

SCIENCETECH



Designer and Manufacturer of Scientific Instruments Since 1985

SOLAR SIMULATORS MANUFACTURER



Fully Reflective Technology

Table of Contents

INTRODUCTION TO SCIENCETECH SOLAR SIMULATORS

Fully Reflective Design.....	1
Air Mass Filters.....	1
Customization.....	1
Solar Simulation.....	2
Solar Constant.....	2
Performance Measurements.....	3

SCIENCETECH SOLAR SIMULATORS

Collimated Solar Simulator	SF-150.....	4
Fully Reflective Solar Simulator	SS-150.....	6
High Power Fully Reflective Solar Simulators.....	SS 5KW,1KW,1.6KW,2.5KW.....	9
Triple Solar Simulator.....	SS..7.5 KW.....	12
Dual 2.5KW Solar Simulator.....	DSS-2.5KW.....	13
For UV Applications.....	SSUV.....	14
Highly Collimated Fresnel Lens Solar Simulators.....	SS-Xe-Fr.....	15
Pulse Solar Simulator.....	PSS06.....	16
Flash Solar Simulator Concentrators.....	FSSC-4000.....	17
Modular Systems for Solar Cell Testing		
Spectral Response Measurement.....	SS-SR-150.....	18
Quantum Efficiency Measurement.....	SS-QE-150.....	18
Internal Quantum Efficiency Measurement.....	SS-IQE-150.....	19
Constant Photocurrent Method System.....	SS-CPM-150.....	20
I-V Test Measurement System.....	SSIVT.....	21
Load Meter.....	LOAD-LM1.....	22
Test Software & Reference Cells.....	SCISPIV,SCIRUNIV,SCIRUNQE	23
Solar Cell Chuck.....	SCI-SCC4.....	25

ACCESSORIES

Air Mass/Solar Filters.....	AM.....	26
Specialty Filters		
UV Blocking Filter.....	UVBlock.....	26
IR Absorbing Water Filter.....	01-8711 12/2-SS.....	26
Hot mirror for UV Applications.....	HM-UVAB-3x3SS.....	26
Band Pass UVA+B Filter.....	UG11WG320x1/3.....	26
Band Pass UVA Filter.....	UVAB-1inch/3inch.....	27
Large Neutral Density Filters.....	OD.....	27
Spare Xenon Lamp.....	100XX-XOF.....	27
Electronic Shutter.....	SSSES.....	28
High Speed Shutter.....	600-VS25-INT Solar.....	28
Variable Focus.....	SSVF-SS.....	28
Alignment Package.....	SSAKF-01.....	29
Beam Turning Assembly for SS-150 Solar Simulators.....	CTBT.....	29
Downward Facing Vertical Stand.....	DFS.....	29
Light Intensity Stabilizer.....	FS-02.....	30
Step-Up Voltage Transformer.....	VTrans.....	30
Output Fiber Bundle.....	FBO.....	30
Water Recirculating Cooler - Sample Cooling Pad.....	130-REC.....	31
Temp. Controller with Thermoelectric Elements.....	EGV 10.....	31
Broadband Thermopile Detector (Power Meter).....	UP19K.....	32
Temp. Control Device & Vacuum and Pressure pump.....	TC-3700.. VP-60.....	33
Solar Cell Testing Workstation.....	SSTwrkstn.....	34

Mission Statement: “To serve the New Product Development market in the field of Optics and Spectroscopy with dedication, integrity and excellence.”

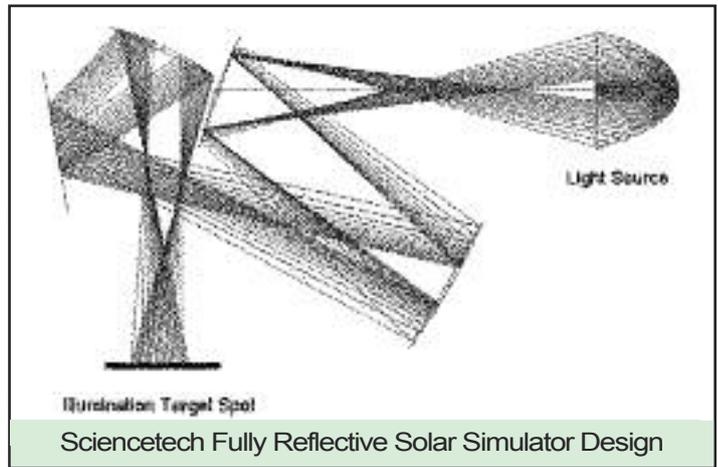


Sun Dogs - Original Photograph by Eric AxdaHL from Wikipedia Image:Sundogs - New Ulm.JPG
 This work is licensed under the Creative Commons Attribution-ShareAlike 2.5 License.

Sciencetech solar simulators produce high intensity, uniform illumination on a target area. Typically, high power solar simulators use an ellipsoidal reflector to capture light from an arc lamp source (usually xenon) inside the reflector, an arrangement that results in a light pattern with a bright outer region and a dark center. This non-uniformity is unacceptable in many solar simulator applications. Where better uniformity is required, many solar simulator designs use diffusers to reduce the non-uniformity, but this results in a reduction in intensity and a distortion of the spectrum on the target area.

Fully Reflective Design

Sciencetech’s solution to these problems is to use a unique system of mirrors that “fold” the light onto the target plane so that less light is lost and there is no spectral distortion. Sciencetech is the only manufacturer that uses this fully reflective principle, making our SS series solar simulators much more efficient. The fully reflective design also ensures no chromatic aberration in the output beam which is a problem other systems have. Figure 1 shows the optical arrangement of Sciencetech’s all reflective solar simulators.



Air Mass Filters

Solar simulators are adjusted to imitate the spectral distribution of sunlight for a variety of environments such as outside the earth’s atmosphere, or at sea level for various sun angles. The spectral distribution from the xenon arc lamp source is altered and refined using Air Mass (AM) filters. Sciencetech’s AM filters are designed to be used individually for standard conditions (though they can also be arranged in series to produce other spectral distributions). Many solar simulator systems *require* filters to be used in series to achieve the same performance as Sciencetech’s filters, for example using AM0 and AM1.0 filters in series to achieve AM1.0 spectral distribution, whereas Sciencetech’s AM1.0 filter is used alone to achieve the same result, reducing the associated power loss and filter cost.

Customization

Sciencetech’s fully reflective solar simulators can be customized for your needs by selecting the appropriate lamp power, target size and target distance. Our Special Development Group is happy to help you customize your device and can be contacted by email: sales@sciencetech-inc.com.

Solar Simulation

Sciencetech Solar Simulators use high pressure xenon arc lamp sources and air mass filters to match the spectrum of light emitted by the sun to Class A standards. Using the xenon lamp allows the design of an optical system that produces an intense, collimated beam. The spectra of the xenon source and the sun are both close to that of a 5800K blackbody, the biggest difference being the xenon lines present in the arc spectrum, and atmospheric absorptions in solar spectra. The difference is especially pronounced in the 800-1100nm range because of the intense line output of the lamp. An AM0 filter reduces this effect so that the average level in specified bands matches solar levels above the atmosphere to better than 25%, although complete elimination of the xenon lines while preserving the rest of the spectrum is impossible with a practical filter. AM1.0, 1.5 and 2.0 filters further modify the visible and UV portions of the spectrum for different sea-level conditions. A xenon-mercury lamp is available for applications which depend on the UV spectral region where it provides better power levels the xenon lamp.

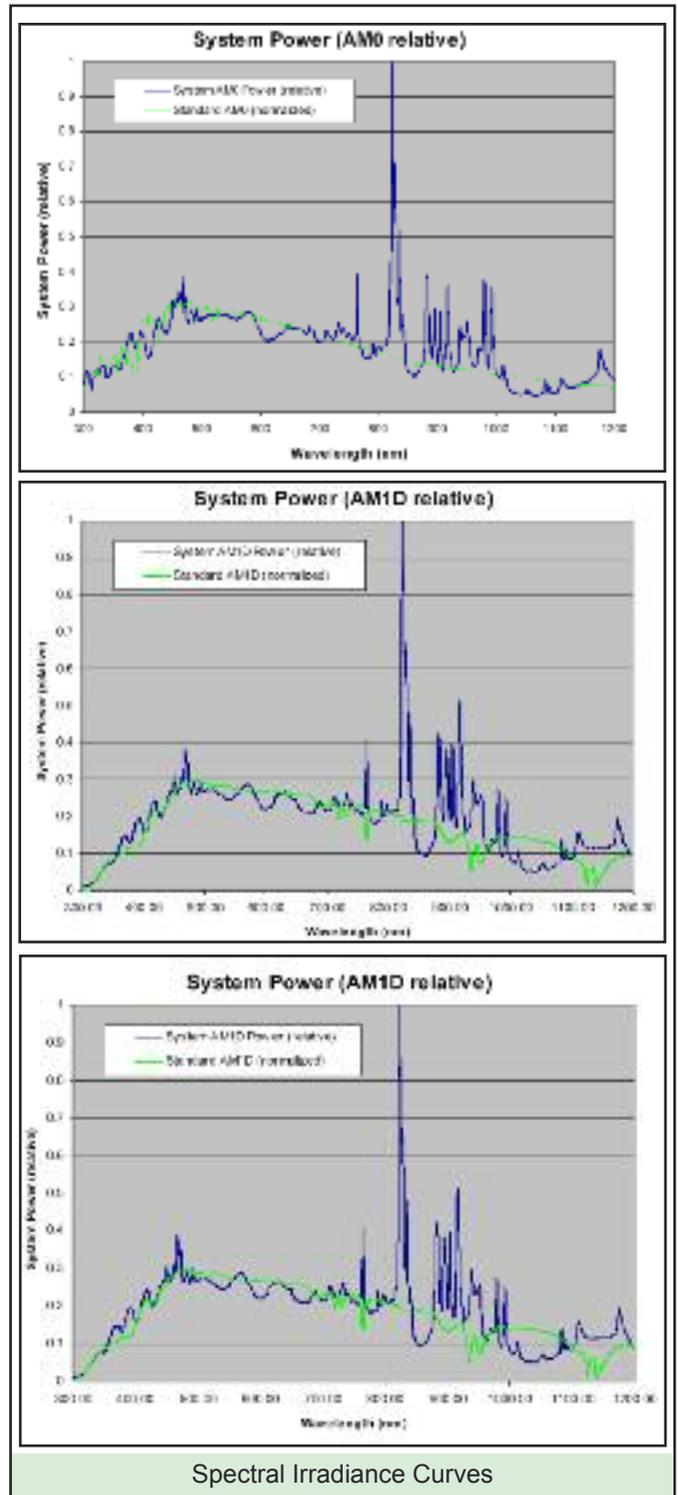
Figure 2 shows the typical output spectra of Sciencetech's Fully Reflective Solar Simulators. These spectra combine the spectral curves of the xenon arc lamp source, air mass filter, and mirrors used inside the solar simulator beam homogenizer. Actual output spectra may vary due to the condition of the lamp and possible manufacturing tolerances of the air mass filters. In order to simplify visual comparison of the spectral curves of our solar simulators with ASTM standard curves, the simulator outputs are normalized to the corresponding standard spectrum. The normalization covers the range for which standards are defined: 300-1200nm.

For applications that require a smoother spectral match longer than 750nm a custom dual-source unit with both Xenon and Tungsten lamps can be provided.

The Solar Constant

The radiation from the sun is measured in two ways for use in a variety of fields of research. The Solar Constant is the irradiance or intensity of light incident at the surface of the Earth's atmosphere on a plane normal to the angle of incidence. This value is defined by the World Meteorological Organization to be 1366.7Wm⁻². The irradiance of the sun at the Earth's surface varies under different conditions due to absorption and scattering effects in the atmosphere, and so a number of other constants are important with regards to the irradiance of a solar simulator.

Below the atmosphere the radiation can be divided into two components: direct radiation that comes from the sun itself, and scattered radiation coming from the rest of the sky, including a portion reflected back from the ground. When discussing filters, the direct radiation spectrum is imitated using a direct (D) filter, and the total including



scattered sky and ground radiation is matched by using a global (G) filter that imitates both components together. The table below gives the 1 SUN irradiance values for both filter types at a number of common conditions that can be simulated.

Solar Spectrum:	Filter	Power Density (mWcm ⁻²)
In Space	AM0	136
Direct solar spectrum at 0° zenith angle	AM1.0D	85
Global solar spectrum at 0° zenith angle	AM1.0G	100
Direct solar spectrum at sea level and 37.5° zenith angle	AM1.5D	90
Global solar spectrum at sea level and 37.5° zenith angle	AM1.5G	100
Direct solar spectrum at sea level and 60.1° zenith angle	AM2.0	65

Detectors available today can detect spectra between 250-2500nm, so the irradiance constants for this range have been provided.

The Air Mass filters reduce the total light power output by the solar simulator, though Sciencetech's independent AM filters lose less than filters produced by other manufacturers that must be stacked. The transmissions relative to unfiltered light between 250-2500nm for Sciencetech's AM filters are approximately as follows

Unfiltered Light	100%
AM0 Direct	61.3%
AM1 Direct	67%
AM1.5 Direct	65%
AM1.5 Global	58.5%
AM2 Direct	57.3%

Performance Measurements

Sciencetech solar simulators are most often used in photovoltaic testing applications and so the relevant standards are discussed here. Our solar simulators can be modified to suit your needs if you have interests in other areas

Sciencetech's fully reflective solar simulators have excellent performance due to their proprietary design. Performance is measured in accordance with the three parameters laid out in ASTM 927-05, IEC 60904-9 and

JIS-C-8912 standards for photovoltaic cell testing. These parameters are listed as:

- 1) Non-uniformity of spatial irradiance
- 2) Spectral match to a reference spectral irradiance
- 3) Temporal instability of irradiance,

and performance classifications are:

Classification	Spectral Match to all intervals	Spatial Non Uniformity of Irradiance	Temporal Instability of Irradiance
Class A	.075 to 1.25	±2%*	≤2%***
Class B	0.6 to 1.4	±5%**	≤5%****
Class C	0.4 to 2.0	±10%	±10%

ASTM: * 3% for target size ≥30cm;
JIS: ** 3%; *** 1%; **** 3%

1) Non-Uniformity of Spatial Irradiance

ASTM standards require that at least 36 intensity readings covering a minimum of 25% of the total surface area be taken and averaged in order to determine the non-uniformity. The maximum and minimum values are compared and the uniformity is classified as Class A, B or C as indicated above.

2) Spectral Match to a Reference Spectral Irradiance

The output spectrum of the solar simulator is compared to that of natural sunlight. Standards are defined for the range from 400nm to 1100nm which is divided into 6 intervals. The deviation of the radiation in each interval from the standard values (determined from tables in ASTM G173-03) IEC60904-3 and JIS-C-8912 determines the Class for the interval, and the worst performing interval determines the class of the solar simulator for this parameter. Class A spectral match is available with Sciencetech's solar simulators depending on model and AM filters.

3) Temporal Instability of Irradiance

This parameter represents the fluctuation of the measurement system during the interval required to fully obtain a current-voltage (I-V) curve which depends on the application. Sciencetech's solar simulators reach 1% stability after a 5 minute warmup.

Each solar simulator is configured to your needs. Speak with a representative, or the Special Development Group sales@Sciencetech-inc.com to select the configuration that best suits your requirements. The design of the reflective solar simulator permits a trade-off between power and uniformity. Higher uniformity can be had at a lower power; or power can be increased with some loss in uniformity.

SF150 Collimated Solar Simulator



Sciencetech is proud to offer a low cost SF150 solar simulator system that includes arc lamp housing, bulb, power supply with igniter, filter holder, and UV fused silica collimator. An option for fiber optic illumination is available, requiring an additional condenser and fiber mount.

The SF150 produces a 2.5cm (1") diameter collimated beam using a 150W (ozone free) xenon lamp with Sciencetech's 201-100 air cooled arc lamp housing (2" diameter optics are available as an option). The system is powered by the Sciencetech 500-200 power supply and igniter.

A multiple filter holder allows the user to selectively trim the xenon spectrum to match the desired Air Mass spectrum. The solar filters available are for AM0, AM1.0, AM1.5 direct and global, and AM2.0. Other filters such as dichroics and bandpass filters are available for further modification of the spectrum. Please specify which filters should be sent with the solar simulator when ordering.

Power Output

The solar simulator typically provides up to 1.6 SUNs (160mW/cm²) at its 25mm (1") diameter output port with an AM1.5G filter. By using a larger lamp, powered at 200W approximately 2 SUNs (200mW/cm²) can be achieved. Normally, the solar simulator is operated at 1 SUN

Non-Uniformity

The SF150 solar simulator provides class A (or B with additional power) non-uniformity over the full field just beyond the output. If the class B non-uniformity location is inconvenient. The uniform full field can be projected outward to a more suitable position (and selectable size) using additional coupling lens. Sciencetech will be glad to position this surface at your working distance. Please talk with your sales agent to confirm the specifications required.

Spectral Range

The solar simulator provides a broadband spectral range of 250-2500nm without any filters. Please note that the spectrum may be affected if a fiber optic bundle attachment or hand probe attachment is used.

Technical Specifications

Lamp Housing:

Sciencetech 201-100 air-cooled research arc lamp housing, Includes back spherical reflector, alignment adjustments

Center beam line height:

136.88mm (5.389") (not including adjustable feet)
One collimating lens 25mm (1") or 50mm (2") diameter UV Fused Silica at the housing exit port

Lamp:

100-150XOF, 150W ozone free, xenon lamp

Coupling & Filters:

Standard filter holder mounts one filter, an additional filter holder or lens can be added

Power Supply & Igniter:

Sciencetech 550-200 highly regulated, linear, adjustable power supply for arc lamps up to 250W; 510- IG igniter for 210 series arc lamp housing.

Input:

110-115v/60Hz or 220-240v/50Hz (selectable)

Power:

0-200W
Operating Voltage - 0-30V
Operating Current - 0-10A
Pre-ignition Voltage >80V
Ripple at Maximum Current <1%
Stability After Warm-up - 0.05%

Line Voltage Regulation:

0.02% current variation for 5V line change

Display:

Digital LCD

Cooling Fan:

120VAC cooling fan

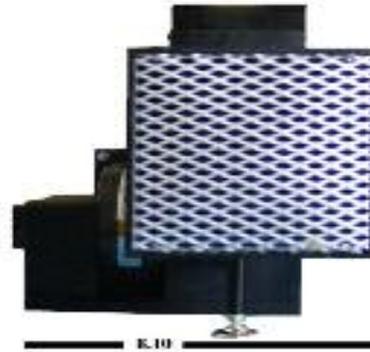
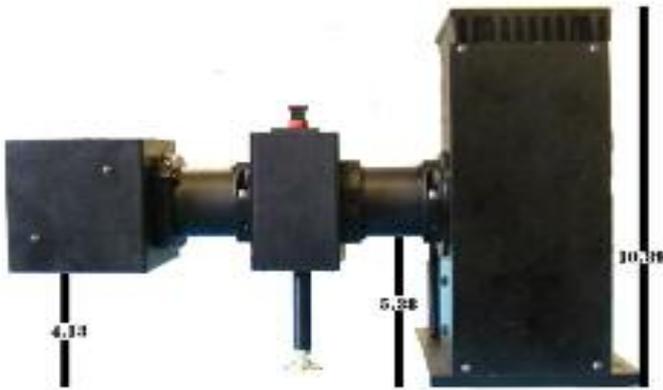
Spatial Non-uniformity:

14% typical, 5% at selected target locations or with additional coupling optics 2% with uniformity mask.

Dimensions and Weight:

51cm x 46cm x 39cm (20in x 18in x 15in)
20kg (44lbs)

Version/Model	Description	Price
SF150-C	150 w Collimated Solar Simulator Class C Non-Uniformity	\$6,126
SF150-A or SF150 B	150 W Collimated Solar Simulator Class A or B (Higher Power) Non-Uniformity	\$6,808



SF 150 Solar Simulator with Beam Turner

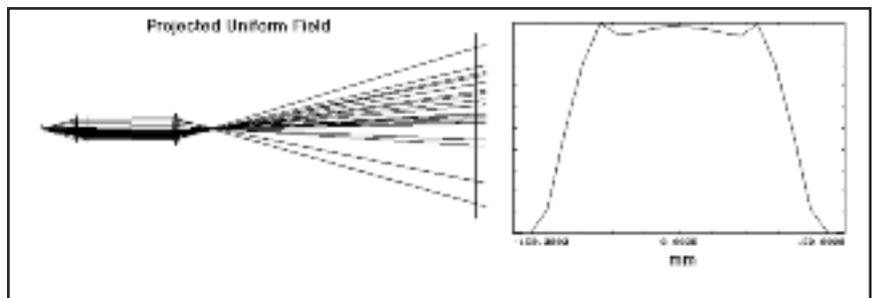
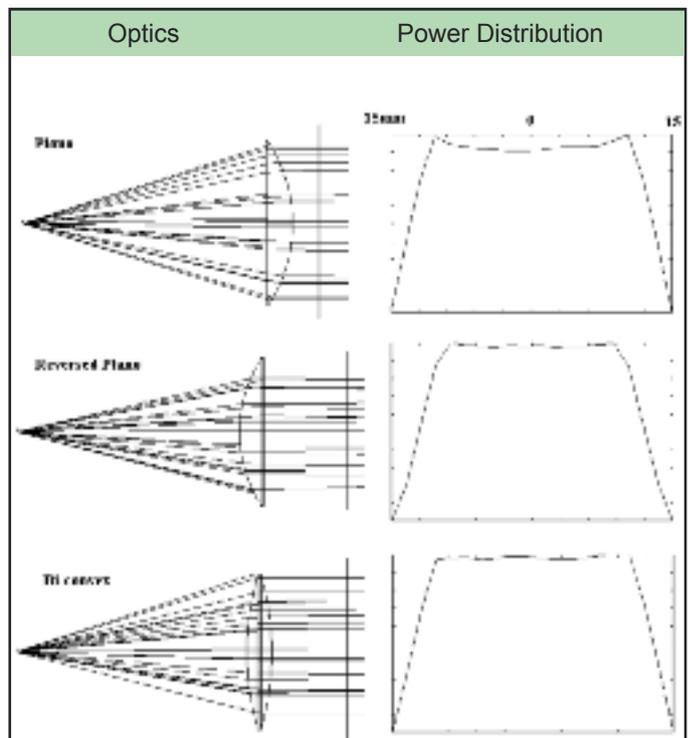
The SF150 illuminator provides a collimated uniform beam. But just how uniform and how collimated depend on the particular lens used and the location of the target field. Modeling with Zemax for a point source and a 1" diameter f/1.5 collimator lens, plano or biconvex gives the table below. It shows the collimation radius for a point source and the position and uniformity at the optimum location.

Lens	Collim.	Unif.(+/-)	Diam.	Pos. (past lens)
Plano	0.5°	5%	20mm	~10mm
Plano Rev	2°	<2%	18mm	~17mm
BiConvex	0.7°	<2%	22mm	~20mm

A plano lens is normally mounted convex side out for best collimation, but it can be reversed instead to get much better uniformity, although collimation is much worse. A biconvex lens gives a good tradeoff.

In practice, the collimation radius is actually larger due to the length of the arc itself. With a 1.5" f.l. collimator this amounts to 1.7°; 0.9° degrees with a 3" f.l. collimator. (The lens contribution remains the same).

A problem for uniformity is that the optimum position is so close to the collimating lens. For many applications the uniform field can be projected to a different size and location with additional optics. In most cases a single coupling lens can be used, but if full collimation is wanted the final lens must be at least as big as the target.



SS150 Fully Reflective Solar Simulator



The Sciencetech SS150 class AAA fully reflective solar simulator is designed for general research applications, particularly solar cell testing following the ASTM E927-05 and IEC-60904-9 standards. The diameter of the illuminated target can be adjusted, and can illuminate solar cells in the 5 x 5cm to 10 x 10cm (2"x2" to 4"x4") size range at 1 SUN.

The SS150 features a fully reflective design that does not require lenses or diffusers to make the output uniform at the target plane. This results in optimum throughput efficiency for the solar simulator, making Sciencetech solar simulators more efficient than competitive designs. The fully reflective design uses only mirrors to direct the light beam from the arc lamp source to the target plane, and produces high intensity, uniform illumination at the target plane. This design provides 1.3 times the output power at the target of competing simulators that use the same wattage of arc lamp and diffusers to make the light field uniform at the target. The high pressure xenon lamp gives an excellent basic match for solar simulation and the solar spectral distribution at different Earth conditions can be simulated through use of Air Mass filters.

This solar simulator requires a special lamp in order to achieve good spatial uniformity (100-150XOF-SS). This is due an irregularity in the glass surface where the hole used for gas insertion is closed off in the normal manufacture of these arc lamps. (The larger fully reflective solar simulators do not require special lamps)

Other Spectral Applications

The output light spectral distribution can also be custom tailored with different removable transmission and reflection filters such as a "water" filter or dichroic mirror. For UV type illuminators we offer a mercury-xenon lamp to enhance UV

Power Density From Sciencetech's Fully Reflective 150W Solar Simulator	2350W/m²
Power Density From Diffuser Based Competitive 150W Solar Simulator:	1805 W/m ²
Improvement in output: 1.3X	

Highlights

Standard Features

- Class AAA
- Fully reflective design for optimum power through put and efficiency
- No light absorbing diffuser or lens
- 150W ozone free xenon arc lamp system
- 50-100mm (2-4") diameter target size (Please specify when ordering)
- Built-in dual filter holder for 76 x 76mm (3 x 3") filters
- Filters can be exchanged or removed through an access panel
- Standard horizontal operation, vertical option
- Air cooled

Optional Features

- Floor stand for vertical operation
- Folding mirror to redirect output beam
- Electronic shutter
- Optical feedback intensity stabilizer
- Water cooling

output. This solar simulator is often configured with a xenon lamp and AM1.5G filter to illuminate a 76mm (3") diameter spot at 1 SUN for solar cell testing.

Spectral Range

The SS150 provides a broadband spectral range of 250-2500nm without any filters.

Solar Cell Testing

Solar cell testing requires strict uniformity to meet the ASTM E927-05 and IEC-60904-9 ANSI standards. For the fully reflective solar simulators to meet the Class A uniformity requirement only the inside portion of the illuminated target spot is used. This is because the uniformity falls rapidly at the outer edge of the illuminated target spot, so the last few millimeters at the edge only meet Class C. The inside spot maintains a 2% non-uniformity, which is in compliance with the ASTM E937-05 and IEC-60904-9 ANSI standards for solar cell testing. Sciencetech also offers optional computer generated spatial filters to meet particular needs (for example 1% non-uniformity).

Version/ Model	Description	Price
SS150	150W Fully Reflective Solar Simulator	\$12,073

Technical Specifications

Total Output Power on Target:

9W with 150W arc lamp (no filter)

Uniformity:

Constant within 15% over full field
2% over central field

Stability of Power on Target (Short Term):

± 1% after 10 minutes

Stability of Power on Target (Long Term Due to Aging of Lamp):

20% (after 1000 hrs)

Wavelength Control:

Solar and Bandpass Filter

Target Diameter:

(Typical, class A uniformity)
50mm (2") at 380mm (15") from output
100mm (4") at 890mm (35")

Power Density:

(no filters, 2" diameter target): 2350W/m²

Distance to Target (typical range):

(from output window of solar simulator)
380-890mm (15" – 35")

Input Aperture:

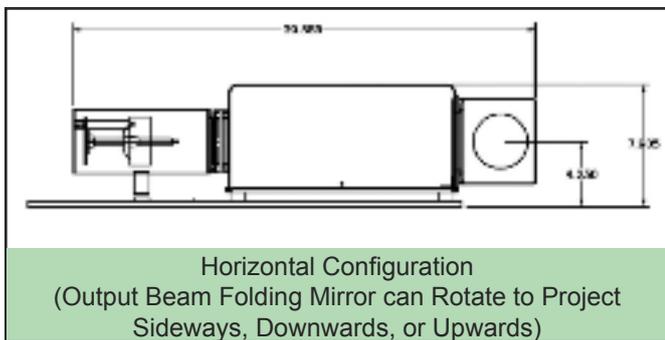
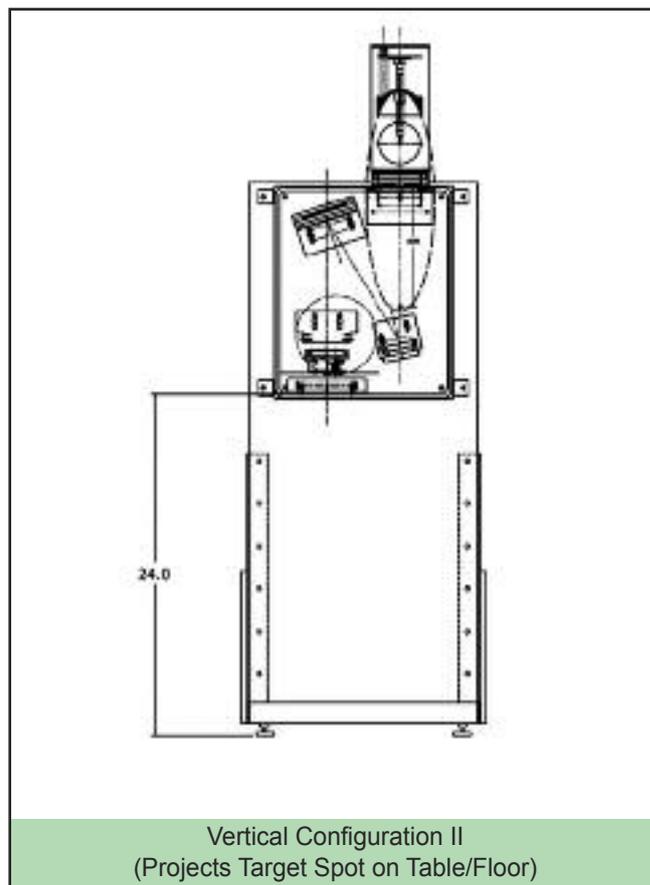
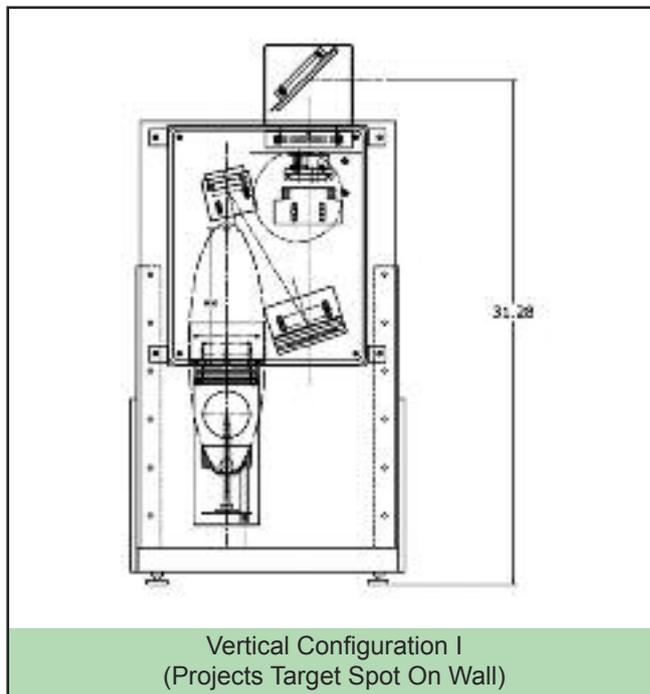
f/2.5 Filter holder accepts up to three 76 x 76mm
(3 x 3") AM filters in series
Includes a filter access door for easy removal.

Dimensions (without power supply):

635 x 304 x 177mm (25 x 12 x 7")

Weight (approx.):

15 kg (33lbs)



Output Power

Using an AM1.5G filter, the SS150 produces 1.5 SUN on a 76mm (3") diameter field at a distance of 609mm (24") with class A uniformity. This can illuminate a sample such as a solar cell up to 50 x 50mm (2 x 2") in size.

Distance from Exit	15" 381mm	24" 610mm	35" 889mm
Beam Diameter (Class A)	2" 51mm	3" 76mm	4" 102mm
Area (cm ²)	20.3	45.6	81.1
Power Density without filters (mW/cm ²)	502	239	125
Power Density with AM0 filter (mW/cm ²)	308	147	77
Power Density with AM0 filter solar constants (SUN)	2.3	1.1	0.6
Power Density with AM1.5G filter (mW/cm ²)	294	140	73
Power Density with AM1.5G filter solar constants (SUN)	3.1	1.5	0.8

Spatial Non-uniformity

This model is designed specifically for solar cell testing and meets ASTM Class A standards at 2% at 1/2 the Class B field diameters listed above

Spectral Match

The spectral match for the SS150 also meets Class A standards and is shown below for each interval:

Interval	Actual	ASTM	Deviation
400~499nm	21.2%	18.4%	15%
500~599nm	20.9%	19.9%	5%
600~699nm	16.4%	18.4%	-11%
700~799nm	12.2%	14.9%	18%
800~899nm	14.0%	12.5%	11.2%
900~1100nm	12.5%	15.9%	-21%

Component Information

The Sciencetech SS150 solar simulator consists of standard modules integrated on a common base bracket.

Sciencetech 200-100 Arc Lamp Housing

Sciencetech 200-100 arc lamp housing with quartz windows (>250nm), air cooled. Includes f/4.5 ellipsoidal reflector for high light throughput and lamp position alignment adjustments.

Sciencetech 550-200 Adjustable Arc Lamp Power Supply and 500-IG Igniter

Power:	Arc lamps up to 200W
Main Input:	90-270VAC (auto-switch)
Frequency:	50/60Hz
Wattage:	150W
Aux. Output:	12V/3.5VA (isolated or for fan)
Lamp stage output:	0-12V/20mA
Lamp Output Stability Current regulation:	better than 1%
Ripple:	less than 1%
Lamp Ignition High Voltage:	25kV
Ignition Voltage power supply:	80V
Maximum Current:	24Amp

Sciencetech 100-150XOF 150W Xenon Arc Lamp

Ozone Free	
Voltage:	17.5 Volts DC
Current:	8.5A
Light intensity:	290cd
Luminous flux:	2900lm
Average luminance:	200cd/mm ²
Arc size:	0.5mm x 1.6mm
Average life:	1200hrs (horizontal), 3000hrs (vertical)
Diameter:	20mm
Cooling Fan	120VAC cooling fan

Sciencetech 5511BC Beam Homogenizer

Includes housing, segmented folding mirror, coupling mirror, filter holders, mount for 150W arc source to beam conditioner, model AD-LBC Adapter for 200-400 arc lamp to beam conditioner

Solar Filters

Please note that the solar filters are sold separately. Please check the Accessories section for available Solar Filter choices. The SS150 uses 76 x 76mm (3 x 3") filters.

High Power Fully Reflective Solar Simulators



Sciencetech manufactures four high power versions of its class AAA ultra-high efficiency solar simulator. The smallest is the 500W unit, which approaches the power output of most conventional 1000W systems on the market. Sciencetech also manufactures 1000W, 1600W and 2500W units which provide significantly greater illumination levels than competing models of the same power rating.

A 7.5KW system that uses three 2.5KW units is described in the next section. For still higher power levels please contact the Sciencetech Special Development Group at sales@sciencetech-inc.com

Sciencetech solar simulators are ideal for high intensity applications and where energy level is important. A high pressure xenon arc lamp is used as the light source in this solar simulator model. The spectral distribution of this source, combined with specially calibrated Air Mass filters, can simulate the sun's true spectral distribution at various conditions on Earth and in Space (the Sun at various angles in the sky, or without atmospheric interference).

These units feature a fully reflective design that does not require lenses or diffusers to make the output uniform at the target plane. This results in optimum throughput efficiency for the solar simulator, making Sciencetech solar simulators more efficient than competitive designs. The fully reflective design uses only mirrors to direct the light beam from the arc lamp source to the target plane, and produces high intensity, uniform illumination at the target plane.

Version/Model	Description	Price
SS0.5KW	500W Fully Reflective Solar Simulator	\$17,063
SS1.0KW	1000W Fully Reflective Solar Simulator	\$19,713
SS1.6KW	1600W Fully Reflective Solar Simulator	\$22,502
SS2.5KW	2500W Fully Reflective Solar Simulator	\$28,050

Highlights

- Class AAA
- Ozone free xenon arc lamp (500W, 1000W, 1600W or 2500W)
- Adjustable digital switching power supply with built-in igniter
- Horizontal or vertical operation
- Access panel for easy changing of filters
- MgF₂ coated mirrors for UV, Visible and IR operation
- Air cooled

Optional Features

- Spare xenon arc lamp
- Floor stand for vertical operation
- Folding mirror to redirect output beam
- Computer controlled electronic shutter
- Computer controlled optical feedback intensity stabilizer

Technical Specifications

Arc Lamp Power Supply:

240VAC @ 20A (2500W Lamp)

Uniformity:

2-10% over target area

Uniform Area Diameter:

50-200mm (2-8")

Power Stability on Target (Short Term):

±1% after 30min

Power Stability on Target (Long Term Due to Aging of Lamp):

-20% (after 1000 hrs)

Mounting Options:

Horizontal or Vertical

Filter Holders:

Up to 3 air mass solar filters and/or bandpass filters

Dimensions (Without Power Supply):

122 x 76 x 36cm (Horizontal).

(48" x 30" x 14")

Dimensions change for vertical set-up due to adjustable height.

Cooling Fan:

120VAC cooling fan

Weight (approx.):

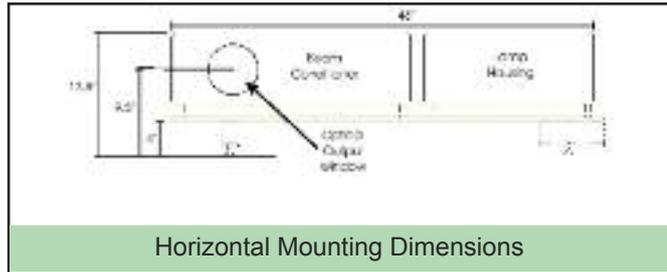
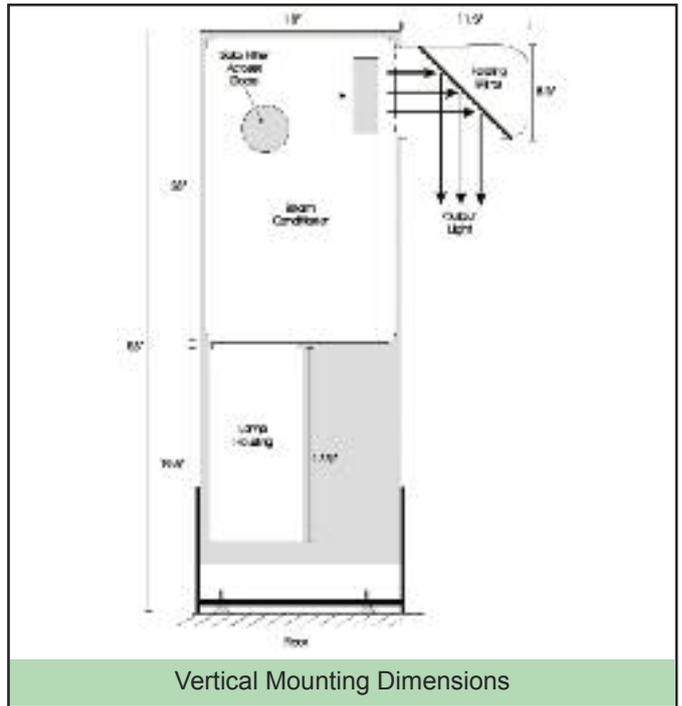
55kg (121 lbs)

Beam Direction

The solar simulator can be mounted in a vertical or horizontal position, please specify which orientation when ordering.

When in a horizontal position, the output beam exits from a side panel and illuminates an area on the wall (or whatever you put in front of it). An optional 90° folding mirror can be mounted at the output window to allow the beam to be redirected upward, downward, left or right.

For vertical operation a floor mounted stand is used. The output beam exits horizontally, and the optional folding mirror can be used to direct the beam upward, downward, left or right.



Horizontal Mounting Dimensions

Vertical Mounting Dimensions

Output Power

The solar simulators can be adjusted in favor of higher power or better uniformity. The following tables give 'typical' levels derived from measurements made with a variety of different setups, and so numbers may seem inconsistent.

Diameters should be reduced 40% from Class B sizes to get 2% (class A) uniformity

As a rough but convenient rule of thumb, to illuminate a target diameter D at a 1 SUN level requires a lamp power $P(\text{in kW}) \sim (D/8")^2 = (D/20\text{cm})^2$.

Specific AM filters require:
Global-10% less; Direct- 30% less; AM0-25% more

Solar Simulators output with 1 sun

Solar Simulator Output Chart AM1.5G				Spatial Non-Uniformity Target Diameter		
Solar Simulator	Sun	Spectrum	Temporal Stability	Class A w/No Mask	Class A w/Mask	Class B
SS500	1	Class A	Class A	8.9cm (3.5")	11.4cm (4.5")	14.2cm (5.6")
SS1.0	1	Class A	Class A	12.7cm (5.0")	16.0cm (6.3")	20.3cm (8.0")
SS1.6	1	Class A	Class A	16.0cm (6.3")	20.3cm (8.0")	25.4cm (10.0")
SS2.5	1	Class A	Class A	20.3cm (8.0")	25.4cm (10.0")	31.8cm (12.5")

Solar Simulators output with 0.5 sun

-Solar Simulator Output Chart AM1.5G				Spatial Non-Uniformity Target Diameter		
Solar Simulator	Sun	Spectrum	Temporal Stability	Class A w/No Mask	Class A w/Mask	Class B
SS500	0.5	Class A	Class A	12.4cm (4.9")	16.0cm (6.3")	20.0cm (7.9")
SS1.0	0.5	Class A	Class A	18.0cm (7.1")	22.6cm (8.9")	28.7cm (11.3")
SS1.6	0.5	Class A	Class A	22.6cm (8.9")	28.7cm (11.3")	35.8cm (14.1")
SS2.5	0.5	Class A	Class A	28.7cm (11.3")	35.8cm (14.1")	44.7cm (17.6")

Solar Simulators output with 2 suns

Solar Simulator Output Chart AM1.5G				Spatial Non-Uniformity Target Diameter		
Solar Simulator	Sun	Spectrum	Temporal Stability	Class A w/No Mask	Class A w/Mask	Class B
SS500	2	Class A	Class A	6.3cm (2.5")	8.1cm (3.2")	9.9cm (3.9")
SS1.0	2	Class A	Class A	8.9cm (3.5")	11.2cm (4.4")	14.2cm (5.6")
SS1.6	2	Class A	Class A	11.2cm (4.4")	14.2cm (5.6")	17.8cm (7.0")
SS2.5	2	Class A	Class A	14.2cm (5.6")	17.8cm (7.0")	22.3cm (8.8")

Class A uniformity can be obtained using a custom uniformity mask configured to your specifications. Please note the Class A uniformity mask is an additional \$1,800. Please talk with your sales agent to confirm the specifications required.

All of Sciencetech's solar simulators meet the following international industrial standards for photovoltaic cell testing.

- ASTM927-05
- IEC60904-9
- JIS-C-8912

For other beam diameters, please contact Sciencetech Special Development Group at sales@sciencetech-inc.com

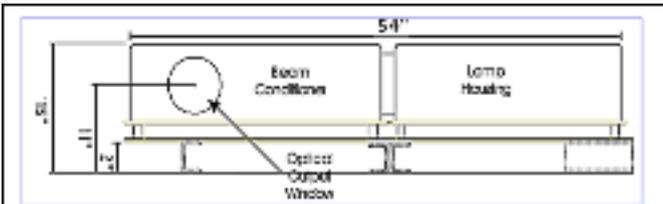
7.5kW Solar Simulator (AAA)



The SS-7.5kW Solar Simulator uses three Sciencetech SS 2.5kW fully reflective Solar Simulators to provide up to 1 Sun of highly uniform illumination on a large area (30 x 30cm) target. The spectral distribution can be tailored to the user's needs with easily removed transmission and reflection filters. These filters provide combinations of solar spectra, UV or IR illumination, or other spectra for special applications.

Highlights:

- Uniform Target Area 30x30cm at 1 Sun
- Horizontal target, lamps
- Adjustable power level
- Fast electronic shutter (optional)
- Optical feedback to stabilized output (optional)
- Completely air cooled



Horizontal Mounting Dimensions of each unit

Technical Specifications

Total Output Power on Target:
1 Sun (1000W/m²) when each unit runs at 95A

Uniformity:
Constant within 2% over 30 x 30cm field

Stability of power on target (Short term):
±1% after 30 minutes

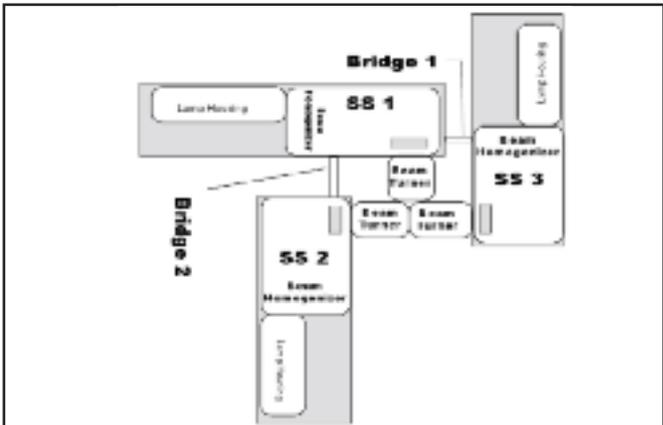
Stability of power on target Long term):
-20% (due to aging of lamp)

Mounting Options:
Horizontal

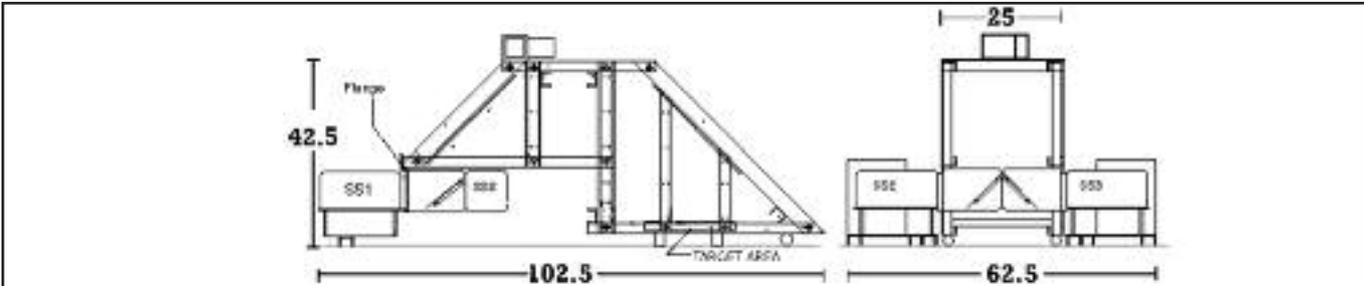
Wavelength Control:
Solar and Bandpass Filter

Dimensions (without power supply) and Weight:
102.5 x 62.5 x 42.5"
260.35 x 158.75 x 107.95cm
220kg (approximate)

Version/Model	Description	Price
SS 7.5kW	7.5kW Solar Simulator	\$150,000



Horizontal Mounting Dimensions of each unit



Three Solar Simulator Units + Beam Folding Unit

High Power Fully Reflective Solar Simulators for UV Applications



Sciencetech’s high powered class AAA fully reflective solar simulators can be used for UV applications by replacing the solar filters with UV filters. The smallest model is the 500W model, which approaches the power output of most conventional 1000W models on the market. Sciencetech also manufactures 1.0kW, 1.6kW, and 2.5kW models which are also noticeably more intense than competing models of the same power rating, especially in the UV spectral range. Sciencetech’s fully reflective solar simulators are ideal for UV applications due to their fully reflective design. Unlike conventional solar simulators that utilize light-losing focusing lens and diffusers to achieve uniformity, Sciencetech’s fully reflective solar simulators use only mirrors to “fold” the light from the arc lamp source to the target. This results in high uniformity without the intensity losses of conventional designs which is especially pronounced in the UV portion of the spectrum.

UVA and UVB Wavelengths Definition

Please note that the wavelength definition of UVA and UVB in the COLIPA sun screen testing community is slightly different from the general scientific community.

General Definition

UVA 315-400nm
UVB 280-315nm

Sunscreen definition

UVA 320-400nm
UVB 290-320nm

Highlights

- Class AAA
- Fully reflective design means minimal UV loss and spectral distortion
- 500W, 1000W, 1600W and 2500W models available
- Xenon base arc lamp light source
- Selection from a wide range of UV filters
- For use in sun screen testing
- For use in photo-lithography (timed exposure)
- 120VAC cooling fan

Built-in Filter Holder inside Beam Homogenizer

The filter holder inside the beam homogenizer has room for two filters mounted in series. The filters are first mounted onto a frame and then inserted into the holder. The filters are 76 x 76mm (3 x 3") to cover the entire beam diameter. Generally two filters in series are required to isolate the UVA or UVB spectral regions. To eliminate the IR radiation, a plane mirror inside the solar simulator beam homogenizer is replaced with a hot mirror.

Types of UV Filters

The UV solar simulator without any filters provides a broadband white light source that ranges from UV to IR light. Hence, filters are required to eliminate the visible and IR light portions such that only UV light remains. There are various types of UV filters available, although they can be generally classified into two applications, for use in sun screen testing and for use in photolithography. Each application requires a different region of the UV spectrum so Sciencetech has separated its UV filter selection into different group accessories by application. Since all such filters work with the UV solar simulators, the user can purchase UV filters from both groups.

Beam Diameter

The target spot diameter is preset at the factory between 50mm (2") to 203mm (8") diameter, but it can be re-adjusted. Please specify target spot diameter when placing a purchase order.

Performance Example

The following values are based on a 1.6kW solar simulator on a 150mm (6") diameter spot without UV Enhanced Coating Optics. Actual performance should be better.

- Broadband power without filters 230mW/cm²
- UVA region is approximately 16.5mW/cm²
- UVA+B region is approximately 20mW/cm²

Version/ Model	Description	Price
SSUV0.5KW	500W UV Application, Fully Reflective Solar Simulator	\$18,113
SSUV1.0KW	1000W UV Application, Fully Reflective Solar Simulator	\$20,763
SSUV1.6KW	1600W UV Application, Fully Reflective Solar Simulator	\$23,552
SSUV2.5KW	2500W UV Application, Fully Reflective Solar Simulator	\$29,010

Highly Collimated Fresnel Lens Solar Simulators (AAA)

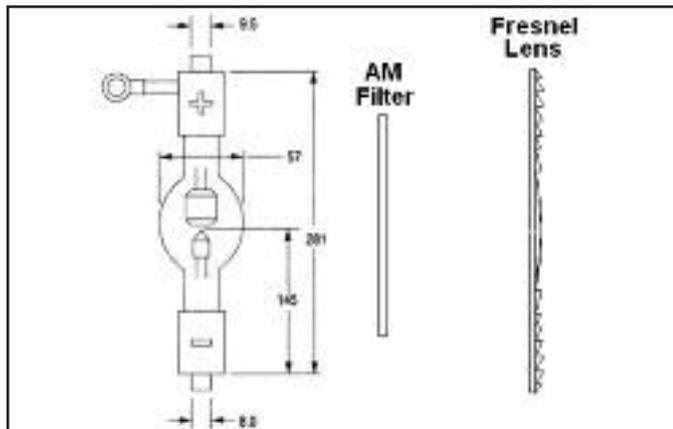


Sciencetech has designed a highly collimated solar simulator for photovoltaic or concentrator cell testing. This large area solar simulator can illuminate a 300mm diameter (12") target. It uses a Fresnel lens to image the arc lamp source to infinity and produce a highly collimated output beam.

A 1.6 or 2.5kW xenon ozone free lamp is used as the light source. The spectral distribution of the xenon light source, along with the use of specially calibrated Air Mass filters closely simulates the sun's true spectral distribution in various conditions on Earth. For solar cell testing an AM1.5D filter is recommended to simulate terrestrial conditions and an AM0 filter is recommended to simulate conditions in Space.

Power output from within a 0.7° collimation radius is approximately 1 Sun on a 300mm (12") diameter disc at the exit window plane, for the 2.5kW unit with an AM1.5D filter (plus less collimated radiation),

Without filters the solar simulator provides a broadband spectral range of 250-2500nm.



Optical Layout for the Fresnel Lens Solar Simulator

Highlights

Standard features

- 1.6 or 2.5kW xenon arc lamp
- Integrated Solid state igniter
- Adjustable DC power supply
- 12" diameter Fresnel optical quality acrylic, UV transmitting lens
- Low f/# for maximum power throughput
- Built-in filter holder for 152 x 152mm (6 x 6") filter
- Vertical or horizontal operation
- Custom designed aluminum lamp housing air cooled
- Ozone-free operation
- Collimation: 1 sun within ± 0.7°
- Uniformity: Constant within ± 5% over 12" diameter (w/mask)
- 120VAC cooling fan

Optional features

- AM0, AM1, AM1.5D, AM1.5G filters available
- Optical feedback intensity stabilizer

Solar Simulator Components

Light Source

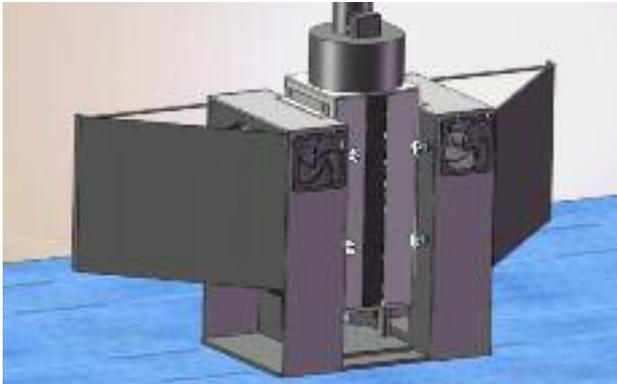
Sciencetech's Highly Collimated Solar Simulator utilizes an ozone-free xenon arc lamp as its light source. It is air cooled with electric blowers and has adjustment pins to align the focal point of the lamp. The arc lamp is powered through an external DC power supply. with a manually operated controller that includes an LCD (1.6kW version) or LED (2.5kW version) display for current and power adjustments. It can be overpowered by 20%. (Although overpowering gives higher intensity output, it also shortens the lamp's service life considerably.)

152mm (6") Diameter Air Mass Solar Filters

These filters can be inserted into an air cooled filter holder inside the lamp housing through an access panel in order to simulate various light conditions on Earth and in Space.

Version/Model	Description	Price
SS1.6KW-Xe-Fr	1600W Highly Collimated Fresnel Lens Solar Simulator	\$27,500
SS2.5KW-Xe-Fr	2.5kW Highly Collimated Solar Simulator	\$35,000
FL-30	30cm (12") Diameter f/0.7 Fresnel Lens	\$394

DUAL 2.5K Solar Simulator



Sciencetech has designed and manufactured this dual solar simulator to serve the large panels photovoltaic testing. This is a new solar simulator type unmatched by present industrial units.

The Model DSS2.5KW can illuminate a 55.8cm (22") diameter target size with 1 Sun (AM 1.5 G). It is based on a special optical collecting system using a Fresnel lens and standard diffracting optics to collimate the light beam from the arc lamp source to infinity, which results in highly collimated illumination of the target spot. (when using single beam). Dual beam divergence is function of the target distance

This Solar Simulator provides a broadband spectral range from 250-2500nm without filters which can be adjusted to different user's special needs by using special filters available at Sciencetech.

Light Source

Sciencetech's Dual Solar Simulator utilizes Xenon, ozone-free arc lamp as its light source. It is air cooled with electric blowers and has adjustment pins to align the focal point of the lamp. The arc lamp is powered through an external adjustable DC power supply. The power supply has a manually operated controller with LED display for current and power adjustments. It can be overpowered by 10%. Although this would results in a higher intensity output, it also shortens the lamp's service life and it is operation at this level is not recommended.

Power output can also be lowered to a value of approximately 60% of nominal. The lamp stability will degrade below nominal, but this offers a continuous control of total power output.

152mm (6") Diameter Air Mass Solar Filters

These filters can be inserted into an air cooled filter holder inside the lamp housing through an access panel in order to simulate various light conditions on Earth and in Space

Main Features:

- 2.5kW ozone free xenon lamp
- Integrated Solid State Igniter
- Adjustable DC power supply with LED
- Dual Air cooled lamp housing
- Dual Filter holder mounts one 15x15cm (6x6") filter (additional filters and other filter sizes available)
- Standard horizontal operation, vertical option
- Ozone-free operation/High UV content optional
- Uniformity: Constant within $\pm 5\%$ over 22" / $\pm 2\%$ Optional
- Class A spectral match to the solar spectra (Optional Class B and C with higher power density delivery). Units with "Better than Class A" (Extended Spectral coverage) available.
- AM1.5G, AM1.5D, AM1G and AM0 available on standard units and Special Spectral filters available as options
- 120V/230V operation (please specify)

Version/Model	Description	Price
DSS2.5KW	Dual 2.5KW Solar Simulator	\$117,340

Flash-Lamp Solar Simulator for Large Photovoltaic Module Testing

The PSS1x1 class AAA Flash Solar Simulator is designed to test large photovoltaic devices, up to 1x1m (40x40") in size with the standard homogenizer. An optional full featured workstation with illumination table and Current Voltage (I-V) measurement system for use in both in-line low volume production and off-line quality control environments is available (*SSTwrkstrn*). The solar simulator utilizes a heavy duty xenon flash lamp and AM1.5G calibrated solar filter to approximate the sun's true spectral distribution following Class A ASTM E927-97(1997) and IEC-60904-9 standards. The solar simulator fires short flashes of light to measure the performance of a photovoltaic device without heating it. Connecting it to the optional current-voltage measurement system, at each flash an I-V data point for the photovoltaic device can be captured. A computer controller sequences the light pulses with the current-voltage measurement system to generate and store a multi-point I-V curve for the photovoltaic device.



Photovoltaic Cell Compatibility

The Sciencetech PSS solar simulator can be used on any type of photovoltaic devices including thin films, amorphous silicon, and traditional crystalline silicon materials. The optional current-voltage measurement system has an active load and wattage range that can be tailored to each type of photovoltaic material.

Performance

The flash pulsed solar simulator utilizes a heavy-duty/low-duty cycle xenon flashtube powered by a digitally controlled power supply. This provides a stable and repeatable flash in a multi-exposure I-V test sequence. The power supply also provides a wide operation range from 70-2400 Joules to accommodate different sizes of photovoltaic panels ranging from 203x203mm (8x8") to 1020x1020mm (40x40") and at intensities selectable from 70-1600mW/cm². To withstand heat stress in a continuous use production operation, the heavy duty xenon flashtube has over dimensioned tungsten electrodes tested to 60,000 Joules.

Definition of Class A

The IEC 904-9 standard states that a solar simulator's spectrum must match the reference spectral distribution over specified bands to within $\pm 25\%$ to be classified as Class A. For large area solar simulators (test plane > 300x300mm or 12x12"), to meet Class A spatial uniformity variation must be $\pm 3\%$ or less, measuring sample areas of 1/36 of the full test area. Class A uniformity. Flash intensity must not vary by more than $\pm 2\%$ from an average value over the total test time.

Solar Simulator Components

- Light source unit
- PC controller

Other Models

A 2x2m model is also available. Speak with our Special Developments Group to customize a PSS06 that meets your needs. Email sales@sciencetech-inc.ca

Highlights

- Class AAA
- Heavy duty xenon flashtube
- Low duty cycle to prevent overheating
- Calibrated AM1.5G solar filter
- Stable power supply and delivery circuitry for consistent power output
- Efficient built-in beam conditioning reflector to maximize light distribution performance
- Wide range of light flash energies/powers
- PC computer controllable
- Built in surge protector circuitry
- Reference photocell

Options

- Solar panel testing workstation
- Current-voltage (I-V) measurement system
- Other calibrated solar filters (not part of ASTM standard for solar cell testing)

Technical Specifications:

Uniformity:

Constant within $\pm 3\%$ over specified area

Uniform Area Dimensions:

Up to 2 x 2m (depending on homogenizer optics)

Flash Lamp:

Maximal Energy: 2400J
 Power Range: 75 - 2400J
 Flash Duration @ 0.9 Max. Power: 1.6 - 2.0ms
 Typical Pulse Width: At 50% Intensity points 4.5 - 6.5mSec.
 Stability of Power on Target: $\pm 2\%$

Intensity range (AM1.5G, 1mx1m):

70-1600mW/cm² (I-V testing to 150mW/cm²).

Wavelength Control:

AM1.5G or other solar and bandpass filters

Distance to Target:

76mm (3") (nominal for uniformity requirements)

Electrical:

115VAC @ 60Hz

Dimensions and Gross Weight:

139 x 139 x 78 cm (54 x 54 x 30")
 100kg (221lbs)

Version/Model	Description	Price
PSS1x1	Flash Solar Simulator	\$28,236

Flash Solar Simulator Concentrator



FSSC-4000

Sciencetech's FlashSolar Simulator Concentrator (FSSC) is a well designed, compact and robust source of very high intensity solar irradiance with high uniformity of testing and characterizing solar cells and other devices up to 5 x 5cm in size.

It may be operated vertically with the normal (61 x 61cm) mounting base and included sample holder requiring a total height of 82cm or, optionally, with the base removed the smaller dimensions of 36 x 36 x 78cm permit the FSSC to be easily mounted to other equipment.

A 75 x 75mm removable Air Mass Filter and a spectrally neutral 8.3:1 mesh attenuator are included with the FSSC. Additional spectrally neutral attenuators up to 100:1 will be available from Sciencetech at additional cost. Contact sales at Sciencetech for more info.

Irradiance may be set by power control in 50 steps of approximately +/- 7% of the current level from about 225 Suns minimum without the mesh attenuator or 27 Suns minimum with the attenuator in place under the air mass filter.

Acceptable uniformity may be obtained at working distances of 1mm to 5mm from the FSSC exit plane with uniformity measured and specified at 3mm distance.

Version/Model	Description	Price
FSSC-400	Flash Solar Simulator Concentrator	\$70,000

Technical Specifications:

Target size:
5 x 5cm

Working Distance:
3mm

Angle of Exit:
47.5 degrees max
30 degrees typical (50%)

Uniformity:
+/- 3%
+/- 2% typical

Irradiance:
1 - 4000 Suns
7000 Suns Max (Limited lamp life)

Repeatability:
+/- 5%
+/- 3% typical

Flash interval:
5 sec
2 sec minimum

Energy Setting:
75 - 2400 joules
($2^{3.5}$ - $2^{8.5}$ in 50 steps)

Duty Cycle:
6750/Suns FPM avg
(Flashes/Minute average)

Lamp Life:
20,000 shots @ 2000 Suns estimated,
100,000 @ 400 Suns estimated

Reference Output:
5.377uA/Sun
11.0mA typical peak @ 2000 Suns

Power Requirements:

120v version:
100-140vac 50/60 Hz
25 Amp surge on fast charge
10 Amp surge slow charge

230v Version:
200-245vac 50/60 Hz
16 Amp surge on fast charge
6 Amp surge slow charge

Dimensions:
(61 x 61cm) mounting base
Total height of 82cm (32.28")

Gross Weight:
39kg (86lbs)

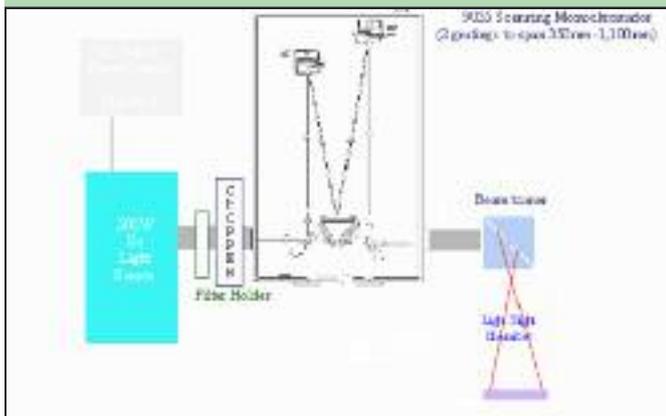
Sciencetech Modular Systems for Solar Cell Testing

In the past Sciencetech has manufactured several spectral response systems, quantum efficiency systems, and internal quantum efficiency systems for solar cell testing. These systems are made using Sciencetech's modular spectroscopic components because they afford the flexibility needed to meet a particular customer's requirement.

A tunable wavelength monochromatic light source is required to make spectral response measurements of solar cells. This light source typically sweeps monochromatic light between 300nm and 1100nm in increments of 1 to 50nm onto the solar cell being tested. A reference detector measures the monochromatic light in a pre-scan to normalize the measured response of the solar cell.

The tunable monochromatic light source consists of a broadband xenon light source connected to a scanning monochromator which sweeps monochromatic wavelengths onto a solar cell. Special focusing optics at the monochromator's output port directs the monochromatic light onto the solar cell, which may reside in a light tight box. A current-voltage (I-V) measurement system records the electrical performance of the solar cell. An optical chopper and lock-in amplifier are required to remove the effects of shunt resistance on the voltage scan.

Spectral Response Measurements SS-SR-150



Due to the geometry of the light put out by the monochromator, only a small rectangular section of the solar cell (typically 2 x 2cm to 5 x 5cm) is illuminated. Fortunately, it is unnecessary to illuminate the entire area of the solar cell since its electrical response is proportional to the photon power it receives regardless if the light is spread out over its entire area or concentrated only onto a particular section. In other words, the physical "footprint" of the illuminated area is irrelevant for a spectral response measurement.

The SS-SR-150 system includes the SCIRUNIV I-V-Test measurement system with software. The software displays the I-V characteristics as a function of wavelength and stores OCV, Isc and I-V measurements are stored in data files.

A Quantum Efficiency system uses two light sources simultaneously illuminating the solar cell being tested. The first is a broadband light source that provides a continuous background white light bias to the solar cell, simulating actual use conditions.

Quantum Efficiency Measurements SS-QE-150



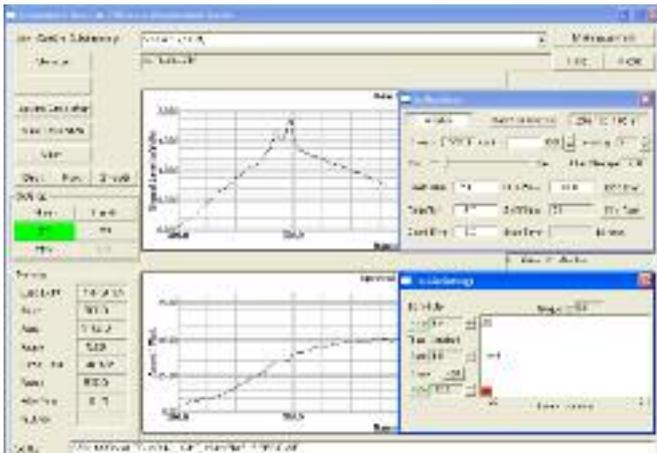
Sciencetech Modular Quantum Efficiency System

The second light source is a modulated, tunable wavelength monochromatic light source that illuminates the target cell to provide the necessary narrow band stimulus. This modulated monochromatic source typically sweeps monochromatic light between 300nm and 1100nm in increments of 1 to 50nm, focussed to be fully captured by the solar cell being tested. A precision lock-in amplifier is required to separate the effects of the monochromatic light on the solar cell from the white light bias source.

This method measures the monochromatic response of a solar cell under more normal conditions than using the monochromatic source without secondary background white light bias. Note that the power intensity of the white light bias does not need to be as much as 1 SUN to provide good measurements and UVB light is required.

Sciencetech's Quantum Efficiency System consists of a tunable wavelength monochromatic light source and a separate solar simulator for use as the white light bias. The tunable wavelength monochromatic light source is nearly identical to the one used for the spectral response system, with a motorized optical chopper between the xenon light source and the scanning monochromator to modulate the light. A source meter used as an active load permits operating the test cell at various load conditions, including shortcircuit, compensating for a series resistor required to sense the current produced by the modulated monochromatic light. This sensed current plus a reference signal at the frequency of the light modulation are both fed into the precision lock-in amplifier to allow measurement of the current generated by the modulated monochromatic light in the presence of the fixed white light bias of the solar simulator.

The geometry of the light from the monochromator is controlled to illuminate only a small rectangular section of the solar cell (typically 2 x 2cm to 5 x 5cm), assuring that 100% of the monochromatic irradiance contributes to the output signal.



A calibrated detector is inserted at a focal point in the monochromatic light path where it can capture the total amount of monochromatic light that will fall onto the solar cell during the test and a calibration scan is taken, usually before each run, to allow absolute External Quantum Efficiency to be calculated.

The SS-QE system includes a SCIRUNQE I-V-Test measurement system, precision lock-in amplifier and system software. The software controls the monochromator, source meter and lock-in amplifier to automatically measure the I-V characteristics and Q.E. v.s. wavelength, plotting the result(s) on screen and outputting calculated results, including OCV, ISC, Pmax, Fill Factor, plus the raw measurements to a standard file format.

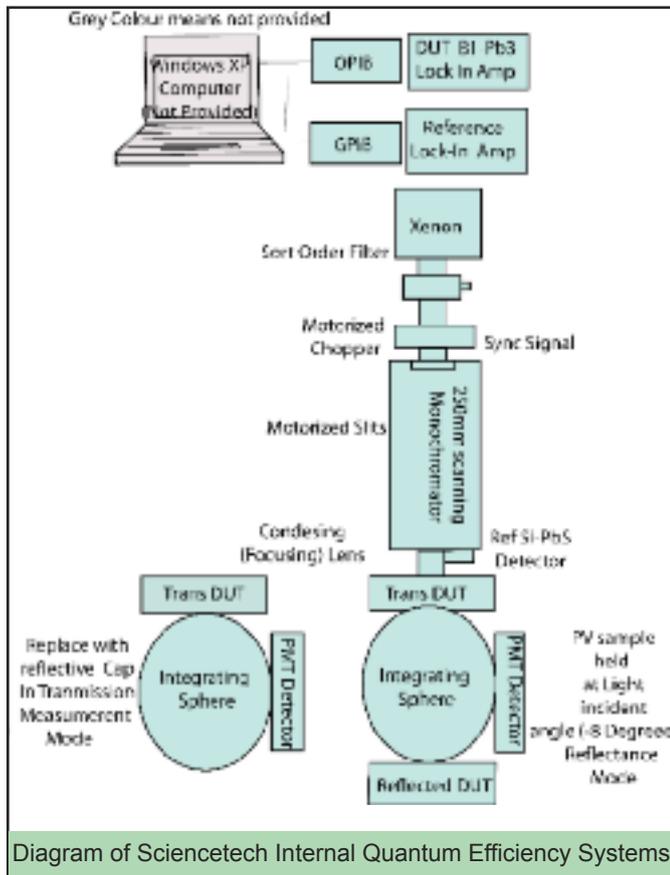
The Spectral Response and Quantum Efficiency (QE) measurement systems provide an overall "external" QE value that doesn't consider that some of the light is reflected or transmitted by the solar cell. From the point of view of cell efficiency this is the most important factor. However to measure the QE of the cell material itself apart from these losses - the internal quantum efficiency or IQE - the reflected and transmitted light must be measured and mathematically deducted so that only the light absorbed by the solar cell is considered in the QE calculations.

Internal Quantum Efficiency Measurements SS-IQE-150



For IQE measurement the monochromator used in the external QE measurement system is fitted with an IQE attachment. This attachment is an integrating sphere sample chamber which allows all the transmitted and reflected light by the solar cell to be captured and measured. The transmitted and reflected light portions are measured in separate readings and then used with the external QE measurement described earlier to calculate the IQE. For transmission measurements the solar cell (or a representative portion) is placed in the sample holder ahead of the integrating sphere. For reflection measurements the cell is placed in the sample holder after the integrating sphere. A detector mated to the integrating sphere port orthogonal to the sample holders measures the reflected and transmitted light.

For cells that are small enough to fit in the IQE sample holder, bias light can be fed from a Sciencetech SF150 solar simulator into the integrating sphere and onto the cell through a fiber bundle or light pipe, so that the external QE itself can be measured with the IQE attachment. (As with the external QE unit, lock-in electronics and likely an I-V test system are used as well). In the case of larger cells however, a separate external QE system is needed to obtain IQE based on full area measurements.



Pricing of an Internal Quantum Efficiency System with a small Sciencetech solar simulator model SF150 as white light bias, Sciencetech I-V test measurement system for electrical measurements, and integrating sphere sample chamber typically depends on light source power and I-V power options.

Version/Model	Description	Price
SS-SR-150	Spectral Response Measurements	\$55,000
SS-QE-150	Sciencetech Modular Quantum Efficiency	\$77,250
SS-IQE-150	Internal Quantum Efficiency Measurements Upgrade	\$20,000

Constant Photocurrent Method (CPM)

In this experimental setup our basic goal is to measure the defect density in the low energy region that is sub band gap of the sample. For that we need to consider different parameters involved in calculating the defect density. Basically it can be interpreted from the graph of wavelength versus absorption coefficient in the low energy region that is below 1eV to 0.4 eV where the absorption is take place predominantly due to the defect present in the sub band gap of material. The values of alpha can be calculated for different wavelengths by keeping the photocurrent constant. The photocurrent I_{ph} depends on the various parameters shown in the following equation,

$$I_{ph} = SeN(1-R)[1-\exp(-\alpha d)]\eta\mu F/d$$

Where I_{ph} is a reference value which we have to keep constant during experiment

- S is active sample area
- N is the number of incident photons
- R is the reflectance of the sample
- η is the measured quantum efficiency of the sample
- τ is the minority charge carrier lifetime
- μ is the mobility
- F is the applied voltage
- d is the film thickness
- e is elementary charge
- α is absorption coefficient

In this particular experiment some of the parameters are known and other parameters can be measured by some another experiment. Putting above measured values in equation, we get the final equation as

$$\alpha_{cpm} \approx \text{constant}/N(\lambda)$$

Further for different wavelengths, we will get the different values of α

We will plot the graph between α verses wavelength. From this graph we can calculate the defect density by using the area under the curve affected by the defects in the low energy region. Some more graphs are needed to be plotted as given below,

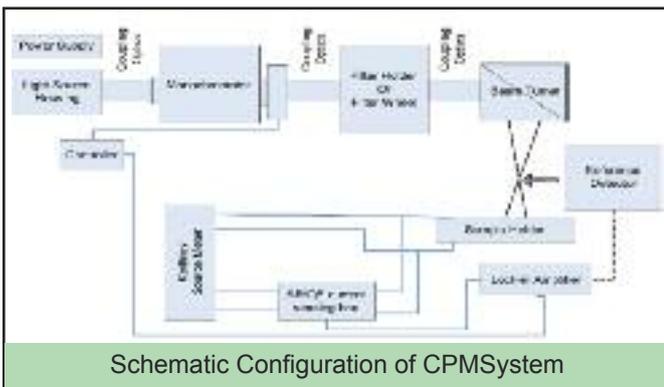
1. % reflectance verses wavelength.
2. Intensity verses voltage.
3. Logarithmic absorption coefficient verses wavelength.
4. Defect density verses energy.

Software Program Needed for Automation of CPM

1. In this experiment in the beginning we adjust the photocurrent at some reference value for some wavelength. Later we keep this photocurrent value constant through out the experiment even after changing the wavelength. To keep the photocurrent constant we vary the intensity of light. The change in photocurrent (error factor) is feedback to the lamp assembly to adjust the intensity accordingly. For that there should be some program to monitor it.
2. For different wavelengths α_{cpm} should be calculated by using the formula provided in the program and corresponding graphs should be plotted.
3. From the given curve the defect density should be calculated from the variation in the curve at low energy region. For that we can use the necessary formula to calculate defect density.

Important:

1. CPM is usually measured from IR to Visible region. So the spectral ranges of the different optical instrument should be under same region
2. The photocurrent is measure in the range of Pico ampere to nano ampere.
3. The contacts on the sample should be carefully made to measure the photocurrent accurately. Also the sample mounting assembly should be flexible enough to mount the variable size samples on it.
4. For low intensity variation the least count of the lamp should be matches with our required value



Version/Model	Description	Price
SS-CPM-150	Constant Photocurrent Method (CPM)	\$86,000

Current-Voltage Measurement System (IV Tester)



The Sciencetech Model SSIVT is an electrical current-voltage measurement system used to characterize photovoltaic cell performance. This "IV Tester" works by setting the voltage and measuring the current while keeping the light source constant. The integrated software is used to operate the flash system, controls the state of the solar cell during QE and SR measurements, measures the reference cell and temperature during IV measurements, generates and operates the solar cell IV measurement procedure and allows the customer calibration of a reference cell. It allows the tester to create multiple sequential pulses (typically 10~100 points selectable) to complete the IV curve measurements. Universal input 100V~240VAC, 50/60Hz. An external computer with RS-232 port (sold separately)

Highlights

- Designed for use with continuous or flash solar simulators
- Max Electrical Power Reading: 20W base model, 60W high power model, and 1000W only for flash solar simulator
- Base Model Voltage range 200V
- Base Model Current range 1A
- High Power Model Voltage range 60V
- High Power Model Current range 3A
- Four wire measurements
- Saves each IV curve dataset in separate ASCII text file
- Number of sample points selectable
- Sci-IVTest Windows based control software

Parameters Measured by IV Software

- V_{oc} , I_{sc}
- V_{max} , I_{max} , P_{max}
- V_{oc} Slope (similar to R_s)
- R_p or R_{shunt} (system measures slope near I_{sc} for this value)
- FF or Fill Factor
- Forward and Reverse Sweep Feature

LOAD METERS

With characteristics quite different from the line of Keithley Source Meters, Sciencetech offers a line of and much higher speeds Load Meters that address the need for operation at higher currents and voltages.

These units operate with the same software described above (SSIVT, SCIRUNIV, and SCIRUNQE).

The tables below describe the main technical characteristics of these load meters

Low Voltage	Rated 32 Volts, Capable 48 Volts @ Zero Amps.	
Single module	8 Amps pulse (256W)	1 Amps continuous (32W)
Dual module	16 Amps pulse (512W)	2 Amps continuous (64W)
Quad module	32 Amps pulse (1024W)	4 Amps continuous (128W)
Full Box	64 Amps pulse (2048W)	8 Amps continuous (256W)

Medium Voltage	Rated 128 Volts, Capable 192Volts @ Zero Amps.	
Single module	2 Amps pulse (256W)	.25 Amps continuous (32W)
Dual module	4 Amps pulse (512W)	5 Amps continuous (64W)
Quad module	8 Amps pulse (1024W)	1 Amps continuous (128W)
Full Box	16 Amps pulse (2048W)	2 Amps continuous (256W)

High Voltage	Rated 128 Volts, Capable 192Volts @ Zero Amps.	
Single module	.5 Amps pulse (256W)	.0625 Amps continuous (32W)
Dual module	1 Amps pulse (512W)	.125 Amps continuous (64W)
Quad module	2 Amps pulse (1024W)	.25 Amps continuous (128W)
Full Box	4 Amps pulse (2048W)	.5 Amps continuous (256W)

Model Number VOLTS x AMPS	Price	Model Number VOLTS x AMPS	Price
32x8	\$5330	128x8	\$11050
32x16	\$6500	128x16	\$18200
32x32	\$8840	512x0	\$7995
32x64	\$14560	512x1	\$9750
128x2	\$6662.50	512x2	\$13260
128x4	\$8125	512x4	\$21840

Test Software & Reference Cells



Software for the SSIVT measurement system can be purchased separately. SCISPIV.exe is the primary module. Two other components, SCIRUNIV and SCIRUNQE, provide screen output for monitoring I-V or QE operations, available separately or bundled with SCISPIV. These interface and control programs are designed for operation with Keithley 2400 series source meters.

Main features:

- Does not require Windows
- Has its own user interface
- Requires RS-232 port (COMM 1 preferred, 1-4 okay)
- The software runs in the background, communicating with the Keithley instrument to:
- Operate flash systems
- Control the state of the solar cell during QE and SR measurements
- Measure the reference cell and temperature during I-V measurements
- Generate and operate the I-V measurement procedure
- Allow customer calibration of a reference cell
- Collect and write data to files readable by the interface programs

Calibrated Reference Cell

Sciencetech also offers calibrated reference cells for use in IV, QE and SR measurements. These reference cells include a platinum resistance thermometer. An adapter is required for use of a reference cell and temperature sensor with a Keithley source meter.

Flash Reference Cell

Reference cells for use with flash systems are also available with in-house calibration. This cell does not require a temperature sensor adaptor.

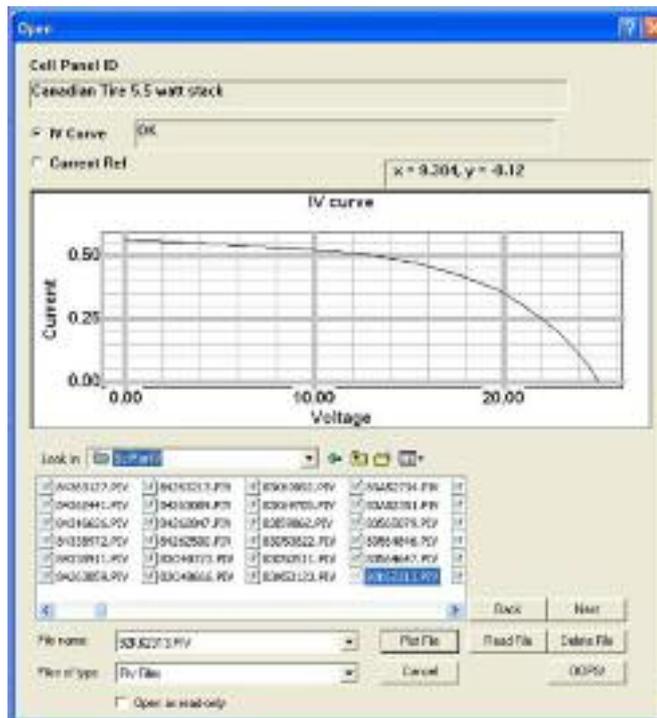
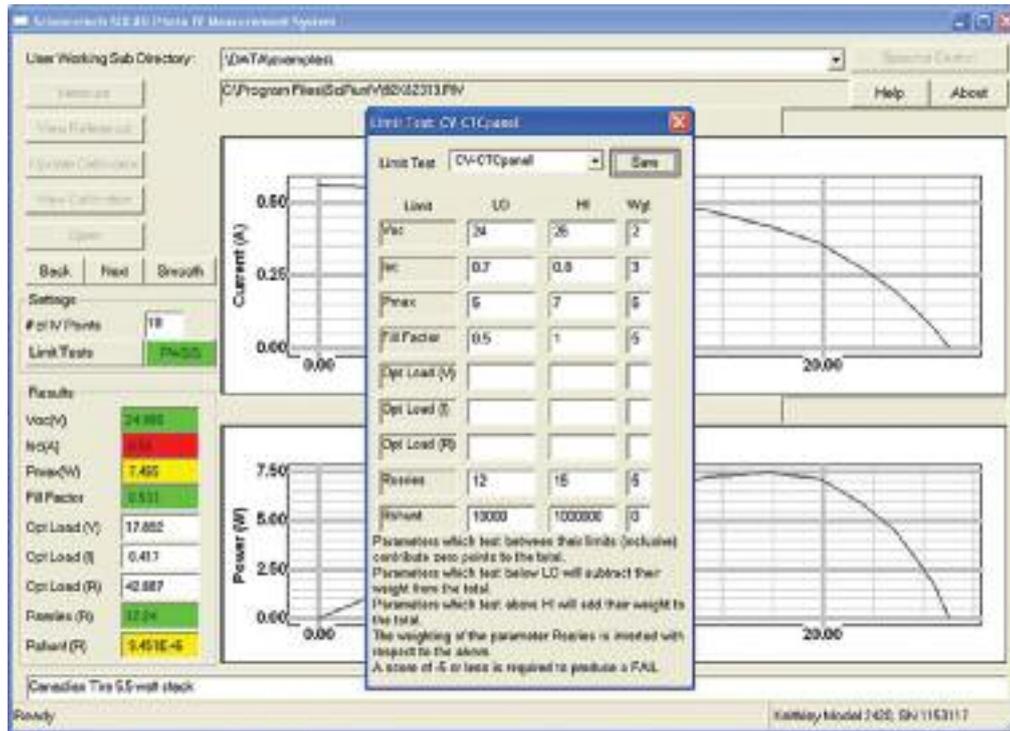
(Use of reference cells with Keithley 2600 series source meters is discouraged as these systems lack the hardware for the control and temperature adaptors.)

Description	Price
Calibrated Reference Cell	\$3,200
Flash Reference Cell	\$620

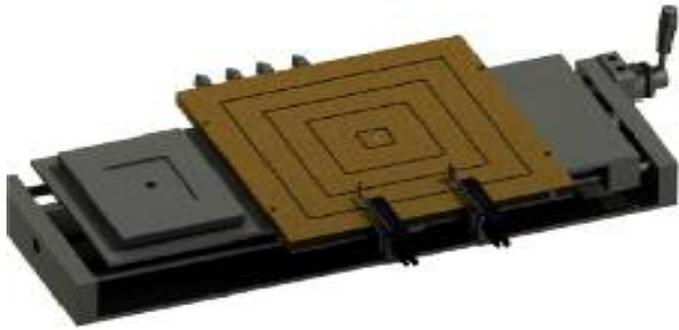
Version/Model	Description	Price
SSIVT-20W C	Current Voltage Measurement System (IV Tester) 20W Version for Continuous Solar Simulator	\$11,543
SSIVT-20W F	Current Voltage Measurement System (IV Tester) 20W Version for Flash Solar Simulators	\$13,470
SSIVT-60W C	Current Voltage Measurement System (IV Tester) 60W Version for continuous Solar Simulators	\$15,007
SSIVT-60W F	Current Voltage Measurement System (IV Tester) 60W Version for Flash Solar Simulators	\$16,934
SSIVT-1KF	Current Voltage Measurement System (IV Tester) 1000W Version for Flash Solar Simulators	\$26,033

Version/Model	Description	Price
SCISPIV	Testing software	\$1,800
SCIRUNIV	I-V Screen module	\$3,600
SCIRUNIV + SCIRUNQE	Combined Screen modules	\$4,800

SSIVT Software Screenshots



Solar Cell Chuck

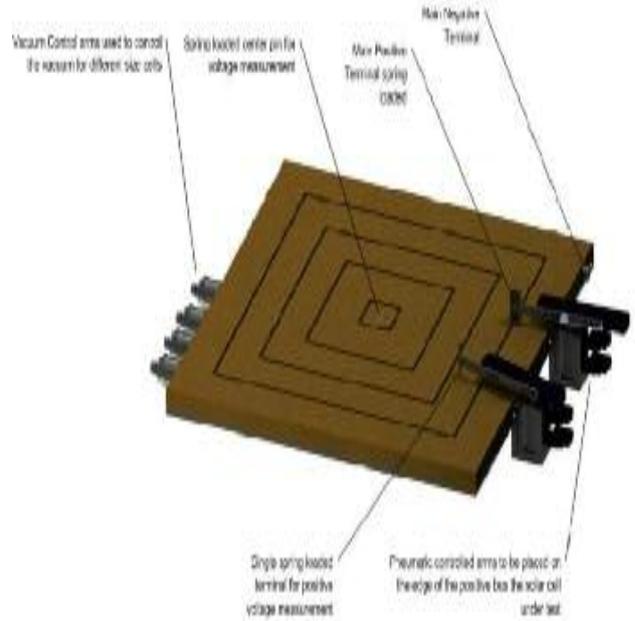


The Chuck is designed to be electrically isolated from all other sources to be a low source of noise.

The Chuck has 4 sizes of vacuum groves (can have additional or fewer based upon your needs) that can be regulated to hold the Solar Cell firmly to allow a variety of different sizes of cells to be tested.

The Chuck Plate is manufactured out of brass but can be upgraded to copper with optional gold or nickel coating.

The chuck plate consists of spring loaded gold pins to make the standard 4 wire IV test connection. One connection is in the center isolated from the plate to make the negative voltage measurement, the plate itself is the negative connection, one 3 axes arm consists of multiple spring loaded gold pins to take the current, and another 3 axes arm with a single gold pin to make the positive voltage measurement. Both arms are independently pneumatic controlled and pressure can be regulated to control the force the pin puts on the cell.



From Figure above you can see the Solar Cell Chuck consists of the following items; liquid cooling/heating exchanger (located under chuck), vacuum connections and groves for holding the cell, electrical and temperature meas

Version/Model	Description	Price
SCI-SCC4	Solar Cell Chuck	\$9,900

Optional Accessories:

- Temperature Control Device
- Vacuum and Pressure pumps

*These items can be found in the Accessories section.

Air Mass Filters



The following removable filter combinations are available. They are to be inserted into the filter holder inside the beam conditioner through the access panel to simulate various light conditions on earth and in space. At minimum, the AM0 filter is required to mimic space conditions with no atmosphere. These filters can be used separately or in series.

Version/Model	Description	Size	Price
AM0	Simulates the solar spectrum under space conditions	3 x 3" 76 x 76mm	\$895
AM1.0	Simulates the DIRECT solar spectrum on the ground when the sun is directly overhead	3 x 3" 76 x 76mm	\$895
AM1.5D	Simulates the DIRECT solar spectrum on the ground when the sun is at 48.2°zenith angle	3 x 3" 76 x 76mm	\$895
AM1.5G	Simulates the terrestrial solar spectrum on the ground when the sun is at 48.2°zenith angle	3 x 3" 76 x 76mm	\$1,033
		6 x 6" 150x150mm	\$4,133
		for PSS06	\$4,133
AM2.0	Simulates the DIRECT solar spectrum on the ground when the sun is at 60.1°zenith angle	3 x 3" 76 x 76mm	\$1,033

Specialty Filters

UV blocking Filter

This 3 x 3" filter eliminates over 99% of all UV wavelengths below 400nm, but allows Visible and IR light (up to 2000nm) through. Unfortunately, its transmission efficiency in the Visible range is only 85%. This filter can be purchased with the correct mounting frame for use in Sciencetech SF150, SS150 and SS (500,1K,1.6K) solar simulators as well as inside the 3" FH filter holder.

IR Absorbing Water Filter

IR absorbing water filters protect downstream optical components from IR thermal damage by absorbing all infrared light between 1000-3000nm. When filled with distilled water, it absorbs nearly 100% of all IR light in this spectral range while allowing approx. 98% of all visible light between 350-700nm through. It also absorbs little UV light between 200-350nm as nearly 80% of all UV light is transmitted through. All Sciencetech IR absorbing water filter models have a re-circulated water jacket to cool the filter itself making it excellent for high power applications. Sciencetech offers IR filters in both aluminum and stainless steel models. Aluminum filters are used where only distilled water is used. Stainless steel filters are used when the absorbing media is water, copper sulfate or nickel sulfate.

Hot Mirror for UV Applications - 3 x 3 Inches

This 76x76mm (3 x 3") hot mirror filters out IR light to remove thermal heat on the target. However, standard hot mirrors also remove UV light as a side-effect which means it cannot be used in UV applications. This special hot mirror removes IR light between 730-1100nm while preserving UVA and UVB light (280-400nm) in addition to visible light. This filter is ideal for Sciencetech UV solar simulators where the filtering of thermal heat on the target is desired and preservation of UVA and UVB light is required.

Band Pass UVA+B filter

Only the 290-400nm UVA and UVB portion of the ultra-violet spectrum is required for SPF (Sun Protection Factor) sun screen testing. Isolating UVA+B rays is achieved by using a Schott WG320 UVC blocking filter in series with a Hoya U330 visible and infrared blocking filter. These two filters eliminate all other wavelengths.

This is the industry's accepted method (COLIPA compliant) for isolating UVA+B wavelengths in SPF sun screen testing. Sciencetech's Band Pass UVA+B Filter is essentially these two filters arranged in series.

The cost on page 27 includes the 3" frames for use with Sciencetech SS series fully reflective solar simulators or 1" frames for use with the Sciencetech SF-150 solar simulator.

Warning! Please note that when used in Sciencetech 500W, 1000W, 1600W, 2400W solar simulators it is necessary to place a dichroic filter before these filters to remove the heat generated by the arc lamp, otherwise the U330 filter will crack.

Band Pass Filter

The ultraviolet spectrum is divided into UVA, UVB and UVC sub-spectral regions. The UVA portion of the spectrum as defined by the SPF (Sun Protection Factor) testing industry is 320-400nm. To isolate these UVA wavelengths, the Hoya U330 filter and Schott WG335/WG345 filter are used in series. The Hoya U330 filter is used to eliminate visible and IR light while the Schott WG335/3mm or WG345/1mm filter is used to eliminate UVB and UVC light. Sciencetech Band Pass UVA Filter is essentially the combination of these two filters. The cost below includes the 3" frames for use with Sciencetech SS series fully reflective solar simulators or 1" frames for use with the Sciencetech SF-150.

Warning! Please note that when used in Sciencetech 500W, 1000W, 1600W, 2400W solar simulators it is necessary to place a dichroic filter before these filters to remove the heat generated by the arc lamp, otherwise the U330 filter will crack.

Version/Model	Description	Price
UVBlock	UV Blocking Filter	\$1,003
01-8711 12/2-SS	IR Absorbing Water Filter	\$1,990
HM-UVAB-3x3SS	Hot Mirror for UV applications	\$866
UG11WG320x1	U330 & WG320 filters (1 inch with frame)	\$530
UG11WG320x3	U330 & WG320 filters (3 inch with frame)	\$864
UVAB-1inch	U330 & WG335/WG345 filters(1 inch with frame)	\$600
UVAB-3inch	U330 & WG335/WG345 filters (3 inch with frame)	\$1,019

Large Neutral Density Filters

A Neutral Density Filter is used to uniformly reduce the amount of light across the visible and near-IR spectrum that pass through it (350-2000nm). This glass substrate 76 x 76mm (3 x 3") square neutral density filter is designed for use with Sciencetech's fully reflective "SS" solar simulators (150- 2500W) and Sciencetech's SF150 solar simulator. Its high cost is due to its metallic reflective material off which the unwanted light is reflected back to the light source rather than being absorbed. This is important in high energy applications such as solar simulation. The cost includes a frame for mounting the filter inside Sciencetech's Solar Simulator internal filter holders. The list below is only a partial list of OD values available. If you are interested in other optical density values speak to an application specialist.

Version/Model	Description	Price
OD0.1	Optical Density OD = 0.10 = 79.49%T	\$1,011
OD0.3	Optical Density OD = 0.30 = 50.12%T	\$1,011
OD0.4	Optical Density OD = 0.40 = 39.81%T	\$1,011
OD0.6	Optical Density OD = 0.60 = 25.12%T	\$1,011
OD0.8	Optical Density OD = 0.80 = 15.85%T	\$1,011
OD1.0	Optical Density OD = 1.00 = 10.0%T	\$1,011
OD1.3	Optical Density OD = 1.30 = 5.01%T	\$1,279
OD1.5	Optical Density OD = 1.50 = 3.16%T	\$1,279

Spare Xenon Lamps

Version/Model	Description	Service Life (Hours)	Price
100-150XOF	150 W Xenon Arch Lamps Ozone Free	1,200	\$461
100-150XOF-SS	150 W Xenon Arch Lamps Ozone Free	1,200	\$638
100-500XOF	500 W Xenon Arch Lamps Ozone Free	2,000	\$893
100-1.0kXOF	1000 W Xenon Arch Lamps Ozone Free	1,500	\$1,057
100-1.6kXOF	1600 W Xenon Arch Lamps Ozone Free	2,000	\$1,160
100-2.5kXOF	2500 W Xenon Arch Lamps Ozone Free	2,000	\$1,116

Electronic Shutter



An arc lamp is not designed to be frequently turned off and on and doing so dramatically lowers its service life. In addition, each time it is turned on the power supply needs to ignite it with a 20,000V+ spark. Therefore, an electronic shutter system inside the beam homogenizer is available to control exposure time. Please note that the shutter cannot be closed for long periods of time while the arc lamp is on because the high intensity beam can damage it. The Electronic Shutter is both manually and computer controlled with an activation time of <150ms.

Version/Model	Description	Price
SSES-SS150	Computer Controlled Electronic shutter for SS150	\$2,756
SSES-SS1kW	Computer Controlled Electronic shutter for High Powered SS1kW	\$2,756

High Speed Shutter

The external version of the 600-VS25 shutter can be used with Sciencetech small beam SF150 Solar Simulator. The 600-VS25 series high speed shutter is computer controlled via Sciencetech's PCI A/D data acquisition board. The shutter has its own power supply, electronics module, and cable that connects it with the Sciencetech PCI A/D data acquisition board. It has a 25mm diameter aperture, minimum exposure time is 6ms (40Hz), and maximum exposure time is several minutes. Time to open is 3ms.

Version/Model	Description	Price
600-VS25-INT Solar	High Speed Shutter (Solar Simulator Version)	\$1,890

Variable Focus



Sciencetech's fully reflective solar simulators are imaging systems where the plane of uniformity is produced by overlapping images of Sciencetech's proprietary folding mirror assembly. Usually the user specifies the target size, power level and uniformity required and the solar simulators imaging system is adjusted in our factory to meet the users specifications. For users that desire the flexibility to change their target size while maintaining uniformity the Sciencetech variable focus assembly is extremely useful. Without the variable focus assembly the user would have to refocus the mirrors inside of the solar simulators beam homogenizer each time the target size was changed. This procedure would involve shutting down the solar simulator and adjusting the position of each internal mirror in the solar simulators imaging system in order to support a different focal spot size. Although possible, this procedure is a hassle should the user need to change the target size regularly. With the Sciencetech variable focus assembly re-adjustment of the solar simulators imaging system is performed with a single knob without having to shutdown the solar simulator. Some users may also wish to use the variable focus assembly to vary illumination intensity on the target (see table below).

The table below illustrates the usefulness of the variable focus assembly. The data in the table is for a downward facing class AAA 1kW solar simulator.

Target Distance from Beam turner / Output flange	Variable focus adjustment	Target Diameter (inches)	Power with AM1.5G filter (Suns)
9.5" / 20"	Fully CW	3.5"	1.3
15.5" / 26"	Middle of range	5"	1.0
27" / 37.5"	Fully CCW	6.5"	0.6

Spot size and working distance

Note that when the spot size is changed, the working distance from the solar simulator's output port changes as well. This means that for each spot size set, the user will have to relocate his sample to the corresponding working distance. See the table above for an example.

Working Principle

The variable focus option readjusts the focal plane after the beam goes through the segmented mirror that folds the light from the outer ring to the central dark spot.

Version/Model	Description	Price
SSVF-SS	Variable Focus	\$3,675

Beam Turning Assembly for SF150 Solar Simulator



A beam turning assembly can be mounted to the output port of a Sciencetech SF150 Solar Simulator to redirect the light downwards onto a horizontal table top. This beam turning assembly is placed after the filter holder. Without this beam turning assembly, the light would shine towards a vertical wall surface. It consists of a flat UV enhanced mirror mounted on a 45° angle and is located after the lamp housing's collection lens at the output port. An optional cold mirror version is available to eliminate IR Light and thermal heat on the sample.

Version/Model	Description	Price
CTBT /b-SF150	Standard Beam Turning Assembly (Non UV Applications)	\$500
CTBT c/UV -SF150	Beam Turning Assembly with Cold Mirror	\$788
CTBT-B-SS1kW	Standard Beam Turning Assembly With Regular Mirror	\$1182

Alignment Package



Sciencetech Solar Simulator System Alignment Kit: it includes (1 sun calibrated alignment Silicon detector, laser and holder, UV protection glasses, Sciencetech multimeter) Can be used on all Sciencetech's Solar Simulators.

Version/Model	Description	Price
SSAKF-01	Alignment Kit	\$480

Downward Facing Vertical Stand for Fully Reflective Solar Simulators



This vertical stand enables the high powered model SS fully reflective solar simulator to project its output beam downwards onto a horizontal illumination table which makes it ideal for solar cell testing. The beam is projected down onto a built-in sample platform where the sample, such as a solar cell, can be placed. The stand assures the distance between the output port of the solar simulator to the sample platform produces exactly 1 SUN intensity (100mW/cm² using an AM1.5G filter or 136mW/cm² using an AM0 filter) onto a 5" diameter area for an SS-500W, 7" diameter for an SS-1000W, and 8" diameter for an SS-1600W.

Version/Model	Description	Price
DFS-SS150	for SS150	\$1,597
DFS-SS0.5KW	for SS0.5KW	\$2,700
DFS-SS1.0KW	for SS1.0KW	\$2,700
DFS-SS1.6KW	for SS1.6KW	\$2,700
VertOp SS1Kmount	for SSUV	\$2,700

Light Intensity Stabilizer



The Light Intensity Stabilizer is a microprocessor based, stand alone unit. It comes with a light sensor, coupled to the light source with a fiber optic cable for electrical isolation. The unit is easy to install/operate, and it is used to monitor the light intensity of a solar simulator. It corrects intensity fluctuations caused by a change in environmental or power conditions by automatically adjusting the power supply output in real time to maintain the same light intensity level. The optical feedback unit uses relative intensity comparison to maintain light levels.

Version Code	Version Description	Price
FS-02	Optical Feedback Unit	\$3,125

Plug Style

Sciencetech electrical devices can be configured with a variety of different electrical plug styles for compatibility with various international electrical outlet standards. The styles available are: NEMA 5-15 115VAC (North America, ROC), NEMA 6-15 240VAC (North America), NEMA L6-15 240VAC (North America), Type E 240VAC (Continental Europe), Type G 220VAC (China, UK, Singapore, Hong Kong), Type M 230VAC (India), Type F 220VAC (South Korea).

Please specify which plug style you require at the time of ordering. Price differs for machine and style, contact a Sciencetech representative for details.

Step-Up Voltage Transformer

Sciencetech 1000W, 1600W arc lamp sources and solar simulators require 230-240VAC electrical service. If your lab does not have a 240VAC electrical outlet as in most North American laboratories, you can use a 120VAC-240VAC step-up voltage transformer to power 240VAC devices with a 120VAC electrical outlet. However, this set up transformer will require a 30 Amp 120VAC circuit.

Version/Model	Description	Price
VTrans	Step-Up Voltage Transformer	\$315

Output Fiber Bundle Attachment

This option mates a 12" flexible fiber bundle or 39" flexible liquid light guide to the output port of an SF150 Solar Simulator such that the light can be channeled through a fiber to illuminate a small point. The fiber bundle or liquid light guide has a collimating lens at its output tip to reduce the divergence of the beam. There are two fiber bundle choices available, one with quartz fibers to preserve the UVA and UVB light and one with glass fibers for only visible and IR light transmission. The liquid light guide is a special IR enhanced version that preserves both visible and IR light but does not transmit UV light. Please note the fiber bundles and liquid light guide distorts the spectrum of the solar simulator light.

Version/ Model	Description	Price (USD)
FBO-Q412	Output Fiber Bundle Attachment 1/4" Quartz	\$1,966
FBO-G412	Output Fiber Bundle Attachment 1/4" Glass	\$1,538
FBO-LLG8x39	Output Liquid Light Guide Attach- ment - 8mm	\$2,492
FBOHP	Output Hand Probe Attachment for Fiber Bundle Attachment	\$1,995

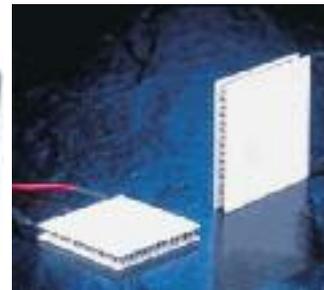
Water Recirculating Cooler and Sample Cooling Pad



This adjustable temperature cooler is designed to keep a sample from overheating under intense light by placing a water cooling pad underneath it. This water cooling pad not only cools the sample to ambient room temperature, but also monitors its exact temperature. This cooling system is an external unit designed to dissipate up to 700W of heat through a fan cooled radiator system, which is enough to cool samples illuminated by 1600W solar simulators. The cooler displays the sample's current temperature in either celsius or Fahrenheit. The temperature of the sample can be adjusted by setting the cooler's internal radiator fan speed which is also displayed on the cooler. If the current temperature wanders above a "warning" preset value, an alarm will go off. The cooling pad temperature is monitored by a thermo sensor wire which can be embedded between the cooling pad and the sample itself.

Version/Model	Description	Price
130-REC-STD	Water Recirculating Cooler-Flat Cooling Pad	\$1,016
130-REC-CUV	Water Recirculating Cooler-Cuvette Cooling Pad	\$1,226

Temperature Controller Thermoelectric Element for PV Cell Holder Assembly



For accurate thermoelectric temperature control, a low cost, high power temperature controller with excellent temperature stability ($\pm 0.1^{\circ}\text{C}$). This controller features PWM control and comes with a 1kohm RTD sensor.

Highlights:

- Adjustable DC output voltages: 3, 7, 12, and 14V(PWM) with maximum output current of 10A
- Control temperature range: 0°C to 100°C
- Temperature sensor: 2-wire PT1000 RTD
- Universal input power: 110/220VAC, 50-60Hz
- LED display of measured value and set point value
- Proportional, integral, and derivative terms adjustable
- 8.5A, 15.4V thermoelectric element

Version/Model	Description	Price
EGV-1410	Temperature Controller Thermoelectric Element for PVC Cell Holder Assembly	\$2,013

Broadband Thermopile Detector

This broadband thermopile detector allows the measurement of total broadband radiation emitted by a light source. It could also be used to measure the light power density on a surface (in W/cm²) which is particularly useful for uniformity measurements and for checking solar simulator performance. This detector has a 19mm diameter sensor and picks up all wavelengths between 190nm-11µm (UV-VIS-IR). Please note that this detector head requires either an external display controller or computer interface (sold separately - see below) to show the measured power. The prices shown include the detector head, the post and post holder only.



Version/Model	Description	Price
UP19K-15W	Broadband Thermopile Detector (Power Meter) -1mW-15W	\$1,030
UP19K-30W	Broadband Thermopile Detector (Power Meter) -1mW-30W	\$1,171
UP19K-XLP12	Broadband Thermopile Detector (Power Meter) -1µW-1W	\$1,727

Difference Between the 15W and 30W Model

The two models have identical electronics and sensor. The only difference is that the 30W model has a heat sink so that it can tolerate more heat power. The electronic readout is also the same, and hence there is no additional digits or precision gained using the 15W model over the 30W model.

NIST Calibration Certificate

The detector head comes with a NIST calibration certificate that states that broadband power readings are accurate to NIST standards. This certification is performed on each individual detector unit and hence each unit has a unique parameter value on the certificate that relates its output voltage (in mV) to the actual power measured (in W).

Spectral Wavelength Sensitivity Curve

Since this detector is a broadband detector, the NIST calibration certificate only certifies broadband measurements. However, a measured spectral wavelength sensitivity curve for that particular detector unit is available at extra cost.

PC Interface for Thermopile Detectors

This is a compatible monitor for thermopile detectors. A computer is required to visualize measurements. Both USB and RS-232 communication versions are available and must be specified when ordering. Display measurement software that shows total broadband power (W) and power density (W/cm²) is included. Since software is written in LabView, the user can add data manipulation algorithms in LabView (like displaying in solar constants) instead.

Version Code	Version Description	Price
P-LINK-USB	PC Interface for Thermopile Detector - USB	\$1,352
P-LINK-RS232	PC Interface for Thermopile Detector -RS-232	\$1,431

Readout Display Controller for Thermopile Detectors

Sciencetech offer a handheld power meter to use with the broadband thermopile detector. This model allow for PC control and data acquisition through USB or RS-232 connections, LabView based software is included. This can store data on flash memory for transfer to a computer as well. The digital displays can be set to real time display, tuning needle, histogram or graph. It also offers various analytical features like averaging, maximum value, minimum value, etc. The power range for the SOLO 2 is 4pW-3W. and a 78 x 58mm LCD screen.

SOLO 2 Power Meter



Version/Model	Description	Price (USD)
SOLO-PE	Read Out Display Controller for Thermopile Detectors	2,899
SOLO-2		2,059

Temperature Control Device



Temperature Control Device

Can both heat and cool the cell to the below specs.

- Cooling capacity:** at 25°C 3700 Watts
- Pressure pump:** Max head at 0 flow 1.3 gallon
- Wetted materials:** PVC, polyethylene, copper, and brass
- Power:** VAC 120
- Hz:** 60
- Dimensions:** 15 x 25 x 15" (W x H x D)

Vacuum and Pressure pumps



Vacuum Connection

Vacuum and Pressure pumps are used to secure the cell to the plate and to press the pins onto the rails of the solar cell. Free-air capacities up to 2.2cfm (62.3L/min) Shaded-pole fan-cooled motor has thermal overload switch to protect your pump system. Heads on pumps 07061-00 and -02 are connected in parallel for higher capacity; heads on 07061-10 and -12 are connected in series for greater vacuum. Select pumps with or without gauges, regulators, and valves. Pumps include 6-ft, three-wire cord; the 115 VAC models include a U.S. standard plug.

Specifications:

- Max pressure:** 60psi
- Free-air capacity:** 1.1cfm (31.2L/min)
- Port size:** 1/4" NPT(F), 3/8" hose barb on gauges
- Noise level:** 68 dB(A)
- Dimensions:** 7-5/8 x 5-1/8 x 10-1/4" (L x W x H)
- Max temperature:** 100°F (38°C)
- Wetted parts:** aluminum stainless steel, NORDEL®, and NOMEX®
- Motor type:** permanent split capacitor
- Duty cycle:** continuous
- Emp range:** From 1 to 77°C

Version/Model	Description	Price
TC-3700	Temperature Control Device	\$3,000

Version/Model	Description	Price
VP-600	Vacuum and Pressure pump	\$825

Solar Cell Testing Workstation

This optional solar panel testing workstation supports the solar simulator and I-V testing system with a work surface for easy storage and organization. Without this option, the user must supply their own illumination table surface. The workstation provides a mainframe structure to support the solar simulator, homogenizer housing and illumination table, plus bench space adjacent to the test area for the system computer, the flash digital sequence controller and power supply, and the I-V measuring system.

The picture shows the flash solar simulator on the workbench. The xenon light source is mounted at the top, shining through the beam homogenizer (large black box) that spreads the light uniformly onto the built-in illumination table below.

Workstation, plus Flash Solar Simulator I-V Testing system and Fully Configured PC



Version/Model	Description	Price
SSTwrkstn-PSS06	Work benches for Flash Solar Simulator	\$2,120

Company Team



Sciencetech Inc. has been designing and manufacturing optical and spectroscopy instruments and components in Canada since 1985. Sciencetech equipment has been used in many applications and fields including medical research, biotechnology, space sciences, analytical chemistry, material research, pharmacology, applied physics, aerospace, food sciences, environmental and academic research.

Office

1450 Global Dr., London, ON
 Canada, N6N 1R3 Tel: 1 (519) 644 - 0135 Fax: 1 (519) 644 - 0136

ARGENTINA**Sciencetech Argentina**

Belgrano 2449, 5° Piso C
Buenos Aires, C1096AAB
Argentina

Phone: (54) 11 4942-0833

E-mail: chenderson@sciencetech-inc.com

AUSTRIA

(Served by *ILEE AG*, see Switzerland)

BRAZIL**Lynx Comercio e Importacao LTDA**

Rua Aimbere, 1887 - Perdizes
Sao Paulo / SP, 01258-020
Brazil

Phone: (55) 11 3862-2099

(55) 11 3862-1747

Email: vendas@lynxbrasil.com.br

CHINA**Zhenzhen China****Photon Energy Development**

Room 909, 9th Floor, Building 2
Haiwai Zhuangshi Mansion
Zhenghua Road, Futian District
Shenzhen, Guangdong, 518027

Phone: (86) 755- 8326 -8113

Fax: (86) 755- 8322- 4328

Golden Way Scientific Co.Ltd.

E5/F, Bldg. M7,
1 JiuXianQiao East Road,
Beijing, 100016

Phone: (86)10 8456 0667

(86)10 8456 2550

Fax: (86)10 8456 9901

E-mail: sms@goldway.com

zhangweibin@goldway.com.cn

Bosheng Quantum**Technology Co. Ltd**

N0.987, Yan'an Road
Choayang District
Changchun, 130021

Phone: (86) 431-85916189

Fax: (86) 431-85956117

Optical Scientific Corp

7f-2, No 421, Sunshang Road, Taipei, Taiwan, 1083

Phone: (86) 886-2-23461510

Fax: (86) 886-2-23461520

COLOMBIA**Hi-Tech Automation S.A**

Cra 5 No 16-27

L4, Pereira

Phone: (57) 6 3257 441

E-mail: hi-tech14@une.net.co

ICL Didactica Ltd.

Cra. 36 A No.57 - 22

Bogotá D.C., Colombia.

Phone: (57) 1 221 82 39

(57) 1 221 66 64

Fax: (57) 1 221 66 69

E-mail: ventas@icl-didactica.com

URL: www.icl-didactica.com

FRANCE**Opton Laser International**

Parc Club Orsay Universite,
29 rue Jean Rostand
91893, ORSAY

Phone: (33) 016-941-0405

Fax: (33) 016-941-3290

Email: gregorie.saget@optionlaser.com

URL: www.optionlaser.com

INDIA**AVJ Optics**

12 Rajgad Society
60 Rambag Colony
Paud Road, Pune, 411038

Phone: (91) 20 2544 8002

E-mail: avjop@vsnl.com

URL: <http://www.avjoptics.com>

Dynotech Instruments (P) Ltd.

101, DDA Building #1, Distt Centre
New Delhi

Phone: (91) 11 2561 2270

Fax: (91) 11 4158 9356

E-mail: sudhir@dynotech.in

Hi-Tech Scientific Equipments

T1/8/4, Ruchira Residency
P.S. Kasba, Kolkata, 700078

Phone: (91) 33 2581 1925

Fax: (91) 33 2502 1751

E-mail: les@hitech.ind.in
support.hitech@gmail.com

Southern Dynamics (P) Ltd

PO Box 2515, Fourth Floor
New # 37, Nelson Manickam Road
Chennai (Madras), 600029

Phone: (91) 44 3741 203

(91) 44 3740 957

E-mail: dynams@vsnl.com

URL: www.southerndynamics.com

ISRAEL**Ben Moshe Manufacturers**

64 Arlozorov St.

Ramat-Gan, 52493

P.O.Box 18125, Tel-Aviv, 61181

Phone: (97) 23670 0007

Fax: (97) 23672 7319

E-mail: bms@ben-moshe.net

URL: <http://benmoshe.net>

ITALY**Biofotonica**

Via Amedeo Bocchi 300
Rome, 00125

Phone: (39) 068 117 5637

Fax: (39) 068 928 0737

Email: antonucci.paolo@gmail.com

URL: www.biofotonica.it

JAPAN**Luminex Trading Inc.**

Avenue-Otowa, 2 2 2
Otowa Bunkyo-Ku
Tokyo 112-0013

Phone: (81) 3 5395 2722

Fax: (81) 3 5395 2721

E-mail: sales@luminex.co.jp

URL: <http://www.luminex.co.jp>

JORDAN

(Served by *United Enterprise Corporation*, see Syria)

LEBANON

(Served by *United Enterprise Corporation*, see Syria)

LIECHTENSTEIN

(Served by *ILEE AG*, see Switzerland)

MEXICO**GRUPO MARH S.A.**

Sur 22 No.247 entre Ote. 259 y
Canal de San Juan
Colonia Agricola Oriental
Delegacion Iztacalco
C.P. 08500
Phone/Fax: (52) 55 2235 3131
E-mail: marioa18@prodigy.net.mx

Intecs S.A. de C.V.

Prolongacion 15 Poniente
No. 3123 Col. La Paz, C.P.
72160, Puebla
Phone: (52) 22 2248 8781
Fax: (52) 22 2231 5166
E-mail: ventas@intecssa.com.mx

MALAYSIA**Megah Suria SDN. BHD.**

Peti surat No.1 pej pos ampang
68000 Ampang
Selangor de Malaysia
Phone: (603) 4292 8140
Fax: (603) 4292 3800
Email: megahria@steamyx.com
megahsuria@gmail.com
avmar@streamyx.com

PAKISTAN**Techno Experts International**

M-13, Mezzanine Floor, Al-Rehman Trade
Center Opposite Sind
Madressah Shahrah-e-Liaquat,
74000, Karachi
Phone: (92) 9221 2471 705
Fax: (92) 9221 2471 706
E-mail: technoexperts@yahoo.com

TMA Intl (Pvt) Ltd

417 Gulshan Block, Iqbal Town,
Lahore, Pakistan.
54570
Phone: +92 (0) 42 3543 3754
+92 (0) 42 3542 5576
Fax: +92 (0) 42 3744 9531
Email: aslam@taintd.com.pk

PERU**Eduware S.A.C**

Av. Intihuatama 799
Urbanizacion Higuera, Surco
Lima 33
Phone: (51) 1 6181920
E-mail: newton@eduware.com.pe

ROMANIA**Apel-Laser-SRL**

Str. Fabricii, Nr 47, Corp Z, Et3
Bucharest
Phone/Fax: (40) 21 3170 910
Mobile: (40) 21 7223 14805
E-mail: office@apellaser.ro
URL: <http://www.apellaser.ro>

SOUTH KOREA**Hanaro Trading**

Digital Empire Two
103-1510 Shindong,
Yeotong-gu, Suwon City
Phone: (82) 31 695 6565
Fax: (82) 31 695 6566
E-mail: hwanakim@hanarotr.co.kr
URL: www.hanarotr.co.kr

WonATech Co., Ltd.

WonA bldg, 8-6
WooMyunDong
SeoChoKu, Seoul
Phone: (82) 2 578 6516
Fax: (82) 2 576 2635
E-mail: sales@wonatech.com
URL: <http://www.wonatech.com/>

UniThink inc

853-3 (#202), V-Town, Jung-Dong,
Giheung-Gu, Yongin-Si,
Gyeonggi-Do, Korea. 446-529.
Phone: +82-70-8244-3331
Fax: +82-31-285-6195
Email: unithink@unithink.co.kr
URL: www.unithink.co.kr

SPAIN**Laser Technology SL**

Poligono Industrial "La Baileta"
08348, Cabriels (Barcelona)
Phone: (034) 937 500 121
Email: info@laser-technology.com

SWITZERLAND**ILEE AG**

Schuetzenstrasse 29 - Postfach
CH-8902 Urdorf
Phone: (41) 44 7361 111
Fax: (41) 44 7361 112
E-mail: office@ilee.ch

SYRIA**United Enterprise Corporation**

Mazra'a-Shahbandar Square,
Al Fudail Bin Iyad St.
Alhafez bl, 3rd Floor, office #4
P.O. Box 10640, Damascus
Phone: (963) 1 1447 2328

THAILAND**A.E.I. Technologies Co. Ltd.**

134/45 Moo 1, Rangsit-Pathum Rd.,
Banklang, Muang, Pathumthani,
Thailand
Phone: +66 2-977-9507
Fax: +66 2-598-4456
Email: jakraphan@aeithai.com

UNITED KINGDOM**AstraNet Systems Ltd.**

P.O. Box 734
Harston, Cambridge,
CB22 7FA
Phone: (44) 1 2238 72197
Fax: (44) 1 2238 72197
E-mail: sales@astranetsystems.com
URL: www.astranetsystems.com

USA**La Computa Vision LLC**

100 Pearl Street 14th Floor, Hartford,
CT-06103, USA
Phone: 1-(888)-882-9535
Fax: 1-(888)-796-7876
Email: sales@lacomputavision.com

VIETNAM**Red Star Vietnam Co. Ltd.**

P.701 - Pathfinder Office Building
73 Tran Duy Hung, Cau Giay
Hanoi, 10000
OR
Lot A, Bldg. 24 Bis, Van Thanh Bac
W.25, Binh Thanh, HCM
Hochiminh
Phone: (844) 5567 371
(844) 5567 372
Fax: (844) 5567 382
E-mail: info@redstarvietnam.com
URL: www.redstarvietnam.com



Grow with Sciencetech Inc. – Distributorships Available!

Sciencetech Inc. is planning for rapid Global sales growth over the coming years and the companies objective is to be a leading international source for custom design and OEM manufacturing of scientific instrumentation. In order to fulfill this objective, our organization seeks to increase our international presence through long term relationships with other 'like minded' sales organizations and/or individuals who have a sales background in Scientific Instrumentation and who are highly motivated self starters.

Sciencetech Inc, currently gathers sales from a number of sources including direct catalogue mail-outs, website, international agents (exclusive and non-exclusive), international distributors (exclusive and non-exclusive), past customers, referrals from past customers and direct sales from head office sources. Agency and Distributorship agreements (both exclusive and non-exclusive) are available in selected international markets and we are eager to locate partners in those areas with whom we can share sales and profit growth over the coming years.

Sciencetech Inc.' s products enjoy wide use in a number of industries and applications including medical research, biotechnology, space sciences, analytical chemistry, material research, pharmacology, applied physics, aerospace, food sciences, environmental and academic research, develop new business and foster strong relationships with academic, civic, research, medical, pharmaceutical and a broad range of industrial clients, we encourage individuals and organizations who can confidently meet these objectives to share in Sciencetech successes and enjoy the rewards of a competitive compensation plan based upon results.

We welcome all submissions
Please contact Sciencetech Inc. Head Office at the address below:

**Sciencetech Inc.
1450 Global Dr.
London, Ontario
Canada
N6N 1R3**

Phone: 1 (519) 644 - 0135 ext. 122
Fax: 1 (519) 644 - 0136

SCIENCETECH



1450 Global Drive, London Ontario
Canada N6N 1R3

Mail to:



www.sciencetech-inc.com

Designer and Manufacturer of Scientific Instruments Since 1985

Phone: 519-644-0135 Fax: 519-644-0136

Email: sales@sciencetech-inc.com