Photo Emission Tech., Inc.
862 Patriot Drive, #F, Moorpark CA 93021 USA
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EXTERNAL QUANTUM EFFICIENCY MEASUREMENT SYSTEM MODEL # EQE1800

EQE1800 SYSTEM INTRODUCTION

QuantumEfficiency(QE)measurementsprovideaprimarycharacterizationmethodforcompletedphotovoltaicdevices.QEsystemprovideselectronicsandsoftwaredesignedforfullyautomatedmeasurementofexternalquantumefficiencyofsolarcells.Allsystemsincludeprobesandafixedplatesamplestageforsamplesupto150mmx150mm.Themainsystemcomponentsinclude:customdesignedsoftware,measurementelectronics,andcomputersystem (Windows8operatingsystem).

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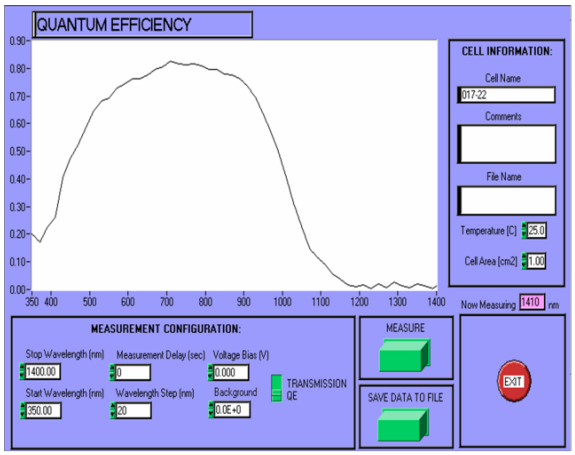
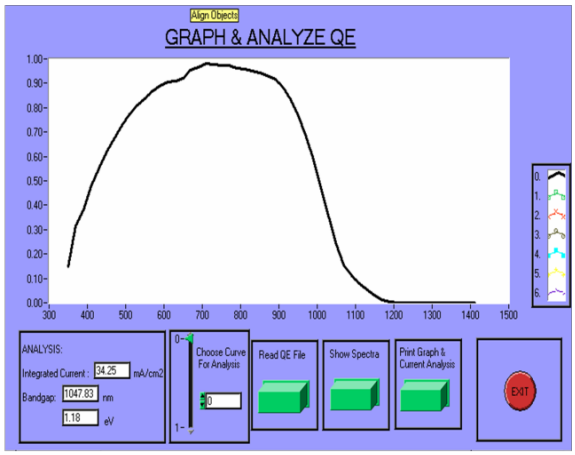
EQE1800MAIN SYSTEM CAPABILITIES

Themeasurementinvolvesfocusingmonochromaticlighttoaspotonthedeviceunder test,thenaccuratelymeasuringthephotonfluxandcurrentfromthetestcell.Thesyste mutilizesadualbeamconfigurationwithlock-indetection,providinganabsoluteaccuracyof±3%.TheQE systemusesagratingmonochrometerwithsilicon/InGaAs/Gedetectors.Thesystemi ncludesautomaticordersortingfiltersandtwolightsourcesformonochromaticillumin ation(aXenon-arclampandahalogenlamp).Asinglelock-inamplifierisusedtomeasureboththerefercedetectorandtestdevice.Themainsys temcomeswithallthehardwareneededtomeasurequantumefficiency, afixed platesample stage andprobes.



The Quantum Efficiency Measurement Screen - example.



Custom-designed Analysis Software-example

CustomdesignedsoftwareusingLabView2009™providesauser-friendlyoperationfordatacollection,plottingandanalysis.The softwareprovidesflexibilityandeaseofusein themeasurementandmanipulationofQE.Fullmanualcontroloverthemono-chrometerandordersortingfiltersisprovidedfordiagnosticpurposes.Thewavelengthrangeandstepsizedu ringmeasurementsareuserdefinable.Datastoredtodisccanbe directlyexaminedwithin thesuppliedsoftware,orcanbeexportedto atext filereadablebymost thirdpartysoftwarepackages.Uptosixdatasetscanbeplottedonasinglegraphforcomparison.ThecalculatedQE is convoluted with astandard AM1.5global spectrum to determine theshort circuitcurrent.

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EQE1800 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-Sibased multi-junctions, mono-silicon,organic,etc.
Monochromatorwavelengthaccuracy	±0.6 nm,thatmonochromatorcanreada wavelength,λ byλ +/- 0.6nm.
Monochromatormaxresolution	<1nminvisiblerange,thatmonochromatorcanreadtwowavelengths separated by1 nm.
Measurementrange	300 nm to 1,800 nm
Type ofmeasurement	Internalquantum efficiencywith options
Operation mode	Automatic, designed softwareusing LabView2009^{TM}

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EQE1800 SYSTEM COMPONENTS

ITEM	DESCRIPTION
Computerand software	CustomdesignedsoftwareusingLabView2009™providesauser-friendlyoperationfordatacollection,plottingandanalysis.Thesoftware providesflexibilityandeaseofuseinthemeasurementandmanipulationofQE.Fullmanualcontrolover themonochrometerandordersortingfiltersisprovidedfordiagnosticpurposes.Thewavelengthrangeandstepsizeduringmeasurementsareuserdefinable.Datastoredtodisccanbedirectlyexamined withinthesuppliedsoftware,orcanbeexportedtoatextfilereadablebymostthirdpartysoftwarepackages.UptosixdatasetscanbeplottedonasinglegraphforcomparisonThecalculatedQEisconvolutedwithastandardAM1.5globalspectrumtodetermine the short circuit current.
Micropositioners	Sampleismountedonafixedplatesamplestageandprobesareprovided formaking currentmeasurements.
SourceLamps	Thesesystemsallowaspotsizeofabout2mmx2mmwithtwolightsourcesformonochromaticillumination(aXenon-arclamp anda halogen lamp).
Photodiode	It uses set of two silicon detectors and two germanium detectors for the reference detector and test device.
Beam splitter	Themeasurementinvolvesaccuratelymeasuringthephotonfluxandcurrentfrom thetest cell usingabeam splitter
PrecisionLightChopper	It provides referencefrequencyfor the lock-in detection
1/8 Monochromator	It uses a dualgratingmonochrometerfor performingquantumefficiencymeasurementsofcellsoverthewavelengthrange from260nm to 1800nm.
AutomatedFilterWheel	Thesystem includes automatic order sortingfilters
DigitalLockIn Amplifier	Thesystemutilizesadualbeamconfigurationwithlock-indetection.
Integrating sphere	3” cube integrating sphere to measure total reflectance
Frame	Welded steel construction, powdercoated
Powerrequirements	110/220V, 50/60Hz,single-phase, 20 A

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EQE1800 SYSTEM OPTIONS

INTERNAL QUANTUM EFFECIENCY OPTION

AtotalreflectancemeasurementusinganintegratingsphereisOPTIONALfor measurement of InternalQuantumEfficiency(I Q E) ofasolarcell.ThedataanalysisoptioncalculatesIQE=EQE/(1-R),whereRisreflection.For monocrystalline silicon basedsolarcells, this is amust option.

VOLTAGEBIASING

ADCpowersupplyforvoltagebiasingthetestdeviceatupto±5Vcanbeincluded.Anelectriccontrolboxonbackofthelock-in-amplifierisincludedtoapplyavoltagebias.Thevoltagebiasisveryusefulsometimetoseparateindividualjunctionsproperlyfromamulti-junctiondevice.Italso helps to look at collectionlosses in a junction.

WHITE LIGHTBIAS ANDFILTERLIGHTBIAS CAPABILITY

Awhitelightexposuresimulatesactualsolarlightconditionsinasolarcellwhereasfilteredlightbiasatdifferent partsofthesolarspectrumhelpstoisolatecontributionsfromindividualcells in a multi-junction cell.

TEMPERATURE CONTROL CAPABILITY

Thetemperaturestageincorporatessolidstatethermoelectricdetectorstoprovideacontrolledmeasurementoftemperature(±1°C)over10°Cto60°Coverasubstrateofsizeupto150mmx150mm.The systemdoesincludeasmallpumptokeepthestageundervacuumsothatonedoesnot havemoisturebuild up at low temperatures.

X-YSTAGECAPABILITY OPTION

An **OPTIONAL**X-Ystageallowsmoving ofasampleinbothdirectionsupto120mmdistances.Themainplatformissupportedbyfourre-circulatingballcarrierbearingsmountedtopreciselyalignedlinearguiderails,whichtogetherarecapableofprovidingsmoothmotionforloadsupto20kg.Abacklash-freelead-screwproducessmoothtranslationthatisdirectlydrivenbyatwo-phasesteppermotorcapableof25,600micro-stepsperrevolution,thusyieldingapositionalresolutionoflessthan100nm.Magneticlimitswitchesallowhomingandoverdrivingprotectioninbothforwardandreversedirections.Itisdrivenbysteppermotorcontrollers,whichcomewithitsowndedicatedsoftwarepackage.Thestageprovidesmicro-steppingresolutionof40nmandspeeds of up to 12 mm/s.

UNIVERSAL SAMPLEHANDLINGCAPABILITY

Thestage allowsthe measurement of a solarcell both in superstrateandsubstratestructures.

CALIBERATED DETECTORS

PET willprovidetwoNISTtraceablethirdpartycalibrateddetectorsforreference.Detectorswillincludeinterfacecablestoconnectdetectorstothe QEsystem.

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