Photovoltaic Module Evaluation via the Application of a Characterized Xenon Arc Lamp Solar Simulator

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In

10th Renewable Energy Postgraduate Symposium (REPS)

Stellenbosch University

Outline

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- Introduction
- Materials and Methods
- Results
- Conclusions
- References
- Acknowledgements

Introduction

- Two methods are employed for the characterisation of a photovoltaic cell or module.
- Outdoor characterisation.
- Indoor characterisation.
- The elemental aim of the solar simulator is to test PV cells or modules under laboratory conditions that are reproducible.

Introduction

- Hence, a control system with an arrangement of distinct physical components was designed.
- The control system should regulate or direct or command.
- A solar simulator of class AAB was used.

Aim and Objectives

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Objectives:

- To achieve solar simulator set point quicker thereby reducing temperature build up on the target area.
- Indoor PV test.
- Monitor the operating state of the solar simulator.

Materials and Methods

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System Architecture

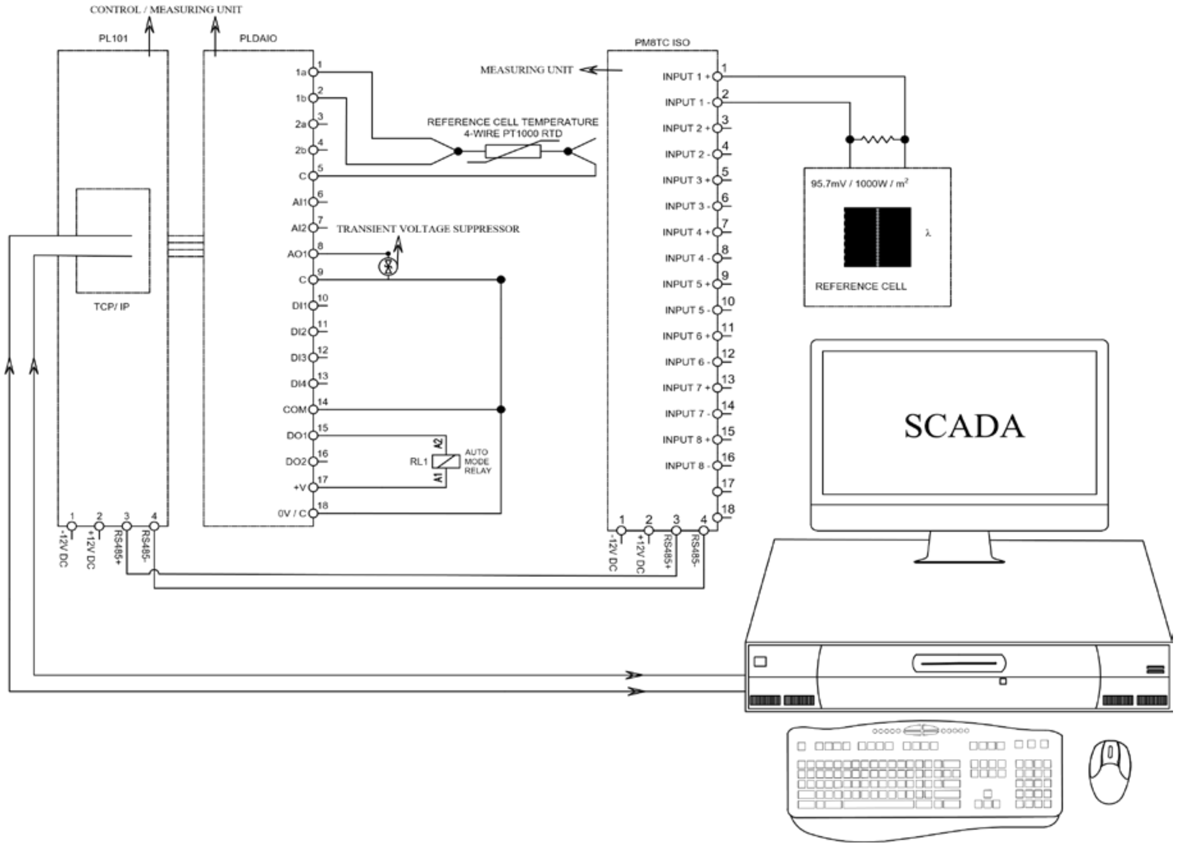
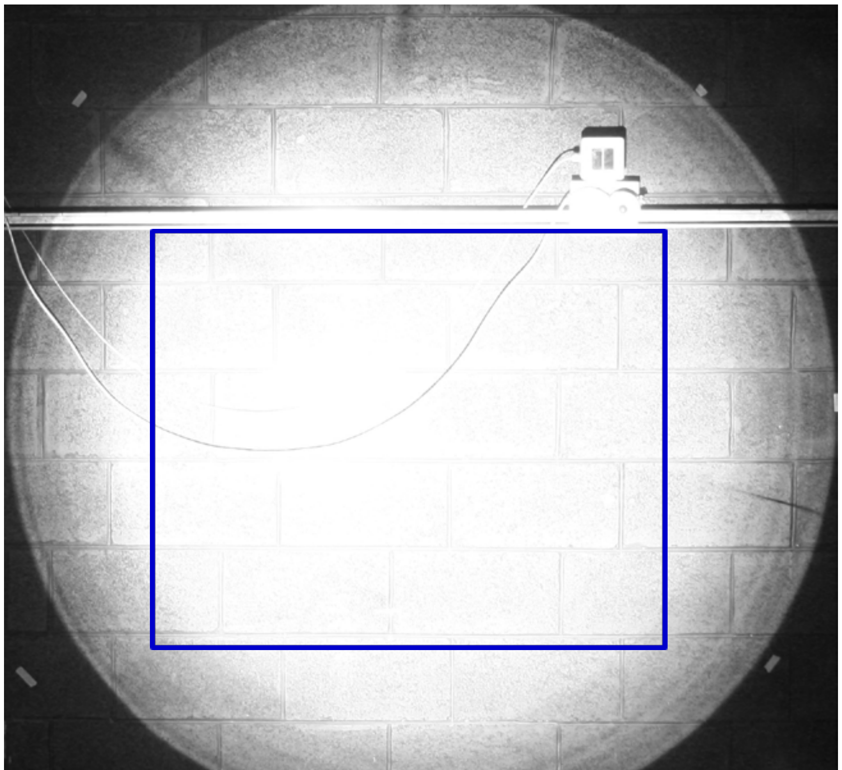


Figure 1: Schematic diagram of the irradiance feedback control system

Irradiance, Temperature & Non-Uniformity Test

- Target area 2m x 2m



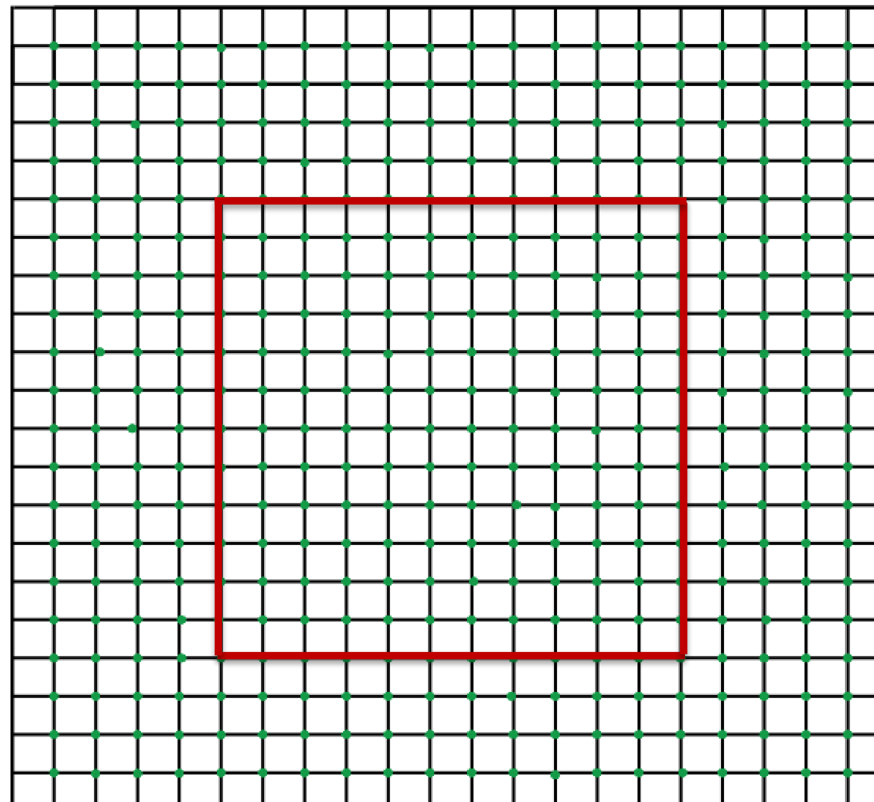


Figure 2: Target area

Device Under Test

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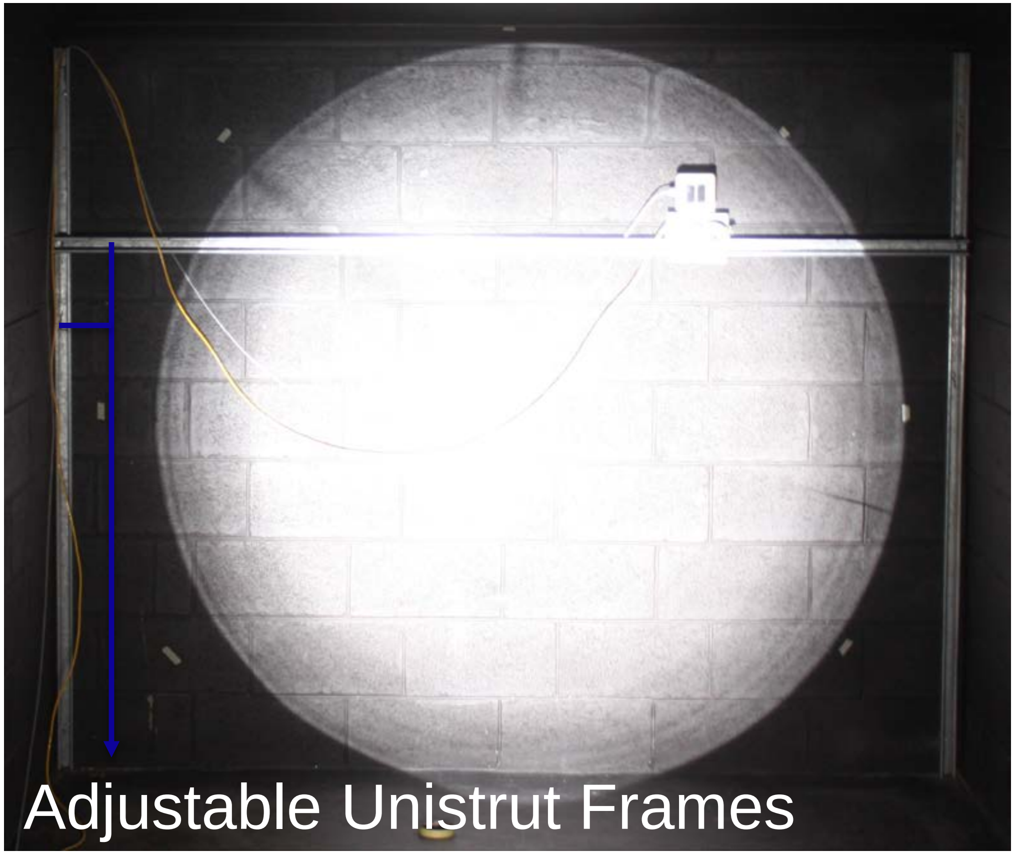

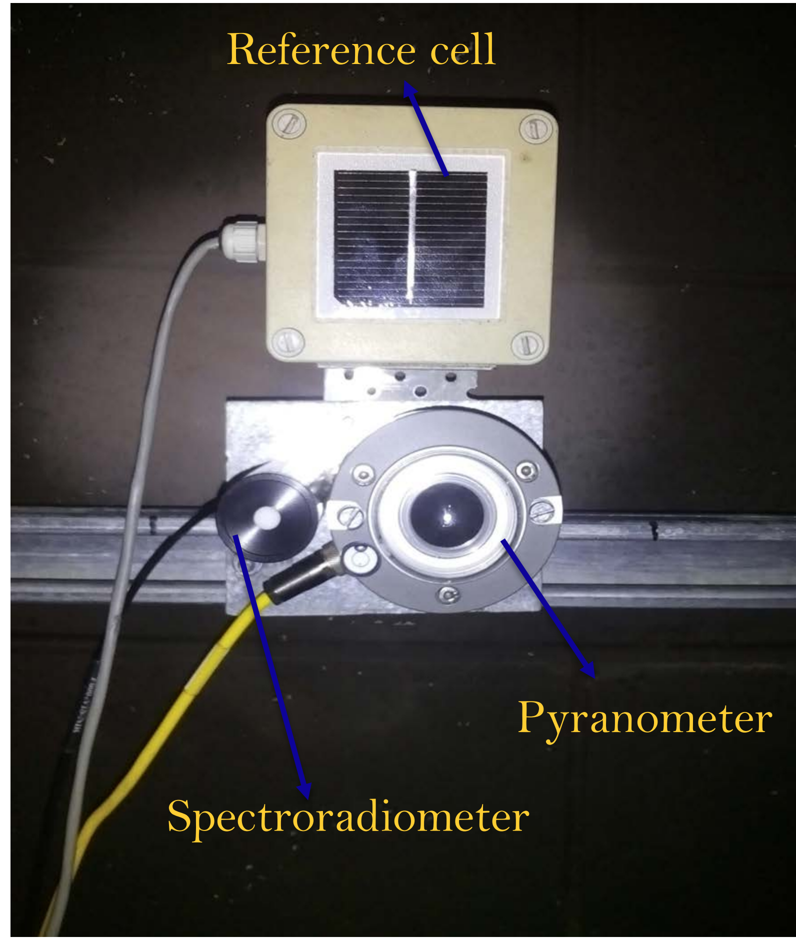

Figure 3: Target area showing device under test

METHODOLOGY

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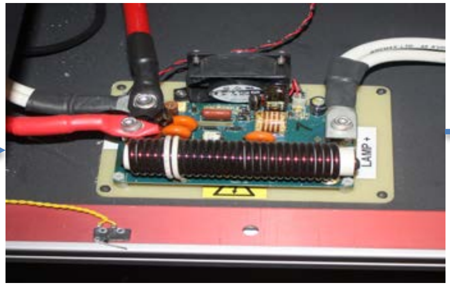
Characterisation

5 kW DC Power Supply

Igniter

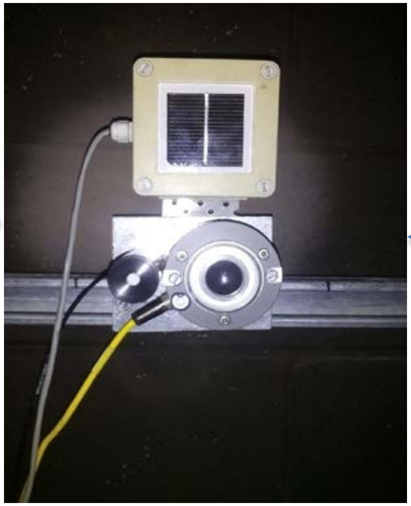


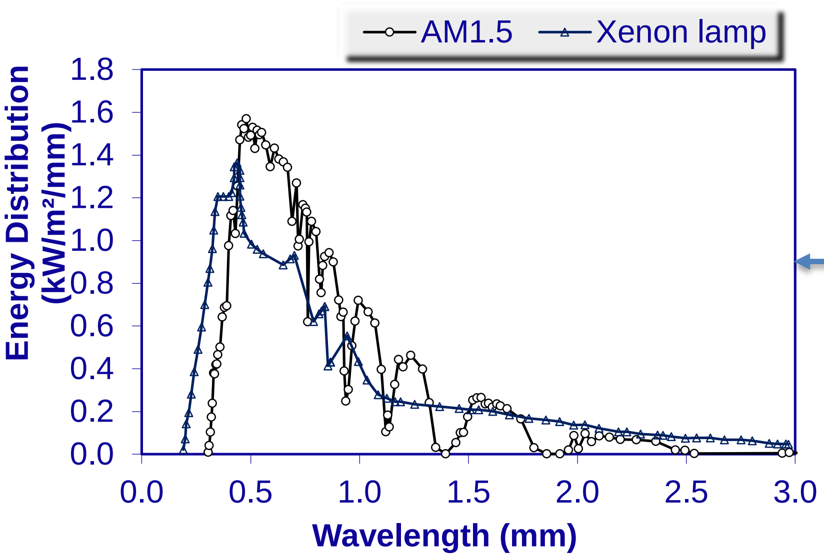
5 kW Xe Arc Lamp

Reflector with Xe-Arc Lamp

Auto/Manual Lamp Control

Target Area with Reference cell, Pyranometer and Spectroradiometer

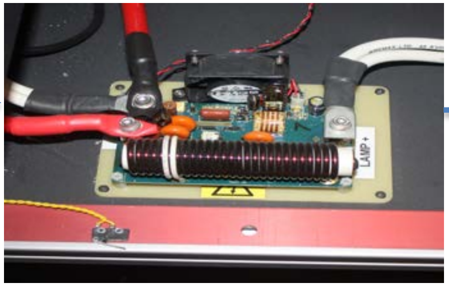




Applying the Xenon-lamp solar simulator on various PV technologies

5 kW DC Power Supply

Igniter

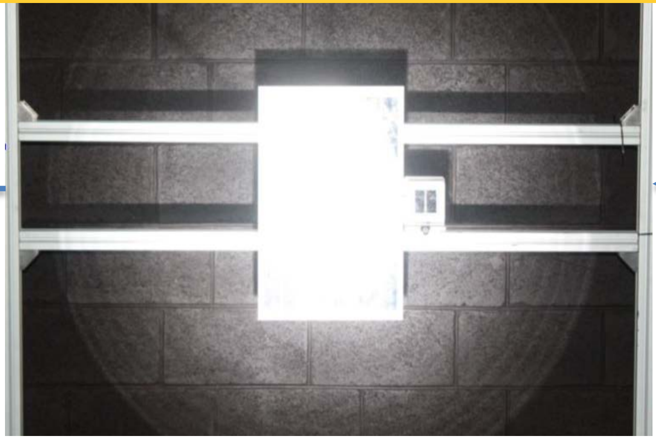


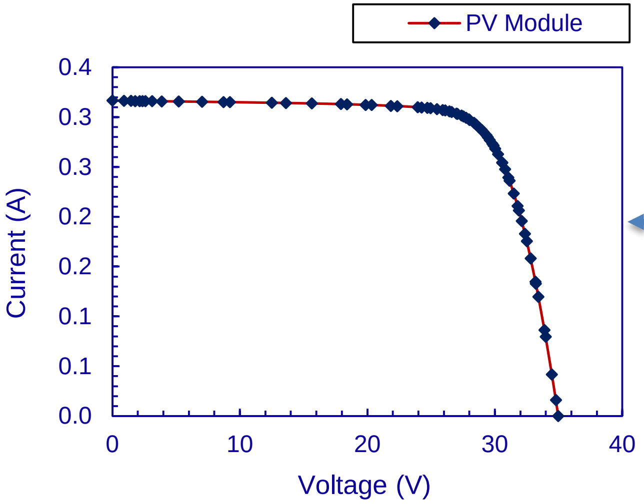
5 kW Xe Arc Lamp

Reflector with Xe-Arc Lamp

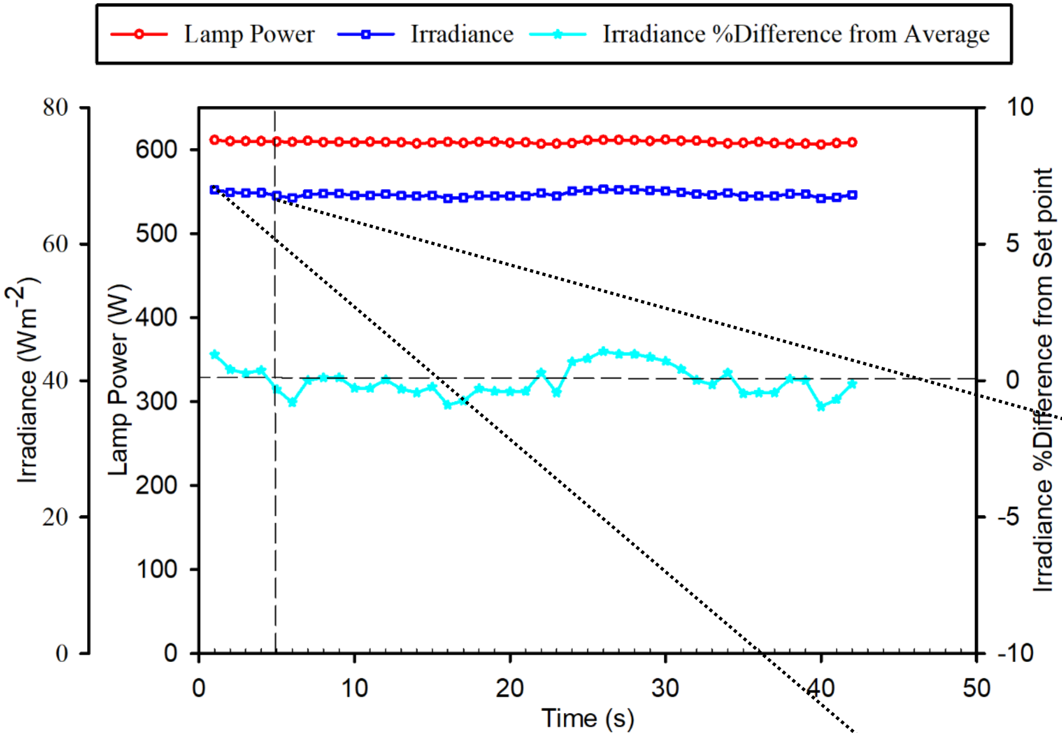
IFCS

Target Area with Reference cell and C-Si Module





Lamp Startup



Irradiance 67 Wm^{-2}

Power 600 W

± 1% drift from set point

Lamp stability 5 sec

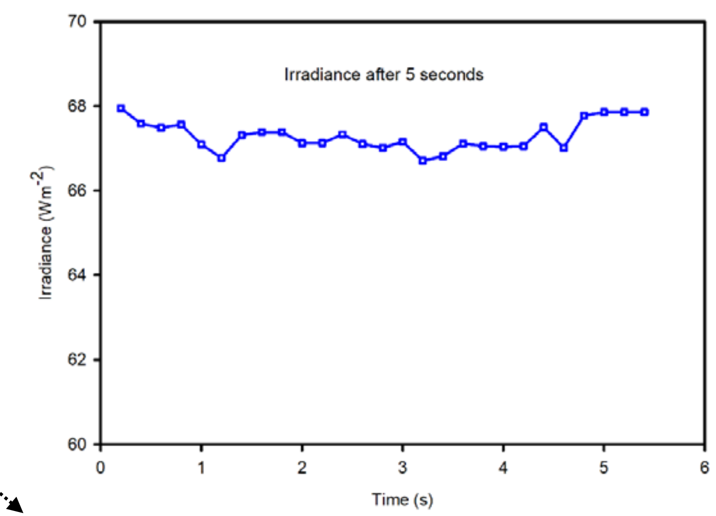
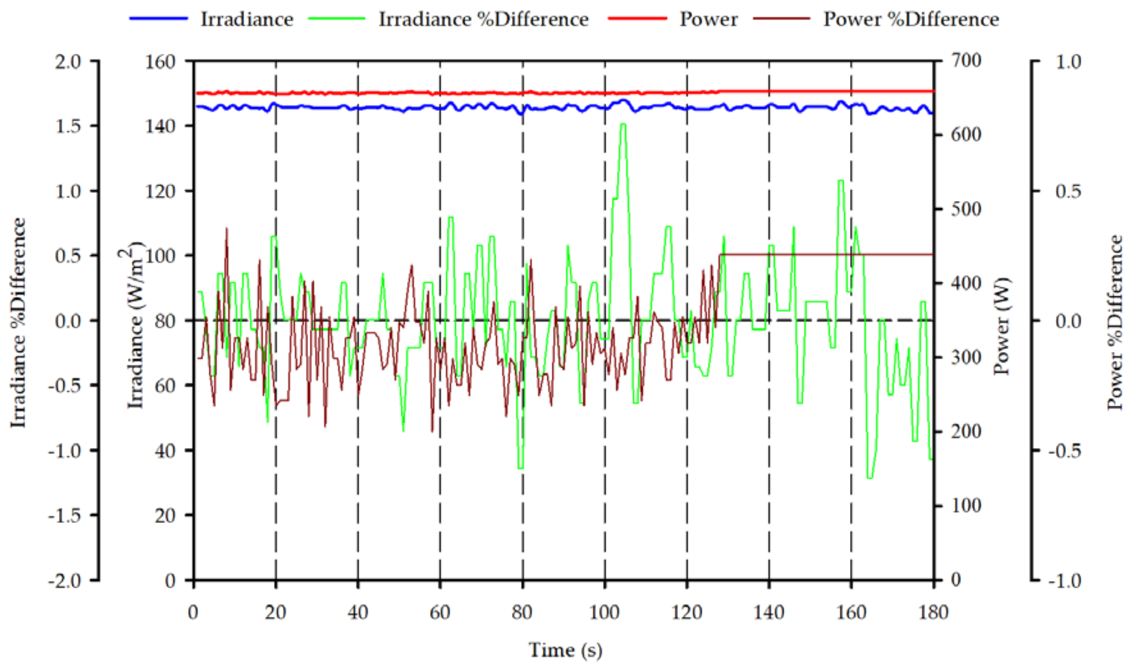


Figure 4: Xenon arc lamp power and irradiance distribution

Results

Lamp Input Power and Irradiance Test



1000 Wm^{-2} at 90% max current.

± 1.4% irradiance drift from set point.

Figure 5: Solar simulator operated at specific set point

Results

Irradiance and Temperature Test

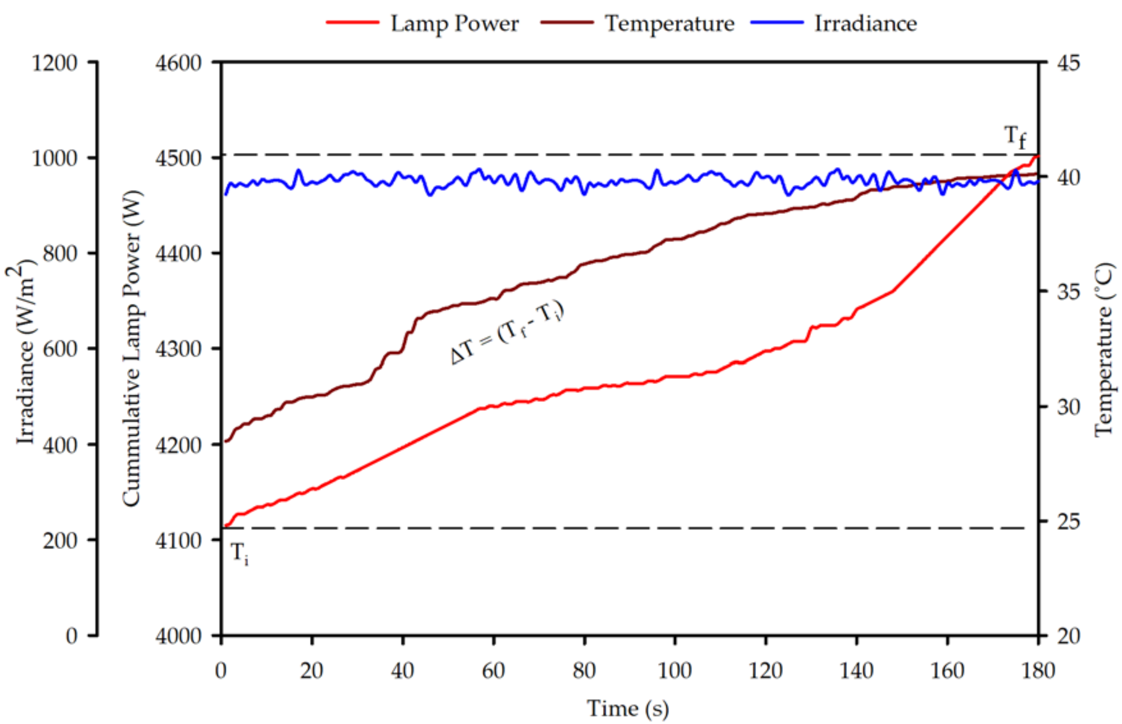


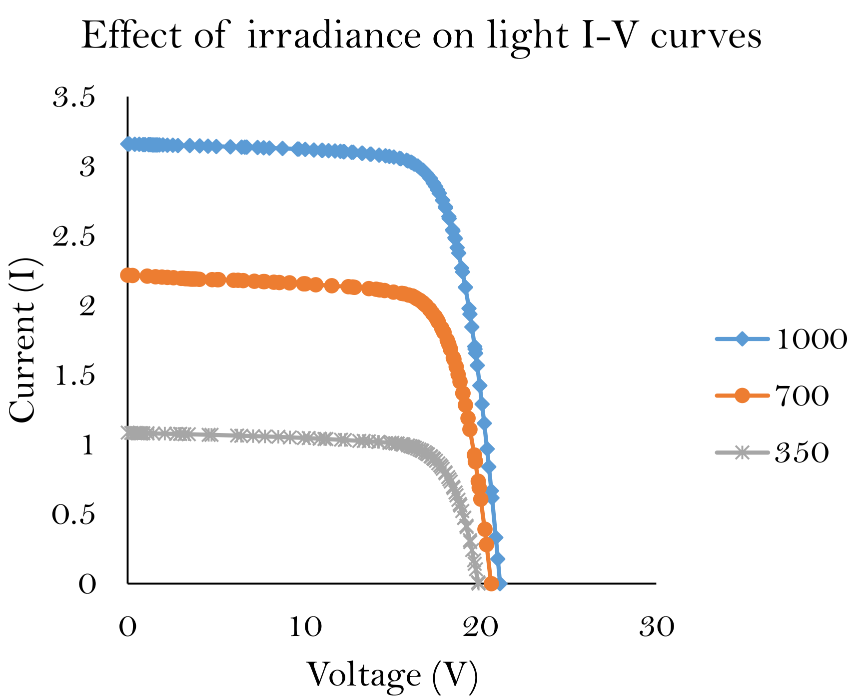
Figure 6: Solar simulator operated without temperature control

Non-Uniformity

Table 1: Non-Uniformity at varying irradiance set points

Power level	Current Drawn (A)	Cell surface Temperature (℃)	Non-Uniformity (%)
20 % of rated max	29	22.6	1.02
50 % of rated max	72.5	24.4	1.53
90 % of rated max	130.5	25.4	3.26

Results



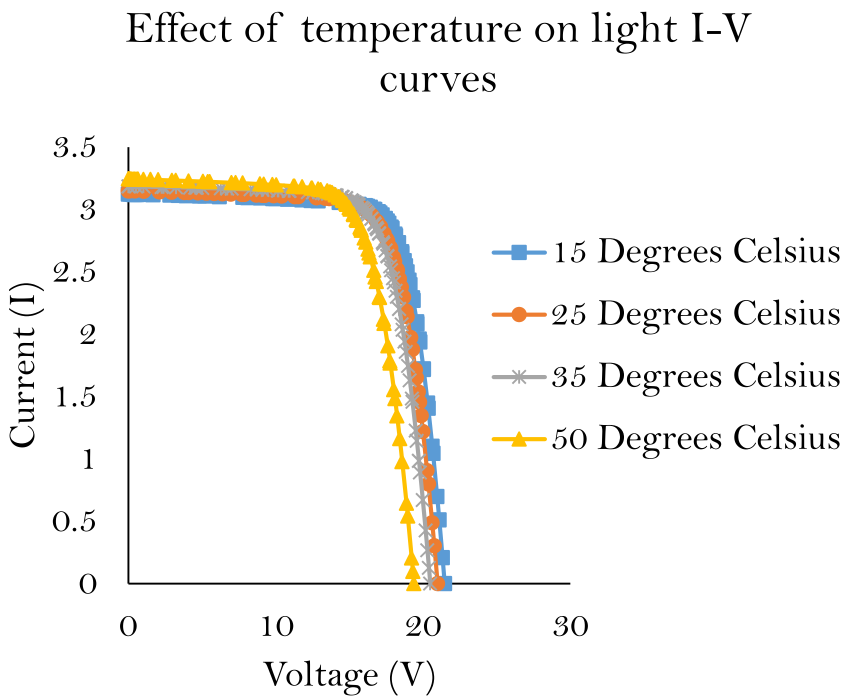


Figure 7: Photovoltaic PV module response

Conclusions

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IRRADIANCE — 1000 Wm^{-2} → 90% → <10 s to stabilize…

Indoor Testing — 1000 Wm^{-2} → Manufacturers Datasheet → Match

PERFOMANCE — Achieves Set points faster,…

References

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Thank you for your attention !

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