



TESTING AND COMMISSIONING FORM OF GRID- CONNECTED PHOTOVOLTAIC SYSTEMS

SOLAR SYSTEM ABOVE 30kWAC

Note: This document is prepared by referring to SEDA's procedure for Testing and Commissioning of Grid-Connected Photovoltaic Systems in Malaysia.

TESTING AND COMMISSIONING FORM

A. CUSTOMER INFORMATION

Name: _____ Contact No: _____

SESCO Contract Account No: _____ Email address: _____

GCPV Installation Address: _____

B. SOLAR PV INSTALLATION DETAILS

Date of Inspection: / / until / / (dd/mm/yyyy)

Time Start: : AM/PM Time Complete: : AM/PM

Date of completion of Installation: / / (dd/mm/yyyy)

Import meter reading (kWh) at pre-comm session:

Export meter reading (kWh) at pre-comm session:

Remarks

Large empty area for entering remarks.

TESTING AND COMMISSIONING FORM

C. CHECKLIST FOR GENERAL INSPECTION

Instructions: This form shall be filled-up for each sub-array connected to one inverter.

Inverter ID:

Sub-array ID:

Note: If the job has been done satisfactory, please tick “/” in the box ; If not applicable, write “N/A” in the box.

Part 1C : General

- | | | |
|--------|---|--------------------------|
| i. | All necessary safety equipment are available at the site | <input type="checkbox"/> |
| ii. | Array frame correctly fixed and stable | <input type="checkbox"/> |
| iii. | All cable entries are weather proof | <input type="checkbox"/> |
| iv. | PV module location, perimeter, gate, control room & switch yard, plant internal road location as per approved layout drawing. | <input type="checkbox"/> |
| v. | Components comply with standards and are selected as per design & not damaged | <input type="checkbox"/> |
| vi. | Equipment accessible for inspection, operation & maintenance | <input type="checkbox"/> |
| vii. | Equipment & accessories are connected as per approved drawing | <input type="checkbox"/> |
| viii. | Protective measures for special locations have been addressed (if applicable) | <input type="checkbox"/> |
| ix. | Equipment & protective measures are appropriate to external influence | <input type="checkbox"/> |
| x. | System installed to prevent mutual detrimental influence | <input type="checkbox"/> |
| xi. | All cables are identified and connected as per approved drawing | <input type="checkbox"/> |
| xii. | All cables are selected for current carrying capacity and voltage drop as per approved design | <input type="checkbox"/> |
| xiii. | Conductors routed are in safe zone or protected against mechanical damage | <input type="checkbox"/> |
| xiv. | All tagging are appropriate. | <input type="checkbox"/> |
| xv. | All signages are appropriate. | <input type="checkbox"/> |
| xvi. | All relevant documents are available. | <input type="checkbox"/> |
| xvii. | Emergency procedure displayed at site. | <input type="checkbox"/> |
| xviii. | PV system schematic displayed at site. | <input type="checkbox"/> |

Part 2C : DC Side

- | | | |
|------|---|--------------------------|
| i. | Adequate physical separation of AC, DC & communication cables. | <input type="checkbox"/> |
| ii. | All DC components are sized for rated operation at maximum DC system voltage. | <input type="checkbox"/> |
| iii. | All DC cables are meant for solar PV applications and as per design document. | <input type="checkbox"/> |
| iv. | PV string fuse or DC breaker are available in the combiner boxes. | <input type="checkbox"/> |

Part 3C : Protection Against Over-voltage & Electric Shock

- | | | |
|------|---|--------------------------|
| i. | Live parts are insulated and protected by barrier/enclosure, placed out of reach. | <input type="checkbox"/> |
| ii. | Surge protection devices are available. | <input type="checkbox"/> |
| iii. | External lightning protection system is available. | <input type="checkbox"/> |
| iv. | PV frame grounding correctly integrated with existing installation. | <input type="checkbox"/> |

Part 4C : AC Side

- | | | |
|-----|--|--------------------------|
| i. | Inverter protection setting as per local regulation (labelling & identification mark) | <input type="checkbox"/> |
| ii. | Protection setting by installers displayed at site (maximum current, range of voltage and frequency) | <input type="checkbox"/> |

Comments:

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TESTING AND COMMISSIONING FORM

D. CHECKLIST FOR PV MODULE MOUNTING STRUCTURE & CIVIL FOUNDATION

Note: If the job has been done satisfactory, please tick “/” in the box ; If not applicable, write “N/A” in the box.

- | | | |
|-------|--|--------------------------|
| i. | Mounting structure and jointing materials as per approved drawing. | <input type="checkbox"/> |
| ii. | Foundation dimensions as per approved drawing. | <input type="checkbox"/> |
| iii. | Switch yard civil foundation as per approved drawing. | <input type="checkbox"/> |
| iv. | The material for structure has corrosion proof coating (check for availability of factory test certificate). | <input type="checkbox"/> |
| v. | Structures are correctly fixed at specific tilt and orientation as per design document. | <input type="checkbox"/> |
| vi. | No crack found in the foundation and/or mounting structure. | <input type="checkbox"/> |
| vii. | Structures are designed based on the maximum wind load of the location (check for availability of structure engineer certificate). | <input type="checkbox"/> |
| viii. | No rust (for steel) or discoloration (for aluminium) found in the structure materials (e.g. frame, clamp, bolt and nuts, etc.). | <input type="checkbox"/> |
| ix. | Water drainage is available. | <input type="checkbox"/> |

E. CHECKLIST FOR DC JUNCTION BOX OR STRING MONITORING BOX

Note: If the job has been done satisfactory, please tick “/” in the box ; If not applicable, write “N/A” in the box.

- | | | |
|-------|---|--------------------------|
| i. | DC Junction/String Monitoring Box connection diagram is available at the inside of the cover. | <input type="checkbox"/> |
| ii. | Wiring is as per approved schematic. | <input type="checkbox"/> |
| iii. | String fuses or DC circuit breakers are available. | <input type="checkbox"/> |
| iv. | Metal casings are earthed as per design document. | <input type="checkbox"/> |
| v. | All boxes are properly fixed at appropriate locations as per design document. | <input type="checkbox"/> |
| vi. | Surge protections devices are available inside the box as per design document. | <input type="checkbox"/> |
| vii. | Box and related component & insulation rating based on maximum DC voltage. | <input type="checkbox"/> |
| viii. | Boxes for outdoor use should be suitably rated based on Malaysia climate. | <input type="checkbox"/> |

F. CHECKLIST FOR EARTHING AND LIGHTNING ARRESTOR

Note: If the job has been done satisfactory, please tick “/” in the box ; If not applicable, write “N/A” in the box.

- | | | |
|------|---|--------------------------|
| i. | Earthing location as per approved drawing. | <input type="checkbox"/> |
| ii. | Earthing conductor properly connected to metal parts of all structures. | <input type="checkbox"/> |
| iii. | All array frames (for framed modules) and structures are earthed and bonded properly. | <input type="checkbox"/> |
| iv. | Earthing & lightning arrestor are installed as per design document. | <input type="checkbox"/> |

G. CHECKLIST FOR PV MODULE INSPECTION

Note: If the job has been done satisfactory, please tick “/” in the box ; If not applicable, write “N/A” in the box.

- | | | |
|------|--|--------------------------|
| i. | PV modules are fixed on the structure as per design drawing. | <input type="checkbox"/> |
| ii. | PV modules are properly levelled on the structure. | <input type="checkbox"/> |
| iii. | PV modules conform to relevant IEC standards as per design document. | <input type="checkbox"/> |
| iv. | Inter-module connectors are properly crimped & securely connected. | <input type="checkbox"/> |
| v. | PV modules are connected with correct polarity. | <input type="checkbox"/> |
| vi. | Non-metallic isolator is present between each PV module frame & structure.
(if they are made from different metals) | <input type="checkbox"/> |
| vii. | Installation of PV modules are done as per manufacturer’s guidelines. | <input type="checkbox"/> |

Comments:

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H. CHECKLIST FOR INVERTER INSPECTION

Note: If the job has been done satisfactory, please tick “/” in the box ; If not applicable, write “N/A” in the box.

- | | | |
|-------|---|--------------------------|
| i. | Inverter is installed as per manufacturer’s guideline. | <input type="checkbox"/> |
| ii. | Sufficient ventilation is available around the inverter (as per manufacturer’s guideline). | <input type="checkbox"/> |
| iii. | Inverter conforms to relevant IEC standards (or equivalent) as per design document. | <input type="checkbox"/> |
| iv. | Inverter unit is properly fastened to floor/wall surfaces. | <input type="checkbox"/> |
| v. | Inverter is properly earthed. | <input type="checkbox"/> |
| vi. | Inverter incoming/outgoing cables are properly tagged. | <input type="checkbox"/> |
| vii. | Inverter incoming/outgoing cables are properly connected as per drawing. | <input type="checkbox"/> |
| viii. | The connections for phase sequence L1, L2 & L3 are in proper order (for three phase inverters). | <input type="checkbox"/> |
| ix. | The connections for L and N are in proper order (for single phase inverters). | <input type="checkbox"/> |
| x. | Inverter for outdoor use shall be suitable rated based on Malaysia climate. | <input type="checkbox"/> |
| xi. | Gap maintained between power cables and signal cables routing as per design document. | <input type="checkbox"/> |
| xii. | The auxiliary power cables are connected properly. | <input type="checkbox"/> |
| xiii. | All cable terminations are done properly. | <input type="checkbox"/> |
| xiv. | Proper labelling of all the cables and components are done. | <input type="checkbox"/> |
| xv. | Inverter factory settings are as per local utility guidelines. | <input type="checkbox"/> |

I. CHECKLIST FOR AC DISTRIBUTION BOX

Note: If the job has been done satisfactory, please tick “/” in the box ; If not applicable, write “N/A” in the box.

- | | | |
|-------|---|--------------------------|
| i. | ACDB is properly mounted as per design document. | <input type="checkbox"/> |
| ii. | Sufficient free space available around each ACDB. | <input type="checkbox"/> |
| iii. | ACDB is properly earthed as per design document (if applicable). | <input type="checkbox"/> |
| iv. | The connections for phase sequence L1, L2 & L3 are in proper order (for three phase inverters). | <input type="checkbox"/> |
| v. | The connections for L and N are in proper order (for single phase inverters). | <input type="checkbox"/> |
| vi. | Incoming/outgoing cables are properly connected as per approved schematic diagram. | <input type="checkbox"/> |
| vii. | All cable terminations are done properly. | <input type="checkbox"/> |
| viii. | Proper tagging of all cables and components are done. | <input type="checkbox"/> |
| ix. | All cable glands are properly secured & tightened. | <input type="checkbox"/> |
| x. | Boxes for outdoor use shall be suitably rated based on Malaysia climate. | <input type="checkbox"/> |

J. CHECKLIST FOR CABLE IDENTIFICATION AND CABLE ROUTING INSPECTION

Note: If the job has been done satisfactory, please tick “/” in the box ; If not applicable, write “N/A” in the box.

- | | | |
|------|---|--------------------------|
| i. | All cable routed areas are properly marked on the ground. | <input type="checkbox"/> |
| ii. | All power cable route & locations are as per drawing. | <input type="checkbox"/> |
| iii. | All cables are properly tagged. | <input type="checkbox"/> |
| iv. | All DC cables are meant for solar PV applications and as per design document. | <input type="checkbox"/> |
| v. | Cable caution tape is used for all underground cables as per design document. | <input type="checkbox"/> |
| vi. | All trunking and conduits are installed as per design document. | <input type="checkbox"/> |

Comments:

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N. ISOLATION DEVICE FUNCTIONAL TEST

Note: Testing Point is at All Isolator, Switches and Fuses.

Instructions: 1- **Switch Off / Disconnect** PV AC Main Switch (Isolator), All AC Switches, All DC Switches and All DC Fuses.
2- Solar irradiance should be at least **350Wm⁻²** when performing this test.

No.	Description	Accept	Reject	Note
		Please Tick "/" in the box.		
1	Confirm voltage is NOT present at array cable terminal at AJB before all fuses are engaged.			
2	Confirm voltage is present at array cable terminal at AJB after all fuses are engaged.			
3	Confirm voltage is NOT present at the outgoing terminal of PV DC Main Switch when the switch is in OFF position.			
4	Confirm voltage is present at the outgoing terminal of PV DC Main Switch when the switch is in ON position.			
5	Confirm voltage is NOT present at the outgoing terminal of AC Switch when the switch is in OFF position.			
6	Confirm voltage is present at the outgoing terminal of AC Switch when the switch is in ON position.			
7	Confirm voltage is NOT present at the outgoing terminal of PV AC Main Switch when the switch is in OFF position.			
8	Confirm voltage is present at the outgoing terminal of PV AC Main Switch when the switch is in ON position.			

Comments:

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O. INFORMATION ABOUT PV MODULE

Number of Panel Installed		Capacity		Check	NA
No.	ITEM	DETAILS		Please Tick “/” in the box.	
1	Module Manufacturer & Model				
2	Power at Maximum Power Point (Pmp_stc)		Wp		
3	Open Circuit Voltage (Voc_stc)		V		
4	Short Circuit Current (Isc_stc)		A		
5	Fill factor at STC		-		
6	Module efficiency at STC		%		
7	Temperature coefficient for Pmp (at STC)		% per deg C		
8	Temperature coefficient for Voc (at STC)		% per deg C		
9	Temperature coefficient for Isc (at STC)		% per deg C		
10	Maximum System Voltage		V		
11	Maximum Reverse Current		A		

O1. INFORMATION ABOUT PV ARRAY

Note: This form shall be filled-up for each connection to each inverter.

		Inverter No.			Check	NA
No.	ITEM	DETAILS		Please Tick “/” in the box.		
1	No. of modules per string		pcs			
2	Total no. of strings		pcs			
3	Total array power at STC		Wp			
4	PV array inclination		deg			
5	PV array orientation (azimuth angel from South)		deg			
6	No. of strings per Array Junction Box/String Monitoring Box		pcs			
7	No. of Array Junction Box/String Monitoring Box		pcs			

Comments:

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P. INFORMATION ABOUT INVERTER

Note: This form shall be filled-up for each connection to each inverter.

Number of Inverter Installed		Capacity		Check	NA	
No.	ITEM	DETAILS			Please Tick "/" in the box.	
1	Inverter Manufacturer & Model					
2	Inverter Type (Single Phase or Three Phase)					
3	AC/DC Ratio					
4	Nominal AC Power Rating				W	
5	Maximum AC Power Rating				W	
6	Maximum DC Voltage				V	
7	DC Voltage Range				V	
8	MPPT Voltage Range				V	
9	No. of MPPT Trackers				unit	

P1. INVERTER FUNCTIONAL TEST

Note: Testing must be done to all installed inverter.

Instructions: 1- **Switch ON** the system and ensure that the inverter is operating.
2- Solar irradiance should be at least **350Wm⁻²** when performing this test.

CAUTION : Before switching on the inverter, make sure Voc measured at the inverter input terminal must be LESS THAN the maximum allowable input DC voltage of the inverter.

		Inverter No.		Accept	Reject	Reasons
No.	Description	Value		Please Tick "/" in the box.		
1	Check whether the measured DC voltage falls within the allowable MPPT voltage range of the inverter.					
2	Check whether the measured grid voltage and frequency are within the acceptable limit.					
3	Anti-Islanding Functional Test (Inverter Turn OFF when grid voltage is not present or outside the operating range.)	Disconnection Time	sec			
		Reconnection Time	min			

Comments:

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R. PERFORMANCE RATIO TEST

Using the logged data for one day during the reliability test period, determine the following parameters for the entire system:

1. Energy Yield, Y_f
2. Specific Yield, SY
3. Perfl

$$PR = \frac{Y_f}{\eta_{mod} \times A_{PV} \times H}$$

η_{mod} = is efficiency of module (decimal)

A_{PV} = is area of array (m²)

H = solar irradiation (kWh/m²)

ACCEPT if

- PR is greater than or equal to 0.8

Note: 1. Testing point is at Monitoring Station/Grid Injection Point.

2. Inverter failure **shall NOT occur more than once (1)** within the reliability test period of one day (excluding forced outages). If this happens, the test should be repeated.

3. If the PR Test is passed the first day, it is **not** necessary to continue to the second day.

During the Performance Ratio (PR) test, the following real time parameters must be sampled at a maximum of **five-minute** intervals for **AT LEAST ONE COMPLETE daylight beginning one hour before sunrise and ending at least one hour after sunset**:

1. Solar irradiance
2. Ambient temperature
3. Module temperature
4. DC voltage of each central inverter or group of string inverters
5. DC current of each central inverter or group of string inverters
6. AC voltage from each central inverter or group of string inverters
7. AC current from each central inverter or group of string inverters

Measurements Result

Day no.	Energy Yield (kWh)	Specific Yield (kWh kWp ⁻¹)	Performance Ratio (AR)	Accept	Reject	Remarks
				Please Tick “/” in the box.		
1						
2						
3						
4						
5						
6						
7						
One Week Value						

Comments:

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S. POWER QUALITY - HARMONICS *(The requirement is specific in Section 6.1 Grid Performance Characteristics)*

Harmonic	50% of rated output	100% of rated output	Limit in Engineering Recommendation G5/5 (in %)
	Measured value in %	Measured value in %	
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
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S1. POWER QUALITY – FLICKER *(The requirement is specific in Section 6.1 Grid Performance Characteristics)*

Test Start Date:				
Test End Date:				
Test Location:				
Description	50%		100%	
	Short Term Flicker	Long Term Flicker	Short Term Flicker	Long Term Flicker
Measured Value				
Limit set under Engineering Recommendation P28				

T. VOLTAGE DETAILS

Description	RED Phase		YELLOW Phase		BLUE Phase	
	V	%	V	%	V	%
Steady State Voltage Measurement (30mins)						
Step Voltage Change During Energization						
Step Voltage Change During Disconnection						
Voltage Unbalance Measurement (30mins)						

U. VOLTAGE PROTECTION AND FREQUENCY PROTECTION TEST *(The is specific in Section 6.1 Grid Performance Characteristics)*

Function	Setting		Trip Test		Limit		Pass / Fail
	Frequency (Hz)	Time Delay	Frequency (Hz)	Time Delay	Setting	Time Delay	
UnderVoltage Stage 1					-13%	2.5s	
UnderVoltage Stage 2					-20%	0.5s	
Overvoltage Stage 1					13%	2.5s	
Overvoltage Stage 2					20%	0.5s	
Underfrequency Stage 1					47.5Hz	9.0s	
Underfrequency Stage 2					47Hz	0.25s	
Overfrequency Stage 1					51.5Hz	2.0s	
Overfrequency Stage 2					52Hz	0.25s	

V. PROTECTION RECONNECTION TIMER

- Test should prove that the reconnection sequence starts after a minimum delay of 2 minutes for restoration of volage and frequency to within stage 1 setting

Description	Check on no reconnection when voltage or frequency is brought to just outside Stage 1 limits					
	Single Phase		Three Phase		Frequency	
	192V	288V	332V	498V	47Hz	52Hz
Time delay setting						
Measured delay						

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W. Self Monitoring Solid State Switching For Inverter

Description	Yes or No
It has been verified that in the event of the solid state switching device failing to disconnect the PV solar, the voltage on the output side of the switching device is reduced to value below 50V within 0.5 seconds	

X. Fault Level Contribution (from OEM Datasheet)

Parameter	Symbol	Value
Peak Short Circuit Current	i_p	
Initial Symmetrical Short-Circuit Current	I_k	
Decaying (aperiodic) component of short-circuit current	i_{DC}	
Reactance / Resistance Ratio of source	X/R	

Y. Testing and Commissioning Acceptance

We, the undersigned, hereby declare and confirm that all information provided in this Testing and Commissioning Form is true, accurate, and complete, and has been submitted in full compliance with the requirements of the MS1837 and the associated IEC standards stipulated within it, Net Energy Metering (NEM) Guideline or Self-Consumption (SELCO) Guideline and Electricity (State Grid Code) Rules 2003.

We further affirmed that the installed PV system has been tested and verified, and is in full compliance with all applicable power quality standards and requirements as outlined in the NEM guidelines or SELCO guideline, thus the system is considered passed and safe to be energized.

We acknowledge and accept that the installed system shall not cause any disturbance, interference, or adverse impact to adjacent customers or Syarikat SESCO Berhad (SESCO) grid network. SESCO reserves the right to disconnect the Grid-Connected Photovoltaic (GCPV) system or the electricity supply to the premises in the event of any safety concerns, interference with other customers, or disruption to SESCO's supply network.

We accept full responsibility for any discrepancies, inaccuracies, misrepresentations, or non-compliance arising from the submitted information or the performance of the installed system.

Furthermore, we agree that SESCO shall not be held liable for any indirect, incidental, punitive, exemplary, special, or consequential damages, including but not limited to loss of profits or revenue, business interruption, loss of use or goodwill, data loss, corruption or deletion (or failure to delete), or costs of substitute goods, arising from any discrepancies, inaccuracies, misrepresentations, or non-compliance related to the submitted information or the performance of the installed system.

Signature and Stamp	
Date	
Name	
Designation	Tested by EIU Certified GCPV Designer