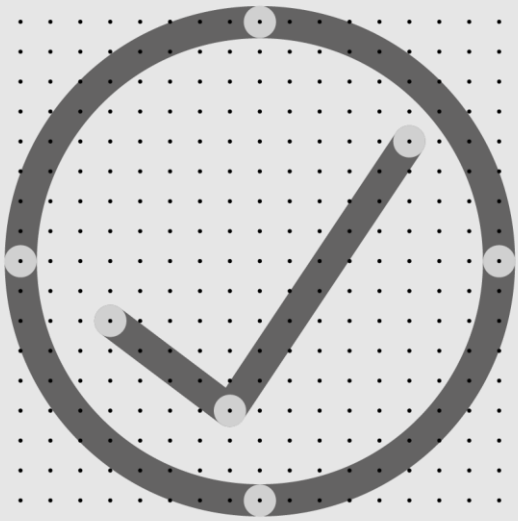
STANDARDS DOCUMENT

MIS 3002 ISSUE 4.0

The Solar PV Standard

(Installation)



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Giving you confidence in home-grown energy

With energy costs constantly rising and climate change affecting us all, low-carbon technology has a bigger and bigger role to play in the future of UK energy.

We're here to ensure it's a positive one.

Working with industry we define, maintain and improve quality – certifying products and installers so people can have confidence in the low-carbon technology they invest in. From solar and wind, to heat pumps, biomass and battery storage, we want to inspire a new generation of home-grown energy, fit for the needs of every UK home and community.

About

The Microgeneration Certification Scheme Service Company Ltd (MCSSCo Ltd) trades as MCS and is wholly owned by the non-profit MCS Charitable Foundation. Since 2007, MCS has become the recognised Standard for UK products and their installation in the small-scale renewables sector.

We create and maintain standards that allow for the certification of products, installers and their installations. Associated with these standards is the certification scheme, run on behalf of MCS by Certification Bodies who hold UKAS accreditation to ISO 17065.

MCS certifies low-carbon products and installations used to produce electricity and heat from renewable sources. It is a mark of quality. Membership of MCS demonstrates adherence to these recognised industry standards; highlighting quality, competency and compliance.

Vision

To see MCS certified products and installations in every UK home and community.

Mission

To give people confidence in low-carbon energy technology by defining, maintaining and improving quality.

Values

1. We are expert – ensuring quality through robust technical knowledge
2. We are inspiring – helping to reshape energy in UK homes and communities
3. We are collaborative – working with industry and government to create positive change
4. We are principled – operating in a way that's clear, open and fair
5. We are determined – supporting the UK's drive towards a clean energy future

CHANGES TO STANDARDS

When MCS Standards are revised, the issue number is also revised to indicate the nature of the changes. This can either be a whole new issue or an amendment to the current issue. Details will be posted on the website at www.mcscertified.com

Technical or other significant changes which affect the requirements for the approval or certification of the product or service will result in a new issue. Minor or administrative changes (e.g. corrections of spelling and typographical errors, changes to address and copyright details, the addition of notes for clarification etc.) may be made as amendments.

The issue number is given on the left of the decimal point, and the amendment number on the right. For example, issue 3.2 indicates that it is the third significant version of the document which has had two sets of minor amendments.

Users of this Standard should ensure that they are using the latest issue.

Issue No.	Amendment Details	Date
1.0	First Publication	
2.0	Update to metering and handover with regards to MCS Certificates and the MID	26/08/2010
3.0	Significant Update introducing PV Guide	07/02/2013
4.0	Significant Update introducing IET Code	16/09/2020

FOREWORD

This document contains references to other documents which may be either normative or informative. At the time of publication any editions of those documents, where indicated, were valid. However, as all documents are subject to revision, any users of this document should apply the most recent editions of those referenced documents (unless a dated version is specified).

This issue 4.0 is a significant update to issue 3.5. It is available for reference from the date of publication (16/09/2020). MCS Contractors certified in accordance with MIS 3002 **may** start working in accordance with this update from the date of publication. Compliance with this update is mandatory for MCS Contractors certified in accordance with MIS 3002 from the date of implementation (16/03/2021).

This Standard describes the MCS requirements for the assessment, approval and listing of contractors undertaking the supply, design installation, set to work, commissioning and handover of solar photovoltaic (PV) microgeneration systems by Accredited Certification Bodies. The listing and approval is based on evidence acceptable to the certification body:

- that the system or service meets the Standard
- that the contractor has staff, processes and systems in place to ensure that the system or service delivered meets the Standard
- And on:
- periodic audits of the contractor including testing as appropriate
- compliance with the contract for the MCS listing and approval including agreement to rectify faults as appropriate

This Standard shall be used in conjunction with the scheme document MCS 001 and any other guidance and supplementary material available on the MCS website specifically referring to this Standard (MIS 3002).

NOTES:
This MCS Installation Standard makes use of the terms 'must', 'shall' and 'should' when prescribing certain requirements and procedures. In the context of this document:

- the term 'must' identifies a requirement by law at the time of publication;
- the term 'shall' prescribes a requirement or procedure that is intended to be complied with in full and without deviation;
- the term 'should' prescribes a requirement or procedure that is intended to be complied with unless reasonable justification can be given.

Compliance with this MCS Installation Standard does not in itself confer immunity from legal obligations.

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1 PURPOSE & SCOPE

This Standard specifies the requirements for MCS Contractors undertaking the supply, design, installation, set to work, commissioning and handover of solar photovoltaic (PV) systems supplying permanent buildings and normally connected in parallel to the electricity distribution network up to a maximum DC output of 50kWp.

2 DEFINITIONS

Refer to MCS 001 for definitions.

3 REQUIREMENTS OF THE MCS CONTRACTOR

3.1 CAPABILITY

3.1.1 MCS Contractors shall have the competency (see Section 8) and capacity to undertake the supply, design, installation, set to work, commissioning and handover of solar PV Microgeneration systems.

3.1.2 Where MCS contractors do not engage in the design or supply of solar PV systems, but work solely as a MCS Contractor for a client who has already commissioned a system design; then the MCS Contractor shall be competent to review and verify that the design would meet the design requirements set out in this Standard and this should be recorded.

3.2 ORGANISATION

3.2.1 MCS Contractors shall organise themselves using policies, procedures and systems which meet the minimum requirements in MCS001 to ensure every solar PV installation meets this Standard.

Note: MCS001 includes requirements for Quality Management System, Consumer Care, Personnel, Continual Improvement, External Documents, Software Control, Customer Requirements, Contracts, Subcontracting, Purchasing, Test and Measurement Equipment, Product Handling, Training and Competence, all of which can affect the quality of installed systems.

4 PRE-SALE INFORMATION

4.1 PERFORMANCE ESTIMATION

4.1.1 An estimate of the annual total generation of the system shall be calculated using the methodology given in Appendix B.

4.1.2 An estimate of self-consumption shall be calculated in accordance with MGD 003: "Determining the Electrical Self-Consumption of Domestic Solar Photovoltaic (PV) Installations with and without Electrical Energy Storage". Systems outside of the scope of MGD 003 shall use a method for calculating self-consumption that is no less valid than that in MGD 003.

4.1.3 The estimates calculated in accordance with 4.1.1 and 4.1.2 shall be communicated to the customer in the prescribed format accompanied by the following text:

"Important Note: The performance of solar PV systems is impossible to predict with certainty due to the variability in the amount of solar radiation (sunlight) from location to location and from year to year. This estimate is based upon the standard MCS procedure is given as guidance only for the first year of generation. It should not be considered as a guarantee of performance.

The solar PV self-consumption has been calculated in accordance with the most relevant methodology for your system. There are a number of external factors that can have a significant effect on the amount of energy that is self-consumed so this figure should not be considered as a guarantee of the amount of energy that will be self-consumed."

4.1.4 Where the shade factor (SF) is less than 1 (i.e. shading is present) the following additional note shall accompany the above Important Note:

Where the MCS methodology is used:

"Shading will be present on your system that will reduce its output to the factor stated. This factor was calculated using the MCS shading methodology and we believe that this will yield results within 10% of the actual energy estimate stated for most systems"

Where another methodology is used:

"Shading will be present on your system that will reduce its output to the factor stated. This factor was NOT calculated using the MCS shading methodology, but we can confirm that the system as quoted, taking into account the shading present, will deliver at least 90% of the energy (in kWh) as set out in this performance estimate"

4.1.5 Where the site has been evaluated remotely, the following additional note shall accompany the above important note:

"This system performance calculation has been undertaken using estimated values for array orientation, inclination or shading. Actual performance may be significantly lower or higher if the characteristics of the installed system vary from the estimated values."

4.1.6 The results of the performance estimate shall be given in the format of the following table:

A. Installation data		
Installed capacity of PV system – kWp (stc)		kWp
Orientation of the PV system – degrees from South		°
Inclination of system – degrees from horizontal		°
Postcode region		
B. Performance calculations		
kWh/kWp (Kk) from table		kWh/kWp
Shade Factor (SF)		
Estimated annual output (kWp x Kk x SF)		kWh
C. Estimated PV self-consumption – PV Only		
Assumed occupancy archetype	Home all day/ Home half day/ Out all day	
Assumed annual electricity consumption, kWh		kWh
Assumed annual electricity generation from solar PV system, kWh		kWh
Expected solar PV self-consumption (PV Only)		kWh
Grid electricity independence / Self-sufficiency (PV Only)		%
D. Estimated PV self-consumption – with EESS		
Assumed usable capacity of electrical energy storage device, which is used for self-consumption, kWh		kWh
Expected solar PV self-consumption (with EESS)		kWh
Grid electricity independence / Self-sufficiency (with EESS)		%

Notes:

Where no EESS is being installed with the solar PV then section D in the above table can be omitted.

Where occupancy archetype is not known (e.g. new build) then both sections C & D in the above table can be omitted (or marked as N/A).

4.1.7 Where self-consumption is quoted with an electrical energy storage system (EESS) it shall be made clear if the MCS Contractor is **not** certified in accordance with MIS 3012.

4.1.8 Additional estimates may be provided using an alternative methodology, including proprietary software packages, but:

a) such estimates shall clearly describe and justify the approach taken and factors used
b) they shall not be given greater prominence than the standard MCS estimate
c) they shall be accompanied by warning text stating that it should be treated with caution if it is significantly better than the result given by the standard method.

4.2 MINIMUM TECHNICAL INFORMATION

4.2.1 As a minimum, the following technical information shall be communicated in writing to the customer at or before the point that the contract is awarded:

a) The result of the performance estimate calculated in accordance with section 4.1
b) Manufacturer's datasheet for the proposed solar modules
c) Manufacturer's datasheet for the proposed inverter
d) Manufacturer's datasheet for the Module Level Power Electronics Device, if applicable
e) Manufacturer's datasheet for the proposed EESS, if applicable
f) A drawing with the proposed module layout
g) The Sunpath diagram used to calculate SF (where SF<1.0 and the MCS methodology is used)
h) Any other requirements stipulated by RECC (if applicable)

4.2.2 For multi-building/system projects (e.g. new-housing developments) items e), f) and g) above can be omitted from the information communicated in writing to the customer.

5 DESIGN & INSTALLATION REQUIREMENTS

5.1 LEGISLATION

5.1.1 All applicable legislation and directives must be met in full.

Note: the legislation which applies may be different in England, Wales, Scotland and Northern Ireland.

5.1.2 MCS Contractors shall ensure, and be able to demonstrate, that they are aware of all current applicable legislation.

5.1.3 MCS Contractors shall make their customers aware of all permissions and approvals required for the installation.

5.1.4 The MCS Contractor shall ensure the building is assessed by a competent professional experienced in solar photovoltaic systems to ensure that it is suitable for the installation and, by undertaking the proposed works, the building's compliance with the Building Regulations (in particular those relating to energy efficiency) is not compromised.

5.1.5 Suitable and sufficient risk assessments shall be conducted before any work on site commences.

Note: The installation of PV systems presents a unique combination of hazards – due to risk of electric shock, falling and simultaneous manual handling difficulty. All of these hazards are encountered as a matter of course on a building site, but rarely all at once. While roofers may be accustomed to minimising risks of falling or injury due to manual handling problems, they may not be used to dealing with the risk of electric shock. Similarly, electricians would be familiar with electric shock hazards but not with handling large objects at heights.

5.1.6 Where work is undertaken that is notifiable under the Building Regulations it shall be made clear to the customer who shall be responsible for this notification.

5.1.7 Where responsible for notification under the Building Regulations, the MCS Contractor shall ensure notification has been completed prior to handing over the installation.

Note: Where notification under the Building Regulations is to be undertaken by others (e.g. the developer of a new-build project) then it is permissible for the MCS Contractor to handover the installation immediately following commissioning.

Self-certification, in lieu of building control approval, is only permitted where installation and commissioning is undertaken by an entity registered with a Competent Persons Scheme (CPS) approved by the relevant government department for the scope of work being undertaken. Further details can be found at http://www.competentperson.co.uk.

5.1.8 The MCS Contractor must ensure the installation is compliant with the Electrical Safety, Quality and Continuity Regulations 2002 and, in accordance with Regulation 22(2)(c), must follow the technical requirements and procedures:

- In Engineering Recommendation (EREC) G98 for installations up to and including 16 A per phase
- In EREC G99 for installations exceeding 16 A per phase
- In EREC G100 where the export of power is to be limited

5.1.9 Notification to the Distribution Network Operator (DNO) in accordance with the procedures set out in EREC G98 or EREC G99 (full or fast-track process as appropriate) shall be undertaken by the MCS Contractor.

Note: the 16 A per phase threshold is the total aggregated AC output of all generators. For example, a 3kW solar PV system and a 3kW electrical energy (battery) storage system are connected in parallel to the same single-phase AC supply, gives a combined maximum theoretical output greater than 16 A. In this case EREC G99 applies.

5.2 STANDARDS AND INDUSTRY PRACTICES

5.2.1 Solar PV systems shall be designed and installed in accordance with the latest edition of the IET Code of Practice for Grid Connected Solar Photovoltaic Systems – hereafter referred to as the Code of Practice – and sections 5.3 to 5.8 below (inclusive).

5.2.2 For a particular installation, should a conflict arise between specific requirements, then the latest version of BS 7671 shall take precedence.

Note: particular attention is drawn to Part 7-712 Requirements for special installations or locations – Solar photovoltaic (PV) power supply systems.

5.2.3 All references in both this Standard, and the Code of Practice, to Harmonized Standards listed in the Official Journal of the European Union for demonstration of conformity to relevant legislation shall be read as a version of that standard listed in the current Official Journal of the European Union, or any replacement standard should that standard have been removed from the Journal.

5.2.4 All references in both this Standard, and the Code of Practice, to other national or international standards shall be read as the latest version of that national or international standard, or any superseding standard should the standard be withdrawn.

5.2.5 References in the Code of Practice to EREC G83, shall be read as the latest version of EREC G98.

5.2.6 References in the Code of Practice to EREC G59, shall be read as latest version of EREC G99.

5.3 MANUFACTURER'S INSTRUCTIONS

5.3.1 All equipment should be installed in accordance with its manufacturer's instructions.

5.3.2 Where the manufacturer's instructions conflict with the requirements of this Standard then the requirements of this Standard take precedence unless it can be proven that system performance, safety and durability are no worse than if the requirements of this Standard are followed.

5.4 EQUIPMENT CERTIFICATION AND LISTING

5.4.1 The solar PV modules installed shall be certified according to MCS005 or MCS017 for Bespoke Building Integrated Modules and listed under the MCS (http://www.mcscertified.com).

5.4.2 Solar PV systems mounted above, or integrated into, pitched roofs shall utilise products tested and certified according to MCS012 Pitched Roof Installation Kits.

5.4.3 All components used to mount the system shall be specifically approved to work together unless described by the manufacturer as universally compatible with other manufacturers' components.

5.4.4 Where mounting systems are certified or listed using a named PV module or modules then only those modules shall be used.

5.4.5 Where there are no MCS 012 certified mounting systems suitable for a given installation, a custom designed mounting system may be used subject to the following being met:

a) The system is compliant with current Building Regulations for weather-tightness, fire and wind resistance.
b) The system designer and/or fixing supplier must confirm in writing that the final installation is in accordance with a) above and its instructions.

5.4.6 All installed equipment:

a) Shall be fit for its purpose in the installation.
b) Has completed the conformity assessment process and is appropriately marked by a Notified Body in compliance with the relevant legislation.

Note: for example this means the CE mark but could change as the UK leaves the EU.

5.5 DESIGN AND INSTALLATION

5.5.1 All work under this Standard work shall be carried out:

a) with adequate and proper materials which
   i) are appropriate for the circumstances in which they are used,
   ii) are adequately mixed or prepared, and
   iii) are applied, used or fixed so as adequately to perform the functions for which they are designed; and
b) in a workmanlike manner.

5.5.2 Module layout should allow access for maintenance and emergency services.

Note: The larger the installation the more care is required and the Solar Trade Association is developing comprehensive guidance on this subject. Consideration should be given to:

- *the provision of access/walkway around the perimeter of the array*
- *arranging larger arrays into smaller blocks with access corridors between*
- *the provision of permanent protection over fragile roof elements such as skylights*
- *the provision and type of permanent access ladders*

5.5.3 PV array DC plug and socket connectors should be protected from water ingress for the lifetime of the system.

Note: For example, connectors should not be installed in such a way that they could stand in any permanent or regularly occurring bodies of water. Raising the connector out of the water, locating the connector away from a potential body of water and installing a drip-loop are all measures that should be considered where practicable.

5.5.4 PV array DC plug and socket connectors shall be assembled with the correct tools and procedures to minimise the risk of failure.

Note: use of incorrect tools for crimping and assembling of DC connectors has been identified as a significant contributing factor to connection failure and even fires.

5.5.5 The appropriate Ingress Protection (IP) rating of all components shall be maintained for the location.

Note: for external installations in particular this will require cable entry into the bottom of enclosures, use of a drip-loop, and a single cable per gland.

5.5.6 Solar PV systems shall not be connected to the AC output of any form of voltage management device without consent of the DNO.

Note: See clause 7.6 in EREC G98 or 7.7 in EREC G99.

5.5.7 Where present, any arc fault detection function within the inverter shall be enabled.

5.5.8 The cables used for the AC circuit shall be sized to minimise voltage drop as far as is reasonably practicable.

Note:

When calculating the voltage drop the reference points are between the "Service Head" (suppliers cut out) and the AC input terminals of the inverter.

Minimising voltage drop is important both to optimise system performance (reducing losses) and to prevent inverters nuisance-tripping due to over-voltage.

For most domestic small scale installations a voltage drop of 1% is considered practicable, whereas for larger systems and/or those with long cable runs, up to 3% may be more practicable.

5.6 METERING & COMMUNICATION

Metering

5.6.1 A means of recording and displaying the total AC generation of the system shall be installed.

5.6.2 If required for billing and / or payment purposes, the means of recording AC generation of the system shall be a meter approved under the European Measuring Instruments Directive (MID) showing the serial number on the front panel where it could be photographed alongside the make, model and meter reading.

Note: Installation of a MID approved meter would also satisfy clause 5.6.1.

5.6.3 The means of recording AC generation, be it a dedicated meter or otherwise, should be accessible and readable by the customer without requiring the use of a tool, ladder or torch.

5.6.4 Where energy is taken from the grid to be stored in an EESS and later returned to the grid or installation, that energy shall not affect the veracity of any meters recording energy generated, imported or exported where those meters are used for billing or payment.

Note: An example would include the meter recording total generation of the solar PV system where the recorded energy is used for payment of financial incentives such as the Feed-in Tariff. Any error in that reading could cause a claim for payment to be inaccurate and fraudulent. For the avoidance of doubt this clause allows for the correct recording by the supply meter of the energy taken from the grid to be stored in the EESS.

Examples of different metering arrangements which do and do not satisfy this clause are given in the Ofgem document: Guidance for generators: Co-location of electricity storage facilities with renewable generation supported under the Renewables Obligation or Feed-in Tariff schemes.

Data, Communication & Security

5.6.5 A means of notifying the customer within 48 hours of the system ceasing to operate, or beginning to operate abnormally, should be provided.

Note: The installation of a MID approved meter installed in accordance with clause 5.6.3 could satisfy this requirement.

5.6.6 The data privacy and security of the site's home area network shall be maintained. Where the installation comprises of any internet connected devices:

- The device's network access credentials (username & passwords) shall be updated in consultation with the customer
- Relevant components in the Solar PV system should comply with the technical specification ETSI Technical Specification 103 645 Cyber Security for Consumer Internet of Things.

5.6.7 For installations requiring local area network, home area network, and/or internet access in commercial and industrial premises, permission shall be obtained from those responsible for the client organisation's information technology and information security policies and procedures.

5.7 SAFETY AND DURABILITY

5.7.1 The MCS contractor shall be able to demonstrate that the installation of the modules has not affected the fire performance of the roof.

Note: This can be demonstrated by:

a) Mounting above an existing non-combustible roof covering (pitched roofs)
b) Where in-roof (forming the main roof covering) using an in-roof kit with the appropriate fire performance rating for the proposed location of the array. See Appendix C for a worked example and guidance on fire classification relevant to distance from boundaries reproduced from Approved Document B applying in England & Wales.

5.7.2 The MCS Contractor shall advise the consumer on any additional measures that may be beneficial to the performance and durability of the system in relation to the protection from:

a) Flora
b) Fauna.

Note: For example, lichen, tree sap, nesting birdlife etc.

5.8 SITE SPECIFIC ISSUES

5.8.1 PV systems should not adversely affect the weather tightness or structural integrity of the building to which they are fitted. The system should be designed and installed to ensure this is maintained for the life of the system.

5.8.2 Where the existing roof covering is under warranty, then the roof warranty provider should be consulted to establish if warranties will be invalidated by the installation.

5.8.3 Where any existing warranty may be invalidated by the proposed installation, the MCS Contractor shall notify the customer in writing and obtain explicit written agreement from the customer if the installation is to proceed.

Note: a clause in the MCS Contractor's standard terms & conditions would not satisfy this requirement.

<u>Installation on pitched roofs</u>

Pitched roofs are defined as those with an angle greater than 10° but less than 70° to the horizontal.

5.8.4 The MCS Contractor shall ensure that the roof structure is checked by a suitably competent person to ensure it can withstand the loads imposed by the solar PV system.

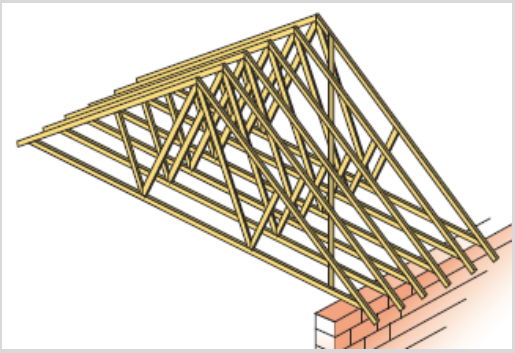
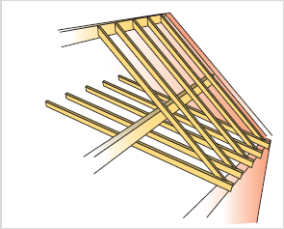
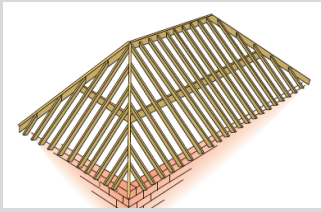
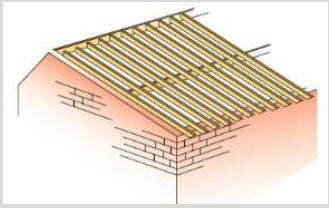
5.8.5 For the typical roof structure types shown in Table 1, the calculation methodologies given should be used.

5.8.6 Where the roof structure is in any way unusual, or there is any doubt whatsoever, a **qualified structural engineer** shall be consulted.

Note: An unusual roof structure would include any that:

- *Is not shown in the* Table 1
- *Shows signs of structural distress*
- *Shows signs of post construction modification (e.g. removal of timbers, notching, change of roof covering to a heavier material),*
- *Where the roof pitch is particularly shallow (i.e. less than 30° to the horizontal)*
- *The roof design has increased potential for snow build-up (e.g. dormers, valleys, parapets etc)*

Table 1

Diagram	Construction Type of Roof	Typical Methodologies
Roof constructed from Timber Trussed Rafters 		Method 1: Assuming a typical **design dead load** of 0.785kN/m^2, deduct the load of the existing roof covering to give the maximum allowable residual load available for the solar array.
		Method 2 (not generally applicable where the roof pitch exceeds 60°): Assuming a typical **design imposed load** of 0.75kN/m^2, deduct the likely snow load for the location taken from Eurocode-1 (BS EN 1991-1) to give the maximum allowable residual load available for the solar array.
	Traditional cut roofs constructed from timber rafters/purlins - gable ended	Calculate the maximum dead load for the rafters and purlins using the timber research and development association (TRADA) Span tables; deduct the load of the existing roof covering to give the maximum allowable residual load available for the solar array.
	Traditional cut roofs constructed from timber rafters/purlins – with hips and/or valleys	Consult a structural engineer
	Asymmetric duo-pitched roofs constructed from rafters and purlins	Consult a structural engineer

5.8.7 Solar PV modules should not be mounted within 400mm from any edge of a domestic roof unless specific measures are taken to:

- Resist the increased wind uplift forces in the edge zone through additional fixings and, where necessary, additional roof timbers for those fixings
- Ensure ridge-tiles remain secure
- Ensure rainwater run-off patterns are not affected
- Ensure build-up and shedding of snow cannot cause injury or property damage

- Reduce nuisance from wind noise

5.8.8 Where necessary to ensure rooftiles or slates are not displaced creating gaps greater than those pre-existing the installation, then those tiles or slates shall be notched or flashed as appropriate.

5.8.9 When screw-fixing brackets directly to metal roof cladding the roof-sheet thickness shall be checked to ensure that it is compatible with the fixing bracket and screws and it can withstand the additional wind uplift introduced by the solar PV system.

5.8.10 The fixing of the metal roof cladding to the main roof structure shall be checked to ensure that it is capable of transferring the imposed and wind uplift loads introduced by the solar PV system.

Installation on flat roofs

5.8.11 Flat roofs are defined as those with an angle less than 10° to the horizontal.

5.8.12 For mechanically fixed systems:

a) When fixing to an existing solid deck (e.g. concrete, brick or similar), a condition survey should be carried out and pull out tests undertaken.
b) Where it is not possible to reliably calculate the pull-out value, for example, concrete roof or where the roof build-up is not possible to ascertain the roof structure from the survey, pull out tests should be undertaken in accordance with the technical guidance published by the Single Ply Roofing Association "Site pull-out test protocol for flat roofs" (S15-19).

5.8.13 For ballasted systems:

c) the pressure coefficients shall be taken from BRE digest 489 or from recognised test data commissioned for the specific purpose of determining the wind loads on solar systems.
d) a protection/slip layer shall be used which is confirmed as compatible with the waterproofing layer(s).
e) the calculation of resistance to sliding for ballasted mounting systems shall use a co-efficient of friction of 0.3 unless the material combination (including slip layer) has been tested in accordance with Appendix D in which case the test results shall be used.
f) where installed on granular substrates (e.g. gravel or green roofs) the calculation of resistance to sliding shall use a test value in accordance with Appendix D or shall be mechanically restrained against sliding (see note).
g) the wind resistance calculation shall declare the coefficient of friction used and where the coefficient of friction is greater than 0.3 the value should be evidenced by a test report.
h) A qualified structural engineer shall be consulted to ensure the roof is able to withstand the imposed load from both the solar PV system and the proposed ballast.

Note: Methods to mechanically restrain the system against sliding include the installation of a kerb in front of the PV systems or to use tether cables attached to an appropriate fixed point on the roof.

6 COMMISSIONING & HANDOVER

6.1 COMMISSIONING

6.1.1 The solar PV system shall be commissioned according to a documented procedure to ensure that the system is safe, has been installed in accordance with the requirements of this Standard and the manufacturers' requirements, and is operating correctly in accordance with the system design.

6.1.2 The system shall be inspected and tested in accordance with Section 16 of the Code of Practice except 16.4.

Note: For information, suitable test and verification reports from BS EN 62446-1 are reproduced in Appendix E with the permission of BSI.

6.2 DOCUMENTATION & LABELLING

6.2.1 MCS Contractors shall collate a comprehensive document pack which, as a minimum, includes:

- Copies of all forms and checklists used to commission the system
- The maintenance requirements and maintenance services available (see clause 7)
- Manufacturer user manuals and warranty details.
- Any documentation or checklists required for any incentive schemes
- Any additional information as detailed in Section 17 of the Code of Practice

6.3 HANDOVER

6.3.1 At the point at which the solar PV system is handed over to the client, the documentation as detailed in 6.2.1 shall be provided and explained along with a document signed by the MCS Contractor containing at least the following:

- A declaration, signed by the MCS Contractor's on-site representative, confirming that the installation meets the requirements of this Standard
- Client name and address
- Site address (if different)
- MCS Contractor's name, address, contact details etc.
- List of the key components installed
- The estimation of system performance calculated according to Section 4
- Recommended interval for the first periodic inspection
- MCS contact details (helpline telephone number and email address)

Note: See Appendix E for a model handover document

6.3.2 No later than 10 working days after commissioning, the installation shall be registered by the MCS Contractor on the MCS Installation Database (MID) and an MCS Certificate generated.

6.3.3 The MCS Certificate shall be sent to the customer with instruction to include it within the handover pack.

6.3.4 The generation of the certificate shall be undertaken in full compliance with the terms and conditions of use of the MID[1] and the registration of the system on the MID shall be undertaken only after the system has been fully installed and commissioned and not before.

6.3.5 A "per installation" fee is levied on MCS Contractors for each registration added to the database. Details of any such fee will be advised from time to time through MCS Certification Bodies.

7 MAINTENANCE

7.1 A maintenance schedule including the checks to be undertaken and their frequency is given in Appendix F according to building type/occupancy.

7.2 **The maintenance checks suggested along with their frequency are advisory only** and include:

- Customer checks (visual only)
- An intermediate maintenance visit by an MCS Contractor
- A full maintenance visit with more involved tests requiring specialist equipment, again by an MCS Contractor.

Note: The actual checks required, and how frequent, will be dependent upon system size, the use/occupancy of the building, and ease of roof access along with specific requirements of the customer and any other stakeholders such as insurers.

7.3 As a minimum, handover documents shall include the checks customers should carry out themselves, the recommended frequency of those checks, and what to do if any issues are identified.

[1] The terms and conditions of use can be found on the MCS Installation Database website.

8 ROLES & COMPETENCY

8.1 All personnel involved in the design and / or installation of Solar PV systems, either employed by or subcontracted to the MCS Contractor, shall be competent, skilled or instructed for the activities they undertake.

8.2 Complete records of training and / or qualifications demonstrating the required competencies shall be maintained by the MCS Contractor, in particular:

- Design personnel - Shall be able to demonstrate a thorough technical knowledge of the technologies involved and the interaction of associated technologies and be able to deliver a compliant design to the requirements of this Standard.
- Installation personnel – Shall be able to demonstrate an adequate level of technical knowledge and installation skills, to install systems to the specified designed in accordance with the requirements of this Standard, applicable codes of practice, manufacturer's instructions and Statutory Regulations.

Note: As a minimum MCS Contractors should have personnel with demonstrable training and / or experience of solar photovoltaic systems in accordance with the requirements of this Standard. Entry level qualifications as shown in Appendix A, may be deemed as suitable for simple non-complex systems.

9 REGIONAL OFFICES

Where the MCS Contractor wishes to design and commission under the Certification Scheme in regional offices, then these offices shall meet the requirements of this Standard to be eligible for Certification.

10 PUBLICATIONS, REFERENCE AND FURTHER READING

10.1 The below lists are provided so that MCS Contractors know which documents have been used as a basis for the development of the requirements of this MIS standard and they are able to further research topics if they need to do so.

10.2 It is a scheme requirement for MCS Contractors to own at least one copy of the following documents in each office or regional office undertaking design and commissioning work:

- BS 7671:2018 Requirements for Electrical Installations (IET Wiring Regulations Eighteenth Edition). Available from British Standards Institution (BSI): www.bsi-global.com or The Institution of Engineering and Technology (IET): www.theiet.org/publications/
- IET Code of Practice for Grid Connected Solar Photovoltaic Systems (IET publication ISBN 978-1-84919-721-2 Paperback, 978-1-84919-722-9 Electronic)

- Engineering Recommendation G99 Issue 1 – Amendment 1 published May 2018 - 'Requirements for the connection of generation equipment in parallel with public distribution networks on or after 27 April 2019'
- Engineering Recommendation G98 Issue 1 – Amendment 1 published May 2018 - 'Requirements for the connection of Fully Type Tested Micro-generators (up to and including 16 A per phase) in parallel with public Low Voltage Distribution Networks on or after 27 April 2019'
- Engineering Recommendation G100 Issue 1 – Amendment 2 May 2018 - 'Technical Requirements for Customer Export Limiting Schemes'
- MCS 001 - MCS - Contractors certification scheme document.

10.3 It is not a scheme requirement for MCS Contractors to own, or have immediate access to, the following documents unless this MIS standard does not adequately cover off the aspects required.

- MGD 003: Determining the Electrical Self-Consumption of Domestic Solar Photovoltaic (PV) Installations with and without Electrical Energy Storage
- MGD 005: Solar PV Shade Evaluation Procedure
- BRE Digest 489 Wind loads on roof-based photovoltaic systems.
- BRE Digest 495 Mechanical installation of roof-mounted photovoltaic systems.
- BS EN 50549-1:2019 Requirements for generating plants to be connected in parallel with distribution networks. Connection to a LV distribution network. Generating plants up to and including Type B
- BS EN 1991-1-1:2002 Eurocode 1. Actions on structures. General Actions. Densities, self-weight, imposed loads for buildings.
- BS EN 13374:2013+A1 Temporary edge protection systems. Product specification. Test methods.
- BS EN 62446-1:2016+A1:2018 Photovoltaic (PV) systems. Requirements for testing, documentation and maintenance. Grid connected systems. Documentation, commissioning tests and inspection.
- BS EN 10088-1:2005 Stainless steels. List of stainless steels.
- BS EN 12975-2:2006 Thermal solar systems and components – Solar collectors – Part 2 Test methods.
- BS EN ISO 14713-1:2017 Zinc coatings. Guidelines and recommendations for the protection against corrosion of iron and steel structures. General principles of design and corrosion resistance.
- ETSI TS 103 645 Cyber Security for Consumer Internet of Things.
- Ofgem: Guidance for generators: Co-location of electricity storage facilities with renewable generation supported under the Renewables Obligation or Feed-in Tariff schemes (version 2).
- MIS 3012 – MCS – The Battery Standard
- IET Code of Practice for Electrical Energy Storage Systems (IET publication ISBN 978-1-78561-278-7 Paperback, 978-1-78561-279-4 Electronic)
- Single Ply Roofing Association "Site pull-out test protocol for flat roofs" (S15-19).

APPENDIX A – ENTRY LEVEL QUALIFICATIONS

The following courses and qualifications can help demonstrate competency but a single qualification should not be presumed to prove an individual competent for all situations.

Level 3 Award in the Installation and Maintenance of Small Scale Solar Photovoltaic Systems (IMSSSPV) – LCL Awards

Level 3 Award in the Installation and Maintenance of Small Scale Solar Photovoltaic Systems – BPEC

Level 3 Award in the Installation of Small Scale Solar Photovoltaic Systems (2399-11) – City & Guilds

Level 3 Award in the Installation and Maintenance of Small Scale Solar Photovoltaic Systems (2399-12) – City & Guilds

APPENDIX B – PERFORMANCE ESTIMATION METHOD

SITE EVALUATION

Inclination, orientation and shading are the three main site factors that influence the performance of a PV system. While drawings, maps or photos are a suitable means to determine inclination and orientation, an accurate estimation of any shade effects will typically require a site visit.

In some circumstances (e.g. for a new build multi-dwelling development), data may need to be estimated or taken remotely.

Where the site has been evaluated remotely, the MCS Contractor shall at all times make the customer aware if the performance of the system may be demonstrably different as a result of any site-based factors that later become apparent and not originally taken into account. Any such variations shall be notified to the client and dealt with accordingly.

STANDARD ESTIMATION METHOD

The approach is as follows:

1) Establish the electrical rating of the PV array in kilowatts peak (kWp)
2) Determine the postcode region
3) Determine the array pitch
4) Determine the array orientation
5) Look up kWh/kWp (Kk) from the appropriate location specific table
6) Determine the shading factor of the array (SF) according to any objects blocking the horizon

The estimated annual electricity generated (AC) in kWh/year of installed system shall then be determined using the following formula:

Annual AC output (kWh) = kWp x Kk x SF

Where:

kWp of Array (kWp)

The kWp value used shall be the sum of the data plate value (Wp at STC) of all modules installed (the value printed on the module label).

Postcode Zone

Determine the postcode zone of the site from the map and the table below. Once this has been obtained, you will be able to select the correct table for the kWh/kWp (Kk) values to be selected.

Note: These zones are the same as the SAP postcode zones

Figure 1: Postcode zones

Postcode	Region	Postcode	Region	Postcode	Region	Postcode	Region
AB	16	G	14	N	1	SK	7E
AL	1	GL	5E	NE	9E	SK13	6
B	6	GU	1	NG	11	SK17	6
BA	5E	GU11-12	3	NN	6	SK22-23	6
BB	7E	GU14	3	NP	5W	SL	1
BD	11	GU28-29	2	NPS	13	SM	1
BD23-24	10	GU30-35	3	NR	12	SN	5E
BH	3	GU46	3	NW	1	SN7	1
BL	7E	GU51-52	3	OL	7E	SO	3
BN	2	HA	1	OX	1	SP	5E
BR	2	HD	11	PA	14	SP6-11	3
BS	5E	HG	10	PE	12	SR	9E
BT	21	HP	1	PE9-12	11	SR7-8	10
CA	8E	HR	6	PE20-25	11	SS	12
CB	12	HS	18	PH	15	ST	6
CF	5W	HU	11	PH19-25	17	SW	1
CH	7E	HX	11	PH26	16	SY	6
CH5-8	7W	IG	12	PH30-44	17	SY14	7E
CM	12	IP	12	PH49	14	SY15-25	13
CM21-23	1	IV	17	PH50	14	TA	5E
CO	12	IV30-32	16	PL	4	TD	9S
CR	1	IV36	16	PO	3	TD12	9E
CT	2	KA	14	PO18-22	2	TD15	9E
CV	6	KT	1	PR	7E	TF	6
CW	7E	KW	17	RG	1	TN	2
DA	2	KW15-17	19	RG21-29	3	TQ	4
DD	15	KY	15	RH	1	TR	4
DE	6	L	7E	RH1-20	2	TS	10
DG	8S	LA	7E	RH77	2	TW	1
DH	10	LA7-23	8E	RM	12	UB	1
DH4-5	9E	LD	13	S	11	W	1
DL	10	LE	6	S18	6	WA	7E
DN	11	LL	7W	S32-33	6	WC	1
DT	3	LL23-27	13	S40-45	6	WD	1
DY	6	LL30-78	13	S49	6	WF	11
E	1	LN	11	SA	5W	WN	7E
EC	1	LS	11	SA14-20	13	WR	6
EH	15	LS24	10	SA31-48	13	WS	6
EH43-46	9S	LU	1	SA61-73	13	WV	6
EN	1	M	7E	SE	1	YO	10
EN9	12	ME	2	SG	1	YO15-16	11
EX	4	MK	1			YO25	11
FK	14	ML	14			ZE	20
FY	7E						

Table 2

kWh/kWp Value (Kk)

Tables of kWh/kWp (Kk) values for each postcode zone are available for download from the MCS website. They provide kWh/kWp values for the zone in question for 1° variations of inclination (pitch) and 5° variations of orientation.

Note: This data has been provided by the European Commission, Joint Research Centre. The data is drawn from the Climate-SAF-PVGIS dataset and multiplied by 0.8.

Orientation

The orientation of the array is to be measured or determined from plan. The required value is the azimuth angle of the PV modules relative to due South. Hence, an array facing due south has an azimuth value of 0°; an array facing either SW or SE has an azimuth value of 45°; and an array facing either East or West has an azimuth value of 90°.

The azimuth value is to be rounded to the nearest 5°.

Inclination

The inclination (or pitch) of the array is to be measured or determined from plan. The required value is the degrees from horizontal. Hence, an inclination of 0° represents a horizontal array; 90° represents a vertical array.

The inclination value is to be rounded to the nearest 1°.

Shade Factor (SF)

Where there is an obvious clear horizon and no near or far shading, the assessment of SF can be omitted and an SF value of 1.00 used in all related calculations.

Otherwise, determine likely losses due to shade using a suitable method such as that described in MGD005 where SF shall be calculated using the following formula:

1 – Estimated Loss = 0.XX

For example, where it is estimated that losses due to shade will be 11% then:

SF = 1 – 0.11 = 0.89

Alternative methodologies to that described in MGD005 shall only be used when it can be demonstrated that they are equivalent to or better than the MCS methodology in MGD005.

Where alternative methodologies are used then SF may have to be derived. Where using proprietary software then one way of doing this would be to model system generation both with and without the obstacles causing shade thus:

$$SF = \frac{\text{Annual Generation with shade}}{\text{Annual Generation without shade}}$$

APPENDIX C – FIRE RATING WORKED EXAMPLE

Approved Document B (2019 edition) applicable in England & Wales provides the following table:

Table 12.1 Limitations on roof coverings

Designation[1] of covering of roof or part of roof	Distance from any point on relevant boundary			
	Less than 6m	At least 6m	At least 12m	At least 20m
B_{ROOF}(t4)	●	●	●	●
C_{ROOF}(t4)	○	●	●	●
D_{ROOF}(t4)	○	●(2)(3)	●(2)	●
E_{ROOF}(t4)	○	●(2)(3)	●(2)	●(2)
F_{ROOF}(t4)	○	○	○	●(2)(3)

● Acceptable.

○ Not acceptable.

NOTES:

Separation distances do not apply to the boundary between roofs of a pair of semi-detached dwellinghouses and to enclosed/covered walkways. However, see Diagram 5.2 if the roof passes over the top of a compartment wall.

Polycarbonate and uPVC rooflights that achieve a class C-s3, d2 rating by test may be regarded as having a B_{ROOF}(t4) designation.

1. The designation of external roof surfaces is explained in Appendix B.
2. Not acceptable on any of the following buildings.
   a. Dwellinghouses in terraces of three or more dwellinghouses.
   b. Any other buildings with a cubic capacity of more than 1500m^3.
3. Acceptable on buildings not listed in (1) if both of the following apply.
   a. Part of the roof has a maximum area of 3m^2 and is a minimum of 1500mm from any similar part.
   b. The roof between the parts is covered with a material rated class A2-s3, d2 or better.

A developer wants to install solar panels onto a pair of semi-detached houses which has a cubic capacity of 1000m^3 and bounded on three sides by other properties and the fourth by a road as shown in the diagram. The relevant boundaries are with the adjoining properties and the centre-line of the road.

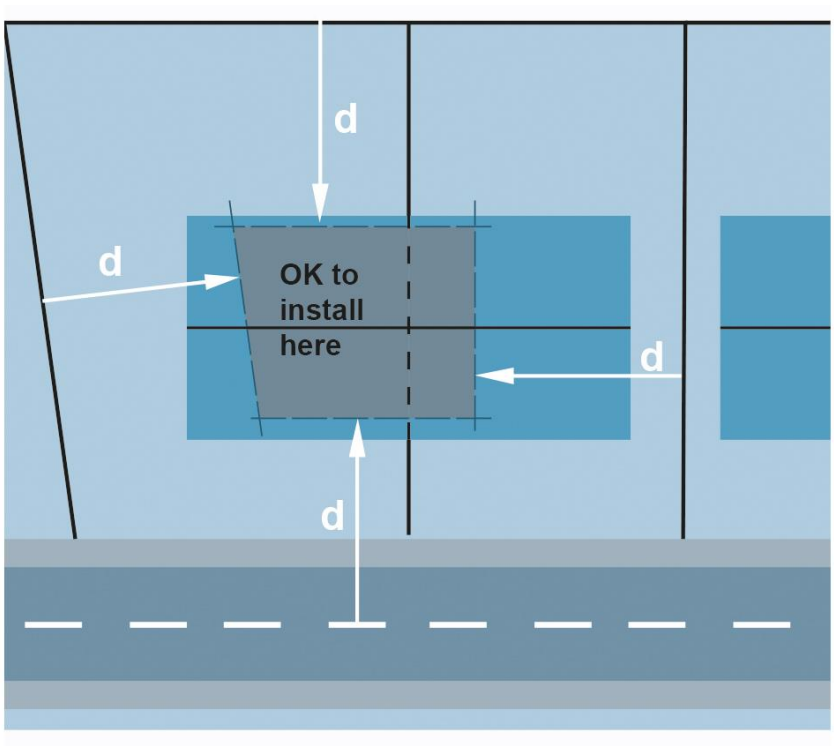


Figure 2

1. B_{roof} rated solar kit - the solar panels can be installed anywhere and in any amount of roof covering.
2. C_{roof} rated solar kit - the panels can be installed within a bounded area with the distance d ≥ 6m.
3. D_{roof} and E_{roof} rated solar kit – the panels can be installed within a bounded area with the distance (because in this example footnote 2 in the table is satisfied):
    a. d ≥ 6m and < 12m provided that the panels are installed in areas no bigger than 3m^2 with a gap of 1.5m covered with tiles between areas which themselves have a classification no less than A2-s3, or d2 or
    b. d ≥ 12m
4. F_{roof} rated solar kit – the panels can be installed as in point 3b. above but within a bounded area with the distance d ≥ 20m

APPENDIX D – ESTABLISHING THE COEFFICIENT OF FRICTION

Principle of the Test

A horizontal force is applied to a specified weight resting on a level platform – see Figure 3. The applied force is steadily increased until the specified weight starts to move. The horizontal force required to initiate movement is used in calculating the coefficient of static friction between the weight and the level platform.

Apparatus

- A plate A: 300 mm long × 100 mm wide and with the necessary thickness to be representative of the material to be tested.
- A block of mass 50 kg which can be supported on the plate A.
- A platform surfaced with the material B with the necessary thickness to be representative of the material to be tested.

Procedure

Support the platform surfaced with B horizontally and level to within ± 0.5 degrees. Prevent movement of the platform in the direction of the applied force. Place the plate A on the platform and load it with the 50 kg block.

Apply the horizontal force F to the 50 kg block in increments of 50 N (see Figure 3) as close as possible to the underside of the plate A. Perform the test in both wet and dry conditions and the coefficient of friction declared is the lower of the two.

Test records

Record the force at which the specified weight moves at least 10 mm along the platform.

Evaluation of test records

The coefficient of static friction, μ, shall be calculated for each test using the equation:

$$\text{Coefficient of static friction, } \mu = F / (M + m) \times g \quad \text{(A.1)}$$

Where:
F = force in Newton
M = mass 50 kg
m = mass of the plate
g = 9.81 ms^{-2}

Calculate the arithmetic average of μ from a minimum of four tests. This average value shall be taken as the characteristic coefficient of static friction, μ, between the plate A and the surface B.

EN 13374:2004 (E)

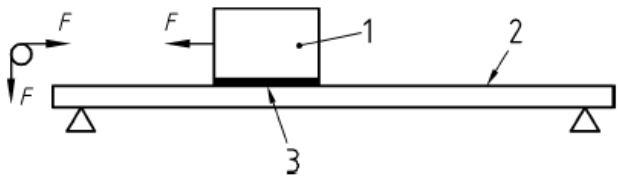


Figure 3: Test to establish coefficient of friction

Key

- 1 Kentledge on upper plate
- 2 Lower surface
- 3 Upper surface as a plate

APPENDIX E – COMMISSIONING TEMPLATES

The following are adapted from Annexes A and C from BS EN 62446-1 with permission from BSI

Model Handover Document

PV System Verification Certificate	☐ Initial verification ☐ Periodic verification

Client	
Installation Address	
Test Date	

Description of installation (key components installed)	
Rated power (kW DC)	
Location	
Estimated system performance	
Circuits tested	

Contractor's name and address	
MCS Contact	Telephone: 0333 103 8130 Email: hello@mcscertified.com

IEC 60364-6 inspection report reference	
IEC 60364-6 test report reference	
PV array inspection report reference:	
PV array test report reference:	

DESIGN, CONSTRUCTION, INSPECTION AND TESTING

I/we being the person(s) responsible for the design, construction, inspection and testing of the electrical installation (as indicated by the signatures below), particulars of which are described above, having exercised reasonable skill and care when carrying out the design, construction, inspection and testing, hereby certify that the said work for which I/we have been responsible is, to the best of my/our knowledge and belief, in accordance with MCS Installation Standard MIS 3002.

Signature(s): Name(s): Date: (The extent of liability of the signatory(s) is limited to the work described above)	Next inspection recommended after not more than:	Years
	Comments:	

Model PV array test report

PV System Verification Certificate	☐ Initial verification ☐ Periodic verification

Installation address	Reference:
	Date:
Description of work under test	Inspector:
	Test Instruments:

String	String reference	1	2	3	4		n
	Module						
	Quantity						
Array parameters (as specified)	V_{oc} (STC)						
	I_{sc} (STC)						
String overcurrent protection device	Type						
	Rating (A)						
	DC rating (V)						
	Capacity (kA)						
String wiring	Type						
	Phase CSA (mm^2)						
	Earth CSA (mm^2)						
String test	V_{oc} (STC)						
	I_{sc} (STC)						
	Irradiance						
Polarity check							
Array Insulation resistance	Test Voltage (V)						
	Pos – Earth (MΩ)						
	Neg – Earth (MΩ)						
Earth continuity (where fitted)							
Array Isolator	Rating (A)						
	Rating (V)						
	Location						
	Functional check						
Inverter	Make and model						
	Serial number						
	Functional check						

Comments:

APPENDIX F – MAINTENANCE SCHEDULE

	Customer	MCS Contractor	
		Intermediate	Full
Visual check of modules from ground level (check for slipped modules, damage, soiling etc)	✓	✓	✓
Visual check of inverter where safe access (check for indication of fault or damage)	✓	✓	✓
Recorded generation is increasing	✓	✓	✓
Visual check for signs of structural distress (Particularly after heavy winter snow)	✓	✓	✓
Reduce shading from vegetation growth where possible	✓	✓	✓
AC & DC isolators (Functional check, damage and ingress)		✓	✓
DC junction boxes where present (Damage and ingress)		✓	✓
Integrity of fuses and surge protectors where present		✓	✓
Generation in line with prediction		✓	✓
Inverter(s) mounted securely		✓	✓
Inverter(s) ventilated (Unobstructed airflow, fans operating etc)		✓	✓
Externally mounted inverters free of signs of water ingress		✓	✓
Inverter fault log(s)		✓	✓
AC voltage at inverter(s) and assess risk of overvoltage		✓	✓
DC connectors (Secure, free of damage, supported away from pooling water)		✓	✓
Clean modules (Particularly where shallow pitch and dusty environment)		✓	✓
Test DC circuits (Vsc, Isc, Earth leakage)		✓	✓
Cables adequately supported and free of damage		✓	✓
All labelling & signage present and correct (Including system schematic)		✓	✓
Emergency shutdown procedure visible		✓	✓
Module clamps secure (Check torque of random sample)			✓
Mounting rails secure and free of distortion (Including fixing brackets)			✓
String series resistance test			✓
String insulation resistance test (Riso)			✓
Potential Induced Degredation test			✓
Thermographic survey for faulty components and module cells			✓

Frequency:			
Domestic Privately Owned	1yr	10yr	15yr
Domestic Rented (Private or Social landlord)	-	5yr	10yr
Public Building (e.g. school, hospital)	6-monthly	1yr	5yr
Commercial and Industrial	monthly	1yr	2yr

Note: the checks above, the categorisation of buildings and systems along with the frequency are advisory only. System size is also a factor such that larger systems may justify an increased frequency and smaller systems a reduced frequency.