



Benha University

Dr : Mohamed Ahmed Ebrahim



Undergraduate Course

Solar Cells Fundamental

Dr./ Mohamed Ahmed Ebrahim

E-mail: mohamedahmed_en@yahoo.com

Web site: <http://bu.edu.eg/staff/mohamedmohamed033>



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Lecture (9)



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PV installation Precautions

Installation precautions

- PV array is made up of a number of modules in series or parallel, corresponding to the input characteristics of the inverter.
- These modules are interconnected, the array is very sensitive to shade or differences in terms of the direction faced.
- By following a few simple cabling rules, supply can be optimized and any operating problems may be avoided.

1. **Position of the panels**

- If, when installing a PV array on a roof, panels need to face in different directions, it is essential to assemble at least one string per direction and ensure each string is facing in just one direction to ensure optimized supply.
- If this instruction is not observed, the array will not be damaged but supply will be reduced, thus increasing the time needed for a return on investment.

2. Shade

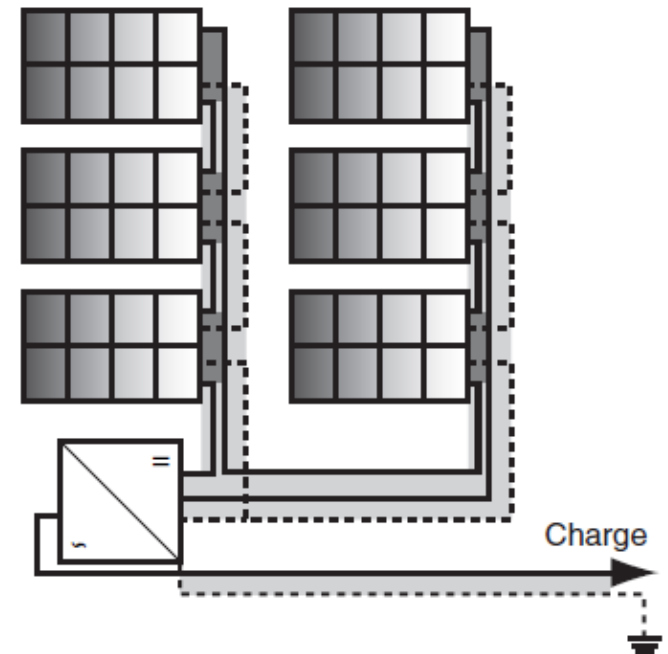
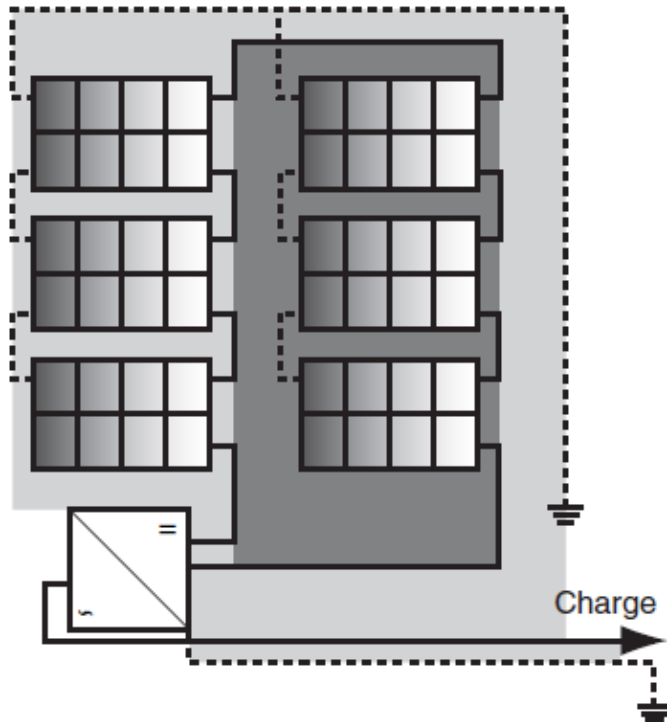
- Shading of 10% of the surface area of a string may cause more than a 30% reduction in output.

- If a PV array includes several strings:
 - * If possible, shaded modules should be included in a single string
 - * Otherwise, a technology should be chosen which responds better to diffuse light than direct light.

3. Eliminating loops

- When connecting components, the first precaution to take is to avoid loops in the cabling within strings.
- Even though direct lightning strikes on arrays are relatively rare, currents induced by lightning are much more common and these currents are particularly destructive where there are large areas of looping.

Avoiding loops when cabling string



PV modules & solar cells

Standards, Calibration, and Testing

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Difference between Regulation & standard?

Regulations	Standards
A Rule that we must follow	Not written by Government but written by organizations.
Rules that the Government makes under an Act	Typically refer to product performance or how to do a job
Rules are made “real” and “enforceable” by the power that the Government gives itself under an Act	Have no authority on their own, but may be adopted into regulations making them legal requirements
e.g. Health & Safety Act Regulation for Hearing Protection	May be referred to specifically in a regulation

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International specifications for solar panels

1. International Electrotechnical Commission (IEC).
2. Country-specific certification.
3. Environmental certifications

International certificates are granted for products

- ❖ It's an International certificates are granted for products conforming to specifications.
- ❖ Most photovoltaic panel companies provide samples to any of the following German accredited bodies for testing And certify that this product conforms to specifications:
 - * TÜV Rheinland
 - * TÜV Süd
 - * VDE

1. IEC

1. International Electrotechnical Commission (IEC)



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- ❖ **IEC** is the world's leading organization that prepares and publishes International Standards for all electrical, electronic and related technologies.
- ❖ **IEC** provides a platform to companies, industries and governments for meeting, discussing and developing the International Standards they require.
- ❖ **IEC** Take numbers from 60000 to 79999 and write in this form (IEC 62446)

IEC Committees

- ❖ **Committee No (TC61):**

which deals with the specifications of household appliances and similar devices.

- ❖ **Committee No (TC62):**

which deals with the specifications of devices in the medical field.

- ❖ **Committee No (TC64):**

which deals with the specifications of electrical installations and protection against electric shocks.



❖ **Committee No (TC108):**

is specialized in the specifications of electronic devices in the fields of audio and video, information, and communication technology.

The importance of conformity assessment for IEC specifications

- ❖ Inspection and Check.
- ❖ Conduct some tests.
- ❖ Granting and renewing quality assurance certificates.
- ❖ The ability of products to maintain continuity and presence in the markets.

The basic components of the conformity assessment body for IEC

1. Regulator.
2. National accreditation bodies
3. Certification bodies.
4. Testing laboratories.
5. IEC and ISO

Renewable Energy Systems IEC Standards

a) **IEC Technical Committee TC82**

- ❖ was established in 1981. It is the most important International body regarding photovoltaic related standardization.
- ❖ The main tasks of TC82 are to prepare international standards for systems of photovoltaic conversion of solar energy into electrical energy and for all the elements in the entire photovoltaic energy system.

b) **ASTM Committee E44**

- ❖ on Solar, Geothermal and Other Alternative Energy Sources is composed of subcommittees that address specific segments within the general subject area covered by the technical committee.

- ❖ In the USA, **The National Electric Code (NEC)** contains sections that specifically cover solar-energy and distributed power generation systems.
- ❖ **The International Residential Code (IRC)** and the International Energy Conservation Code (IECC) reference related standards that apply if installing, respectively, a residential or commercial PV system.
- ❖ **The International Fire Code (IFC)** establishes solar provisions relating to fire access and fire safety.

2. CE

2. Conformity Europeans (CE):

- ❖ A European organization that sets standards and specifications to ensure that products comply with the quality, security and safety laws of the EU. Construction was envisaged in parallel with the creation of the European Union.



3. ISO

3. International Organization for Standardization (ISO):

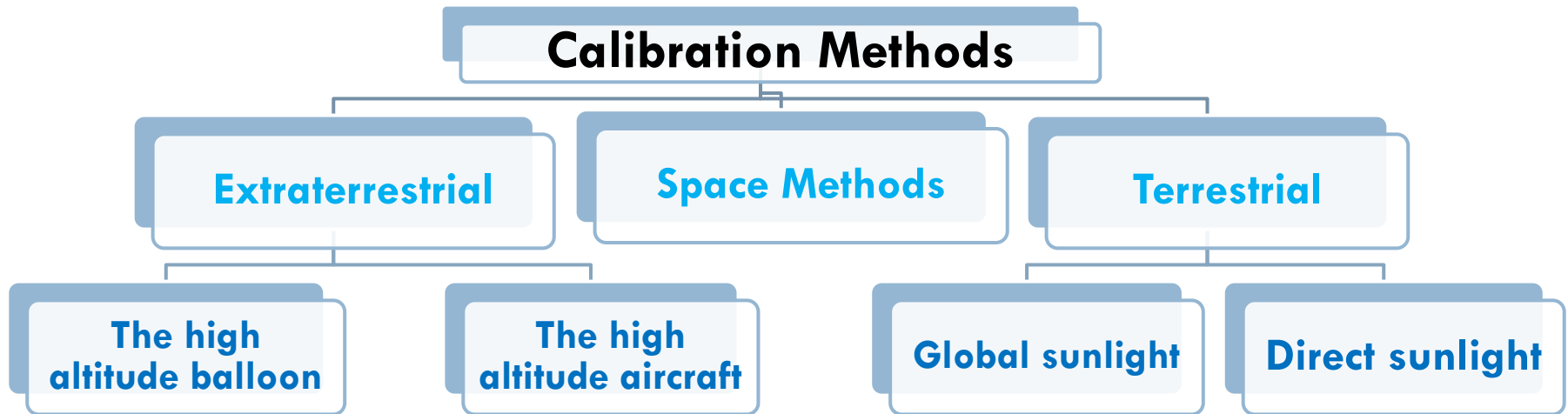
- ❖ It is a global federation based in Geneva and has more than 90 national statistical bodies.
- ❖ It is abbreviated as **ISO** based on the Greek word "ISOS" which means "equal".
- ❖ It was built a year ago **1947**.

ISO Certificate

- ❖ It's a certificate issued by foreign and Arab parties, which is mandated by the International Organization for Measurement and Standardization (ISO).
- ❖ Provides requirements and guidelines necessary for the establishment of quality management system and aims to provide products or services that meet the global requirements

Calibration

- Standard solar cells are used to set the intensity of solar simulators to standard illumination conditions, in order to electrically characterize solar cells with similar spectral response.
- The calibration methods of solar cells can be classified as:



The high altitude balloon

- On board stratospheric balloons flying at altitudes of around 36 km.
- The illumination sun conditions are very close to 0 AM.
- The cells are directly exposed to the sun.
- The cells mounted on supports with sun trackers.



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The high altitude aircraft

- On board of an aircraft capable of flying at altitudes of 15-16 km.
- Cells are mounted at the end cap of a collimating tube on a temperature controlled plate.
- data are corrected for:
 - * The ozone absorption.
 - * The geocentric distance.
 - * Extrapolated to the air mass value of zero.

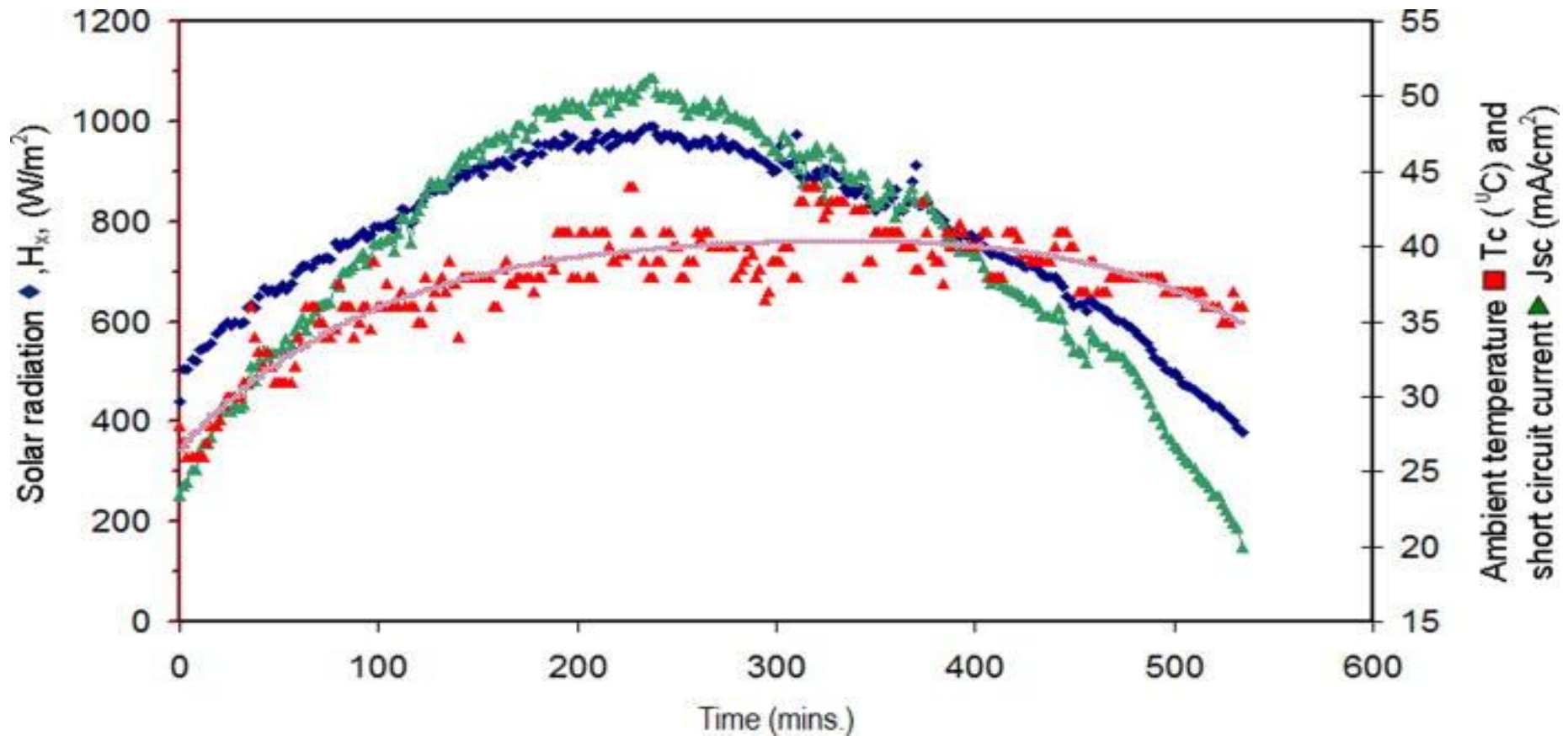


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Global Sunlight

- The cells to be calibrated and a Pyranometer are placed on a horizontal surface.
- The calibration site environmental conditions need to fulfil several requirements relating to global and diffuse irradiance levels, solar elevation, unobstructed view over a full hemisphere.

- The solar cells calibration under global solar radiation



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Direct Sunlight

- The cells to be calibrated are placed on the bottom plate of a collimation tube.
- a normal incidence Pyrheliometer and a Spectroradiometer are kept pointing to direct sunlight while measurements of short-circuit current, total irradiance and spectral irradiance are recorded.
- Several conditions need to be fulfilled by the calibration site and its environment EX (certain irradiance level, stable cell short-circuit readings, and ratio of diffuse to direct irradiance).

Testing

Solar Module Model Pass-Fail Qualification

- The specific series of test are specified in standards of the **IEC**
 - * IEC Standard 61215 (modules with silicon crystalline cells).
 - * IEC Standard 61646 (modules with thin-film cells).
- These two **IEC** standards reference several other related IEC standards:



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- PV module manufacturers voluntarily conduct these series of tests.
- Testing only conducted on new modules.
- Modules are labeled to confirm passing the applicable suite of **IEC** qualification tests.
- Although sometimes used to infer module lifetime, not designed to do so; alternative ways being developed to perform accelerated aging testing

