**Solar Electric Technician (Level 2)**

**Module 3: Measurement of electrical and solar parameter**

**E5: Assignment - Measurement of power**

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| **E5: ASSIGNMENT MEMO** | |
| **Date** | …. |
| **To** | Participants |
| **From** | Trainers |
| **Subject** | Measure current at different points of solar PV system as mentioned in the question sheet below and compare and analyse the findings. |
| **What** | Study the measurement of power. |
| **Why** | The objective of the assignment is to perform the power measurement including:   * Power output of individual panel. * Power output of series connected solar array. * AC power output of inverter. * Power delivered to solar array to battery bank. * Power loss * Efficiency |
| **How** | 1. Individual or group work of 2 or 4. 2. Gather the required tools and equipment. 3. Read and carefully follow the instructions for each given task carefully and perform the task. 4. Some tasks are provided with notes to assist participants for tallying the measured value or results. 5. Record the findings, measured values, and any observations during the test. 6. After completing the assigned tasks, discuss your results with the class and answer any related questions. |
| **Time** | 60’ |

**Task 1: Measure power output of individual solar panel under standard sunlight conditions.**

1. **Instructions**

* Measure the DC voltage (V) across the positive and negative terminals of the panel using a multimeter.
* Measure the DC current (A) flowing through the panel using a clamp meter or multimeter in series with the panel.
* Formula: Power (P) = Voltage (V) x Current (I)
* Note down the value.

1. **Measured value**

* Voltage: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Volt
* Current: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Amp
* Power: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Watt

1. **Notes**

* For a 250W solar panel, in good sunlight, the power should be close to its rated value (e.g., around 200-250W).

**Task 2: Measure power output of solar array (string power) connected in series.**

1. **Instructions**

* Measure the DC voltage across the entire string of solar panels.
* Measure the DC current at the positive or negative terminal of the string.
* Formula: Power (P) = Voltage (V) x Current (I)
* Note down the value.

1. **Measured value**

* Voltage: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ V
* Current: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ A
* Power: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ W

1. **Notes**

* If you have 10 panels rated at 250W each, the total power should be around 2.5kW in full sunlight (assuming 100% efficiency).

**Task 3: Measure AC power output of Inverter when connected to grid.**

1. **Instructions**

* Measure the AC voltage (V) at the inverter’s output terminals using a multimeter.
* Measure the AC current (A) at the output using a clamp meter.
* Formula: Power (P) = Voltage (V) x Current (I) x Power factor
* Note down the value.

1. **Measured value**

* Voltage: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ V
* Current: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ A
* Power factor: \_\_\_\_\_\_\_\_\_\_
* Power: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ W

1. **Notes**

* The power should match the inverter’s output capability. For example, for a 5kW inverter, the output should be close to 5kW if the solar array is producing enough power.

**Task 4: Measure power delivered from solar array to battery bank in off-grid solar system.**

1. **Instructions**

* Measure the DC voltage (V) at the battery terminals using a multimeter.
* Measure the DC current (A) flowing into the battery using a clamp meter or multimeter.
* Formula: Power (P) = Voltage (V) x Current (I)
* Note down the value.

1. **Measured value**

* Voltage: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ V
* Current: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ A
* Power: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ W

1. **Notes**

* The power should vary depending on the sunlight and battery state of charge. For a 12V battery system, you might expect around 100-300W in moderate sunlight conditions.

**Task 5: Measure power consumption of load connected to inverter in solar system.**

1. **Instructions**

* Measure the AC voltage (V) at the outlet powering the load using a multimeter.
* Measure the AC current (A) drawn by the load using a clamp meter.
* Formula: Power (P) = Voltage (V) x Current (I) x Power Factor
* Note down the value.

1. **Measured value**

* Voltage: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ V
* Current: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ A
* Power factor: \_\_\_\_\_\_\_\_\_\_
* Power: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ W

1. **Notes**

* The power should match the load’s rated power. For example, if a 1kW appliance is connected, the power should be around 1000W.

**Task 6: Measure power loss in cables (voltage drop and power loss) between solar array and inverter.**

1. **Instructions**

* Measure the voltage at the solar array and at the inverter terminals.
* Measure the current flowing from the array to the inverter.
* Formula:  
  Power at array (P1) = Voltage at array (V1) x Current (I)  
  Power at inverter (P2) = Voltage at inverter (V2) x Current (I)  
  Power loss = P1 – P2
* Note down the value.

1. **Measured value**

* Voltage at array: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ V
* Voltage at inverter: \_\_\_\_\_\_\_\_\_\_\_\_\_ V
* Current: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ A
* Power loss: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ W

1. **Notes**

* Power loss should be minimal, typically less than 3% in a well-designed system.

**Task 7: Measure efficiency of solar inverter by comparing DC power input and AC power output.**

1. **Instructions**

* Measure the DC voltage and current at the inverter’s input.
* Measure the AC voltage and current at the inverter’s output.
* Formula:   
  DC power (input) = DC voltage (VDC) x DC current (IDC)
* AC power (output) = AC voltage (VAC) x AC current (IAC) x Power factor  
  Efficiency (%) =
* Note down the value.

1. **Measured value**

* DC input power: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ W
* AC output power: \_\_\_\_\_\_\_\_\_\_\_\_\_\_ W
* Efficiency: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ %

1. **Notes**

* Most modern inverters have an efficiency of around 95-98%.

**Task 8: Measure maximum power point tracking (MPPT) performance of charge controller.**

1. **Instructions**

* Measure the DC voltage and current at the input of the charge controller (from the solar array).
* Measure the DC voltage and current at the output of the charge controller (to the battery).
* Formula:  
  Input power = Input voltage (V) × Input current (I)  
  Output power = Output voltage (V) × Output current (I)
* Note down the value.

1. **Measured value**

* Input power: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ V
* Output power: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ A
* Efficiency or MPPT gain: \_\_\_\_\_\_\_ %

1. **Notes**

* The power output should be optimized for maximum efficiency, and you should observe an increase in the power delivered to the battery compared to direct charging.

**Task 9: Measure power output with and without shading on solar panels.**

1. **Instructions**

* Measure the DC voltage and current of the panel under full sunlight conditions.
* Measure the DC voltage and current of the panel after partially shading it (e.g., cover a part of the panel with an object).
* Formula: Power (P) = Voltage (V) x Current (I)
* Note down the value.

1. **Measured value**

* Power under full sunlight: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ W
* Power under shaded conditions: \_\_\_\_\_\_\_\_\_\_ W

1. **Notes**

* The power output will drop significantly when the panel is shaded.

**Task 10: Measure combined power input to an inverter from multiple solar arrays connected in parallel.**

1. **Instructions**

* Measure the DC voltage and current at the input of each solar array.
* Measure the DC voltage and current at the inverter’s input, where all arrays combine.
* Formula: Power (P) = Voltage (V) x Current (I)
* Note down the value.

1. **Measured value**

* Voltage of Array 1: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ V
* Voltage of Array 2: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ V
* Current of Array 1: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ A
* Current of Array 2: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ A
* Power of Array 1: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ W
* Power of Array 2: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ W
* Combined Voltage: \_\_\_\_\_\_\_\_\_\_\_\_\_\_ V
* Combined Current: \_\_\_\_\_\_\_\_\_\_\_\_\_\_ A
* Total Power input: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ W

1. **Notes**

* If the combined power input is significantly lower than expected, there may be a fault in one of the arrays, shading on some panels, or poor wiring connections. Investigate individual array performance and wiring integrity.