant Solar PV kits are intended for 'Grid-connected' installations only, i.e. those installations where the output from the PV installation is connected to the electricity supply grid via the electrical installation in the property concerned.**

Grant Solar PV kits (and the Inverters included in them) are NOT suitable for a 'stand alone' or 'off-grid' Solar PV installations. For advice on such installations please contact the Grant Technical department.

**Function**
The main functions of a 'grid-connected' inverter are:

1. To convert the DC power generated by the Solar PV modules to AC that can either used in the property concerned or fed back into the electricity supply grid.
2. To monitor the supply grid and, in the event of power failure, shut down the Solar PV installation.

To comply with the requirements of the ENA Engineering Recommendations G38/1-1 this disconnection must be within 0.5 seconds of the power failure occurring. All inverters used in the Grant Solar PV kits satisfy this requirement.

It must be understood that a grid-connected system will NOT operate whilst there is a failure of the mains supply to prevent 'Islanding' – where it would be dangerous for the Solar PV system to feed power into the distribution grid (e.g. when the grid is shut down for maintenance work).

Full installation, connection and operating instructions for the Inverters used with Grant Solar PV systems is given in the manufacturers information supplied with each inverter. Please refer to this information BEFORE commencing the installation of the Solar PV system.

## 3.6 AC output from inverter

The AC power output from the Inverter must be connected to the electrical system in the property concerned via a dedicated circuit in the Consumer Unit.

Refer to Section 7 for further details on electrical connection. This AC circuit will invariably include an 'Export' or 'Generation' meter (refer to Section 3.7 below) and an isolator – located between this meter and the Inverter, to allow isolation of the AC supply from the Solar PV system.

A further Isolator may be required under some installation conditions . For example, if the Inverter is located in the loft of the property and the consumer unit is on the ground floor, to allow local isolation of the Solar PV system at or near the AC output of the inverter an additional AC isolator should be installed.

The inverter should be earthed as any other electrical apparatus in accordance with the requirements of BS.7671:2008 – IEE Wiring Regulations 17th Edition, including any amendments.

## 3.7 Generation (or Export) meter

An electric kWh meter should be connected in the AC circuit between the output of the inverter and the consumer unit. This meter records the amount of electricity generated by the Solar PV system.

A 'generation' (or 'export') meter will be required in any installation subject to the Government's 'Feed-in Tariff' (FiT) scheme, where the consumer is paid for all the electricity generated (irrespective of whether it is used by the consumer or not). Some electricity suppliers feed-in tariff schemes also require a 'generation' meter as a basis for the payment of the tariff.

To meet the conditions of these 'Feed-in Tariff' schemes, an 'OFGEM' approved export meter must be used.

Check with the power supplier concerned for further details regarding the selection and installation of the export meter they require for their own respective feed-in tariff schemes.

## 3.8 Consumer unit connection

Generally, smaller domestic Solar PV installations up to 16A per phase will require the use of a dedicated protective device (circuit breaker/fuse) in the consumer unit for connection of the AC output from the Inverter to the domestic electrical installation of the property. This will apply to installations using one of the Grant Solar PV kits, as detailed in Section 2.1 of these Installation Instructions.

For larger installations the circuit breaker rating and method of connection will have to be determined depending on the output of the system and after consultation with the local Distribution Network Operator (DNO). Refer to Section 1.3 of these Installation Instructions.

Refer to Section 7 for typical consumer unit connection diagrams.

## 3.9 Bonding of module frames

Bonding of the PV module frames can reduce the risk of electric shock to anyone coming into contact with the array. Such bonding of module frames also provides some protection from lightning strikes.

Bonding will only typically be required if the modules, DC cables and connectors are not Class II and the frames are considered to be an extraneous conductive part, as defined in BS.7671:2008 – IEE Wiring Regulations.

However, bonding of the array frames is not always required. Refer to Figure 3-12 for the flow chart (taken from the DTI Guide to the installation of PV systems – URN 06/1972) to determine whether or not bonding is required for a particular installation.

**Figure 3-12:** Array frame bonding flow chart

Following the guidance given in the flow chart in Figure 3-12, bonding of the PV modules would NOT be required as long as ALL three of the following conditions exist:

1. The modules are Class II. All Grant Modules meet this requirement.
2. The cables, connectors, junction boxes are Class II. All cables, connectors and DC isolators supplied by Grant meet this requirement.
3. The inverter has an isolating transformer between the DC and AC parts. All Inverters supplied by Grant meet this requirement as they have the necessary Galvanic Isolation, as required by G83/1–1.

## 3.10 Lightning protection

The risk of a direct lightning strike on a typical roof mounted Solar PV installation is generally considered to be low, but where the building in question is either tall or in an exposed open area, making it the highest structure in that area, there may be a greater risk. In such a case advice should be sought from a lightning protection specialist and, where necessary, a lightning protection system installed conforming to BS 6651: Code of Practice for Protection of Structures against Lightneng.

If not at risk from a direct lightning strike, a solar PV system can also be damaged from induced surges in the power supply, particularly where this is via overhead power lines. Power surges due to lightning can occur in either the DC or AC parts of the system.

To protect against surges the DC cable runs should be kept as short as possible and the positive and negative cables from a string or main DC supply cables should be bundled together. Long runs of DC cable (e.g. over 50m) should be installed in earthed metal trunking or conduit to shield them from induced surges.

# 4 On-roof Module Installation

**Figure 4-1:** On-roof installation of modules

| Number of Modules | Module Dimensions | | Modules: Portrait Rails: Horizontal | | | Modules: Portrait Rails: Vertical | | | Modules: Landscape Rails: Vertical | | | Modules: Landscape Rails: Horizontal | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | Emax | C | D | Emax | C | D | Emax | C | D | Emax |
| 3 | 1581 | 809 | 2515 | 2471 | 1400 | 4831 | 4787 | 1800 | 2515 | 2471 | 1400 | 4831 | 4787 | 1800 |
| 4 | 1581 | 809 | 3346 | 3302 | 1400 | 6434 | 6390 | 1800 | 3346 | 3302 | 1400 | 6434 | 6390 | 1800 |
| 5 | 1581 | 809 | 4177 | 4133 | 1400 | 8037 | 7993 | 1800 | 4177 | 4133 | 1400 | 8037 | 7993 | 1800 |
| 6 | 1581 | 809 | 5008 | 4964 | 1400 | 9640 | 9596 | 1800 | 5008 | 4964 | 1400 | 9640 | 9596 | 1800 |
| 7 | 1581 | 809 | 5839 | 5795 | 1400 | 11243 | 11199 | 1800 | 5839 | 5795 | 1400 | 11243 | 11199 | 1800 |
| 8 | 1581 | 809 | 6670 | 6626 | 1400 | 12846 | 12802 | 1800 | 6670 | 6626 | 1400 | 12846 | 12802 | 1800 |
| 9 | 1581 | 809 | 7501 | 7457 | 1400 | 14449 | 14405 | 1800 | 7501 | 7457 | 1400 | 14449 | 14405 | 1800 |
| 10 | 1581 | 809 | 8332 | 8288 | 1400 | 16052 | 16008 | 1800 | 8332 | 8288 | 1400 | 16052 | 16008 | 1800 |
| 11 | 1581 | 809 | 9163 | 9119 | 1400 | 17655 | 17611 | 1800 | 9163 | 9119 | 1400 | 17655 | 17611 | 1800 |
| 12 | 1581 | 809 | 9994 | 9950 | 1400 | 19258 | 19214 | 1800 | 9994 | 9950 | 1400 | 19258 | 19214 | 1800 |
| 13 | 1581 | 809 | 10825 | 10781 | 1400 | 20861 | 20817 | 1800 | 10825 | 10781 | 1400 | 20861 | 20817 | 1800 |
| 14 | 1581 | 809 | 11656 | 11612 | 1400 | 22464 | 22420 | 1800 | 11656 | 11612 | 1400 | 22464 | 22420 | 1800 |
| 15 | 1581 | 809 | 12487 | 12443 | 1400 | 24067 | 24023 | 1800 | 12487 | 12443 | 1400 | 24067 | 24023 | 1800 |
| 16 | 1581 | 809 | 13318 | 13274 | 1400 | 25670 | 25626 | 1800 | 13318 | 13274 | 1400 | 25670 | 25626 | 1800 |
| 17 | 1581 | 809 | 14149 | 14105 | 1400 | 27273 | 27229 | 1800 | 14149 | 14105 | 1400 | 27273 | 27229 | 1800 |
| 18 | 1581 | 809 | 14980 | 14936 | 1400 | 28876 | 28832 | 1800 | 14980 | 14936 | 1400 | 28876 | 28832 | 1800 |
| 19 | 1581 | 809 | 15811 | 15767 | 1400 | 30479 | 30435 | 1800 | 15811 | 15767 | 1400 | 30479 | 30435 | 1800 |
| 20 | 1581 | 809 | 16642 | 16598 | 1400 | 32082 | 32038 | 1800 | 16642 | 16598 | 1400 | 32082 | 32038 | 1800 |
| 21 | 1581 | 809 | 17473 | 17429 | 1400 | 33685 | 33641 | 1800 | 17473 | 17429 | 1400 | 33685 | 33641 | 1800 |
| 22 | 1581 | 809 | 18304 | 18260 | 1400 | 35288 | 35244 | 1800 | 18304 | 18260 | 1400 | 35288 | 35244 | 1800 |

Grant Solar PV – On-roof installation dimensions

## 4.1 Dimensions

a) Landscape/one above the other
Mounting rails: vertical

b) Landscape/adjacent
Mounting rails: horizontal

A - Length of module
B - Width of module
C - Length of mounting rail
D - Overall width/height of modules
*(Refer to table on opposite page)*

**Figure 4-2:** PV modules arranged in landscape position

c) Portrait/one above the other
Mounting rails: vertical

d) Portrait/adjacent
Mounting rails: horizontal

A - Length of module
B - Width of module
C - Length of mounting rail
D - Overall width/height of modules
*(Refer to table on opposite page)*

**Figure 4-3:** PV modules arranged in portrait position

# 4 On-roof Module Installation

## 4.2 Installation summary

**Figure 4-4:** Modules installed in portrait format

| Item | Description |
|---|---|
| 01 | PV Module |
| 02 | Mounting rail |
| 03 | Roof anchor – type selected to suit roof covering (slates, profile tile or flat tile) |
| 04 | Module retaining end clip |
| 05 | Module retaining mid clip |
| 06 | Fixing screw - M8 x 14 |
| 07 | Anchor block |
| 08 | T-bolt |
| 09 | Module stop bracket |

**Figure 4-4:** Modules installed in landscape format

| Item | Description |
|---|---|
| 01 | PV Module |
| 02 | Mounting rail |
| 03 | Roof anchor – type selected to suit roof covering (slates, profile tile or flat tile) |
| 04 | Module retaining end clip |
| 05 | Module retaining mid clip |
| 06 | Fixing screw - M8 x 14 |
| 07 | Anchor block |
| 08 | T-bolt |
| 09 | Module stop bracket |
| 10 | End stop |
| 11 | Fixing bolt |

# 4 On-roof Module Installation

## 4.2 Profile tile

**Roof Anchors fixed to Rafters**

1. For profile concrete tiles, these roof anchors are attached directly to the roof rafters (rafter-mounted installation).

   Caution:
   Never attach safety harness to the installation system!

2. Expose the installation area above the rafters. For roof anchor intervals, see Page 17, Section 4.1 On-Roof System installation.

   Note:
   As a rule, pushing up the roof tiles is sufficient. Horizontal positioning of roof anchors is dependent on the rafters and the tile valleys.

**Figure 4-6:** Dimensions of roof anchor A

**Figure 4-7:** Horizontal and vertical alignment

3. Place roof anchor (03-A) in line with the top edge of the roof tile in the tile valley. Fix the base plate of the roof anchor to the rafter with screws (16).
4. Fix all further roof anchors in the same way. For roof anchor intervals, see Page 17, Section 4.1 On-Roof System installation.

   Note:
   Roof anchors must be horizontally and vertically aligned (follow roof tile valleys).

**Figure 4-8:** Installation of roof anchors A

## 4.4 Flat tile

**Roof Anchors fixed to Rafters**

1. For flat concrete tiles, these roof anchors are attached directly to the roof rafters (rafter-mounted installation).

   Caution:
   Never attach safety harness to the installation system!

2. Expose the area above the rafters. For roof anchor intervals, see Page 17, Section 4.1 On-Roof System.

   Note:
   As a rule, pushing up the roof tiles is sufficient. Horizontal positioning of roof anchors is dependent on the rafters and the tile valleys.

**Figure 4-9:** Dimensions of roof anchor B

**Figure 4-10:** Horizontal and vertical alignment

3. Place roof anchor (03-B) in line with the top edge of the roof tile. Fix the roof anchor to the rafter with screws (16).
4. Fix all further roof anchors in the same way. For roof anchor intervals, see Page 17, Section 4.1 On-Roof System installation.

   Note:
   Roof anchors must be horizontally and vertically aligned (follow roof tile valleys).

**Figure 4-11:** Fixing mounting battens and roof anchors

# 4 On-roof Module Installation

## 4.5 Slate tile

**Roof Anchors fixed to Rafters**

1. On slate roofs, additional mounting battens are fixed to the roof substructure. Roof anchors 'C' are fixed through the slate tiles to the mounting batten (batten-mounted installation).

   Caution:
   Never attach safety harness to the installation system!

2. Expose the area required for installation (length of mounting batten). For roof anchor intervals, see Page 17, Section 4.1 On-Roof System installation.

   Note:
   As a rule, pushing up the roof slates is sufficient. Horizontal positioning of roof anchors is dependent on the rafters and the tile valleys.

**Figure 4-12:** Horizontal and vertical alignment

**Figure 4-13:** Horizontal and vertical alignment

Note:
If roof is fully sarked (timber boards) then mounting anchors should be screwed through sarking into the rafters below.

3. Mounting battens (18) are fixed with screws to the rafters at a distance of 185mm from the roof batten below.

   Note:
   The distance of 185mm is dependent on the roof anchor and type of roofing and must be modified if necessary.

4. Place the roof anchor (17) on to the slate tile and mounting battens and fix with screws (16).

5. Fix all further roof anchors in the same way. For roof anchor intervals, see Page 17, Section 4.1 On-Roof System installation.

   Note:
   Roof anchors must be horizontally and vertically aligned.

**Figure 4-14:** Fixing mounting battens and roof anchors

**Figure 4-15:** Fixing mounting battens and roof anchors through sarking

## 4.6 Alignment and fixing of mounting rails

1. Close the roof covering at the top and bottom.
2. Fix top mounting rail (04) to the roof anchor (03).

   Position the heads of interlocking T-bolts (10) parallel to the mounting rail (04) and place them on the mounting rail, push the interlocking T-bolts to the top in the roof anchor (03) and secure with a 90° turn. Tighten the nuts of the interlocking T-bolts (hand tight). Use serrated washers to secure the nuts.

   Install all further mounting rails in the same way.
3. Align the mounting rails horizontally and vertically so that the rails and the roof tiles are parallel. Diagonal dimensions between mounting rails must be equal:
   D1 = D2

   Tighten the nuts on the interlocking T-bolts.

   Installation of solar collectors:
   See pages 33 to 35.

**Figure 4-16:** Roof covering with roof anchors

**Figure 4-17:** Fixing the mounting rail

## 4.7 Joining mounting rails

On many installations it will be necessary to join two or more sections of mounting rail to create a longer length of rail. The sections of rail are butted together and joined using the connector kit(s) provided. Each kit comprises two connector plates and eight fixing screws.

Join the rails, using the fixing kit(s), as follows:

1. Fit four of the fixing screws provided into one of the connector plates provided, ignoring the middle hole. Ensure that the ends of the screw threads DO NOT protrude through the connection plate at this time. Refer to Figure 4-19A.
2. Fit one end of the connector plate into the end of the one mounting rails to be joined – locating the plate into the lower section of the rail profile. Refer to Figure 4-19B.
3. Position the connector plate so that approximately half the length of the plate is within the rail. Tighten the two fixing screws at that end (using a suitable Allen key – not supplied in the kit). Refer to Figure 4-19B.
4. Fit the next section of mounting rail onto the protruding half of the connector plate, Ensure that the two sections of rail correctly aligned and then tighten the remaining two fixing screws. Refer to Figure 4-19C.
5. Repeat the process to join further mounting rails as necessary.

**Figure 4-19A:** Connector plate with screws fitted

**Figure 4-19B:** Rail with connector plate fitted

**Figure 4-19C:** Two rails jointed together

**Figure 4-18:** Aligning the mounting rail

*Now go to Section 7.*

# 4 On-roof Module Installation

### 4.8 Preparations for installation of PV modules on horizontal mounting rails

1. Insert the anchor blocks (07) with the bullet side facing inwards - at one end of the mounting rails (02). See section 4.1 for cutting dimensions.

**Tip:**
**The anchor blocks is slotted into the mounting rail from above.**

2. Pre-mount module retaining end clips (04) loosely onto the mounting rail using fixing screws (06).

**Figure 4-20:** End retaining clip to be fitted at one end of mounting rail

| Item | Description |
|---|---|
| 02 | Mounting rail |
| 04 | Module retaining end clip |
| 06 | Fixing screw |
| 07 | Anchor block |

## 4.9 Fixing the first PV module

The PV modules should be positioned so that the connecting boxes are in the same position. The modules are fitted with pre-fabricated solar cables. We recommend that the modules be connected together electrically as they are mounted on the roof. Refer to Section 3.2.

Ensure connectors are correctly connected together to give a durable watertight connection. See Section 3.2.

Always make the connection in an open circuit, ie.. the cable should be attached to the inverter last.

Never open the connector while under load, ie. first disconnect the inverter.

1. Hook two PV module stop brackets (09) into the lower mounting rail as illustrated in Figure 4-16.
2. Position PV module on the mounting rails/PV module stop brackets and slide into the end fixing clips (04) as illustrated in Figure 4-17.
3. Align PV module and tighten the fixing screws (06).

| Item | Description |
|---|---|
| 02 | Mounting rail |
| 09 | Module stop bracket |

**Figure 4-21:** Location of module stop bracket

**Figure 4-22:** Location of module on rail

| Item | Description |
|---|---|
| 01 | PV module |
| 02 | Mounting rail |
| 04 | Module retaining end clip |
| 06 | Fixing screw |
| 09 | Module stop bracket |

# 4 On-roof Module Installation

### 4.10 Fixing the second and additional PV modules

1. Insert the anchor blocks (07) into the mounting rails for the second PV module.
2. Fix intermediate module retaining mid clips (05) using screws (06) as illustrated in Figure 4-23.
3. Push the retaining mid clips onto the PV module and screw on loosely. Do not tighten at this stage.
4. Insert two module stop brackets (09) into the mounting rail as illustrated in Figure 4-24.

| Item | Description |
|---|---|
| 01 | PV module |
| 02 | Mounting rail |
| 05 | Module retaining mid clip |
| 06 | Fixing screw |
| 07 | Anchor block |
| 09 | PV stop bracket |

**Figure 4-23:** Fixing the module retaining mid clips

**Figure 4-24:** Fixing the module stop brackets

5. Place the second PV module onto the mounting rails/PV module stop brackets and slide into the mid retaining clips (05) as illustrated in Figure 4-25.
6. Align PV module and tighten the fixing screws (06).
7. Connect PV modules electrically. Installing additional PV modules following steps 1 to 7 again.
8. Secure the last PV module on the outside using two module retaining end clips (04). See Figure 4-20. Insert the anchor blocks into the mounting rail with the bullet side facing inwards.
9. Position the two retaining end clips on the module and fit the fixing screws, as shown in Figure 4-20.
10. Tighten the fixing screws to secure the retaining end clips.

**Figure 4-25:** Installing the second PV module

| Item | Description |
|---|---|
| 01 | PV module |
| 02 | Mounting rail |
| 05 | Module retaining mid clip |
| 06 | Fixing screw |
| 09 | PV stop bracket |

**Figure 4-26:** Securing final PV module

# 4 On-roof Module Installation

### 4.11 Preparations for installation of PV modules on vertical mounting rails

**Tip:**
**The mounting rails can be prepared prior to mounting onto the roof as illustrated in Figure 4-27 and 4-28.**

**The anchor block can be presses into the mounting rail from above (this may also be done after the securing clip has been fitted).**

1. Drill a hole (Ø8mm) in the mounting rail (dimensions: see Figure 4-27).
2. Push the securing clip (10) into the mounting rail as illustrated in 4-27. Drill both parts together (Ø 5mm) using the pre-drilled securing clips as a drilling template.
3. Insert the bolts from the securing kit into the drilled holes.
4. Insert the anchor block (07) - with the bullet side facing inwards - at one end of the mounting rails (02). See Section 4.1 for cutting dimensions.
5. Pre-mount retaining end clip (04) loosely onto the mounting rail using fixing screws (06).

**Figure 4-27:** Assembling the securing kits

| Item | Description |
|---|---|
| 02 | Mounting rail |
| 10 | Securing clip |

**Figure 4-28:** Module retaining end clip to be fitted at the end of mounting rail

| Item | Description |
|---|---|
| 02 | Mounting rail |
| 04 | Module retaining end clip |
| 06 | Fixing screw |
| 07 | Anchor block |

**Figure 4-29:** Fixing of securing clip

| Item | Description |
|---|---|
| 02 | Mounting rail |
| 04 | Module retaining end clip |
| 10 | Securing clip |
| 11 | Fixing bolt |

## 4.12 Fixing the first PV module

The PV modules should be positioned so that the connecting boxes are in the same position. The modules are fitted with pre-fabricated solar cables. We recommend that the modules be connected together electrically as they are mounted on the roof. Refer to Section 3.2.

Ensure plugs are correctly connected together to give a durable watertight connection. See Section 3.2.

Always make the connection in an open circuit, ie. the cable should be attached to the inverter last.

Never open the plug connector while under load, ie. first disconnect the inverter.

1. Insert the PV module into the module retaining end clips (04) as illustrated in Figure 4-30.

   Secure PV module during assembly until at least two retaining end clips are tightly fixed.

2. Align PV module and tighten the screws (06).

| Item | Description |
|---|---|
| 01 | PV module |
| 02 | Mounting rail |
| 04 | Module retaining end clip |
| 06 | Fixing screw |
| 10 | Securing clip |

**Figure 4-30:** Location of module on rails

# 4 On-roof Module Installation

### 4.13 Fixing the second and additional PV modules

1. Insert the anchor blocks (07) into the mounting rails for the second PV module.
2. Fix intermediate module retaining mid clip (05) using screws (06) and anchor blocks as illustrated in Figure 4-31.
3. Push the retaining mid clip onto the PV module and screw on loosely. Do not tighten at this stage.
4. Place the second PV module onto the mounting rails and slide into retaining mid clips (05), as illustrated in Figure 4-32.
5. Align PV module and tighten the fixing screws (06).
6. Connect PV modules electrically.

| Item | Description |
|---|---|
| 01 | PV module |
| 02 | Mounting rail |
| 04 | Module retaining end clip |
| 05 | Module retaining mid clip |
| 06 | Fixing screw |
| 07 | Anchor block |

**Figure 4-31:** Fixing the retaining mid clip

**Figure 4-32:** Installing the second PV module

To install additional PV modules follow steps 1 to 6 again.

7. Secure the last PV module on the top using two module retaining end clips (04). See Figure 4-33. Insert the anchor blocks into the mounting rails with the bullet side facing inwards.
8. Position the two retaining end clips on the module and fit the fixing screws, as illustrated in Figure 4-33.
9. Tighten the fixing screws to secure the retaining end clips.

| Item | Description |
|---|---|
| 01 | PV module |
| 04 | Module retaining end clip |

**Figure 4-33:** Fitting final module retaining end clips

# 5 Flat-roof Module Installation

**Figure 5-1:** Flat-roof installation of modules

## 5.1 Dimensions

Portrait/adjacent
Mounting rails: horizontal

**Figure 5-2:** PV modules arranged in portrait position

A - Length of module
B - Width of module
C - Length of mounting rail
D - Overall width/height of modules
*(Refer to table on opposite page)*

| Number of Modules | Module Dimensions A | B | Modules: Portrait Rails: Horizontal C | D | Emax |
|---|---|---|---|---|---|
| 3 | 1581 | 809 | 2515 | 2471 | 1400 |
| 6 | 1581 | 809 | 5008 | 4964 | 1400 |
| 8 | 1581 | 809 | 6670 | 6626 | 1400 |
| 10 | 1581 | 809 | 8332 | 8288 | 1400 |
| 12 | 1581 | 809 | 9994 | 9950 | 1400 |
| 14 | 1581 | 809 | 11656 | 11612 | 1400 |
| 16 | 1581 | 809 | 13318 | 13274 | 1400 |
| 18 | 1581 | 809 | 14980 | 14936 | 1400 |
| 20 | 1581 | 809 | 16642 | 16598 | 1400 |
| 22 | 1581 | 809 | 18304 | 18260 | 1400 |

Grant Solar PV – Flat-roof installation dimensions

# 5 Flat-roof Module Installation

## 5.2 Installation summary

**Figure 5-3:** Modules installed in portrait format

The standard installation kit allows solar collectors to be fitted vertically onto horizontal mounting rails.

Mounting rails are supported using the triengular roof mounting frames.

| Item | Description |
|---|---|
| 01 | PV Module |
| 02 | Mounting rail |
| 03 | Roof mounting frame |
| 04 | Module retaining end clip |
| 05 | Module retaining mid clip |
| 06 | Fixing screw |
| 07 | Anchor block |
| 08 | T-bolt |
| 09 | Module stop bracket |

## 5.3 Flat roof system installation

1. Lay mounting rails on the installation surface with the wide groove uppermost. Mounting rail interval = 1470mm.

   Diagonal dimensions between mounting rails must be equal: D1 = D2

**Figure 5-4:** Installation of the first flat roof mounting frame

2. Open out a prefabricated flat roof mounting frame and place the long L-profile on the mounting rail so that the T-profile points backwards. For maximum rail overhang 'a', see Page 33.
3. Fix the flat roof mounting frame to the mounting rail using the Tee-bolts (14), serrated washers and nuts provided.

   Note:
   Tee-bolts must be secured to the mounting rail using a 90° turn.
4. Place the next flat roof mounting frame on the mounting rail and fix using the Tee-bolts. Do not tighten the bolts too tightly, as final adjustment may be required. For mounting frame interval b, see Page 33.

**Figure 5-5:** Fixing using Tee-bolt

**Figure 5-6:** Installation of the second flat roof mounting bracket

# 5 Flat-roof Module Installation

5. Unscrew securing cruciform (13). It is fixed to the legs of the flat roof mounting frame and the mounting rail.

   Place the angled long ends of the securing cruciform between the flat roof mounting frame and fix with bolts (M8x18), washers and nuts provided.

   Note:
   Always fit the stays of the securing cruciform to the right hand side of the flat roof mounting angles. See detail views (A and B).

6. Tighten the nuts on the Tee-bolts, If necessary, modify the position of the second flat roof mounting frame.

   Note:
   Use punch bolt (15) with offset screw tip for fixing to the mounting rail. Do not confuse with fixing screw (06).

**Figure 5-7:** Punch bolt/fixing screw

7. Place an interlocking nut (23) in mounting rail (02) and secure it in the mounting rail by turning it 90°. Place a spacer sleeve (17) on the interlocking nut and fix the stays of the securing cruciform (13) using locking washer (18) and punching bolt (15).

   Tighten the punch bolt until a clear snap is heard. Continue to turn and tighten normally.

   Caution:
   Turning the punch bolt fixes the securing cruciform into its final position; check distances and correct seating of the interlocking nuts beforehand.

**Figure 5-8:** Installation of the second flat roof mounting frame

**Figure 5-9:** Fixing the securing cruciform and mounting rail

| Item | Description |
|---|---|
| 02 | Mounting rail |
| 12 | Roof mounting frame |
| 13 | Cruciform |
| 14 | Tee bolt |
| 15 | Punch bolt |
| 16 | Flat nut |
| 17 | Spacer sleeve |
| 18 | Locking washer |

8. Fix all further flat roof mounting frames to the mounting rails in accordance with steps 2-4, and fix the legs tightly using the Tee-bolts M8x18mm.

   For mounting frame intervals see Page 33.

9. Place the flat roof mounting frame together with the T-profiles, align according to plan and make the structure robust.

   To prevent damage to the roof covering, it may be necessary to use protective mats. If the flat roof mounting frame is not bolted to the building structure, it must be secured according to technical requirements.

Caution:
The complete flat roof mounting frame must be adequately weighted down or bolted. If the supporting frame is to be secured by dead weight rather than being screwed down, the weights must be as given in table opposite for a wind pressure zone up to 8 m building height and a snow load zone up to 0.75 kN/m².

Permissible roof load must not be exceeded under any circumstances, and if necessary a structural engineer must be consulted beforehand. If the substructure has been penetrated, it must be carefully re-sealed in accordance with technical standards.

## 5.4 Joining mounting rails

On many installations it will be necessary to join two or more sections of mounting rail to create a longer length of rail. The sections of rail are butted together and joined using the connector kit(s) provided. Each kit comprises two connector plates and eight fixing screws.

Join the rails, using the fixing kit(s), as follows:

1. Fit four of the fixing screws provided into one of the connector plates provided, ignoring the middle hole. Ensure that the ends of the screw threads DO NOT protrude through the connection plate at this time. Refer to Figure 4-19A.
2. Fit one end of the connector plate into the end of the one mounting rails to be joined – locating the plate into the lower section of the rail profile. Refer to Figure 4-19B.
3. Position the connector plate so that approximately half the length of the plate is within the rail. Tighten the two fixing screws at that end (using a suitable Allen key – not supplied in the kit). Refer to Figure 4-19B.
4. Fit the next section of mounting rail onto the protruding half of the connector plate, Ensure that the two sections of rail correctly aligned and then tighten the remaining two fixing screws. Refer to Figure 4-19C.
5. Repeat the process to join further mounting rails as necessary.

**Figure 5-10:** Rotate complete support frame

Table of Dead Weight Requirements

| Number of modules | Wt (kg) |
|---|---|
| 3 | TBC |
| 6 | TBC |
| 8 | TBC |
| 10 | TBC |
| 12 | TBC |
| 14 | TBC |
| 16 | TBC |
| 18 | TBC |
| 20 | TBC |
| 22 | TBC |

**Figure 5-11:** Support frame with dead weighting

*Now go to Section 7.*

# 6 In-roof Module Installation

**Figure 6-1:** In-roof installation of modules

## 6.1 Dimensions

**Figure 6-2:** PV modules arranged in portrait position

| Number of Modules | Single Row Dimensions A B (mm) X | Y | Two Row Dimensions C D (mm) X | Y |
|---|---|---|---|---|
| 4 | 3598 | 2000 | 1938 | 3602 |
| 6 | 5258 | 2000 | 2768 | 3602 |
| 8 | 6918 | 2000 | 3598 | 3602 |
| 10 | 8578 | 2000 | 4428 | 3602 |
| 12 | 10238 | 2000 | 5258 | 3602 |
| 14 | 11898 | 2000 | 6088 | 3602 |
| 16 | 13558 | 2000 | 6918 | 3602 |
| 18 | 15218 | 2000 | 7748 | 3602 |
| 20 | 16878 | 2000 | 8578 | 3602 |

Table of overall width and height dimensions for In-roof installations

# 6 In-roof Module Installation

## 6.2 Installation summary

**Figure 6-3:** Calculating sizes for profiles and accessories

**Figure 6-4:** Calculating of dimensions for fixing brackets, fixing points and butyl tape

**Figure 6-5:** Calculation of dimensions for metal sheeting

# 6 In-roof Module Installation

**Figure 6-6:** Calculation of dimensions for plate protector, side and centre stop

**Figure 6-7:** Preparation of roof area

**Figure 6-8:** Distances between roof battens

**Figure 6-9:** Overlap dimensions

## 6.3 Substructure

### 6.3.1 Installation of button cover plates

1. Remove roof covering in the installation area. The distances must be greater than the dimensions calculated in chapter 1.

   (29) Rafters
   (30) Waterproof membrane
   (31) Cross batten
   (32) Roof batten

**Important:**
**There must be adequate rear ventilation of the in-roof installation kit, e.g. by means of cross battens. A waterproof membrane - waterproof membrane (30) - is absolutely essential.**

**Irregularities in the roof substructure (in particular, the clean lines of the rafters) must be checked and if necessary corrected.**

**Broken roof battens must be replaced.**

2. Calculation of distance between roof battens.

   Note:
   If its position is appropriate, an available roof batten can also be used.

## 6.4 Installation of In-roof kit

3. When installing several cover plates, the number must be calculated in accordance with chapter 1 and the bottom cover plates cut to length accordingly.

**Important:**
**Length adjustment only on the side away from butyl tape.**

# 6 In-roof Module Installation

**Figure 6-10:** Installation of bottom roof batten and bottom cover plate

**Figure 6-11:** Installation of bottom roof batten and bottom cover plate

**Figure 6-12:** Installation of gasket on single vertical profile

**Figure 6-13:** Installation of gasket on single vertical profile

4. Install the bottom roof batten (supplied by others) with the specified distances to the roof batten underneath and fix tightly with screws (supplied by others) to each counter batten.

   The horizontal distance from the edge of the roof tile to the roof batten **and** to the bottom cover plate (36) is 90mm.

   Push the bottom cover plate up to the roof batten but do not screw tightly.

**Important:**
**The position of the bottom roof batten determines the overall position of the module field. It is therefore important to ensure that the layout is fully horizontal (in alignment with the roof covering).**

Note:
The additional roof battens must have the thickness of existing roof battens.

### 6.4.1 Installation of left vertical profile

5. Install the top batten (supplied by others) with the given distances to the bottom roof batten and fix tightly with screws (supplied by others) to each counter batten.
6. Cut the single vertical profiles (38) to length in accordance with chapter 1.9.

   Install the facing gasket (43) in the groove next to the wide channel and cut to length flush with the single vertical profile (38).

**Important:**
**Do not confuse it with the double vertical profile (44). The gasket lip must be facing outwards (towards the wide channel).**

Note:
Install gasket for all 1-part vertical profiles (without joint) on the floor.

7. Lay the single vertical profile on the left side **with the wide channel on the outside** (and the gasket lip facing outwards) and align vertically to the roof construction.

   Fix the single vertical profile with one sealing screw (39) per roof batten.

**Figure 6-14:** Bottom drill hole in single vertical profile

**Figure 6-15:** Installation of gasket for double vertical profile

**Figure 6-16:** Fixing brackets used to determine horizontal distance between vertical profiles

8. Make the bottom drill hole diameter 6mm for the sealing screw in the single vertical profile in the right channel using the side stop (40) as a drilling template.

**Important:**
**The side stop has no cut-out. Do not confuse with the centre stop.**

9. Push the side stop up to the bottom face between the single vertical profile and the bottom cover plate as far as possible.

   Fix the single vertical profile and side stop tightly in the roof batten with a sealing screw.

### 6.4.2 Installation of central vertical profile

10. Install the facing gasket (43) in the groove next to the inner channel and cut to length flush with the double vertical profile (44).

**Important:**
**Do not confuse with the single vertical profile (38). The gasket lips must face towards the inner groove.**

Note:
Install gasket for all 1-part vertical profiles.

11. Use the fixing brackets as a template to calculate the horizontal distance between the vertical profiles.

    To do this, insert 4 anchor blocks (07) into the vertical profiles at top and bottom, and tighten the fixing brackets slightly using cylinder head screws M8 x 14mm (06). Then fix the double vertical profiles onto the roof battens in the right and left grooves with the sealing screws.

    Dismantle the fixing brackets; the anchor blocks can remain installed.

**Important:**
**Do not fix to the bottom roof batten with screws yet.**

# 6 In-roof Module Installation

**Figure 6-17:** Bottom drill hole in double vertical profile

**Figure 6-18:** Installation of right vertical profile

**Figure 6-19:** Lengthening of single vertical profiles

12. Make the bottom drill hole diameter 6mm for the sealing screw in the vertical profile in both the outer channels using the centre stop as a drilling template, see Fig. 14.

    Push the centre stop up to the bottom face between the double vertical profile and the bottom cover plate as far as possible.

    Fix the double vertical profile and the centre stop tightly into the roof batten with two sealing screws.

    Note:
    Butyl tape has strong adhesive properties meaning that mistakes cannot be corrected after application.

13. Additional vertical profiles can be fixed onto the roof.

### 6.4.3 Installation of right vertical profile

14. Installation of the left vertical profile is a mirror image (see 2.2).

**Important:**
**Gasket lip and wide channel outside.**

### 6.4.4 Lengthening of the vertical profiles

15. Where several vertical profiles are placed one above another, you connect the single vertical profiles (right and left) to the joint plates (46).

    Then push the narrower end of the joint plate into the assembled bottom vertical profile as far as possible. Remove the protective strips from the butyl tape, lay the single vertical profile flush **on top of** the side joint plate from above and fix with screws.

    Note:
    Butyl tape has strong adhesive properties meaning that mistakes cannot be corrected after application.

    The facing gasket must bridge the joints.

**Figure 6-20:** Lengthening of single vertical profiles

**Figure 6-21:** Position anchor block

**Figure 6-22:** Bottom drill hole in single vertical profile

16. Where several vertical profiles are used, you connect all double vertical profiles to the central joint plates (47).

    Then push the narrower end of the joint plate into the assembled bottom vertical profile as far as possible. Remove the protective strips from the butyl tape, lay the double vertical profile flush **on top of** the centre joint plate from above and fix with screws.

    Note:
    Butyl tape has strong adhesive properties meaning that the vertical profile cannot be corrected after application.

    The facing gasket must bridge the joints.

### 6.4.5 Installation of PV modules

17. Push the bottom anchor blocks until they are flush to all bottom edges of the vertical profiles.

    The position of the top anchor blocks for the first horizontal row of modules must be calculated based on the module.

18. Lay the module-specific single fixing bracket (50) on the vertical profiles with the edge facing upwards and pre-assemble without tightening in the anchor blocks using two M8 x 14mm cylinder head screws.

    Note:
    No butyl tape is required here because the fixing bracket is installed above the bottom cover plate.

# 6 In-roof Module Installation

**Figure 6-23:** Installation of first PV module

**Figure 6-24:** Alignment of double fixing bracket

### 6.5 Installation of modules

19. The PV modules should be positioned so that the connecting boxes are in the same position. If the modules are not fitted with solar cables, then these should be fitted before the modules are installed.

    Place the first PV module in front of the installation position and attach connector cables. Insert the PV module behind the fixing bracket, align it flush with the fixing bracket and fix tightly using M8 x 14mm cylinder head screws.

20. Affix butyl tape to the inside of both short bars of the double fixing bracket and cut off flush with the sides. Affix only one butyl strip to the top fixing bracket.

    Note:
    Affix the butyl tape on the floor.
    **Leave protective strips in place.**

    The butyl tape can also be cut into pieces joint by joint.

    Install the modules in rows working from top to bottom (no inspection of modules necessary).

21. Put the double fixing bracket in place, and adjust the blocks to the holes in the double fixing bracket.

    Place the second module in front of the installation position and attach connector cables. Lay the module out and align roughly flush with the bottom module.

22. For modules with a horizontal length greater than 1000mm, an additional pressure point must be installed.

**Figure 6-25:** Installation of double fixing bracket

**Figure 6-26:** Lever in side cover plate

**Figure 6-27:** Side cover plate fitted against module side

23. Remove the protective strip from the butyl tape, position the double fixing bracket flush **above** the first module. Join the second module from the top to the fixing bracket and push the double fixing bracket (flush with the modules) downwards. Fix the fixing bracket by tightening the M8 x 14mm cylinder head screws.

    Note:
    Butyl tape has strong adhesive properties meaning that the fixing bracket cannot be corrected after application.

    Correct switching of the PV modules should be tested (per string) by a PV generator tester.

24. The top module is also fixed with a double fixing bracket. There is no need for butyl tape on the top inside, since the cover plate is attached here later.

## 6.6 Installation of side cover plates

25. The process for calculating any cutting of the side cover plate is described in chapter 1.

    Lay the side cover plate (34) into the visible groove of the right and left single vertical profiles from above and lever under the modules.

    Where several side cover plates are used, these must be installed from **bottom to top**. The side cover plate above overlaps the side cover plate underneath.

26. Fix the side cover plate onto each second roof batten.

# 6 In-roof Module Installation

**Figure 6-28:** Roof tile overlapping on cover plate

**Figure 6-29:** Overlapping of top cover plates

**Figure 6-30:** Installation of top cover plate

27. Lay the roof tiles overlapping on the side cover plate.
28. Install the right side cover plate accordingly. If necessary, cut the roof tiles up to the plate edging.

## 6.7 Fitting top cover flashing

29. When installing several top cover plates (33), the number must be calculated in accordance with chapter 1 and the top cover plates cut to length accordingly.

**Important:**
**Length alignments only on side turned away from the butyl tape.**

30. Push the plate edging of the top cover plate into the short bar of the double fixing bracket as far as it will go.
31. Fix the top cover plate with grips on the roof batten approximately every 500mm.

    Roof tiles above the collector array usually have to be cut. The overlap of the top cover plates must be in accordance with the following values for roof pitch:

    – = 35° at least 120mm

    – > 35° at least 100mm

    – > 50° at least 80mm

**Figure 6-31:** Visible installation of plate protector

32. On each vertical profile at the top, install a side and/or centre plate underneath the top cover plate.

## 6.8 Roof penetration

1. Guide the electric connector cables through the waterproof membrane. Sealing of the roof covering can be ensured, for example, using an overlapping strip of waterproof membrane and a suitable adhesive strip.

**Figure 6-32:** Visible installation of plate protector

# 7 Electrical Connection - AC Circuit

**Figure 7-1:** Schematic diagram of system using - one string of modules connected in series

**Figure 7-2:** Schematic diagram of system using - two strings of modules connected in series

# 7 Electrical Connection - AC Circuit

**Figure 7-3:** Schematic diagram of system using - two inverters each with single strings of modules connected in series

**Figure 7-4:** Schematic diagram of system using - two inverters with three strings of modules

# 7 Electrical Connection - AC Circuit

**Figure 7-5:** Typical connections - consumer unit

**Figure 7-6:** Typical connections - split load consumer unit

**Figure 7-7:** Typical connections - garage consumer unit

**Figure 7-8:** Connections for 'Export/Generation' kWh meter

# 8 Installation Procedure

## 8.1 Risk assessment

Prior to commencing any work, a full risk assessment must be made of all activities and risks involved in the installation of the Solar PV system, including:

Any roof working and working at heights - necessary to install the PV modules.

Manual handling – necessary to get PV modules on to roof.

Risk of electrocution – Live working on the DC side is inevitable due to the nature of the work involved.

Risks due to falling objects or broken glass.

Risks associated with working in loft spaces.

## 8.2 DC cable installation

DC cabling should be installed and terminated into the DC isolator or inverter prior to installation of PV modules. Ensure that DC cables are:

Correctly connected with all plugs/spring connectors correctly made.

Correctly routed such that they are not prone to damage.

Adequately fastened in place where necessary.

Clearly labelled at each end especially where multiple strings are involved.

Run separately from any AC cabling.

Tested for continuity and insulation.

Checked that double insulation is intact throughout.

ALWAYS ensure that connections are not made or disconnected whilst under load, the DC isolator should always be in the off position whenever connections are being made or disconnected and when installing, until all of the array connections have been finalised.

## 8.3 PV module installation

Refer to the information given in the Sections 4, 5 or 6 of these Installation instructions, as appropriate, for the module mounting method being used BEFORE commencing installation of the modules, as follows:

Section 4 – On-roof installation.

Section 5 – Flat roof installation.

Section 6 – In-roof installation.

Installation of the modules should only be carried out when:

Proper access equipment is used, e.g. correctly erected scaffolding.

The area below any roof work is secure and warning notices displayed.

Any lifting machinery is certified safe and operative trained to use it.

Installer(s) are wearing the appropriate safety equipment/clothing.

Installer should be qualified or experienced in both working at heights and also the hazards associated with working with PV modules and DC electrical systems.

Whilst Grant Solar PV modules are rigid in construction, they are fragile and can be damaged if dropped. Care must be taken when handling them, e.g. lifting them onto, or carrying on, a roof, as they can be caught by the wind.

**Important:**
**Grant Solar PV modules will not support the weight of an installer and therefore must not be stood on under any circumstances.**

## 8.4 Interconnect the modules

Refer to information given in Section 3 of these instructions for the method of connecting modules in series to form a string.

Ensure that DC cables between modules are connected as each one is fitted to the mounting system, leaving the 'free' cable and plug accessible for connection to the cable of next module, and so on.

The cables must be adequately supported and, where applicable, secured (such as with cable ties) to the array frame, this will avoid damage being caused to the cables under windy conditions where, if unsecured, they would move and chafe against the roof or the array frame.

Finally, if not already done, connect the extension cables from within the building to the remaining male (positive) and female (negative) plugs.

## 8.5 DC/AC inverter installation

Identify the most convenient location for the Inverter. This may be in the loft space (to minimise the length of DC cable runs from roof mounted modules) or at a lower level in the property. Whatever the location, the inverter should be easily and safely accessible for the user of the system as well as the installer.

Reference MUST be made to the manufacturers instructions supplied with the inverter for specific installation requirements – e.g. clearances around the inverter and the need for any ventilation to allow dissipation of the heat generated by these devices in operation.

**Important:**
**The inverter(s) must not be mounted on a combustible surface.**

## 8.6 Install the AC wiring

All electrical installation work must comply with the requirements of the Electricity at Work Regulations 1989 and BS.7671:2008 – IEE Wiring Regulations 17th Edition, Including any amendments.

All domestic installations must also comply with all applicable parts of the Building Regulations, in particular, Part P.

All 'grid-connected' Solar PV installations must conform to the requirements of the 'ENA Engineering Recommendations for the connection of a small scale embedded generator (SSEG) in parallel with public low voltage distribution networks' published by the Energy Networks Association, as follows:

G83/1-1 – for systems up to 16A per phase.

G59/1 – for systems exceeding 16A per phase.

The AC output circuit between the Inverter and consumer unit will include a double pole isolator and an export (or generation) meter. A further Isolator may be required if, say, the Inverter is located in the loft of the property and the consumer unit is on the ground floor, to allow local isolation of the Solar PV system at or near the AC output of the inverter.

AC circuit design : The AC circuit should be designed in accordance with BS7671 including any amendments as would be the case for any other type of AC circuit. For installations less than 16A per phase (those falling within G83/1-1) typically a cable size of 2.5mm$^2$ and protective device of 16A or less would be adequate. However the designer of the circuit must make sure that they have taken into account any voltage drop considerations and the earth fault loop impedance calculations for the circuit.

RCD protection for the circuit should be considered if required by BS7671. For example if the cable is buried in a wall at a depth of less than 50mm and the installation is not under the supervision of a skilled or instructed person then it is likely that RCD protection is required for the cable. If however the AC cable is surface mounted then it is unlikely that it will require RCD protection.

**It should be noted that with modern fully electronic inverters a higher than expected protective conductor current can be present, in some cases where RCD's are used this can result in nuisance tripping of the RCD. The use of RCD'S with these types of inverters should be considered carefully by the designer of the AC circuit prior to installation.**

Refer to Section 7 of these Instructions for electrical connection details.

## 8.7 Connection of kWh meter

An electric kWh meter should be connected in the AC circuit between the inverter and consumer unit. Refer to Figure 7.1 for location.

This meter will record the amount of electricity produced by the Solar PV installation and will be the basis for the payment under the Feed in Tariff scheme (as well some energy supplier 'export' tariff schemes that may apply).

Refer to the connection instructions provided with the meter. Ensure that the meter is correctly connected, remembering that the supply being metered in this instance is that coming from the PV system/inverter and NOT that coming from the power supply grid.

Thus connections to the meter must be as follows:

MAIN – Connect the supply from the PV system inverter

LOAD – Connect the supply from the Consumer Unit

Refer to Figure 7.8 for further connection details.

# 9 System Commissioning

## 9.1 Commissioning procedure

All electrical installation work must comply with the requirements of the Electricity at Work Regulations 1989 and BS.7671:2008 – IEE Wiring Regulations 17th Edition, Including any amendments.

The following guidance applies mainly to the DC side of the installation, it is envisaged that those undertaking the installation work will be familiar with the requirements of the AC side of the installation.

## 9.2 Inspection

With all electrical installations there is a requirement under the regulations to inspect and test all new components that make up the installation to verify that all equipment has been installed and selected in accordance with BS7671 and the appropriate standards.

The inspection and testing process is to confirm before energisation that there are no faults on the system and the integrity of the electrical installation is not compromised.

The inspection process should always precede the testing.

A visual inspection of the system and components is required and the following items as a minimum should be inspected:-

- AC wiring and connections
- AC isolators and junction boxes
- Full labelling of the AC and DC supplies
- Earthing, Bonding and lightning protection
- Inverter/s
- DC wiring and connections including PV cabling
- DC isolators and junction boxes
- PV modules
- Over current protective devices
- Array mounting system (secure and properly weather sealed)

**The installer should keep a record of the inspections as per the schedule of inspections given in BS7671 and in addition the PV system installation check list.**

**All serial numbers associated with the modules should be recorded on the PV array test report.**

## 9.3 Testing

There are a number of tests that need to be carried out before the installation can be safely put into service and these can be broken down into groups of tests.

- Module testing
- Array Testing
- DC testing
- AC testing (outside of the scope of these installation instructions) but see below for advice on completion of the documentation.

All tests should be carried out by suitably qualified personnel; some of the tests stated may result in a FATAL electric shock risk, especially when undertaken at height, if not carried out correctly. If you are unsure about any of the tests please consult a suitably qualified person.

## 9.4 Module testing

The testing of a PV system should begin during the Installation phase. It is most efficient to verify each module as it is installed as if faults are found it will save time in troubleshooting and the need to dismantle the entire array to find a faulty module. Below is a suggested sequence for module testing:-

1. Place the module in sunlight and then measure the open circuit voltage on the output of the module. Refer to Section 2.2.
2. Remove the module from the sunlight (preferably by covering it). Then short the output of the module and then once again place it in sunlight. Use a clamp meter (set on DC amp) to then measure the short circuit current. (Not all clamp on meters will measure DC amps). Refer to Section 2.2.
3. At the same time measure the solar irradiance using a suitable irradiance meter. The module temperature should be measured.
4. The measured short circuit current of the Module (Isc) should be corrected for the measured irradiance level as shown in the following:

   $$1000 \times \frac{\text{(Measured value of Isc)}}{\text{(Measured irradiance)}}$$

   The result should be compared to the rated module output on the data plate of the module to verify that the module output is as declared.
5. The Voc is then corrected for the temperature change (-0.5% change for each degree of increase from 25˚C or + 0.5% for each degree decrease from 25˚C).

The result should be compared to the rated module output on the data plate of the module to verify that the module output is as declared.

## 9.5 Insulation resistance testing

NOTES REGARDING TEST METHOD

Two test methods are possible:

**Method 1**
Test between Earth and Array Negative followed by a test between Earth and Array Positive.

**Method 2**
Test between Earth and Array Positive & Negative short circuited together (simplified method).

In either case where the structure/frame is bonded to earth, the earth connection may be to any suitable earth connection or to the array frame (where the array frame is utilised, ensure there is good contact, and that there is continuity over the whole metallic frame).

For systems where the array frame is not bonded to earth, for example where there is a class II.

Installation, the commonest of installation methods, the following test may be the most appropriate to verify there are no shorts between the DC cabling and the array frame.

Procedure for Test Method 1 & 2 between Array cables and Frame.

**Test Preparation:**
Remove any electronic equipment that may be vulnerable to a the test or that may cause false readings. As a minimum isolate the PV array from the inverter at the array switch disconnector (DC isolator).

Ensure that there are no connections between the positive or negative connections and earth.

Where the test is to be undertaken between Earth and short-circuited Array positive and Array negative cables an appropriate test box should be used.

The test can be conducted on the entire array at the same time if the connections are possible, if not then each string can be tested individually.

Select an appropriate test instrument to conduct the test and select the correct test voltage (usually 500v DC) as per IEE guidance note Three.

Following the instructions on the insulation resistance tester connect one lead from the instrument to the array cable(s).

Connect the other lead from the Insulation resistance device to array frame or earth as per above, dependant on which method is being used.

Press the button to apply the test and record the readings on the PV array test report.

Ensure that the test is repeated to cover all required permutations required (dependant on test method selected).

Ensure that any charge has had time to discharge before removing the leads or touching any parts under test.

## 9.6 Array testing

The open circuit voltage and short circuit current of the array need to be measured prior to connection to the A.C supply. Essentially the array test is the same as that stated above for the module test. A suggested sequence for array testing is as follows:

1. Isolate all of the strings by ensuring that all of the string DC isolators and the main DC Array isolators are set to the OFF position.
2. Insulation resistance testing.
3. For each string in turn complete the following:
   - a Connect a voltmeter across the positive and negative input terminals of the DC isolator or use a suitable test box, and record the voltage displayed. Then correct this value for temperature changes from the standard test conditions. This is the open circuit Voltage (Voc).
   - b Verify that the open circuit voltage value is around ‘n’ multiplied by Voc for a module, from the data plate, where ‘n’ is the number of modules connected in series in the string. This is the string Voc and should be recorded on the PV array test report.
   - c With the DC isolator set in the OFF position, connect a shorting link across the positive and negative output of the DC isolator, or use a suitable test box.
   - d Using a clamp meter with DC amps position it around the link or the leads of the test box.
   - e Switch the DC isolator or test box to the ON position and record the current displayed. This is the short circuit current (Isc) and should be recorded on the PV array test report.
   - f Where possible a simultaneous reading of the solar irradiance should be taken.
   - g As per the module testing under Section 9.4 point 4 above, divide the measured value of Isc by the measured value of the in-plane solar irradiance and multiply the result by 1000 to correct the measured value of Isc to STC radiation (1000 W/m$^2$).
   - h Verify that the corrected short circuit current value agrees with manufacturer's data for the module. Refer to Section 2.2.
   - i Switch the DC isolator to the OFF position before removing the link or test box.
4. Assuming no faults, i.e. the open circuit voltage for each string has a similar value, set all of the string DC isolators to the ON position.
5. Repeat 2 steps (a-j) for the whole array and using the main array isolator if provided.
6. Verify that the array voltage is approximately equal to the lowest measured string voltage (n x Voc) and that all string voltages have similar values (+/-3V).
7. Verify that the corrected array current is equal to the sum of the corrected string currents.

   Complete the PV array installation Certificate commissioning report and Check list with the above details.

# 9 System Commissioning

### 9.7 AC tests and commissioning documentation required

The AC side of the installation should be inspected and tested as per BS7671 (including any amendments) and the IEE Guidance note Three.

For all installations this will mean that the following will need to be completed for the AC side as a minimum.

- Electrical installation certificate
- Schedule of inspections
- Schedule of test results

NOTE : Great care should be taken on completing the above documentation as it when completed it should cover both the AC and DC side of the installation. In some cases this may mean that when software is used to complete the documentation it will not allow the user to complete all fields (i.e. when you have to indicate that the installation is both AC and DC) where this is the case the commissioning engineer should consider using wither two sets of the electrical installation certificate or completing the documentation by hand.

### 9.8 DC documents required

As detailed in the tests listed above, following DC documentation is required:

- PV array test report
- PV system installation check list

These documents should be completed in full and serial numbers of the installed modules detailed.

### 9.9 DNO notification

For installations under 16A per phase (falling under G83/1-1) the DNO must be informed that a small scale embedded generator has been installed onto the network at or immediately after commissioning, then completion & submission of the following documentation to the DNO must be undertaken.

- ENA Engineering recommendation G83/1-1.SSEG installation commissioning confirmation

This documentation must be completed and submitted to the DNO within 30 days of the installation being commissioned.

For installations in excess of 16A per phase the advice of the DNO must be sought during the design stage to gain their permission to install such a system. It is likely that such an installation will require compliance with G59/1 and each DNO's requirements may differ so early communication is essential.

# 10 Servicing & Maintenance

Grant Solar PV systems require little routine maintenance. However to keep them running safely and at optimum output some regular attention is required, as follows:

## 10.1 PV modules

Regular cleaning of the glass and frames is not essential. However, a large build up of dirt can reduce the output of the system so, if required, wipe the glass and frames using water and a soft sponge or cloth. Mild non-abrasive cleaning agent can be used, where necessary to remove stubborn dirt.

Check the electrical connections are clean, secure and undamaged and also check that all cables undamaged and secured (e.g. with cable ties) and not free to move in the wind.

If any electrical problems are found with the modules, cables or connectors isolate and lock off the AC supply to the inverter and isolate the DC input from the modules. Any rectification work must be carried out by a competent Solar PV installer as necessary before putting the system back into operation.

## 10.2 Inverters

Reference should be made to the Installation and operating instructions supplied with each Inverter.

Check the inverter for any signs of external physical damage. Also check that the inverter is in operation – usually shown by an indicator light on the unit.

If any damage is seen to the unit that might compromise safe electrical operation then isolate and lock off the AC supply to the inverter and isolate the DC input from the modules. Any rectification work must be carried out by a competent Solar PV installer as necessary before putting the system back into operation.

The Inverter casing and displays, if dirty, can be cleaned by wiping with a damp cloth. Solvents, abrasives or corrosive cleaning agents must not be used.

If necessary any dirt/dust deposits on the cooling fins of heat sinks should be carefully removed using an appropriate soft brush or paintbrush.

Caution – Inverter heat sink fins may be HOT! Isolate and lock off the AC supply to the inverter and isolate the DC input. Then allow the inverter to cool before inspecting and/or cleaning.

On SMA Sunny Boy inverters periodically check the integral DC isolator (Solar switch) for wear. Refer to the SMA Installation Guide supplied with the inverter for details of the procedure involved.

## 10.3 DC cables and connectors

All DC cables and connectors that are accessible (e.g. in the loft space) should be periodically inspected. Check the connections are clean, secure and undamaged and also check that all cables are undamaged, suitable secured where necessary, and not located where they can be easily damaged.

Any rectification work must be carried out by a competent Solar PV installer as necessary before putting the system back into operation.

## 10.4 Labelling

Check all parts of the system are adequately labelled and that safety labels fitted at the time of installation have not been removed in the meantime. If necessary replace any missing safety labels.

## 10.5 Electrical installation

As with all electrical installations a periodic inspection is required, as specified by the installer on the initial inspection certificate. This should be conducted by a suitably competent electrical contractor/solar PV installer, and the appropriate inspection certificates completed and left with the householder.

# 11 Spare Parts

**Grant Solar PV System Spare Parts**

| Part Name | Part No. |
|---|---|
| Solar Cable 4mm² x 10m c/w male & female MC Type 4 connectors (fitted) | GPV249640 |
| Adaptor cables MC Type 4 to type 3 (1 pair) | GPV231333 |
| Rail connection kit | GPV221165 |
| Module retaining end clip c/w anchor block and fixing screw | GPV221673 |
| Module retaining mid clip c/w anchor block and fixing screw | GPV221674 |
| Anchor block (single) | GPV221353/S |
| Fixing screw – to fit anchor block (single) | GPV221227/S |
| Solar Irradiance meter | GPV222020 |
| T-bar Allen key (6mm) – to fit fixing screw | GS222001 |
| Module stop bracket | GPV221201 |
| AC Isolator (lockable) – 20A | GPVAC20 |
| DC isolator (lockable) | GPVDC02 |
| MC Type 4 connectors - male & female (1 pair) | GPV231333 |
| Crimping tool – for MCType 4 connectors | GPV231037 |
| kWh Meter (Elster) | GPV5235B/WF |
| Bolt, nut & washer - for flat-roof frames (box of 100) | GS222094 |
| Solar test box | GSSOLARTESTBOX |

# 12 Fault Finding

## 12.1 General

The investigation and rectification of any fault with a Grant Solar PV system must be conducted by a suitably competent electrical contractor/Solar PV installer.

All electrical checks and testing must be carried out in accordance with the requirements of BS7671:2008 – IEE Wiring Regulations 17th Edition (including any amendments).

Any work carried out at high level (e.g. on a roof) must be done so in a safe manner, in compliance with the Work at Heights Regulations 2005 (including any amendments).

## 12.2 Fault finding procedures

For guidance on fault identification and rectification please refer to the manufacturers' Installation and User instructions supplied with the inverter(s).

Each inverter has a display which will indicate the nature of a system fault. Follow the directions given in the relevant section of the inverter instructions to diagnose and rectify the fault.

Before commencing any work on the system ensure that BOTH electrical present on site are isolated, as follows:

- Isolate and lock off the AC supply to the Consumer unit
- Switch off Solar circuit MCB in Consumer unit.
- Isolate the DC input to inverter from the PV modules at the DC isolator(s). This may be at the DC isolator integrated into the inverter or at the external DC isolator(s) fitted – depending on the type of inverter(s) used.

**Important:**
**NEVER disconnect a DC connection between the PV modules and the inverter whilst the system is under load, i.e. with the AC output connected to the inverter.**

**ALWAYS isolate the AC side of the system (AC supply to the inverter) BEFORE isolating the DC output from the PV modules.**

**ALWAYS isolate the DC output from the PV modules before disconnecting or connection any DC connectors.**

**CAUTION**
**Solar PV modules will generate an electrical output whenever exposed to daylight!**

# 13 De-commissioning

If required Grant Solar PV systems should be de-commissioned as follows:

## 13.1 Shut down procedure

Isolate and lock off the AC supply to the Consumer unit.

Switch off Solar circuit MCB in Consumer unit.

Isolate the DC input to inverter from the PV modules at the DC isolator(s). This may be at the DC isolator integrated into the inverter or at the external DC isolator(s) fitted – depending on the type of inverter(s) used.

## 13.2 DC cables

Disconnect the DC cables from the inverter. Refer to Section 3.2 for inverter connections.

Disconnect the DC string cables from the PV module array.

Disconnect the interconnecting DC cables between the modules

Disconnect the string cables from the DC isolator(s).

Disconnect any cables between DC isolator(s) and the inverter(s)

Remove DC isolators.

## 13.3 PV modules

Unscrew the retaining clips and remove the modules from the roof mounting system. Refer to sections 4, 5 or 6 as required for details of the fixing system concerned.

Carefully remove the modules to ground level and either store or dispose of as required.

If modules are to be re-used: ensure that DC cables/connectors are tied away to avoid any damage or risk of electrocution. Store such that no excessive load is applied to the solar PV cells, e.g. store in an upright position.

Important: Solar PV modules produce electricity whenever exposed to daylight. Therefore care must be taken when handling PV modules during daylight hours.

Remove all mounting rails and fixing brackets from roof and keep together.

If the modules are to be disposed of then do so in accordance with all local and national regulations for electronic waste.

Make good any holes to the roof covering. In the case of an in-roof installation the area will need to be re-tiled when the modules and roof installation system is removed, to re-weather the roof.

## 13.4 Inverters

Disconnect inverter(s) from the AC supply (from Consumer unit).

Remove the Inverter and, if it is to be used again, store in a dry location. If possible pack the inverter in the original packaging if still available.

If inverter is to be disposed of, do so in accordance with all local and national regulations regarding electronic waste.

## 13.5 AC circuit from consumer unit

With consumer unit isolated from the AC supply, disconnect the AC connections to the Solar circuit MCB.

Remove cable from between Consumer unit and inverter as required.

## 13.6 Consumer unit

With Solar circuit MCB set to 'off' reconnect AC supply to consumer unit and check that other circuits connected, e.g. lights, ring mains, etc. work correctly.

# 14 Warranty

## The Grant Solar PV System Warranty

**Dear Customer**
You are now the proud owner of a Grant Solar PV System from Grant Engineering (UK) Limited that has been designed to give years of reliable, trouble free operation. Grant Engineering (UK) Ltd. guarantees the manufacture of the system, including all electrical and mechanical components, for a period of twelve months from the date of purchase provided the system is installed in full accordance with the installation instructions provided. This will be extended to a period of five years* if the system is registered with Grant UK within thirty days of installation and it is serviced at twelve month intervals. See Terms and Conditions below.

**Performance Guarantee**
Grant Solar PV Modules have a twenty five year performance guarantee, i.e. the modules are guaranteed to produce the following minimum output.

Minimum of 90% of original output for up to ten years of operation.

Minimum of 80% of original output for between ten to twenty five years of operation.

**Important**
Please register your Grant Solar PV system with Grant UK within thirty days of installation, as follows:

Either

a) visit www.grantuk.com and follow the links to the 'Householder Zone', or

b) go to www.grantuk.com/solarpvregistration.aspx,

where you can register your Solar PV system for a further four years warranty (giving five years* from the date of purchase). This does not affect your statutory rights.

**Breakdown during the Manufacturer's Warranty**
If your Grant Solar PV System should fail within the first five years* of the date of purchase you must contact Grant Engineering (UK) Limited, who will arrange for the repair under the terms of their Warranty, providing that the system has been correctly installed and commissioned, serviced (if older than twelve months) and the fault is not due to misuse, or the failure of any system components not supplied by Grant UK (e.g. circuit breakers, AC cabling, etc.), any fault in the existing electrical installation or the incorrect setting of the system controls. This extended five year* warranty only applies if the system is registered with Grant UK within thirty days of installation.

**In the first Instance:**
Contact your installer to ensure that the fault does not lie with any part of the existing electrical installation in the property, any other components not supplied as part of the Grant Solar PV System, or any incorrect setting of the system controls.

**If a Fault is Found:**
Ask your installer to contact Grant Engineering (UK) Limited Service Department on 01380 736920 who will arrange for a qualified service engineer to attend to the fault.

**Free of Charge Repairs:**
During the first five years* no charge for parts or labour will be made providing that the Solar PV System has been installed and commissioned correctly in accordance with the manufacturer's instructions, serviced at twelve month intervals and the system was registered with Grant UK within thirty days of installation. Proof of 'purchase' date must be provided upon request.

**Chargeable Repairs:**
**A charge will be made if the cause of the breakdown is due to any of the following:**

- **Faults caused by the existing electrical system in the property, the AC wiring to the PV system or any external electrical systems and components.**
- **The Grant Solar PV System has not been commissioned, or serviced, in accordance with the Installation & User manual supplied with the system.**
- **The system has been installed for over five years.**

**Remember before you contact Grant:**
Please register your Grant Solar PV System within thirty days of the installation.

**Terms of Manufacturer's Guarantee**

1. The Grant Solar PV System guarantee starts from the date of purchase.
2. All electrical and mechanical components supplied with the Grant Solar PV System (including the modules, inverter, etc.) are guaranteed for a period of five years*, subject to them being supplied as a kit. The Grant Warranty does not cover any 'mixed' systems – i.e. where the modules or inverter(s) were not supplied by Grant Engineering UK Ltd.
3. This guarantee does not cover breakdowns caused by incorrect installation, neglect, misuse, accident or failure to operate the system in accordance with the Installation and User Instructions provided.

4. The Grant Solar PV System is registered within thirty days of installation. Failure to do so does not affect your statutory rights.
5. The Grant Solar PV System must be installed by a competent installer and in full accordance with the relevant Codes of Practice, Regulations and Legislation in force at the time of installation.
6. The Grant Solar PV System components must not have been modified or tampered with.
7. The installation is subject to a twelve month visual inspection – to include checking that the modules are not in shade and are in a clean condition. Routine cleaning of the modules is not usually required as normal dirt build up is removed by rain. Any Receipts should be kept as proof.
8. The installation is checked by a qualified electrician every ten years, or sooner, as required by the current BS.7671 (Wiring Regulations – 17th Edition).
9. All claims under this guarantee must be made to Grant Engineering (UK) Ltd prior to any work being undertaken. Proof of purchase and date of installation must be provided on request. Invoices for call out/repair work by any third party will not be accepted unless previously authorised by Grant Engineering (UK) Ltd.
10. This guarantee is transferable providing the installation is serviced prior to the dwelling's new owners taking up residence. Grant Engineering (UK) Ltd must be informed of the new owner's details.
11. Grant Engineering (UK) Ltd will endeavour to provide prompt service in the unlikely event of a problem occurring, but cannot be held responsible for any consequence of delay however caused.
12. This guarantee applies to Grant Solar PV Systems installed on the UK mainland, Isle of Man and Channel Islands only. Provision of in-warranty cover elsewhere in the UK is subject to agreement with Grant Engineering (UK) Ltd.

* 2 years warranty for Mastervolt Soladin 600 inverter only

EFFICIENT HEATING SOLUTIONS

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