# **EXPERIMENT NO: 2**

# **SOLAR PHOTOVOLTIC CELL TRAINER**

# **DESCRIPTION –**

In today’s scenario, importance of Non-Conventional Energy Resources is getting very much importance. And Sun is really pouring it to us in an abundant manner. Sun Energy is the easiest to tap as it is available with every one. So naturally Solar Cells or Photovoltaic Cells are primary kind of transducers to convert this Solar or Photo Energy in to Electrical Energy. So from Students point of view, study of such Sensor’s Working Principle is very important. And keeping this view in mind, we developed this ‘Solar System Unit / Set Up’.

Here a Solar Panel is formed by placing individual Solar Cells together in a Transparent Enclosure after specific wiring /circuit arrangement. This Solar Panel, in total, works as Transducer to convert Solar or Photo Energy in to Electrical Energy. Output of this Solar Panel is connected to Ni-Cd Battery or Resistive Load through specifically combined Switches, their related wiring & operating sequence. Related working Modes are explained below.

1. **Battery Voltage Vs Solar Voltage –**

This Switch Mode is totally meant for indicating Voltage on Digital Voltmeter. When it is in **Battery Voltage position** it shows connected Battery (Ni-Cd) Voltage, depending on Battery Condition. And when it is in **Solar Voltage position** it shows Solar panel Voltage, depending upon to what extent it receives Solar or Photo Energy. One can use this Voltage indication mode despite of any Load & Current related Switches positions.

1. **Battery Current Vs Load Current –**

This Switch Mode is basically meant for two aspects.

* 1. For connecting Solar Panel output for direct Battery (Ni-Cd) charging. In this case one has to place the switch on **Battery Current position**. And then Digital Ammeter shows Battery Charging Current, depending upon to what extent it receives Solar or Photo Energy & Battery Condition. Here Load (external) gets disconnected from Solar Panel & / or Battery (Ni-Cd). Means this Mode is used for Battery (Ni-Cd) Charging.
  2. For connecting Solar Panel or Battery (Ni-Cd) output to Load (external). In this case one has to place the switch on **Load Current position**. And then Digital Ammeter shows Load Current, depending upon to what extent Solar Panel receives Solar / Photo Energy or Battery Condition. Here Battery (Ni-Cd) gets disconnected from Solar Panel; hence Battery Charging is not possible. Now for connecting Load (external) to either Solar Panel or Battery (Ni-Cd) output another related Switch is required to be operated as given below.

1. **Battery Load Vs Solar Load –**

For connecting Solar Panel output to Load (external), one has to keep this Switch on **Solar Load Position**. With this mode one can check Solar Cell Characteristics. Where as for connecting Battery (Ni-Cd) output to Load (external), one has to keep this Switch on **Battery Load Position**. With this mode one can discharge Battery (Ni-Cd) if desired, so that one can recharge it again.

However be sure that Load (external) must a Resistive Load in the Range as given below.

1. For Solar Load: 10 to 1000 Ω. (Min 1W)

1. For Battery Load: 10 to 20 Ω. (Min 5W)

# **OPERATING PROCEDURE –**

1. Following Steps are required to be followed & ensured, before connecting Solar Panel, Battery (Ni-Cd) & Supply Mains to Experimental Module / Chassis.
   1. Ensure that External Loads are disconnected in total.
   2. Selector Switches are in following position,
2. Battery Voltage Vs Solar Voltage: on Solar Voltage.
3. Battery Current Vs Load Current: on Load Current.
4. Battery Load Vs Solar Load: on Solar Load.
   1. Mains ON / OFF switch is ‘OFF’. (Optional on Back Side)
5. Connect 230V A. C. – 50 Hz – Mains Supply to the Module.

This Mains Supply must be free of Fluctuations & with good Earthing.

1. Just once again ensure all the steps given above.
2. Place two Batteries (Ni-Cd) of 1.2V each in the Battery Holder which is just on the back side on Unit. However confirm polarities before placement.
3. Connect Solar Panel using front end socket provided for it. Carefully lock it after connection.
4. Now Switch on Module with Mains Switch – ‘ON’.
5. For Solar Cell Characteristics Experiment follow below given steps.
   1. Carry Solar Cell panel to various light / sun intensity levels & see Solar Cell panel actual output voltage accordingly. If you find any problem with getting various light / sun intensity levels inside laboratory then use given attachment for artificially achieving the same.

Here a variable height adjustment based Lamp Post is provided as a additional attachment. Before connecting this Lamp Post to back side related socket on Unit, ensure that front end Lamp Dimmer is ‘Off’ i.e. most anti-clock wise position. Now, place Solar Cell panel just below the well height adjusted Lamp Post while avoiding direct heating of Solar Panel. But ensure that enough light intensity falls on Solar Panel. So one can now note down Solar Cell panel actual output voltage with respect to Lamp Post light intensity controlled using Lamp Dimmer. This is Solar Cell output voltage Vs Light Intensity experiment at ‘No Load’ Or ‘Open Load’ condition.

* 1. For Solar Cell output voltage Vs Light Intensity experiment at ‘Load’ condition repeat (7a) but with Load (external) as per the given directions above. Do not forget to remove Load (external) after experiment.

1. For Battery (Ni-Cd) Charging Experiment (using two Batteries (Ni-Cd) of 1.2V each) follow below given steps. However before that please ensure - connected Batteries are at least 50% Or more discharged to see practical results.
   1. Keep Selector Switches in following position.
2. Battery Voltage Vs Solar Voltage: on Battery Voltage.
3. Battery Current Vs Load Current: on Load Current.
4. Battery Load Vs Solar Load: on Solar Load.
   1. One can see the Battery Voltage which is lower than its regular voltage(2.4V).
   2. Now keep Solar Panel at max. Light Intensity either using given Lamp Post or any natural means. And change Battery Voltage Vs Solar Voltage: to Solar Voltage. One can see it is around 3.5V to 4V.
   3. As Solar Voltage is more than Battery Voltage we can use Battery Charging Mode. So change Battery Current Vs Load Current: to Battery Current. Also change Battery Voltage Vs Solar Voltage: to Battery voltage. And one can now see that Batteries are getting charged. As Batteries goes on charging their voltage reaches towards their desired voltage 2.4V (plus 10% some times i.e. 2.65V). However during this charging process Digital Ammeter shows Battery Charging current. This Current reduces to Zero when Batteries get fully charged to their capacity. Then once again change Battery Current Vs Load Current: to Load Current.
5. After completion of Experiment, Keep Solar Panel, Batteries, Load (external) & Lamp post in removed position & turn ‘OFF’ the Mains ON/OFF switch.
6. Please keep entire set up in safe & dry place.

**NOTE –**

1. Don’t allow Solar panel to get heated up beyond ambient as it degrades it performance to some extent.
2. If you wish to discharge the Batteries without removing them then keep following selector Switch conditions.
   1. Battery Voltage Vs Solar Voltage: on Battery Voltage.
   2. Battery Current Vs Load Current: on Load Current.
   3. Battery Load Vs Solar Load: on Battery Load.

And then connect Load (external) as per the given directions

above.

1. For temporary Short Circuit Load test on Solar Panel one has to short the Load terminals using remaining third un-used terminal (Most Right Hand & Most Left Hand from Front – while leaving middle unused). But this test is to be carried out by expert persons only. Other wise use Regular Solar Load terminals i.e. Most Left Hand & Middle from Front – while leaving Most Right Hand unused).
2. Lux Meter & Stop Clock is not in our Scope.
3. Don’t Short Circuit Batteries while discharging them as it may prove Dangerous.

## **OBSERVATIONS –**

1. Solar Cell output voltage Vs Light Intensity experiment at ‘No Load’ or ‘Open Load’ condition.

|  |  |  |
| --- | --- | --- |
| **Sr. No** | **Solar / Light Intensity** | **Solar panel Output in V** |
| 1 |  |  |
| 2 |  |  |
| 3 |  |  |
| 4 |  |  |

#### GRAPH –

1. Observed Solar Output in V Vs Solar Output in A

At Load (external) Condition - as per the given directions above