Solar PV: observations and lessons learnt

Common errors and what to look for

Common errors on site

Labelling

DC wiring needs protection, clear labels and a wiring diagram in the property

Testing and commissioning

Evidence that a competent person tested the whole system

Safe isolation

Accessible AC and DC isolation, plus a documented shutdown procedure

Bird proofing

Removable mesh skirts around the array perimeter

Labelling: why DC wiring is different

It supports arcing

Where wiring is compromised, direct current sustains arcs, raising the risk of fires and faults

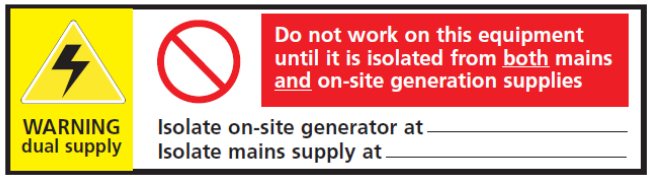
Higher voltages

DC runs are often at higher voltages

Hard to recognise

Smaller-diameter cabling isn't ordinarily recognisable as carrying current

Wiring must be protected as required and suitably labelled. A wiring diagram must also be in the property so electricians and other workers can identify the location and type of electrical system.



Testing and commissioning

THE ASSUMPTION

Solar is plug and play

To an extent it is, thanks to the connectors and components.

THE REALITY

It works as a system

Components and connections can fail or be damaged during installation.

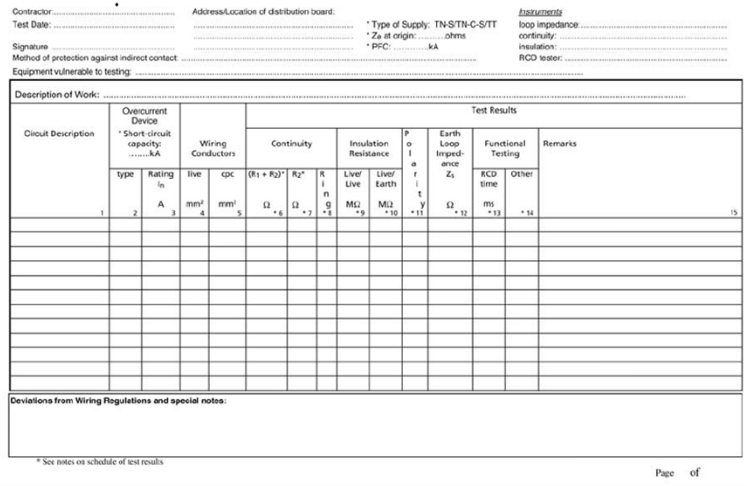
What we can do

- We can't know it is operating safely without testing and commissioning, a requirement of MCS
- We can't expect scheme managers to be electrical experts, but we can ask for evidence
- Evidence that a competent person operating under a CPS tested and commissioned the system

Testing and commissioning

What should be present?

- Electrical Inspection and Testing Certificates (including schedules), for both the AC and DC sides of the installation and the PV Arrays. Installation Check Sheet and Commissioning Test Sheets.
- Emergency Shutdown Procedures (should also be communicated to occupant)
- MCS Registration of the system
- Evidence of notification of the system to the DNO



Contractor: ..... Address/Location of distribution board: ..... Instruments

Test Date: ..... * Type of Supply: TN-S/TN-C-S/TT Loop impedance: .....

..... * Z_e at origin: .....ohms continuity: .....

Signature ..... * PFC: .....kA insulation: .....

Method of protection against indirect contact: ..... RCD tester: .....

Equipment vulnerable to testing: .....

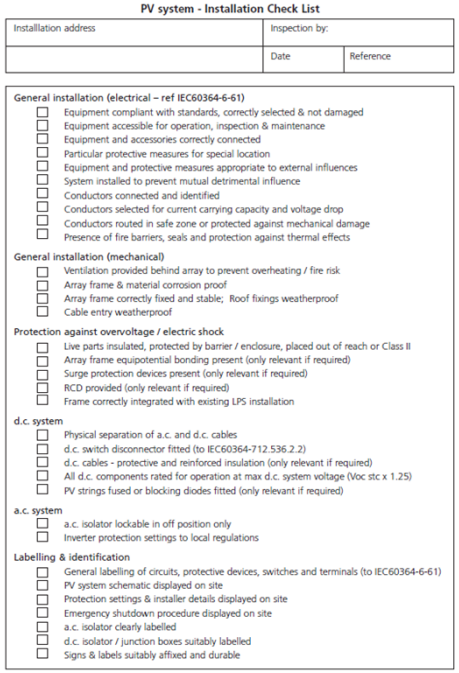
Description of Work: .....

Circuit Description	Overcurrent Device: * Short-circuit capacity: .....kA — type	Overcurrent Device — Rating I_n A	Wiring Conductors — live mm²	Wiring Conductors — cpc mm²	Test Results — Continuity — $(R_1 + R_2)$* Ω *6	Continuity — R_2* Ω *7	Continuity — Ring *8	Insulation Resistance — Live/Live MΩ *9	Insulation Resistance — Live/Earth MΩ *10	Polarity *11	Earth Loop Impedance Z_s Ω *12	Functional Testing — RCD time ms *13	Functional Testing — Other *14	Remarks 15
1	2	3	4	5										

Deviations from Wiring Regulations and special notes:

* See notes on schedule of test results

Page of



PV system - Installation Check List

Installation address	Inspection by:	
	Date	Reference

General installation (electrical – ref IEC60364-6-61)

- ☐ Equipment compliant with standards, correctly selected & not damaged
- ☐ Equipment accessible for operation, inspection & maintenance
- ☐ Equipment and accessories correctly connected
- ☐ Particular protective measures for special location
- ☐ Equipment and protective measures appropriate to external influences
- ☐ System installed to prevent mutual detrimental influence
- ☐ Conductors connected and identified
- ☐ Conductors selected for current carrying capacity and voltage drop
- ☐ Conductors routed in safe zone or protected against mechanical damage
- ☐ Presence of fire barriers, seals and protection against thermal effects

General installation (mechanical)

- ☐ Ventilation provided behind array to prevent overheating / fire risk
- ☐ Array frame & material corrosion proof
- ☐ Array frame correctly fixed and stable; Roof fixings weatherproof
- ☐ Cable entry weatherproof

Protection against overvoltage / electric shock

- ☐ Live parts insulated, protected by barrier / enclosure, placed out of reach or Class II
- ☐ Array frame equipotential bonding present (only relevant if required)
- ☐ Surge protection devices present (only relevant if required)
- ☐ RCD provided (only relevant if required)
- ☐ Frame correctly integrated with existing LPS installation

d.c. system

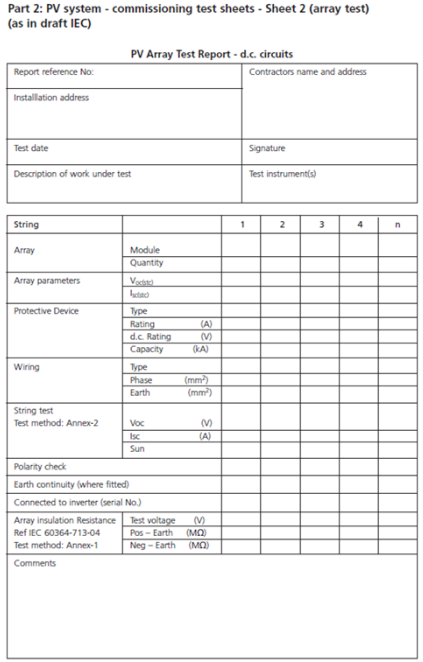
- ☐ Physical separation of a.c. and d.c. cables
- ☐ d.c. switch disconnector fitted (to IEC60364-712.536.2.2)
- ☐ d.c. cables - protective and reinforced insulation (only relevant if required)
- ☐ All d.c. components rated for operation at max d.c. system voltage (Voc stc x 1.25)
- ☐ PV strings fused or blocking diodes fitted (only relevant if required)

a.c. system

- ☐ a.c. isolator lockable in off position only
- ☐ Inverter protection settings to local regulations

Labelling & identification

- ☐ General labelling of circuits, protective devices, switches and terminals (to IEC60364-6-61)
- ☐ PV system schematic displayed on site
- ☐ Protection settings & installer details displayed on site
- ☐ Emergency shutdown procedure displayed on site
- ☐ a.c. isolator clearly labelled
- ☐ d.c. isolator / junction boxes suitably labelled
- ☐ Signs & labels suitably affixed and durable



Part 2: PV system - commissioning test sheets - Sheet 2 (array test) (as in draft IEC)

PV Array Test Report - d.c. circuits

Report reference No:	Contractors name and address
Installation address	
Test date	Signature
Description of work under test	Test instrument(s)

String		1	2	3	4	n
Array	Module					
	Quantity					
Array parameters	$V_{oc(stc)}$					
	$I_{sc(stc)}$					
Protective Device	Type					
	Rating (A)					
	d.c. Rating (V)					
	Capacity (kA)					
Wiring	Type					
	Phase (mm^2)					
	Earth (mm^2)					
String test Test method: Annex-2	Voc (V)					
	Isc (A)					
	Sun					
Polarity check						
Earth continuity (where fitted)						
Connected to inverter (serial No.)						
Array insulation Resistance Ref IEC 60364-713-04 Test method: Annex-1	Test voltage (V)					
	Pos – Earth (MΩ)					
	Neg – Earth (MΩ)					
Comments						

Safe isolation and bird proofing

Safe isolation

- A safe, accessible way to isolate both AC and DC supply from the inverter and panels
- A documented emergency shutdown procedure
- Explained to occupants and made available to them

Bird roosting and nesting

- Fit non-invasive mesh skirts around the array perimeter
- Clip-on systems attach to the panel frame, with no drilling or gluing
- Removable for servicing and widely used to avoid warranty issues

Inverters in lofts: best avoided

Not recommended

For a number of reasons, including accessibility for servicing.

The trade-off

Social housing providers benefit from having equipment in a separate space from the householder, but this must be balanced with the risks.

Nearly all

inspected installs under Warm Homes were missing one or more of the loft requirements that follow

If an inverter must go in the loft

1. **Non-combustible mounting**
   On gable brick or block, or a bespoke fire-resistant board (typically cementitious)
2. **Permanent access**
   Fixed walk boards from the hatch, noting these may compromise loft insulation
3. **Clearances and ventilation**
   Manufacturer clearances met; ventilated to avoid overheating and degraded performance
4. **Hard-wired smoke alarm**
   Linked to the main house system to notify the occupant of a fire
5. **Deployable safe isolation**
   A DC-side emergency procedure that the occupant can carry out

Hard-wired, linked smoke alarms



Pictured: a battery alarm that is not hard-wired or linked

REQUIRED

A hard-wired smoke alarm system, linked to the main house system, so the occupant is notified of a fire

WHAT NOT TO ACCEPT

A standalone battery alarm that is not hard-wired or linked gives the occupant no warning from the house system

Safe isolation: the DC side

If the DC side fails (the panels and wiring, outside and in the loft) the occupant needs a recognisable isolator switch and an emergency procedure they can carry out. If that switch is in the loft, two challenges arise:

1

Not readily accessible

Many social housing occupants may not be able to reach the loft alone, let alone cross it and find and operate the switch.

2

A risk to the tenant

If the smoke alarm is triggered, would you want a tenant entering a loft with a known fault or possible fire on the roof or in the roof space?

What do isolators look like?

The image below shows the AC and DC isolators positioned either side of the inverter. There are clear warning labels on the DC cabling and on the isolators themselves.



Ground level first

Locate the inverter at ground level, inside or outside

This overcomes the accessibility and isolation challenges and removes the other risks of a loft inverter. It should always be the priority.



Solar PV and storage heaters

A common misconception: that they combine well

Solar generation peaks in summer

When tenants need little or no heating

Heating demand peaks in winter

When solar generation is at its lowest

A flat is unlikely to have enough roof space to generate sufficient energy, and even a large battery is unlikely to overcome the seasonal mismatch in demand.

Tariffs and controls

Electric storage heaters are typically charged at night on a lower tariff, then release heat during the day.

The right tariff

It is really important that tenants are on the correct tariff

Systems that talk

Solar PV and storage heaters should 'talk' to each other, so electricity is used when it most benefits tenants financially

Battery storage: further considerations will be covered in a separate bulletin.

Other ‘starter’ resources

• On the MNZH pages of the AECL website there are some helpful ‘starter’ docs for PV:

https://www.andrewsenv.co.uk/docs-by-measure/

•Including:

- PV Top Tips:
  - Includes additional topics such as SEG, DNO Connections
- Top Tips for PV QA:
- MNZH PV Guide:

Questions