Benha University

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Faculty of Engineering at Shoubra
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Undergraduate Course

Solar Cells Fundamental

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Lecture (11)

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MPPT

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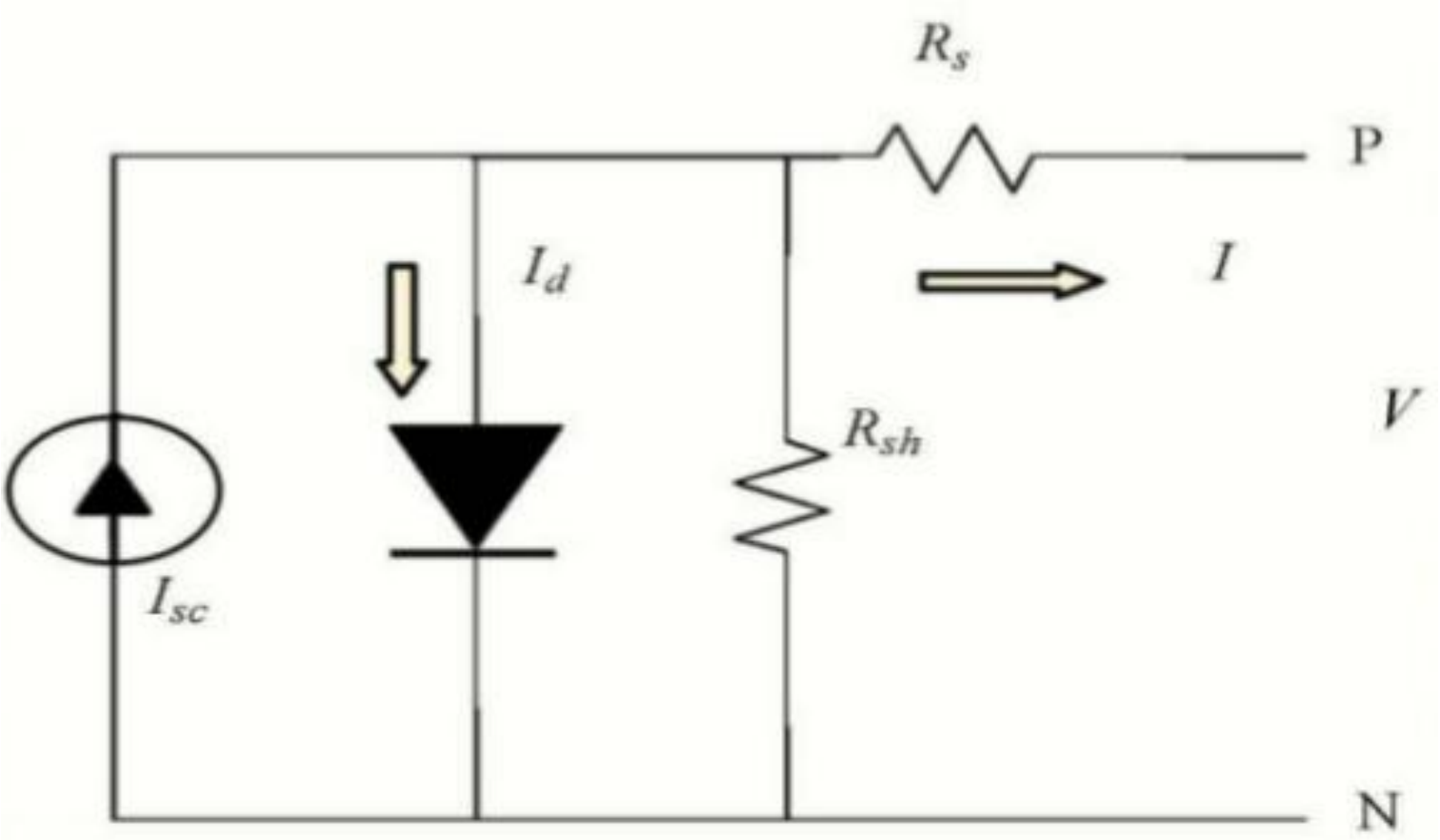
What is MPPT ?

- MPPT (maximum power point tracking) is algorithm that included in charge controller used for extracting maximum available power form PV module under certain condition.

- The voltage at which PV module can produce maximum power is called (maximum power point) or (peak power voltage).

Mathematical Model



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How MPPT Work?

- The major principles of MPPT is to extract the maximum available power from PV module by making them operate at the most efficient voltage (MPP).

- MPPT check output of PV module, compares it to battery voltage then fixes what is the best power that PV module can produce to charge the battery and convert it to the best voltage to get maximum current into battery.

Most effective MPPT

- **MPPT is most effective under these conditions:**

1. **Cold weather, cloudy days:**

normally, PV module works better at cold temperature and MPPT is utilized to extract maximum power available from them.

2. **When battery is deeply discharge:**

MPPT can extract more current and charge the battery if the state of charge in the battery is lowers.

MPPT solar charger controller

- A MPPT solar charge controller is the charger controller embedded with MPPT algorithm to maximize the amount of current going into the battery from PV module.
- MPPT is DC to DC converter which operates by taking DC input from PV module, changing it to AC and converting it back to different DC voltage and current to exactly match the PV module to the battery.
- MPPT algorithm can be applied to (Boost converter, Buck converter) both of them depending on system design.

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Mppt solar charge controller are useful for off-grid solar power system such as (stand-alone solar power system, solar home system and solar water pump system).

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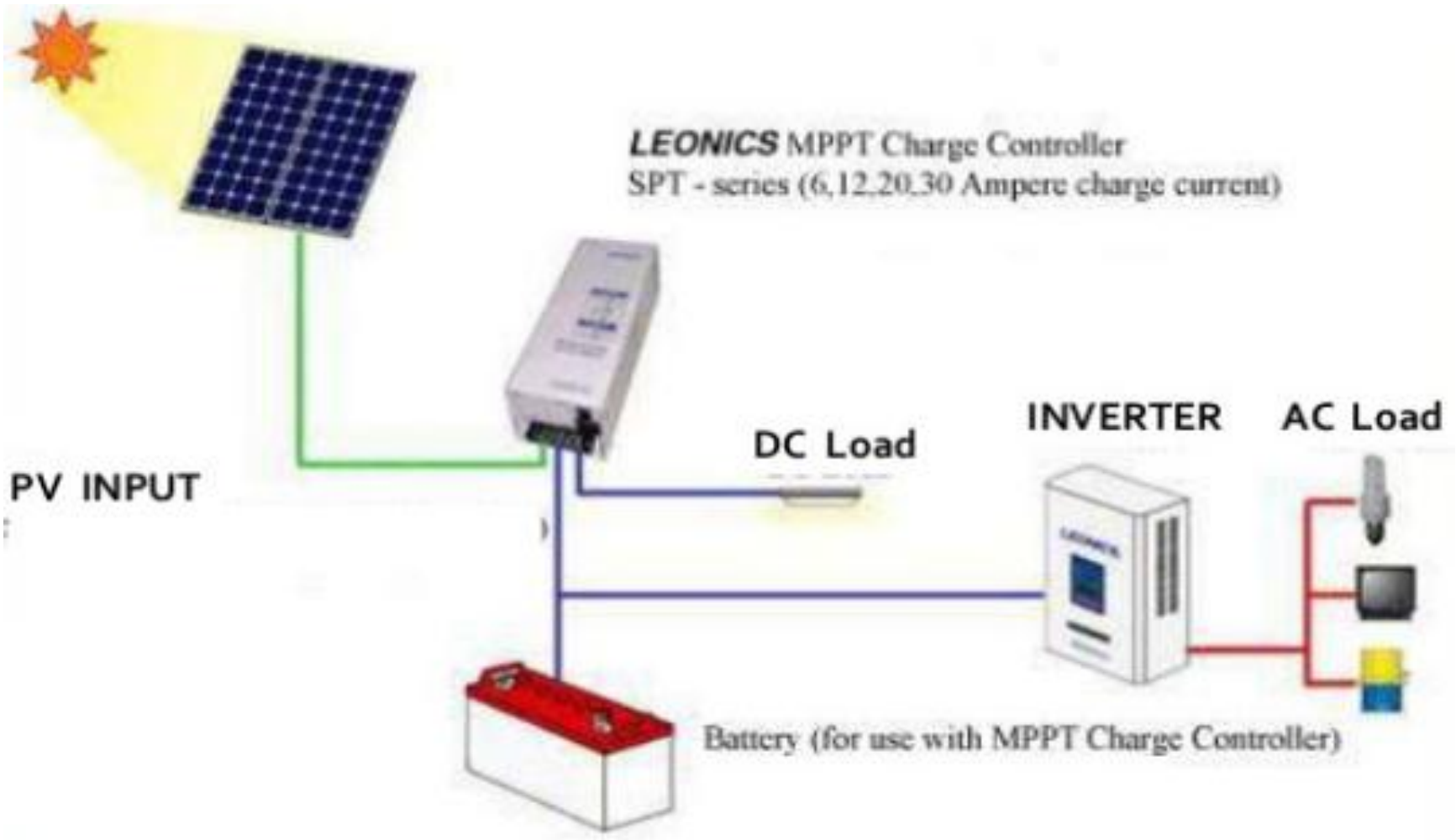
General configuration of the MPPT solar charge controller



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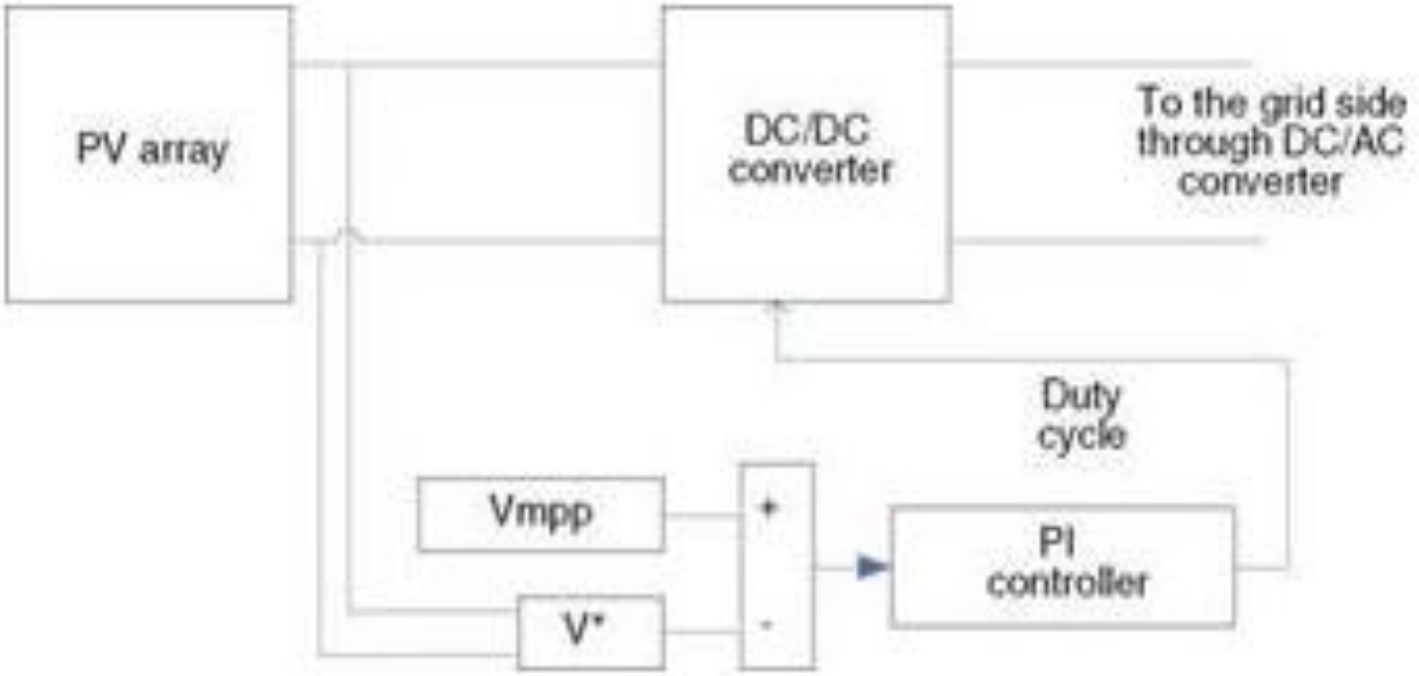
MPPT Techniques

1. Fractional open-circuit voltage.
2. Fractional short-circuit current.
3. Perturb and observe.
4. Incremental conductance

1. Fractional open-circuit voltage (FOCV)



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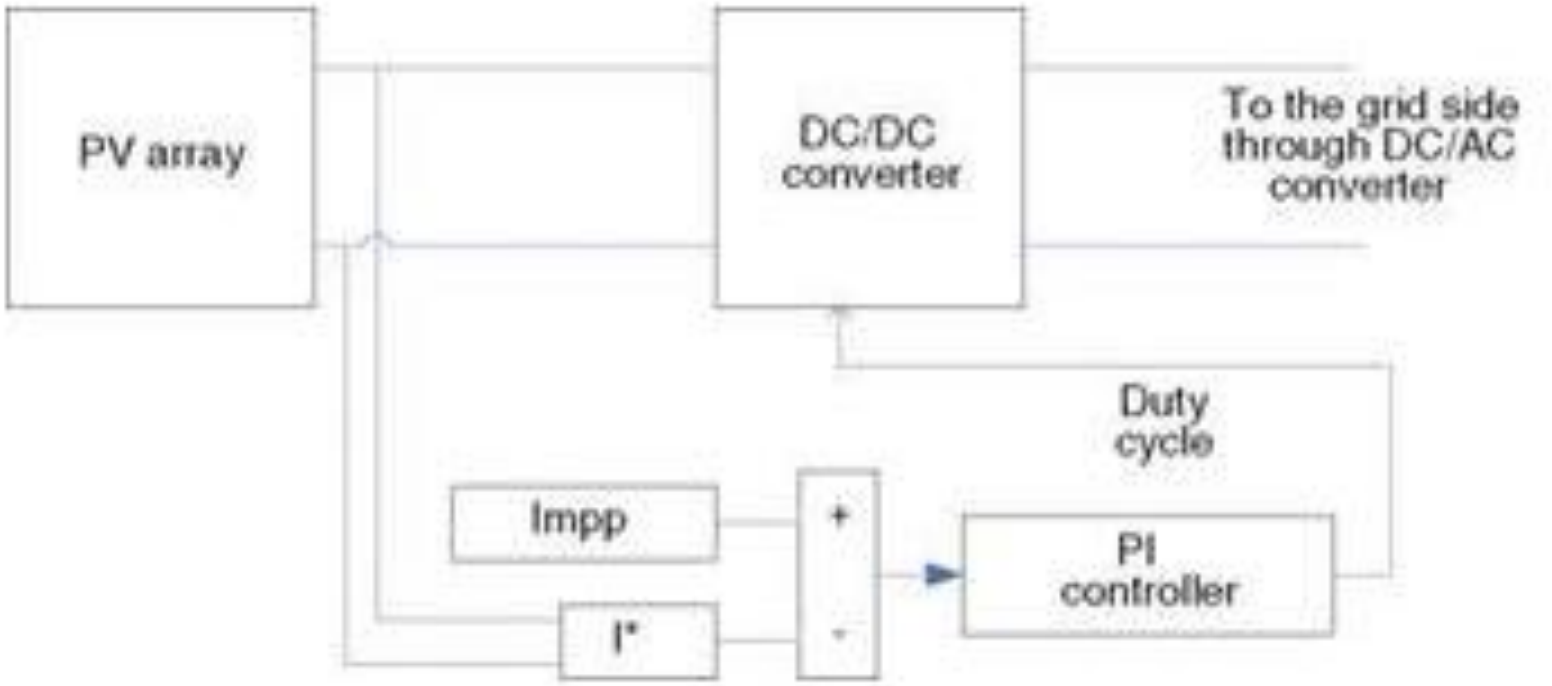
- Fractional open-circuit voltage method sets the voltage value at the MPP equal to some fixed fraction of the measured open-circuit voltage.
- As the PV cells keep operating over longer periods, their open-circuit voltages are reduced and so are the values used for MPPT.
- Implementation of this method is simple.
- Its tracking efficiency is relatively low.
- $V_{MPP} \approx K\ V_{OC}$

  (K is the factor has been reported to be between 0.71 and 0.78)

2. Fractional Short-Circuit Current (FSCC)



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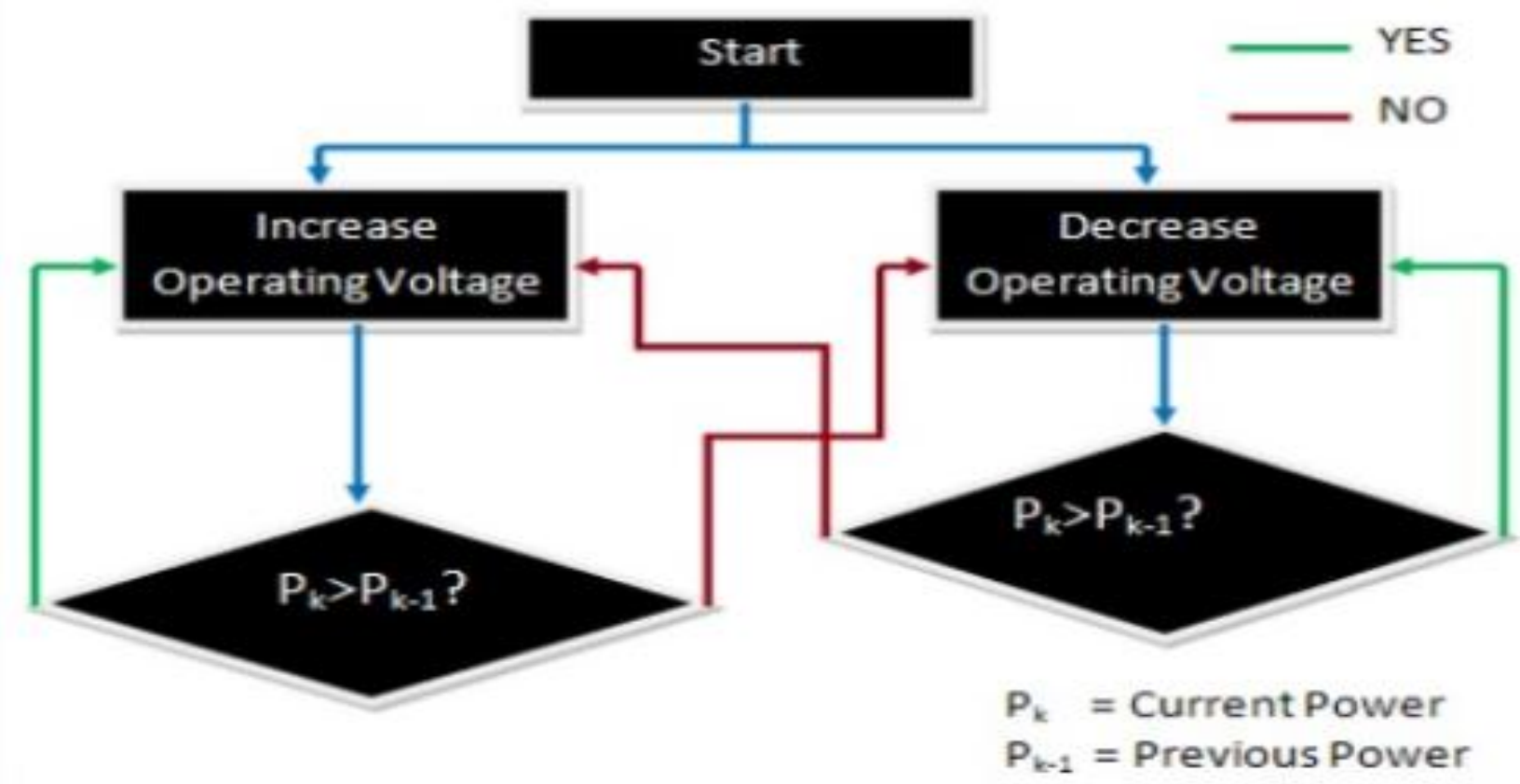
- FSCC is an unsophisticated but a swift technique of tracking the MPP.
- To track the power, this MPPT technique requires the value of SCC by isolating the PV array.
- The MPPT calculated using this technique is based on this equation ($I_{mpp} \approx K\ I_{SC}$) which is an approximation, hence this method does not operate on true MPPT.

  (K is not constant. Its found to be between 0.78 and 0.92)
- This method is suitable to be implemented by using either the analog or the digital mode.

- The basic outline of this technique follows that the current at MPP (I_{mpp}) is closely located near the short circuit current Isc.
- Therefore, the operating point can be reached by multiplying Isc by the factor **k .**
- The constant "k" can be easily calculated from the specifications of the PV module and it is always less than 1.
- The constant k is a fixed value and therefore, can be used as a fixed entity in the algorithm.
- The accuracy of the method and tracking efficiency depends on the accuracy of K and periodic measurement of short circuit current.

3. Perturb and observe (P&O)



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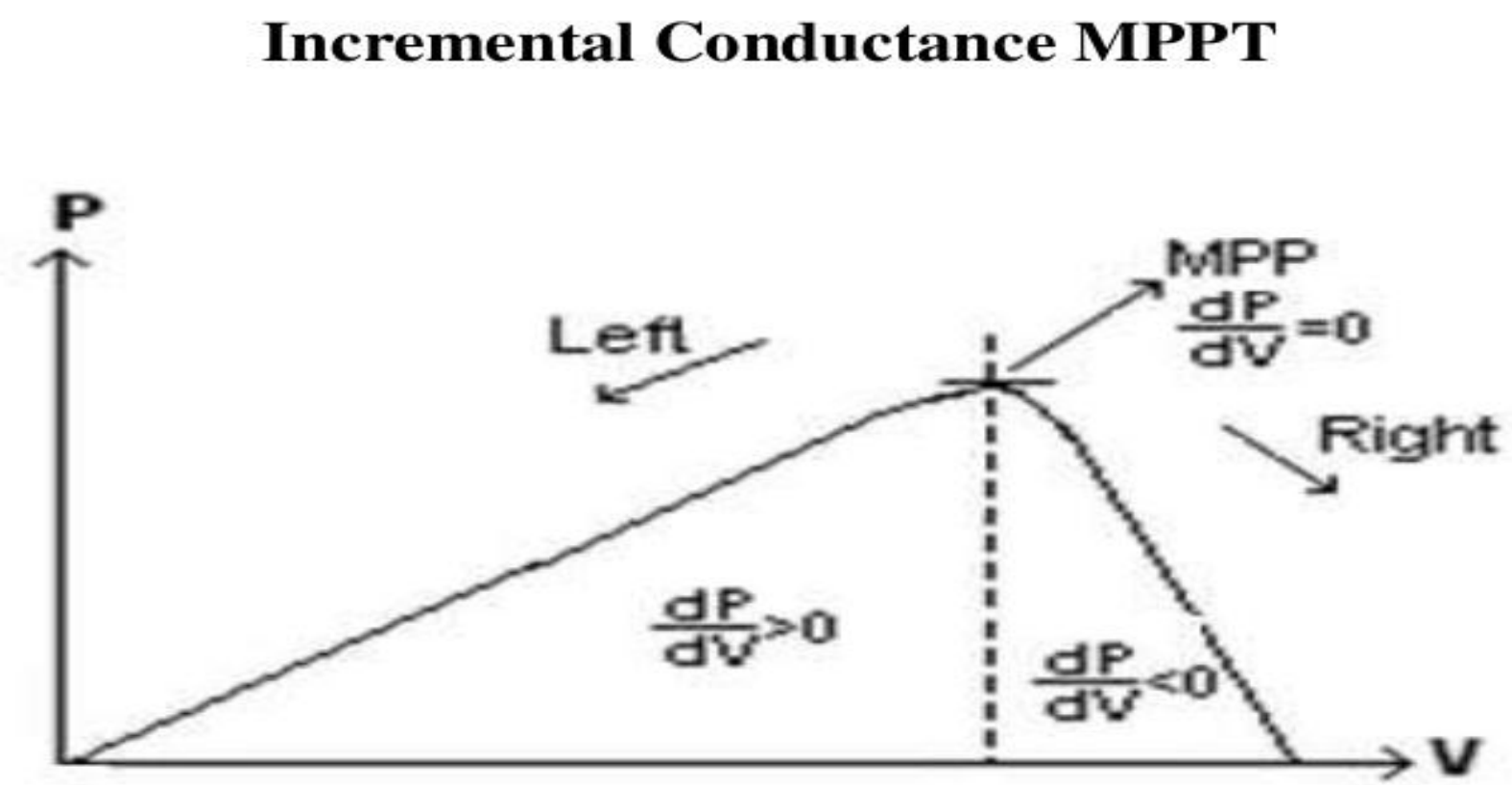
- Perturb and observe techniques, essentially, an application of the hill-climbing method.
- If an adjustment that increases the voltage raises the PV power output, then the voltage needs to be increased until the voltage increment no longer raises the power output.
- If the voltage increment lowers the PV power output, then in the next voltage adjustment reverse the sign of the disturbance.

4. Incremental conductance (IC)



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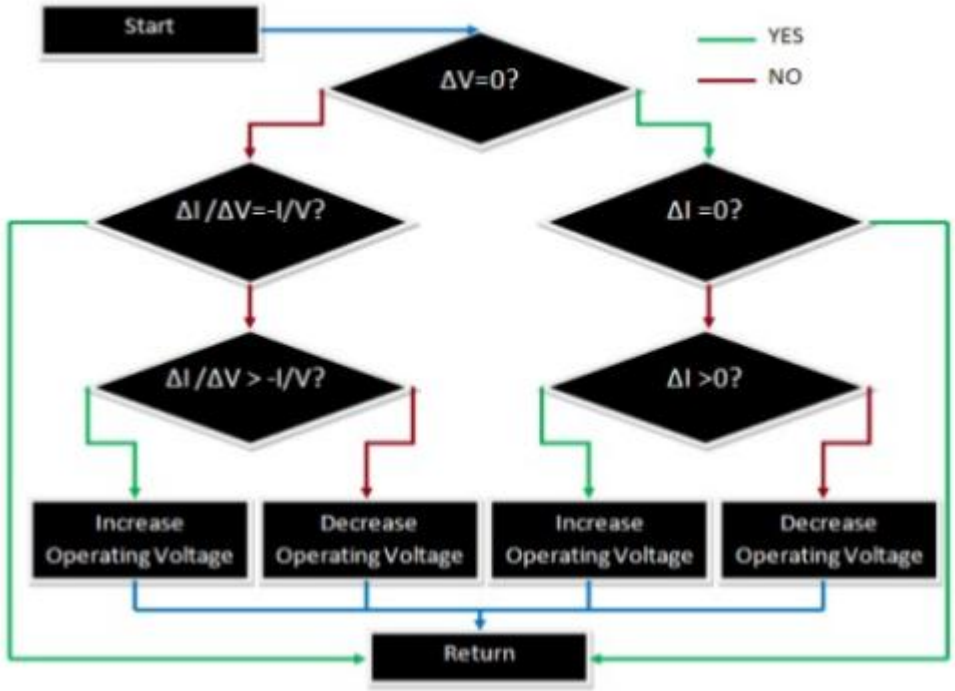
- Incremental conductance considers the fact that the slope of the power-voltage curve is zero at the maximum power point, positive at the left of the MPP, and negative at the right of the MPP.

- $\Delta I / \Delta V = -I/V$, at MPP
- $\Delta I / \Delta V > -I/V$, at left of MPP
- $\Delta I / \Delta V < -I/V$, at right of MPP

- The disadvantage of the perturb and observe method to track the peak power under fast varying atmospheric condition is overcome by IC method .
- The IC can determine that the MPPT has reached the MPP and stop perturbing the operating point.
- This algorithm has advantages over P&O in that it can determine when the MPPT has reached the MPP, where P&O oscillates around the MPP.
- Also, incremental conductance can track rapidly increasing and decreasing irradiance conditions with higher accuracy than P and O

flow chart of IC



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