Photo Emission Tech., Inc.
862 Patriot Drive, # F, Moorpark, CA 93021 USA
Tel: (805) 482-5200 Fax: (805) 482-5252
Email:pet@photoemission.com

EXTERNAL QUANTUM EFFICIENCY MEASUREMENT SYSTEM MODEL # EQE2400

EQE2400 SYSTEM INTRODUCTION

Quantum Efficiency (QE) measurements provide a primary characterization method for completed photovoltaic devices. QE system provides electronics and software designed for fully automated measurement of external quantum efficiency of solar cells. All systems include probes and a fixed plate sample stage for samples up to 150mm x 150mm. The main system components include: custom designed software, measurement electronics, and computer system (Windows operating system).

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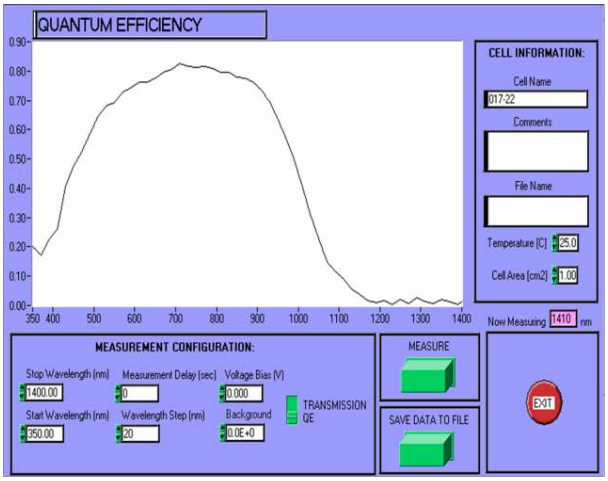
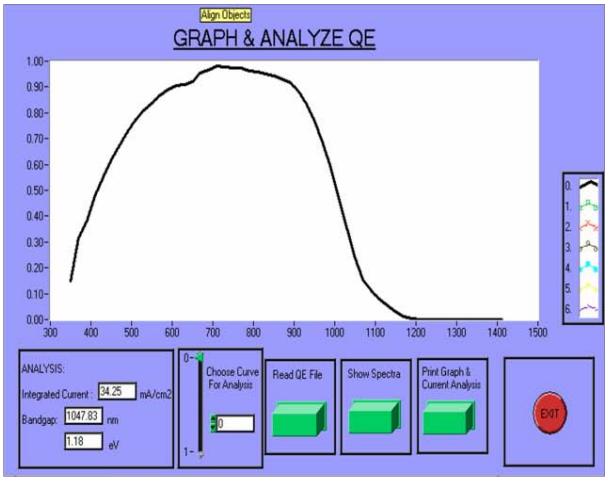
EQE2400 MAIN SYSTEM CAPABILITIES

The measurement involves focusing monochromatic light to a spot on the device under test, the n accurately measuring the photon flux and current from the test cell. The system utilizes a dual beam configuration with lock-in detection, providing an absolute accuracy of ±3%. The QE system uses a grating monochrometer with silicon/InGaAs/Ge detectors. The system includes automatic order sorting filters and two light sources for monochromatic illumination (a Xenon-arc lamp and a halogen lamp). A single lock-in amplifier is used to measure both the reference detector and test device. The main system comes with all the hardware needed to measure quantum efficiency, a fixed plate sample stage and probes.



The Quantum Efficiency Measurement Screen - example.



Custom-designed Analysis Software-example

Custom designed software using LabView2009^{TM}provides a user- friendly operation for data collection, plotting and analysis. The software provides flexibility and ease of use in the measurement and manipulation of QE. Full manual control over the mono-chrometer and order sorting filters is provided for diagnostic purposes. The wavelength range and step size during measurements are user definable. Data stored to disc can be directly examined within the supplied software, or can be exported to a text file readable by most third party software packages. Up to six data sets can be plotted on a single graph for comparison. The calculated QE is convoluted with a standard AM1.5 global spectrum to determine the short circuit current.

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EQE2400 SYSTEM PERFOMANCE SPECIFICATIONS

ITEM	*DESCRIPTION*
Solarcelltype	Superstrate,Rigid orFlexible, 1-5 milthickness
Solarcell size	Up to 150 mm x150mm
Gridarea	At least 2 mm x2 mm
Cooling	None
Solarcellmaterial	CIGS, CdTe, a-Si based multi-junctions, mono-silicon, organic, etc.
Monochromatorwavelengthaccuracy	±0.6 nm, that mono-chromator can read a wavelength, λ by λ +/- 0.6nm.
Monochromatormaxresolution	<1nm in visible range, that mono-chromator can read two wavelengths separated by 1 nm.
Measurementrange	300 nm to 1,800 nm
Type ofmeasurement	Internal quantum efficiency with options
Operation mode	Automatic, designed software using LabView2009™

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EQE2400 SYSTEM COMPONENTS

ITEM	*DESCRIPTION*
Computer and software	Custom designed software usingLabView2009^{TM}provides a user-friendly operation for data collection, plotting and analysis. The software provides flexibility and ease of use in the measurement and manipulation of QE. Full manual control over the mono-chromater and order sorting filters is provided for diagnostic purposes. The wavelength range and step size during measurements are user definable. Data stored to disc can be directly examined within the supplied software, or can be exported to a text file readable by most third party software packages. Up to six data sets can be plotted on a single graph for comparison. The calculated QE is convoluted with a standard AM1.5 global spectrum to determine the short circuit current.
Micro-positioners	Sample is mounted on a fixed plate sample stage and probes are provided for making current measurements.
Source Lamps	The systems allow a spot size of about 2mmx2mm with two light sources for monochromatic illumination (a Xenon-arc lamp and a halogen lamp).
Photodiode	It uses set of two silicon detectors and two germanium detectors for the reference detector and test device.
Beam splitter	The measurement involves accurately measuring the photon flux and current from the test cell using a beam splitter
Precision Light Chopper	It provides reference frequency for the lock-in detection
1/8 Mono-chromator	It uses a dual grating mono-chromater for performing quantum efficiency measurements of cells over the wavelength range from 260nm to 2,400nm. ***Option to extend to 2,500nm or higher.***
Automated Filter Wheel	Thesystem includes automatic order sortingfilters
Digital Lock-In-Amplifier	The system utilizes a dual beam configuration with lock-in detection.
Integrating sphere	3” cube integrating sphere to measure total reflectance
Frame	Welded steel construction, powder coated
Power requirements	110/220V, 50/60Hz,single-phase, 20 A

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EQE2400 SYSTEM OPTIONS

VOLTAGE BIASING

A DC power supply for voltage biasing the test device at up to ±5V can be included. An electric control box on back of the lock-in- amplifier is included to apply a voltage bias. The voltage bias is sometimes very useful to separate individual junctions properly from a multi-junction device. It also helps to look at collection losses in a junction.

WHITE LIGHT BIAS AND FILTER LIGHT BIAS CAPABILITY

A white light exposure simulates actual solar light conditions in a solar cell where as filtered light bias at different parts of the solar spectrum helps to isolate contributions from individual cells in a multi-junction cell.

TEMPERATURE CONTROL CAPABILITY

The temperature stage incorporates solid state thermoelectric detectors to provide a controlled measurement of temperature(±1°C) over 10°C to 60°C over a substrate of size up to 150mm x 150mm.The system does include a small pump to keep the stage under vacuum so that one does not have moisture build up at low temperatures.

X-Y STAGE CAPABILITY OPTION

An **OPTIONAL** X-Y stage allows moving of a sample in both directions up to120mm distances. The main platform is supported by four re-circulating ball carrier bearings mounted to precisely aligned linear guide rails, which together are capable of providing smooth motion for loads up to 20kg. A backlash-free lead-screw produces smooth translation that is directly driven by a two-phase stepper motor capable of 25,600micro-steps per revolution, thus yielding a positional resolution of less than100nm.Magnetic limit switches allow homing and over driving protection in both forward and reverse directions. It is driven by stepper motor controllers, which come with its own dedicated software package. The stage provides micro-stepping resolution of 40nm and speeds of up to 12 mm/s.

UNIVERSAL SAMPLE HANDLING CAPABILITY

The stage allows the measurement of a solar cell both in superstrate and substrate structures.

CALIBERATED DETECTORS

PET will provide two NIST traceable third party calibrated detectors for reference. Detectors will include interface cables to connect detectors to the QE system.

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